Paleontological Bulletin, No. 37.

ON A

New Basin of White River Age

IN DAKOTA.

Read before the American Philosophical Society, Sept. 21st, 1883.

ON THE

DISTRIBUTION OF THE LOUP FORK FORMATION

IN NEW MEXICO.

A SECOND ADDITION

To the Knowledge of the Fauna of the Puerco Epoch.

ON THE

Trituberculate Type of Molar Tooth in the Mammalia.

Read before the American Philosophical Society Dec. 7th, 1883.

By PROF. E. D. COPE.

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PALEONTOLOGICAL BULLETIN,

No. 37.

From Prof. E. D. Cope, a letter to the Secretary, dated Sully Springs, Dakota, Sept. 7, 1883, was read, as follows:

On a New Basin of White River Age in Dakota.

"I have the pleasure to announce to you that I have within the past week discovered the locality of a new lake of the White River epoch, at a point in this Territory nearly 200 miles north-west of the nearest boundary of the deposit of this age hitherto known. The beds, which are unmistakably of the White River formation, consist of greenish sandstone, and sand-beds, of a combined thickness of about 100 feet. These rest on white calcareous clay, rocks and marls, of a total thickness of 100 feet. These probably also belong to the White River epoch, but contain no fossils. Below this deposit is a third bed of drab clay, which swells and cracks on exposure to weather, which rests on a thick bed of white and gray sand, more or less mixed with gravel. This bed, with the overlying clay, probably belongs to the Laramie period, as the beds lower in the series certainly do.

"The deposit as observed, does not extend over ten miles in north and south diameter. The east and west extent was not determined, but is much greater.

"The fossils, which indicate clearly the age of the formation, are the following:

PISCES.

Rhineastes, sp. nov. } 2
Amiurus, sp. nov. }

LACERTILIA.

Sp. indet	1

TESTUDINATA.

Trionyx, sp.	3
Trionyx, sp.	
Stylemys, sp.	

RODENTIA.

Castor, sp.	2

CARNIVORA.

Galecynus gregarius	3
Hoplophoneus, sp	
? *Hoplophoneus*	

PERISSODACTYLA.

Aceratherium, sp	3
Aceratherium, sp	
Anchitherium, sp.	

ARTIODACTYLA.

Elotherium ramosum	7
Hyopotamus sp	
Oreodon, sp	
Oreodon, sp	
Oreodon, sp	
Leptomeryx, sp	
Hypertragulus, sp	
Total species	21

"Interesting features of the above catalogue are: The absence of Hyracodon and Poëbrotherium, so abundant in the beds of this age elsewhere; the presence of fishes, not hitherto detected in them; and the presence of the genius of tortoises, *Trionyx*. The latter genus has not hitherto been found in our Western lacustrine beds of later than Eocene age; while they are abundant in our modern rivers. This discovery partially bridges the interval. The same is true of the fishes mentioned, which represent the order Nematognathi."

On the distribution of the Loup Fork formation in New Mexico. By E. D. Cope.

(*Read before the American Philosophical Society, December 7, 1883.*)

In his report on the Geology of New Mexico to the Secretary of the Interior, by Dr. F. V. Hayden, in 1869, this eminent geologist described the Santa Fé marls in their principal physical features. In 1874, in my report to Capt. George M. Wheeler, U. S. Engineers, I showed that this formation is a member of the Loup Fork division of the Miocene Tertiary, a conclusion clearly deducible from the remains of vertebrata which it contains. An illustrated report on the latter was published in the fourth volume of the report of the United States Geographical and Geological Survey, W. of the 100th meridian, Capt. G. M. Wheeler in charge(1877).

Since that time the writer has made several visits to parts of New Mexico not previously explored, and I am able to show that the Loup Fork formation has a much wider distribution in that Territory than has hitherto been supposed to be the case.

In descending the Rio Grande, beds appear on the west side of the river, which strongly resemble those of Santa Fé. They extend along the eastern base of the Magdalena mountains, and as far south as Socorro, in considerable extent and thickness. South of Socorro they appear, but less extensively. The eastern part of the plain which lies between the Rio Grande and the Mimbres mountains is composed of beds of this age where cut by the grade of the Atchison, Topeka and Santa Fé railroad, west of Hatch station. West of the Mimbres mountains the valley of the river of the same name is filled with débris of the bed of eruptive outflow which once covered the country, as far as traversed by the railroad from Deming to Silver City. Its age I could not ascertain.

A great display of the Loup Fork formation is seen in the drainage basins of the heads of the Gila river. In traveling westward from Silver City, its beds first appear in the valley of Mangus creek, which enters the Gila from the east. Crossing the Gila, the mail route to the west passes through the valley of Duck Creek, which flows eastwards into that river. Though bounded by eruptive hills and mountains and their outflows, the valley was once filled with Loup Fork beds, which have been extensively eroded, the principal exposures being on the north side of the valley, forming the foot hills of the Mogollon range. On the divide between the waters of the Gila and San Francisco rivers the formation rises in bluffs of 300 feet elevation. The descent into the valley of the San Francisco brings to light a still greater depth of this deposit. The valley which extends from the canyon which encloses the river south from the mouth of Dry creek to the Tulerosa mountains on thenorth, and between the Mogollons on the east and the San Francisco range on the west, was once filled with the deposit of a Loup Fork lake. This mass has been reduced by the erosive action of the San Francisco and its drainage, to a greater or less

extent, as it has been protected by basaltic outflows or not. When so protected, the river flows through comparatively narrow canyons. Where the outflow is wanting, the valley of the river is wider, and the Loup Fork formation remains as wide grassy mesas which extend to the feet of the mountain ranges.

The age of these beds would have remained problematical but for the fortunate discovery by Mr. Robert Seip, of the skull of a species of Rhinoceros of the typical Loup Fork genus, Aphelops. It is apparently the *A. fossiger* Cope, a species abundant in the Loup Fork beds of Kansas and Nebraska. It was found near the mouth of Dry creek in a conglomerate bed of the formation.

In the valley of the San Francisco the Loup Fork beds reach a thickness of 500 feet, and consist of sand, clayey sand, soft sandstone, and conglomerates of larger and smaller pebbles of eruptive material, having a near resemblance to those of the region of Santa Fé.

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*Second Addition to the Knowledge of the Puerco Epoch. By E. D. Cope.**

(*Read before the American Philosophical Society, December 7, 1883.*)

Recent collections from the formation above-named, include many finer specimens than have been previously obtained. Skulls of several species in calcareous concretions were received, so that their characters can be developed more fully than heretofore. I mention especially *Deltatherium fundaminis; Periptychus rhabdodon* and *P. coarctatus; Haploconus lineatus; H. entoconus; Anisonchus sectorius; Protogonia plicifera; Mioclænus turgidus, M. ferox, M. subtrigonus* and *M. cuspidatus*, sp. nov. Some species hitherto rarely seen, prove to be abundant, as *Hemithlæus kowalevskianus, Protogonia plicifera, Mioclaenus minimus* and *M. subtrigonus*. With the additional species now described, the number of Mammalia from the deposit of the Puerco epoch amounts to seventy-four species.

Didymictis primus, sp. nov.

That the genus Didymictis existed during the Puerco epoch, has been already demonstrated by the discovery of the *D. haydenianus* Cope. This species is of aberrant form however, so that it remained to prove that the typical form had appeared so early in Tertiary time. This is now shown to have been the case by the discovery of the present animal, which is allied to the *D. leptomylus* of the Wind river and Wasatch epochs.

The *Didymictis primus* is known from two maxillary bones with teeth,

*The "First addition" appeared in the Proceedings of the American Philosophical Society for 1883, beginning at page 545. Since that date I have described in the Proceedings of the Philadelphia Academy, 1883, p. 168, the following species: *Periptychus coarctatus, Pantolambda cavirictus, Zetodon gracilis* (g. n.) and *Conoryctes ditrigonus*.

and a part of a mandibular bone with the last two molars in place, all belonging to different individuals. The inferior sectorial tooth is much like that of the *D. leptomylus*, but the tubercular is only two-thirds as long, and is not only absolutely, but relatively narrower posteriorly. It has the usual three cusps in a reduced condition. In the first superior true molar the external cusps are conical, and there is a small cusp between the anterior one and the produced anterior angle of the crown. There is an anterior intermediate tubercle, but no posterior one. The cingulum does not extend all round the inferior base of the crown, as it does in *D. protenus*. The sectorial has a distinct anterior basal conic lobe. The internal lobe is in transverse line with the last named, and is conical and not large.

Measurements.		M.
Diameter inferior sectorial	anteroposterior	.0138
	transverse	.0055
Diameter inferior tubercular	anteroposterior	.0050
	transverse	.0033
Depth of ramus at M. i		.0098
Diameter superior sectorial (No. 1)	anteroposterior	.0110
	transverse	.0060
Diameters superior sectorial (No. 2)	anteroposterior	0050
	transverse	.0090

The fourth specimen is especially important as presenting almost the entire dentition including canines and incisors, and the anterior part of the skull from the line of the coronoid process of the mandible. The specimen shows that the species differs from the species of the Wasatch period with oval inferior tubercular, in the absence of the posterior cutting lobe of the third, and probably fourth inferior premolar. The corresponding superior premolars are also simple. The first premolars in both jaws are one-rooted. The canines are long and acute, and are directed vertically. Both have flat facets on their external (the only visible) faces: on the superior canine I count four lateral, and one nearly anterior. On the inferior I see three lateral and one nearly anterior. There are three small superior incisors, of which the first is the largest, and has a subconical crown. The infraorbital foramen is large, and is above the anterior border of the superior sectorial.

Measurements.	M.
Length of superior dental series to front of canine	.041
" " crown of superior canine	011
" " superior true molars	.0105
Depth of ramus at inferior sectorial	.0090

In its simple premolars this species agrees with the *D. haydenianus*, and is more primitive than the Wasatch species.

Triisodon rusticus, sp. nov.

Founded on a portion of the mandible which supports the first two true molars and part of the last premolar. The species is of the type of *T.*

levisanus, but is much larger. I give here a synopsis of the species of the genus, so that its affinities may be better understood. In general, the genus *Triisodon* is characterized by the rudimental character in the inferior molars of the anterior cusp. It is thus like *Ictops*, but differs in having the fourth premolar different from the true molars and like the premolars. From *Mioclænus* it differs in having the anterior and posterior cusps of the inferior molars unequal; the anterior forming together an elevated crest with two apices, while the posterior are low, and on the borders of a heel.

I. Cusps of inferior molars compressed.
Anterior cusp very low..... *T. quivirensis.*
II. Cusps of inferior molars not compressed.
Anterior cusp very low; *T. rusticus; T. levisanus*, and *T. assurgens.*
Anterior cusp as high as other anterior cusps to which it is closely united. *T. conidens* and *T. heilprinianus.*

In dimensions the *T. rusticus* is about equal to the *T. quivirensis*, thus exceeding the other species excepting the *T. conidens*. The interior anterior cusp is nearly as elevated as the exterior, and is united with it nearly to the apex; the anterior cusp is a tubercle which projects forwards from its anterior base. The heel of the tooth is wide, and is rounded posteriorly, and supports three tubercles, an external, a posterior and an internal, all in contact with each other. On the second true molar the internal anterior tubercle presents a slightly projecting edge anteriorly and posteriorly, which bounds a shallow vertical groove of the mass which represents their united bodies. This is not apparent in the first. The enamel is smooth, but the animal is rather old.

Measurements.			M.
Diameters of m. i	anteroposterior		.0123
	transverse		.0068
	vertical	in front	.0068
		at heel	.0038
Diameters of m. ii	anteroposterior		.0137
	transverse		.007
	vertical	anteriorly	.007
		at heel	.0062

D. Baldwin, discoverer.

TRIISODON ASSURGENS, sp. nov.

This is the least species of the genus, and resembles in its inferior dentition the species of *Diacodon*. It is very much larger than the *D. alticuspis*, the larger species of that genus, which is found in the Wasatch formation.

The *T. assurgens* is known from a mandibular ramus which supports the last four molars, the last premolar having lost its principal cusp. The peculiarity of the true molars is seen in their generally more produced character; the anterior cusps are higher and the heels are longer. The anterior cusp is very small and basal; the principal anterior cusps are united

to near their free summits. There are the usual low marginal tubercles on the heels. That of the fourth premolar is a short simple edge.

Measurements.	M.
Length of four molars on basis	.028
" " three true molars	.0212
" "second true molar	.008
Elevation of cusps of molars	.0045
Length of last true molar	.0067
Width of last true molar	.0030
Elevation of last true molar in front	.0035

Found by D. Baldwin.

MIOCLÆNUS CUSPIDATUS, sp. nov.

The species of this genus known to me are, with the present one, nine in number. They range in size from that of a rat (*M. minimus*) to that of a wolf (*M. ferox*). The general osteological characters of the last named species are best known, and are described in the Proceedings of the American Philosophical Society, 1883, p. 547. In two of the species the superior dental series only is more or less known, and one species rests on mandibular dentition only. In the remaining seven species the dentition of both jaws is more or less known. The species may be arranged in groups as follows :

I. The posterior heel of the second inferior molar bordered by a curved edge or crest.

a. Posterior cingulum of superior true molars obsolete ; *M. minimus.*

aa. Posterior superior cingulum weak ; *M. turgidus.*

aaa. Posterior superior cingulum large, angulate ; *M. corrugatus ; M. ferox.*

II. The posterior heel of the second inferior molar supporting a cusp.

a. Posterior inner cusp of superior molars small, present on m. ii only ; *M. cuspidatus.*

aa. Posterior inner cusp large, present on m. i and m. ii ; premolars small, *M. subtrigonus ;* premolars large, *M. opisthacus* (*Hemithlæus mihi olim*).

III. Second lower molar unknown. *M. protogonioides,* and *M. mandibularis.*

The supposed *M. baldwini,* resembles closely the species of *Hemithlæus.*

It is probable that two genera are here included under the head of *Mioclænus.* If the character is permanent, these will be distinguished as follows :

Third superior premolar with internal tubercle.....*Mioclænus.*
Third superior premolar without internal tubercle.....*Oxyclænus.*

The species of *Mioclænus* are *M. turgidus* (type) ; and very probably *M. opisthacus, minimus* and *M. subtrigonus* ; but the diagnostic tooth has not been seen in them as yet. The species of *Oxyclænus* are : *O. cuspidatus*

and *O. corrugatus;* and very probably, *O. ferox.* The position of the *M. protogonioides, M. baldwini* and *M. mandibularis* is uncertain, though the last two are probably *Oxyclæni.*

The *Mioclænus cuspidatus* is distinguished among its congeners, by the transverse character of its superior molar teeth, that is, by the relatively smaller anteroposterior diameter as compared with the transverse; and by the prominence and acuteness of their principal cusps. They thus stand at the opposite extreme of the genus from the *M. turgidus,* where the teeth are characterized by the robustness and obtuseness of the cusps, although in the triangular basis of the second superior molar they agree. The external cusps are compressed cones, and in contact at the base; the intermediate tubercles are small and distinct. The internal cusp is large and prominent. The base of the fourth premolar is T-shaped, and is as long as wide. Its internal and external cusps are well developed. The cingulum of the true molars is complete all round on the last one, and on the two others except at the internal base, where it is interrupted. The second molar only displays a posterior inner tubercle of the cingulum, which is small, and does not give a truncate interior outline of the crown, characteristic of *M. opisthacus, M. ferox,* etc. On the ms. i and ii, the cingulum is expanded at the external angles of the crown, most so anteriorly. The anterior expansion rises in a low cusp in the P-m. iv. The enamel is smooth.

This species need only be compared with *M. opisthacus* and *M. subtrigonus,* which are of about the same size. Passing by the differences already mentioned in the table, the fourth premolar has a different form from that of the *M opisthacus.* In the latter it is narrower and more transverse, and with larger conical cusps, much as in *M. turgidus;* in the present species it has the trilobate outline seen in *M. subtrigonus.* As to the latter species, the teeth are wide, and the cusps smaller and separated at at the base, and the cingulum is crenate and lobate, in a manner quite different from the smoothness and compactness of structure seen in the *M. cuspidatus.*

Measurements.	M.
Length of base of last four superior molars	.026
" " " three true molars	.019
Diameters of P-m. iv { anteroposterior	.006
Diameters of P-m. iv { transverse	.004
Diameters of m. i. { anteroposterior	.006
Diameters of m. i. { transverse	.006
Diameters of m. ii { anteroposterior	.0064
Diameters of m. ii { transverse	.008
Diameters of m. iii { anteroposterior	.0045
Diameters of m. iii { transverse	.006

D. Baldwin, discoverer.

CHRIACUS TRUNCATUS, sp. nov.

The genus *Chriacus* m. was characterized in the Proceedings of the

Academy of Philadelphia, 1883, p. 80, and two species were mentioned, *C. pelvidens* (type) and *C. angulatus*. The former of these is from the Puerco, the latter from the Wasatch formation; the former is the larger species; the latter quite small. I now add two species to the genus which are intermediate in dimensions between those already known.

I. Posterior cingulum of superior molars with large tubercle.

Large species; *C. pelvidens;* small species, *C. truncatus.*

II. Posterior cingulum with small tubercle; small species; *C. angulatus.*

III. Posterior cingulum without tubercle; small species; *C. simplex.*

In the *C. truncatus* the posterior singular (inner) tubercle reaches the largest development, but is not present on the cingulum of the last superior molar. The anterior cingulum is weak on that tooth and on the first true molar, but on the second it is thickened into a small anterior or inner tubercle. This with the posterior inner gives the crown a truncate internal outline, as is also the case in the *C. pelvidens*. The intermediate tubercles are distinct, and the external cusps are separate at the base. An external cingulum. The fourth premolar has a triangular base; a single compressed external cusp, and a small acutely conical internal one. The internal tubercle is small and acute on the third premolar. The second premolar is small and probably one-rooted, and it is possible that there is no first premolar. The canine is directed vertically downwards, and the base of the crown is oval.

Besides the considerably smaller size, the posterior internal cusps are relatively larger than in *C. pelvidens*.

Measurements.	M.
Length of superior dental series including canine	.039
Length of true molar series	.014
Diameters P-m. iii { anteroposterior	.004
Diameters P-m. iii { transverse	.003
Diameters P-m. iv { anteroposterior	.004
Diameters P-m. iv { transverse	.005
Diameters M. ii { anteroposterior	.005
Diameters M. ii { transverse	.0064
Diameters m. iii { anteroposterior	.0033
Diameters m. iii { transverse	.005

Two individuals from New Mexico. D. Baldwin.

CHRIACUS SIMPLEX, sp. nov.

This species is represented by a part of the left maxillary bone, which supports the true molars except a part of the last one; and by parts of the mandible, with the first and second true molars, and perhaps one of the premolars. The true molars are about the size of those of the *C. truncatus*, but of very different detailed structure, as already pointed out. The posterior cingulum is stronger than the anterior, but does not support a trace of a cusp, and they do not unite on the inner face of the crown. External

cingulum present. External cusps rather small, separate. Intermediate cusps present; V large and distinct. Enamel smooth.

The inferior true molars support Vs; in the second the anterior is smaller and is more elevated than the posterior. The latter is continued as a raised posterior, and partly interior border of the heel, without prominent cusp. The crown has a distinct external and a very faint internal cingulum. In the supposed first true molar, the anterior V is more prolonged anteroposteriorly as in the corresponding tooth of *Mioclænus ferox*, etc., and the fourth premolar of *Phenacodus primævus*. The anterior cusp is the lowest. The heel supports three low cusps, of which the external has a crescentic section, and the posterior is the smallest.

It is probable but not certain that the fourth premolar has an internal cusp, as the tooth, presumably this one, is injured at that point, Should the internal cusp be absent, this species cannot be referred to *Chriacus*.

Measurements.		M.
Length of superior true molars		.0135
Diameters of first true molars	anteroposterior	.005
	transverse	.006
Diameters of second true molars	anteroposterior	.0053
	transverse	.007
Diameters of third true molar	anteroposterior	.0034
	transverse	.006
Diameters of first inferior true molar	anteroposterior	.005
	transverse	.0035
Diameters of second inferior true molar	anteroposterior	.0056
	transverse	.0043

D. Baldwin, discoverer.

TRICENTES CRASSICOLLIDENS, gen. et sp. nov.

Char. gen. This genus is *Chriacus* with only three premolars in the superior, and probably inferior series. The canines are well developed, and lateral in position, leaving space for small incisors, thus differing from the genera of the *Mixodectidæ*, *Mixodectes*, *Microsyops*, and *Cynodontomys*, on the one hand, and from *Necrolemur* on the other. It has, so far as known, the dental formula of several genera of typical Lemuridæ, but differs from these in the following points. The orbit is open posteriorly; the inferior molars have the anterior triangle of three cusps; and the fourth inferior premolar has an interior cusp. I have demonstrated the last mentioned characters on the type, *T. crassicollidens* only, but suspect its presence on some or all of the other species. In their details the superior true molars are like those of Mioclænus, as distinguished from those of Pelycodus.

To this genus belongs the *Mioclænus subtrigonus*, and probably, from the small size of its fourth premolar, the *M. bucculentus*. I add to these three a fourth, *T. inæquidens*, and remark that it is yet uncertain how many premolars are present in the *Chriacus simplex*. Should the latter possess three only, it will be properly referred to Tricentes.

These species differ as follows :

I. Posterior cingulum of true molars i and ii, wide, rising into a small cusp.

Length of true molars, M. .0155.....*crassicollidens.*

II. Posterior cingulum distinct, thickened inwards.

Length of true molars (m. ii inferential) .0175, crowns narrowed, transverse.....*bucculentus.*

Length of true molars .0170 ; crowns quadrate.....*subtrigonus.**

Length of true molars .0135 ; crowns narrowed, transverse.....(*Chriacus*) *simplex.*

III. Posterior cingulum weak, disappearing inwards.

Length of true molars .0105, crowns transverse except the third, which is very small.....*inæquidens.*

Char. Specif. The *Tricentes crassicollidens* is about the size of the *Chriacus truncatus* and resembles it a good deal. The latter has, however, a more transverse form of true molars, as compared with the present species, where the form is subquadrate. In the present animal the premolars are smaller, and if the third (second present) has an internal cusp, it is much more insignificant than in the *C. truncatus.* These two species and the *Mioclænus opisthacus* resemble each other in the similar size, and in the true molars having the posterior inner cusp more distinct than in other species. They differ in the dimensions of their premolars, those of the *M. opisthacus* being the largest, and those of *C. truncatus* being intermediate in size. In the *T. crassicollidens* the anterior cingulum is also distinct. The external cusps are conic, and are well separated, and the internal V is distinct. The internal cusp of the fourth premolar is small and compressed, so as to be transverse. The base of the third premolar is triangular and much longer than wide. All the superior molars, except the first premolar, are furnished with an external cingulum, which rises into a more or less distinct apex at its anterior and posterior angles. The first premolar is a simple cone. The alveolus of the canine tooth is of large size. The last true molar is not much reduced, and the first is as large as the second. This is not the case with the *T. bucculentus,* where the first is considerably smaller than the second.

Measurements.	M.
Length of dental series to canine, exclusive	.036
" " diastema	.006
" " premolar series	.0143
" " true molar series	.0152
Diameter of P-m. iv { anteroposterior	.0042
Diameter of P-m. iv { transverse	.0042

* There may be two species confounded under this name. A specimen figured in Vol. III of the final (4to) Report of the Hayden Survey, Plate XXIV, f, fig. 4 has four inferior premolars, all simple.

Measurements.		M.
Diameter of M. i	anteroposterior	.0058
	transverse	.0050
Diameter of M. iii	anteroposterior	.0030
	transverse	.0048

A pair of mandibular rami, found on the same day, and at or near the same place, probably belong to the same species, if not to the same animal, they support all the teeth, but only the P-m iv and the M. i and ii have yet been disengaged from the matrix. The P-m. iv is rather large and robust, and has a short wide heel, and an anterior cusp which leaves the main cusps half way to the apex, or at the same elevation as the internal cusp. The anterior three cusps of the true molars are elevated above the heel, and the anterior is nearly median, forms no blade with external anterior, and is smaller than the anterior internal cusp. The heel is well developed, and its borders rise in two obtuse open Vs, whose apices look away from each other. The internal supports two cusps, the external, but one. No cingula; enamel smooth.

Measurements of inferior teeth.		M.
Diameters of P-m. iv	anteroposterior	.0060
	transverse	.0035
Diameters of m. ii	anteroposterior	.0050
	transverse	.0039
Length of bases of m. i and m. ii		.0110

From Upper Puerco; D. Baldwin.

TRICENTES INÆQUIDENS, sp. nov.

This species is represented by two mutilated crania, obtained on the same day and near the same locality as the preceding species. One of these, which I select as type, embraces the muzzle and palate anterior to the posterior border of the maxillary bone.

Besides its inferior size, other characters distinguish this species. The simplicity of the superior molars is seen in no other, and the very reduced size of the third superior molar is not found in any of its allies. This is correlated with an oblique reduction of the maxillary bone behind, which gives the second true molar an oblique external border instead of the longitudinal one seen in the other species. The external cusps of the molars are conic, and are not in contact at the base. The internal cusp is also conic, and is larger than the external. The internal cusp of the fourth premolar is large. It is probable that the third premolar supports an internal cusp, as the crown base is as wide as long. The premolars are spaced in this species, as in the last, but the diastema is shorter than in the *T. crassicollidens*, not exceeding the premolar interspaces. The external cingulum is quite weak. The canine alveolus is large. The incisors are wanting, but the premaxillary region is wide. The inferior dentition is unknown.

Measurements of superior teeth.	M.
Length of dental series, including canine	.0272
" from canine to m. i, exclusive	.0130
Length of true molar series	.0100
Diameter of P-m. iii { anteroposterior	.0028
{ transverse	.0025
Diameters of P-m. iv { anteroposterior	.0030
{ transverse	.0042
Diameters M. i { anteroposterior	.0038
{ transverse	.0048
Diameters M. ii { anteroposterior	0039
{ transverse	.0059
Diameters M. iii { anteroposterior	.0015
{ transverse	.0024

Upper Puerco ; D. Baldwin.

INDRODON MALARIS, gen. et sp. nov.

Char. gen. Family Anaptomorphidæ, suborder perhaps Lemuroidea, as indicated by the dentition only. It differs from *Anaptomorphus* in three points. First, there are three superior incisors ; second, the first (third) premolar has no internal lobe ; and third, there is a distinct posterior internal tubercle on the first and second superior molars.

The animals of the Eocene period of the family of the *Adapidæ*, may belong to the *Lemuroidea*, but the evidence which I have derived from the feet of *Pelycodus** has led me to refer them† to the Insectivorous division of the Bunotheria, to the neighborhood of the Tupæidæ and Erinaceidæ. At the same time I retained provisionally the genera with three and two superior premolars in the suborder Lemuroidea, although the foot structure of these extinct genera is yet unknown. I also indadvertently defined the Lemuroidea as having quadrituberculate superior molars, a character which I well knew to be wanting in various extinct and recent genera where they are tritubercular. Two families were proposed† for the Eocene lemuroids, which are defined as follows :

Superior premolars three ..... *Mixodectidæ.*
" " two ..... *Anaptomorphidæ.*

The genera of the first named family are defined as follows :

I. Canine teeth large and lateral, well separated.
First superior premolar without internal lobe ; superior true molars tritubercular with cingula ..... *Tricentes.*

II. Canine teeth median in position or much reduced in size.
a. Last inferior premolar without internal tubercle.
Inferior premolars all one-rooted ; canine and incisor small. . *Necrolemur.*‡

* Report of U. S. G. G. Survey W. of 100th Mer. G. M. Wheeler, iv, p. 140.
† Proceedings Academy Natural Sciences, of Philadelphia, 1883, p. 78-80.
‡ Filhol Rech. Phosph. Quercy.

First premolars only one-rooted ; canine small ; incisor very large..... *Mixodectes.**

aa. Last inferior premolar with internal tubercle.

A very large ? canine ; first premolar only, one-rooted..... *Microsyops.*†

A very large ? canine ; first and second premolars both one-rooted..... *Cynodontomys.*‡

The genera of Anaptomorphidæ, which on dental characters includes *Indrodon*, differ as follows :

a: Incisors three.

First superior incisor without inner lobe ; posterior inner tubercle present on first and second tubercle..... *Indrodon.*

aa. Incisors two.

First superior incisor with inner lobe ; no posterior inner tubercle on superior molars..... *Anaptomorphus.*

The superior dental formula of *Indrodon* is I. $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{2}{2}$; M. $\frac{3}{3}$. The canine is compressed and acute ; the third premolar is compressed conic, and has two roots. The fourth premolar has but one external cusp. The external cusps of the true molars are conic and acute, and are connected with the internal cusp by ridges which form a V. Posterior inner cusp distinct on ms. i and ii, a part of the posterior cingulum. Intermediate tubercles present, small. The superior incisors are well developed, and display no tendency towards the rodent type. A portion of lower jaw adheres to the skull, and may belong to the same animal. It supports the last two molars. These have two anterior, opposite, approximated cusps. The heel of the penultimate molar is rather large, and has a raised edge, which develops low tubercles at the angles.

Char. Specif. The first and third superior incisors are a little larger than the second. Canine preceded and followed by diastemata, each of which is 1.5 times as long as the long diameter of the base of the crown. Premolars separated from each other and from the first true molar by interspaces half as long as the diastema. Neither tooth has any basal tubercles, but the posterior has a weak external cingulum, which is stronger posteriorly. The internal cusp of the same tooth is anterior, is acute and elevated. The superior true molars have a strong external cingulum, which rises into a small tubercle opposite the space between the external principal cusps. Of the latter, the anterior is a little more conic than the posterior, and both are well within the external border. On the last molar, the posterior external cusp is continuous with the external intermediate tubercle, and forms a cutting edge within the posterior margin of the crown. The posterior inner tubercle is rather large, and projects further inwards than the apex of the anterior V on the second true molar, but not so far as in the species of *Anisonchus* and *Haploconus*.

*Proceedings American Philosophical Society, 1883, p. 559.

†Leidy Report U. S. Geol. Survey, Terrs. I.

‡Cope, Pal. Bull., No. 34.

The surface of the cranium is too much obscured by cracks and films of matrix to permit a view of the sutures and foramina. The face is wide, as the posterior part of the maxillary and the malar bone are expanded outwards. I have not yet been able to ascertain the condition of the orbit posteriorly. The mandibular ramus is rather slender.

Measurements.	M.
Length of dental series from posterior base of i iii.	.0248
" " bases of superior incisors.	.0060
" from i iii to P-m. iii, exclusive.	.0074
" of premolars on maxillary bone.	.0060
" " base of P-m. iii	.0020
" " P-m. iv	.0028
Width " "	.0038
Diameters m. i anteroposterior	.0030
Diameters m. i transverse	.0032
Diameters m. ii anteroposterior	.0033
Diameters m. ii transverse	.0040
Diameters m. iii anteroposterior	.0030
Diameters m. iii transverse	.0040
Diameters inferior m. ii anteroposterior	.0032
Diameters inferior m. ii transverse	.0030
Depth of ramus mandibuli at m. ii	.0070

The skull is about the size of that of the *Bassaris astuta*. D. Baldwin, discoverer.

The discovery of this type in the Puerco formation is a fact of interest. In the shortening of its dental series it is the most specialized genus of the epoch, while the forms of its true molars are like those of the simpler Creodonta, and more specialized than those of *Anaptomorphus*, and the lemurs generally. In the simplicity of its premolars, however, it maintains the general character of the Puerco fauna, and is more primitive than the forms just named. Its nearest ally of the Puerco yet known is *Chriacus*.

ANISONCHUS AGAPETILLUS, sp. nov.

This species is founded on parts of six mandibular rami, none of which has more than four continuous molars in position, including the last. It is not entirely certain that these belong to a species of *Anisonchus*, because the superior molar teeth by which that genus is distinguished from *Haploconus* and *Hemithlæus*, are wanting. The inferior molars have the anterior inner cusp moderately well developed, as in *Anisonchus gillianus*.

The crowns of the true molars consist of two Vs; of which the posterior base of the posterior one, is rendered irregular by the presence of a small posterior median tubercle. Of the anterior pair of cusps, the external is a little the more elevated, and the internal is more elevated than any of the posterior ones. The internal posterior as well as the external posterior

cusp has a V-shaped section, because its anterior border is continued as an oblique ridge to the base of the anterior internal cusp. Internal cingula none ; a slight one on the external base of the large anterior external cusp. The heel of the third true molar is well developed, and rises into an acute cusp. That of the fourth premolar is short and flat. The anterior cusp of the same is basal and rudimental. This tooth is not enlarged as is usually the case in the *Periptychidæ*, and it first here differs from these animals, and agrees with the unguiculate types in that its lateral faces are unequally convex.

Measurements.	M.
Length of last four molars on base	.014
" " fourth premolar	.0035
Elevation of " "	.0038
Length of second true molar	.0031
Width " " " (greatest)	.003
Length of third " " "	.004
Width " " " "	.0028
Depth of ramus at second true molar	.007

ANISONCHUS COPHATER, sp. nov.

A mandibular ramus supporting three molars, two of them true, is all that I have seen of this species. Its proportions are the same as those of the *A. agapetillus*, that is, much smaller than the *A. gillianus*, and the single premolar is much more like that of other species of the genus. The true molars differ from those of the *A. agapetillus* in two strong characters. First, the internal posterior cusp is inside the rim of the heel of the crown, that is, outside the bordering edge, and is therefore very distinct from the posterior median cusp. It is a sharp cone ; secondly, there is a cingulum extending from this cusp round the internal base of the internal anterior cusp. There is also one at the base of the external anterior cusp, which continues to the heel only on the last inferior molar. The posterior heel is relatively wider, and the anterior V relatively more contracted, than in the *A. agapetillus*. The anterior tubercle is moderately developed at the anterior base of the anterior V. The third or fourth premolar is equilateral, and larger than the true molars. It has a short apiculate heel, and a rudimental anterior basal tubercle.

Measurements.			M.
Diameters of m. ii	horizontal	anteroposterior	.0032
		transverse	.0030
	vertical	anterior	.0025
		posterior	.0013
Diameters of P-m. iii or iv	anteroposterior		,0043
	vertical (restored apex)		.0040
	transverse		.0023

D. Baldwin, discoverer.

CHIROX PLICATUS, gen. et sp. nov.

Char. gen. These are known from three superior molars ; viz : the last

premolar, and the second and third true molars. The fourth premolar has two external, and one internal cusps, and the true molars have four cusps each. The cusps are of peculiar form. The second true molar resembles a convex body which has been divided by two cuts at right angles to each other, from which the quarters thus produced has spread away from each other subequally. The external faces of the cusps are convex. The apices are acute. The last superior molar is larger anteroposteriorly than transversely. The fourth premolar (supposed) is two-rooted.

These molar teeth remind one of the inferior molars of *Ptilodus*, through they differ much from them. The genus is probably nearer to *Catopsalis*, and belongs to the Marsupial order. The presence of only two series of cusps in the superior molars, distinguishes it from these genera, which have presumably three series of such cusps. Lemoine has shown this to be the case in *Neoplagiaulax*.

Char. specif. The external cusps of the fourth premolar are flattened on the external side, and lean a little inwards. The internal cusp (probably homologically the anterior) is opposite the anterior external, and has a convex internal face. Its apex is acute and compressed; the apices of the external cusps are trihedral and acute.

The cusps of the second true molars are more widely separated transversely than anteroposteriorly; that is, the longitudinal fissure is wider than the transverse. The apices are all acute, the internal trihedral, the external more compressed.

The transverse diameter of the last true molar is smaller than that of the second true molar, while the longitudinal is nearly the same. The crown projects convexly posterior to the posterior pair, and there is a small tubercle at the anterior base of the external anterior cusp.

None of the teeth preserved display cingula. The bases of the crown are smooth, but the cusps are sharply and finely parallel-grooved on their external faces.

Measurements.		M.
Diameters of P-m. iv	anteroposterior	.0030
	transverse	.0038
Diameters of m. ii	anteroposterior	.0033
	transverse	.0035
Diameters of m. iii	anteroposterior	.0035
	transverse	.0030

D. Baldwin, discoverer.

CATOPSALIS FISSIDENS, sp. nov.

This Marsupial is represented by a portion of the lower jaw which supports the molar teeth. The first, which is probably the fourth premolar, is represented only by its single root, which fills a round alveolus near the anterior base of the first true molar.

In size this species is intermediate between the small *C. foliatus* and the large *C. pollux*. The first molar is the longer and narrower, and the

second the shorter and wider, as in the known species. The first molar differs from that of both the latter, in having the tubercles of one side separated nearly to the base. These tubercles are conic, and not flattened as in *C. foliatus* and *C. pollux*, and the two rows are separated by a distinct valley, as in the first named. There are five tubercles on one side, and four on the other side of the crown, and in addition, two small cusps at the anterior extremity of each row, and another at the posterior extremity of one of the rows. These additional cusplets are not present in the other species.

The last molar is relatively wider than in the other species. Its crown is a good deal worn, but there are probably more than two rows of tubercles, as there are some appendicular rows on one side of the crown at least.

Measurements.		M.
Diameters M. i	anteroposterior	.0135
	transverse	.0050
Diameters M. ii	anteroposterior	.0090
	transverse	.0075

The Upper Puerco ; D. Baldwin.

General remarks on the characters of the Mammalia of the Puerco Epoch.

I have already called attention to the fact that the Mammalia of the Puerco epoch possess, with but few exceptions, superior molar teeth whose crowns include only three of the component tubercles of the normal mammalian molar, in a condition of full development.* In the number of species of supposed placentals now known, sixty-seven, the proportion of species (1), with quadrituberculate superior molars is even smaller, being only four to sixty-three. The premolars display equally primitive characters, and to these I wish now to draw attention.

2. The presence of two internal tubercles of the fourth superior premolar is unknown as yet in the fauna.

3. The presence of two external cusps of the same tooth is known or inferred in only five species in the sixty-seven, and in two of the five it is of reduced size.

4. The presence of one internal cusp of the fourth superior premolar is demonstrated or inferred in all of the placental species.

5. The presence of the internal cusp of the third superior premolar is, on the other hand, only demonstrated in twenty-two species. In seventeen it is wanting.

Referring to the inferior premolars :

6. No species presents an internal cusp of the third premolar.

7. An internal cusp of the fourth premolar is present in only fourteen species. In twenty-nine species it is certainly wanting.

* Proceedings of the American Philosophical Society, 1883, 562. American Naturalist, 1883, 407.

8. In no species of this formation is the fourth inferior premolar like a molar tooth.

It is thus evident that the dentition of the mammalia of the Puerco fauna presents a much greater degree of simplicity than does that of the species of any of the later Eocene or other age. This result coincides with the results I have already obtained from a study of the structure of the feet, etc.* These may be summarized again as follows:

1. The species in which the number of toes is known, have them 5–5.
2. Those in which the feet are known are plantigrade.
3. No species is known to have interlocking carpal and tarsal bones, excepting the two species of *Pantolambda* (carpus unknown).
4. No species is known to have well grooved astragalus (its presence is inferred in two species of *Dissacus*).
5. No species is known to have a faceted radius or ulno-radius, adapted to the separate carpal bones of the proximal row.
6. In no species is the tongue in the metapodio-phalangeal joints developed on the front of the metapodial bones.
7. The zygopophyses where known are all flat, except in some species (probably all) of *Oxyclænus*, where they are simply convex-concave, and not doubly so.

On the Trituberculate Type of Molar Tooth in the Mammalia. By E. D. Cope.

(*Read before the American Philosophical Society, Dec. 7, 1883.*)

It is now apparent that the type of superior molar tooth which predominated during the Puerco epoch was triangular or tritubercular; that is, with two external and one internal tubercles.† Thus, of sixty-seven species of placental mammalia of which the superior molars are known, all but four have three tubercles of the crown, and of the remaining sixty-five, all are triangular, excepting those of three species of Periptychus, and three of Conoryctes, which have a small supplementary lobe on each side of the median principal inner tubercle.

This fact is important as indicating the mode of development of the various types of superior molar teeth, on which we have not heretofore had clear light. In the first place, this type of molar exists to-day only in the insectivorous and carnivorous Marsupialia; in the Creodonta, and the tubercular molars of such Carnivora as possess them (excepting the plantigrades.) In the Ungulates its persistence is to be found in the molars of the Coryphodontidæ of the Wasatch, and Dinocerata of the Bridger Eocenes. In later epochs it is occasionally seen only in the last superior molar.

It is also evident that the quadritubercular molar is derived from the tritubercular by the addition of a lobe of the inner part of a cingulum of the

* American Naturalist, 1883, p. 1056; Science, 1883, p. 275.
† See *American Naturalist*, April, 1883, p. 407.

posterior base of the crown. Transitional states are seen in some of the Periptychidæ (*Anisonchus*), and in the sectorials of the Procyonidæ.

The tritubercular or triangular superior molar is associated with a corresponding form of the anterior part of the inferior molar, This kind of inferior molar*, I have called the tubercular sectorial, and is very variable as to the degree of development of the sectorial cutting edge. The anterior triangle is formed by the connection by angle or crest, of the median and anterior internal crests with the anterior external. Its primitive form is seen in Didelphys, Pelycodus, Pantolambda and the Amblypoda generally ; in Centetes and Talpa ; and in its sectorial form, in Stypolophus and Oxyæna, etc.

The mechanical action of such teeth is as follows : Of course, it results from the form of the superior molars that the spaces between them are wedge-shaped, the apex external, the base opening to the palate. The base of the triangular section of the anterior part of the inferior molar is interior, and the apex exterior, and when the jaws are closed, this triangular prism exactly fits the space between the superior molars. The lower heel of the inferior molar receives the impact of the crown of the superior molar. Thus the oblique edges of the inferior triangle shear on the edges of two adjacent superior molars. The anterior parts of the inferior molars, and the superior molars, form an alternate dental series as distinguished from the prevalent opposed dentition of most mammalia. In so far it resembles the reptilian dentition.

This primitive dentition has been modified in two directions ; viz. to form the grinding and the sectorial dentitions. As already remarked, the superior molars gradually acquire a posterior internal lobe, which produces the quadrituberculate type. This lobe, by opposing the anterior internal lobe of the next posterior inferior molar, precludes the entrance of the anterior triangle of the latter between the two superior molars. Hence we find in the types which possess quadritubercular superior molars, that the anterior triangle of the inferior molar is not elevated, if present, as for instance in Rhinocerus. It is, however, more frequently atrophied, and disappears, forming the inferior quadritubercular molar so well known.

On the other hand, as I have pointed out,† the anterior internal cusp of the triangle of the inferior molar may be more developed anteroposteriorly, giving the antero-internal edge of the triangle much greater obliquity than the postero-internal. In correspondence with this modification, the superior triangular molar loses its equilateral character by the more anterior position of its internal angle, thus elongating the posterior internal side of the crown. The latter thus fits the corresponding form of the triangle of the inferior molar, forming with it the shear of the sectorial tooth.

*See Report G. M. Wheeler, D. Chief of Engineers on Explor. Surv. W. 100th Mer. Vol. IV, pt. ii ; on the Creodonta.

†On the origin of the sectorial tooth of the Carnivora, *American Naturalist*, 1875.

In a former article, "On the Homologies of the Molar Teeth," etc., I traced the modifications of the superior and many of the inferior molars of the ungulate mammals to a parent quadrituberculate type. In a subsequent essay* I traced the origin of the inferior sectorial to a primitive five-tubercled, or "tubercular sectorial" type. Farther than this I did not go, and made no attempt to derive the few cases of triangular superior molars then known, nor the type of the superior sectorial. The revelations of the Puerco fauna show, that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a "tubercular sectorial" type. Shall we look for the origin of the latter in a tritubercular tooth also, *i. e.* tubercular sectorial without heel; and will the crowns of the true molars of the primitive mammals alternate with, instead of oppose each other? This is a probable result of future discovery.

*Journal Academy Natural Sciences, Philadelphia, March, 1875.

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