First Addition to the Fauna of the Puerco Eocene. By E. D. Cope.

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There are fifty-five species included in my synopsis of the vertebrata of the Puerco epoch*. Ten of these are reptilia, the remainder mammalia. In the present paper a number of interesting additions are made. The typical specimens are figured in the fourth volume of the U. S. Geological Survey of the Territories, now in press.

OPHIDIA.

HELAGRAS PRISCIFORMIS, gen. et sp. nov.

Char. gen. The generic characters are drawn from vertebræ only. These display a modified form of the zygosphen articulation, as follows: The roof of the zygantrum is deeply notched on each side of the median line so as to expose the superior lateral angles of the zygosphen. This separate median portion of the roof of the zygantrum forms a wedge-shaped body which may be called the *episphen*, It is surmounted by a tuberosity, which constitutes the entire neural spine. The latter is thus entirely different in form from that of other serpents. Articular extremities of centrum round, the ball looking somewhat upwards. Costal articulation 8-shaped, the surfaces convex and continuous. Hypapophyses none on the two vertebræ preserved. Zygapophyses prominent. Free diapophyses none.

This genus is readily distinguished by the presence, now first observed, of the *episphen* in addition to the zygosphen ; and by the peculiar form of the neural spine. We have now several vertebral articulations originally discovered in American vertebrata. These are the *episphen* as above, the *hyposphen*, which characterizes the Opisthocœlous Dinosauria (*Sauropoda* Marsh), and the *Diadectidæ* of the Permian period ; and the *zygantrapophysis*, which is present in the Diplocaulid family of Batrachia.

Char. specif. A section of the vertebra at the middle is pentagonal, the inferior side slightly convex downwards. The lateral angle is the section of the angular ridge which connects the zygapophyses The episphen has a shallow rounded groove on its infero-posterior side, which is bounded by a projecting angle on each side at its middle. The episphen does not project so far posteriorly as the postzygapophyses, and the degree of its prominence differs in different parts of the vertebral column. In one of the two vertebræ in my possession its prominence is small. The tuberosity on its summit is a truncate oval with the long diameter anteroposterior, and equaling two-fifths the length of the arch above. It is elevated above the rest of the median line, which is roof-like, with obtuse angle. The tubercular articular facet is entirely below the prezygapophyseal surface, but the free part of the prezygapophysis extends well in front of it. It is distinguished from the capitular surface by a very slight constriction. A slight ridge extends from the capitular articulation

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to the edge of the ball of the centrum. Below this the surface is slightly concave, and the middle line is gently convex. The latter terminates in an obtuse angled mark just in front of the edge of the ball. This edge is also slightly free from the ball. The capitular costal surfaces do not project inferiorly quite to the line of the inferior surface of the centrum.

Measurements of a Vertebra.	M.
Length of centrum (with ball)	.0070
Diameters of ball { vertical	.0035
Diameters of ball { transverse	.0040
Elevation of vertebra at episphen	.0085
" " middle	.0062
Width at prezygapophyses	.0120
" tubercular costal faces	.0105
" of zygantrum	.0058
Vertical diameter costal faces	.0040
Transverse diameter tubercular costal face	.0028

This snake was about the size of the black snake, *Bascanium constrictor.* It is an interesting species for two reasons. First, it is the oldest serpent known from North America. Second, in the imperfection of the zygantrum we observe an approximation to the ordinary reptilian type of vertebra, from which the ophidian type was no doubt derived. In the former there is no zygosphen or zygantrum.

Mammalia.

Triïsodon levisianus, sp nov.

This creodont is represented by part of a right mandibular raums which contains the fourth premolar minus its principal cusp, and the first and second true molars, with the alveoli of the third. The ramus is deep, and probably belonged to an animal of about the size of the red fox. The molars have the structure most like that of the *T. heilprinianus*, especially anteriorly. The principal anterior cusps are united together for most of their elevation, while the anterior inner is much smaller and lower, and is situated between the middle and inner side of the anterior cusp. The heel is rather wide, and has a raised border. The external part of it is angular, and is somewhat within the vertical line of the base of the crown. The fourth premolar differs from that of the type the genus, *T. quivirensis*, in having two acute longitudinal tubercles situated close together on the heel.

The anterior masseteric ridge is very prominent. The masseteric fossa is strongly concave, but shallows gradually inferiorly. Its inferior border presents a low thickened ridge, which is recurved in front. This may be an individual character only. The inferior outline of the ramus is generally convex, and does not rise much below the masseteric fossa.

Measurements.		M.
Length of last four inferior molars		.0315
" true molars		.0230
Diameters of M. i.	anteroposterior	.0085
	transverse	.0055
Length of P-m. iv. on base		.0090
Depth of ramus at M.i		.0200
Thickness " "		.0085

This *Triïsodon* is not only materially smaller than the *T. heilprinianus*, but differs in the characters of the heel of the inferior molars. In that species the internal border is tubercular; in this one it is entire. The *T. conidens* and *T. quivirensis* differ in the arrangement of the anterior cusps.

Dedicated to my friend, Henry Carvill Lewis, professor of mineralogy and geology in the Academy of Natural Sciences, Philadelphia.

Mioclænus ferox, sp. nov.

This new species is represented by three specimens. One of these includes various separate teeth and a considerable portion of the skeleton; a second includes loose teeth and a smaller number of bones of the skeleton; and the third consists of a part of a mandibular ramus, which contains the three true molars. These indicate the largest species of the genus yet known, the first individual above mentioned being about the size of a wolf.

The bones of the *Mioclænus ferox* enable me to refer the genus approximately to its proper position in the system. Although we do not possess the corresponding parts of the *Mioclænus turgidus*, the type of the genus, it is probable, if not certain, that they agree in generic characters. The agreement in dentition extends to all the principal technical points, though the specific differences are marked.

The skeleton is that of a creodont. The unequal phlanges are compressed claws, and the metapodial bones have protuberant condyles. The astragalus has a simple head with convex surface, and the trochlea is a shallow open groove.

The tubercular dentition refers this genus to the *Arctocyonidæ*.* With this family it is accordingly placed provisionally. It differs from the known fossil genera in the single tubercle of the internal part of the crown of the superior molars.

The species *M. brachystomus* and *M. etsagicus* of the Wasatch epoch must now be removed from this genus. I have shown that the former is an Artiodactyle. Now in technical points, the dentition of those species is identical with that of *Pantolestes* Cope, as well as with *Mioclænus*. Although the skeleton of the type of *Pantolestes*, *P. longicaudus* of the Bridger Beds, is yet unknown, it is safe to suppose that it does not differ from that of the *M. brachystomus*. I therefore refer the two species first mentioned to *Pantolestes*, and place that genus in the Artiodactyle sub-order.

* For the dentition of this family see Lemoine, Annales, Sc. Nat., 1878, July.

Char. specif.—The canines are well developed, and have a robust root. The crown is rather slender and is very acute. It is rounded in front, but has an acute angle posteriorly. It is not grooved, and the enamel is smooth. The single-rooted first superior premolar is situated close to the canine, and behind it is a short diastema. I have the probable first true molar or fourth premolar. The external cusps are rather small, and are well separated from each other. The inner outline of the crown is rather broadly rounded. The internal tubercle is connected on wearing, with an anterior transverse crest which terminates near the inner base of the anterior external cusp in an intermediate tubercle. There is a posterior intermediate tubercle. There is a cingulum all round the crown excepting at the posterior intermediate tubercle. The second (? first) true molar is like the one just described, but has relatively greater antero-posterior width. In this tooth the cingulum extends all the way round the crown.

There are but two inferior molars of this individual preserved, the second and third true. The former of these has a parallelogrammic outline with rounded angles. There are two posterior and two anterior rather large tubercles; an anterior transverse ledge; and a narrow external and posterior cingulum, the latter running into the internal posterior tubercle. The latter has a circular section, and is much smaller than the external posterior, which has a wide crescentic section. Of the anterior tubercles the anterior is much the larger, judging from its worn base. The third true molar is triangular in outline. Its crown includes two anterior and an external median tubercle. The inner and posterior parts of the crown form a wide shelf, with the internal edge denticulate. A weak external cingulum.

Measurements of Teeth.

		M.
Diameters base of crown of incisor	anteroposterior	.0045
	transverse	.004
Diameters base crown of canine	anteroposterior	.0130
	transverse	.0095
Diameters crown, superior M. i.	anteroposterior	.0095
	transverse	.0120
Diameters, M.? ii.	anteroposterior	.0110
	transverse	.0110
Diameters of inferior M. ii	anteroposterior	.0120
	transverse	.0105
Diameters of inferior M. iii.	anteroposterior	.0125
	transverse	.0090

The second individual includes part of the superior walls of the skull. The fragment displays a high sagittal crest, which is fissured in front so as to keep the temporal ridges apart to near its anterior apex. The brain surfaces show small, smooth, flat hemispheres, separated by a constriction from the wide and large olfactory lobes. The navicular bone shows three well defined distal facets, indicating probably five digits in the pes. The teeth of this specimen include a posterior superior molar, and an inferior third or fourth premolar, with other teeth. The premolar is like that of a creodont. Its principal cusp is a simple cone. To this is added a short wide heel, whose superior surface is in two parts, a higher and a lower, divided by a median ridge. A low anterior basal lobe, and a weak external cingulum.

The third specimen belonged to an individual a little smaller than the other two. It includes the first inferior true molar, a tooth lost from the others. Its form is somewhat narrowed anteriorly, where it has two low, but well separated anterior inner tubercles, which form a V with the external anterior.

Specimen No. 1 is accompanied by fragments of vertebræ and limbs. The former are principally from the lumbar region, but fragments of the atlas remain. This vertebra is of moderate length, and the cotylus is somewhat oblique. The vertebrarterial canal is rather elongate, and its anterior groove-like continuation in front of the diapophysis is not deeply excavated. The lumbar vertebræ are remarkable in the characters of their zygapophyses. These display subcylindric surfaces of the posterior pair, which indicates that the anterior ones are involuted, as in the specialized Artiodactyles and Perissodactyles of the later geological ages. Such a structure does not exist among carnivora, nor to my knowledge among creodonta, nor in any mammals of the Lower Eocene. I do not find it in *Didelphys* nor *Phascolarctos*, but it exists in a moderately developed degree in *Sarcophilus*. The articular surface forms more than half of a cylinder, and its superior portion is bounded within by an anteroposterior open groove. The surface within this is not revolute, as in *Bos* and *Sus*, but the articular surface disappears, as in *Cervus*. Eight such postzygapophyses are preserved, all disconnected from their centra. Two of them are united together. There are two other separated zygapophyses of smaller size, which have but slightly convex surfaces. One is probably a prezygapophysis of a dorsal vertebra. No centrum is preserved.

Of the anterior limb there is a probable distal half of a radius. It is of peculiar form, and resembles that of *Sarcophilus ursinus* more than any other species accessible to me. One peculiarity consists in the outward look of its carpal surface, which makes an angle of about 45° with the long axis of the shaft. The obliquity in *S. ursinus* is less. The external border of the shaft in *M. ferox* is, however, straight, and terminates in a depressed tuberosity. Beyond this, the border extends obliquely outward to the carpal face, which it reaches at a right angle. The internal border of the shaft is gradually curved outwards to the external border of the carpal face. Its edge is obtuse, while the external one is more acute for a short distance, and rises to the anterior (superior) plane of the shaft. The carpal face is a spherically subtriangular with rounded angles. It displays two slightly distinguished facets, one of which is superior, and the other is larger and surrounds it, except on the superior side. The internal marginal projection, or "styloid process," is not so prominent as in *S. ursinus*, and is a roughened raised margin. Joining it on the inferior edge of the carpal face is another rough projection of the margin. Immediately opposite this, on the superior edge of the carpal face, is a rough tuberosity, which encloses a small rough fossa, between itself and the styloid process. Internal to it is a shallow groove for an extensor tendon of the manus; then a low short ridge, and internal to that a wide shallow depression for other extensors. The carpal face differs greatly from those of *Sarcophilus* and *Didelphys* in having the inner portion wider than the outer, instead of the reverse, and in having no distinct styloid process. It indicates that the manus was turned outwards much more decidedly than in those genera.

Of carpal bones the only recognizable one is the unciform. Its proximal articular surface rises with a strong convexity entad, and descends to an edge ectad. The metacarpal surface is concave in anteroposterior section, forming a wide shallow groove, extending in the direction of the width of the foot. Its two metacarpal areas are not distinguished. The entire first and second metacarpals, with the heads of the third and fourth are preserved. They considerably resemble those of *Sarcophilus ursinus*. The distal articulations are injured in both, but both display a sharp trochlear keel posteriorly, which on the second extends nearly to the superior face of the articulation. The condyle is subround, and is constricted laterally, and at the base above. The second metacarpal is short and robust, shorter than in *Sarcophilus ursinus*. The first is also robust, but is relatively longer, as it is three-quarters the length of the second. Its head is expanded, especially posteriorly, and the large trapezial face is subtriangular, with round apex directed inwards as well as forward. The posterior face of the head is notched ectad to the middle. On the external side of the head there is a vertical facet with convex distal outline, for contact with the second metacarpal. The head of the latter is narrow, and is concave between the sides. The concavity is bounded posteriorly by a raised edge. The anterior part of the proximal facet is decurved. The shaft is deep proximally, but on the distal half is wider than deep. The lateral distal fossæ are remarkably deep and narrow, the condyle very much contracted. The head of the supposed third metacarpal is as wide as the second anteriorly, but narrows to the posterior third, and then contracts abruptly to a narrow apex. The supposed external side of the head is perfectly straight, and is continuous with the side of the shaft without interruption. The entad side displays no facet, but has a depression below the head which adapts itself very well to the head of the first metacarpal. In fact, if the metacarpals just named second and third, exchange places, so that second is placed third and third second, the metacarpal series fits far better. The fourth fits the so-called second much better than the so-called third. This may therefore be the true order, although that first used agrees better with the carpus of *Sarcophilus*. The head of the so-called third is slightly convex anteroposteriorly, and is oblique laterally, descending a little to the inner side. The fourth metacarpal is wider anteriorly than either the second or third. The inner edge is straight, while the outer is concave, the head being narrower before than behind. It has a lateral facet on each side ; the inner plane, the external concave in the vertical as well as in the anteroposterior direction. It thus approaches the form of a metatarsal, but is not so strongly excavated, nor is the head notched on either side. The unciform face is convex anteroposteriorly and plane transversely.

The *femur* is broken up so that I cannot restore it. The head of the *tibia* is gone, but a considerable part of the astragalar face is preserved. This is transverse to the long axis of the tibia. It is narrowed anteroposteriorly next the fibular facet. Malleolus lost. The shaft is robust, and does not expand distally for articulation with the astragalus. Three centimeters proximal to the distal end, the external side throws out a low, rough, ridge-like tuberosity. Above the middle the crest turns outwards, leaving the internal face convex. There is a broken patella, which has one facet much wider than the other.

The *astragalus* has the trochlear portion a little oblique. That is, the internal crest is a little lower than the external, and the inner face is a little sloping. The latter is impressed by a fossa above the posterior part of the sustentacular facet, which runs out on the neck. The trochlea has a shallow groove which is nearer the external than the internal crest, and which passes entirely round the posterior aspect to the plane of the inferior face of the astragalus. The groove for the flexor tendon is thus entirely enclosed, and issues on the inferior face at the posterior extremity of the groove which separates the sustentacular from the condylar facets. The external crest of the trochlea is less prominent posteriorly than the internal, thus reversing the relations of the superior part. The internal ridge becomes quite robust, but does not flatten out and project sub-horizontally as in *Oxyæna forcipata*. The fibular face is vertical ; neither its anterior nor posterior angles are produced. The neck is somewhat contracted (the internal side is injured). The head is a transverse oval, strongly convex vertically, moderately so horizontally, and without flattening. A *mesocuneïform* (or possibly *ectocuneïform*) bone is wedge-shaped in horizontal section, without posterior tuberosity, and its anterior face is a slightly oblique square. The narrower facet is oblique in the transverse sense.

The *metatarsals* are represented, excepting the first and second. The only complete one is the fifth. The heads of the third and fourth are much like those of *Oxyæna forcipata*, and of about the same size. Their anterior width is equal, and in both the external side is more oblique than the internal. Both have a notch at the middle of the internal side, but they differ in that the third has an open notch on the external side which is wanting to the fourth. The lateral excavations of the external sides are deep and rather large, and thin out the anterior external edge. The lateral facets are correspondingly large on the fourth and fifth ; on the third metatarsal it is small, and a mere decurvature of the proximal surface. That of the fourth is longer proximo-distally than transversely. That of the fifth is about as long as wide, and presents more anteriorly ; or, to express it more accurately, the shaft and head present more outwardly than those of the fourth. The proximal, or cuboid facet is narrow anteroposteriorly, and is curved, the external side being concave. On the external side just distal to this facet, the head of the bone expands into a large outward-looking tuberosity, which is separated from the posterior tuberosity by a strong notch. Between it and the head proper, on the anterior face, is a large fossa. The entire form is something like that of the proximal extremity of a femur with head, neck, great trochanter and trochanteric fossa. A somewhat similar form is seen in the corresponding bone of *Oxyæna forcipata.* The shaft of the fifth metatarsal, is one-fifth longer than that of the second metacarpal (? 3d) above described. Its direction is straight, but it is somewhat curved anteroposteriorly. Its section is subtriangular, the apex external. The condyle is narrowed and sub-globular above, and spreads laterally behind, the external expansion being wide and more oblique. The keel is prominent, and is only visible from above (in front) as an angle. The distal extremities of some other metatarsals differ in being flatter at the epicondyles, and concave between them on the posterior face. The condyles are more symmetrical, and are bounded above on the anterior face by a profound transverse groove. Several *phalanges* are preserved, including part of an unguis. They are all depressed, and with well marked articular surfaces, of which the distal are well grooved, and the proximal notched below. The lateral areas of insertion of the tendons of the flexors are well marked on the edges of the posterior faces. An ungual phalange is much compressed at the base. The basal table is well marked, and has a free lateral edge. The nutritive foramen enters above the posterior extremity of this edge. No trace of basal sheath.

Measurements of No. 1.		M.
Length of atlas at anterior vertebrarterial foramen		.0165
Expanse of postzygapophyses of a lumbar vertebra		.0230
Diameter radius at middle of shaft		.0100
Greatest distal width of radius		.0220
Diameters carpal surface	vertical	.0140
	transverse	.0185
Diameters of unciform	vertical (interiorly)	.0130
	anteroposterior (greatest)	.0140
	transverse (in front)	.0150
Diameters head metacarpal I	anteroposterior	.0130
	transverse	.0120
Length of metacarpal I		.0310
Width metacarpal I at epicondyles		.0110
Diameters head metacarpal II	anteroposterior	.0110
	transverse	.0070
Length of metacarpal II (or III)		.0400
Width do. at epicondyles		.0120
Diameter head of M. III (or II)	anteroposterior	.0125
	transverse	.0075

Measurements of No. 1.	M.
Diameters head of M. IV, anteroposterior	.0120
Diameters head of M. IV, transverse (at middle)	.0070
Width of patella near middle	.0190
Diameters of tibia .07 M. from astragalus, anteroposterior	.0185
Diameters of tibia .07 M. from astragalus, transverse	.0130
Anteroposterior width of astragalar face	.0200
Total length of astragalus	.0310
Diameters of the trochlea, length on groove	.0210
Diameters of the trochlea, width above	.0160
Diameters of the trochlea, elevation externally	.0130
Greatest width of astragalus below	.0225
Length anterior to internal crest of trochlea	.0100
Diameters head of metatarsal III, anteroposterior	.0130
Diameters head of metatarsal III, transverse (in front)	.0110
Diameters head of metatarsal IV, anteroposterior	.0140
Diameters head of metatarsal IV, transverse	.0105
Diameters head M. V, without tuberosity, anteroposterior	.0120
Diameters head M. V, without tuberosity, transverse, with lateral facet	.0080
Diameters head M. V, without tuberosity, transverse, without do.	.0040
Diameters head M. V, transverse over all	.0170
Length Mt. V	.0460
Width do. at epicondyles	.0120
Width do. at condyle above	.0065
Width of M. III or IV at epicondyles	.0120
Width of proximal end of phalange	.012
Length of smaller phalange (1st series)	.0230
Proximal diameter do. vertical	.0070
Proximal diameter do. transverse	.0110
Ungual phalange, vertical diameter of cotylus	.0090

The specimen which has been partially described in the preceding pages as No. 2, has many pieces which are identical with those preserved in specimen No. 1. Among these may be mentioned the glenoid cavities of the squamosal bone. These display, besides the large postglenoid process, a well developed preglenoid ridge, as in *Arctocyonidæ*, *Oxyænidæ* and *Mesonychidæ*. A large distal caudal vertebra of elongate form, indicates a long tail. An articular extremity of a flat bone is intermediate in form between the proximal end of the marsupial bone of *Didelphys* and that of *Sarcophilus*. Its principal and transverse articular surface is transversely convex, as in the latter (*S. ursinus*), but the lesser articular face is separated from it by an even shorter concave interspace than in the opossum. It has almost exactly the form of that of the latter animal. It is a short, flat cone, with two faces presenting on the same side, the one part of the concavity mentioned, the other flat and presenting away from it. This piece has a slight resemblance to the very peculiar head of the fibula in the oppossum, but is not like that of *Sarcophilus ursinus*. I, however, think it much more probably the proximal extremity of a marsupial bone.

A supposed *cuneïform* is subtransverse in position, and resembles in general those of *Oxyæna* and *Esthonyx*. It has the two large transverse proximal facets, the anterior one-quarter wider than the posterior. The distal facet (trapeziotrapezoidal) is simple. The *navicular* is much like that of *Oxyæna forcipata*, but is more robust. Its external tuberosity is flattened anteroposteriorly, and is produced proximally. The three distal facets are well marked, the median a little wider than the external, while the internal is subround, convex, and sublateral in position. The *entocuneïform* is a flat bone, with cup-shaped facet for the navicular, and narrow facet for the first metatarsus. This facet is transverse transversely, and concave anteroposteriorly. It shows (1), that there is a pollex; (2), that it is probably small ; and (3), that it was not opposable to the other digits, as is the case in the opossum. (4). It does not show whether the pollex has an unguis or not.

Measurements No. 2.

		M.
Transverse width condyle of mandible		.0230
Anteroposterior width condyle of mandible (at middle)		.0103
Diameters head of *os marsupii*	transverse	.0220
	anteroposterior	.0068
Diameters cuneïform	vertical	.0075
	anteroposterior	.0115
Diameters navicular	vertical in front	.0085
	transverse	.0180
	anteroposterior (middle)	.0110
Diameters ectocuneïform	vertical at middle	.0100
	anteroposterior (middle)	.0140
	transverse distally	.0060

Two other bones of specimen No. 2 I cannot positively determine. The first resembles somewhat the trapezium of *Sarcophilus ursinus*, and still more that of *Didelphys*. I will figure it, as a description without identification will be incomprehensible. The next bone is of very anomalous form. It may be the magnum, which is the only unrecognized bone of importance remaining, or it may be a large intermedium. It has no resemblance to the magnum of any mammal known to me. It was evidently wedged between several bones, as it has eight articular facets. Two are on one side ; the largest (convex and oval) is on one edge ; three are on one end, and two, the least marked, are on the other flat side, opposite to the first.

Restoration. We can now read the nature of the primitive mammal *Mioclænus ferox*, in so far as the materials above discussed permit. It was a powerful flesh-eater, and probably an eater of other things than flesh. It had a long tail and well-developed limbs. It had five toes all around, and the great or first toe was not opposable to the others, and may have been rudimental. The feet were plantigrade and the claws prehensile. The fore feet were well turned outwards. There were in all probability marsupial bones, but whether there was a pouch or not cannot be determined. These points, in connection with the absence of inflection of the angle of the lower jaw, render it probable that the nearest living ally of the *Mioclænus ferox* is the *Thylacynus cynocephalus* of Tasmania. The presence of a patella distinguishes it from Marsupials in general. Its dentition, glenoid cavity of the skull and other characters, place it near the *Arctocyonidæ*. Should the forms included in that family be found to possess marsupial bones, they must probably be removed from the *Creodonta* and placed in the *Marsupialia*.

This species is about the size of a sheep. The bones are stated by Mr. Baldwin, who discovered it, to be derived from the red beds in the upper part of the Puerco series.

MIOCLÆNUS BUCCULENTUS, sp. nov.

A part of the right maxillary bone which supports three molars indicates this species. The molars are P-m iv, M. i and M. ii. This series is characterized by the remarkably small size of the fourth premolar, and large size of the second true molar. The first true molar is intermediate.

The fourth premolar consists of an external cone and a much smaller internal one. There is a weak posterior basal cingulum. The reduced size of the internal cone suggests the probability that the third premolar has no internal cusp, and that there may be but three premolars. In either case the species must be distinguished from *Mioclænus*.

The first and second true molars have conic well separated external cusps, and a single pyramidal internal cusp. The intermediate tubercles are distinct. There is a posterior cingulum which terminates interiorly in a flat prominence. There is an anterior cingulum and a strong external one, which form a prominence at the anterior external angle of the crown. Enamel wrinkled.

Measurements of Superior Molars.

		M.
Length of bases of P-m. iv M. i and ii		.0180
Diameters P-m. iv	anteroposterior	.0040
	transverse	.0046
Diameters of M. i	anteroposterior	.0060
	transverse	.0065
Diameter of M. ii	anteroposterior	.0070
	transverse	.0085

MIOCLÆNUS SUBTRIGONUS Cope.

This species has been known hitherto* from a palate with three molars. I am now able to give the characters of the inferior molar series, which have been found, by Mr. Baldwin, associated with the true superior molars. Of the latter it may be remarked that the second true molar is not so much

*American Naturalist, 1881, 490–1.

longer than the first as in *M. bucculentus*, although the difference in size is very evident. The third is smaller than the first, and ovoid in outline, while the first and second are subquadrate. The external cusps are conic and widely separated and the intermediate areas are distinct. There is a cingulum all round the crown of the last two, and round that of the first except at the inner side, and at the anteroëxternal angle.

The last three inferior premolars are higher than long at the base, and are compressed and the apex acute. The posterior edge of the third and fourth is truncate, and simple. Each has a posterior cingulum which forms a narrow heel on the fourth. No other cingula. Of the true molars only the second is wanting. The form of these is like those of the *M. ferox*, with the cusps more prominent. The first only has trace of the anterior V; in the others, the two anterior tubercles are opposite and connected by a short anterior ledge. The heel of the first consists of a basin bounded by these tubercles, of which the external is pyramidal and largest. The median posterior is small. The heel of the third is narrow and prominent, and the internal lateral tubercle is represented by a short raised edge. The enamel of all the molars is wrinkled, and the inner side of the premolars is grooved with the height of the crown. A weak external cingulum on M. iii.

Measurements.		M.
Length of last three superior molars		.0265
Diameters of M. i	anteroposterior	.0060
	transverse	.0060
Diameters of M. ii	anteroposterior	.0062
	transverse	.0072
Diameters of M. iii	anteroposterior	.0047
	transverse	.0060
Length of last inferior molars		.0340
Length of last three premolars		.0140
Length of P-m. iv		.0050
Elevation of P-m. iv		.0050
Diameters of M. i	anteroposterior	.0057
	transverse	.0042
Diameters of M. iii	anteroposterior	.0070
	transverse	.0035

Rather larger than the pine weasel, *Mustela americana*.

MIOCLÆNUS CORRUGATUS, sp. nov.

This species is known from a right maxillary bone which contains the last four molar teeth, with parts of pelvis and other bones of one individual.

This species is intermediate in size between the *M. protogonioides* and *M. ferox*, as the following measurements of the second superior true molar show:

	M. protogonioides.	*M. corrugatus.*	*M. ferox.*
Diameter, transverse	.011	.0118	.015
" anteroposterior	.008	.010	.013

The superior molars are more nearly quadrate than in the other species of the genus, owing to the better development of the posterior internal tubercle, which is, however, as in the others, a mere thickening of the posterior cingulum. It is wanting from the last superior molar. The cusps on the true molars are as in the *M. ferox*, small, and not large and closely placed as in *M. protogonioides*. The intermediate ones are nearly obsolete. The crowns are all entirely surrounded by a cingulum. The entire enamel surfaces wrinkled so as to be rugose, although the teeth are those of an adult and well used. The second superior molar is larger than the first, exceeding it in the transverse rather than the fore-and-aft diameter. The third is the smallest, and is of oval form with obliquely truncate external face. It is less reduced than in the *M. turgidus*.

The fourth premolar consists of a strong compressed-conic cusp with three basal cusps of small size, viz., an anterior, a posterior, and an internal. The last is the larger, though small, is formed like a heel, and is connected with the others by a cingulum. No external cingulum.

Measurements.		M.
Length of last four molars		.036
Diameters P-m. iv	anteroposterior	.010
	transverse	.008
" M. i	anteroposterior	.010
	transverse	.010
" M. iii	anteroposterior	.008
	transverse	.011

From the Upper Puerco beds.

PANTOLAMBDA BATHMODON Cope, American Naturalist, 1882, p. 418.

In describing this genus and species, I remarked, loc. cit., that they were "founded on a mandibular ramus, which supports the first true molar, and the last two premolars. The characters of these teeth remarkably resemble those of *Coryphodon*. * * * It will be for additional material to demonstrate whether this genus belongs to the *Amblypoda* or *Perissodactyla*."

A considerable part of the skeleton of this species having been recently sent me by Mr. D. Baldwin, I am able to throw much light on the affinities of this curious genus.

In the first place, the phalanges (not ungual), show that the genus is ungulate. Secondly, the astragalus has a large distal facet for the cuboid bone. This proves that the genus cannot be referred to the Taxeopod order. The question as to whether it belongs to the *Amblypoda* or the *Diplarthra* would be decided by the carpus, but that part is unfortunately not preserved, and I have to rely on empirical indications for a provisional determination. Apart from the astragalus, the characters are those of the *Condylarthra* rather than of the *Perissodactyla*, and it is therefore to be supposed that the carpus has also the characters of that order. This would place the genus in the *Pantodonta*, which has the carpus nearly that of the *Taxeopoda*, and the tarsus of the *Diplarthra*. The points of resemblance to the *Condylarthra* are the following: The ilium is narrow. The humerus has an epitrochlear canal. The superior molar teeth have but one internal lobe. The resemblances to the *Pantodonta* are these: The cervical vertebræ are plane and short. The femur has a third trochanter. The premaxillary bone in dentigerous. The astragalar trochlea is as in the *Periptychidæ*, and the *Proboscidia*; that is without groove, and slightly convex anteroposteriorly, thus differing from that of the *Pantodonta*. The dentition is especially like that of the *Amblypoda* in general, and that of the superior series is unlike anything known in the *Diplarthra*.

I propose to place this genus in the *Amblypoda* for the present, next to the *Pantodonta*, but it cannot enter that sub-order on account of the form of its astragalus. The sub-orders of *Amblypoda* will be defined as follows:

Astragalus with a head distinct from trochlea, with distal articular facets .... *Taligrada*.
Astragalus without head; distal facets subinferior .... *Pantodonta*.

In the sub-order *Taligrada*, the single family *Pantolambdidæ* presents the following characters:

Superior and inferior molars with the cusps developed into Vs. Postglenoid process present; postympanic and paroccipital not distinct. All the vertebræ with plain articulations. Humeral condyles without intertrochlear ridge. Femur with third trochanter. Digits of posterior foot probably five. Metapodial keels small and posterior.

Of this family *Pantolambda* is as yet the only known genus. Its leading characters are as follows:

Canine teeth distinct; dental series continuous. Superior molars all triangular, that is with a single internal cusp. External cusps of premolars unknown; of molars two. Internal cusp V-shaped, sending its horns externally as cingula to the anterior and posterior bases of the external side of the crown, without intermediate tubercles. Inferior true molars with a crown of two Vs, the anterior the more elevated. Premolars consisting of one open V, with a short crest on a short heel, as in *Coryphodon*. Dental formula I $\frac{?3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{?4}{?4}$; M. $\frac{3}{3}$; the last inferior with a heel. A strong sagittal crest. Auricular meatus widely open below. Large postparietal, postsquamosal and mastoid foramina.

Cervical vertebræ rather short; other vertebræ moderate, the lumbars not elongate. A large tail. Humerus with large internal epicondyle. Femur with all the trochanters large. Ilium with the anterior inferior spine well developed. Metacarpals short, plantigrade. Phalanges of second series flat, and of subquadrate outline. The astragalus has a wide head, but no neck, as it is not separated from the tochlear portion by a constriction. It is as wide as the trochlear portion, but about one-third of its length extends within the line of the malleolar face of the trochlear portion. The navicular face is flat, that of the cuboid bone is convex vertically, and one-half as long horizontally as the navicular, and only half as deep. These two facets are continuous with the sustentacular below. Interior to all of these, on the internal tuberosity of the head is a sub-round facet looking inwards, like that characteristic of the genus *Bathmodon*, but relatively larger. A continuous facet is seen on the adjacent edge of the navicular. The use of these facets is unknown.

The brain case indicates small and nearly smooth hemispheres, extending with little contraction into a rather large cerebellum. The olfactory lobes are produced anteriorly at the extremity of a rather long isthmus.

If we consider the dentition alone, *Pantolambda* is the ancestor of the *Coryphodontidæ*. The history of the feet requires further elucidation.

The *Pantolambda bathmodon* is about as large as a sheep.

From the upper beds of the Puerco.

MIXODECTES PUNGENS, gen. et sp. nov.

Char. Gen.—The position of this genus is uncertain, but may be near to *Cynodontomys* Cope, which I have provisionally placed among the Prosimiæ*. It is only known from mandibles, which have presumably the following dental formula. I. 0 ; C. 1 ; P-m. 4 ; M. 3. An uncertainty exists as to the proper names of the anterior teeth, which cannot be decided until the discovery of the superior series. For instance the formula may be ; I. 1 ; C. 1 ; P-m. 3.

The supposed canine is a large tooth, issuing from the ramus at the symphysis like a rodent incisor, and has an oval section, with long diameter parallel to the symphysis. The crown is lost from all the specimens. The second tooth is similar in form to the first, but is much smaller. It is situated posterior and external to the first. The next tooth is still smaller and is one-rooted. The third and fourth premolars have simple conic crowns, and more or less developed heels without cusps. The true molars are in general like those of *Pelycodus ; i. e.*, with an anterior smaller, and a posterior triangle or V. The supplementary anterior inner cusp is quite small, while the principal anterior inner is elevated. The posterior inner is much more elevated than in the species of *Pelycodus*. Last inferior molar with a fifth lobe.

This genus cannot be referred to its place without additional material, but the parts discovered indicate it to be between *Pelycodus* and *Cynodontomys ;* either in the *Mesodonta* or the *Prosimiæ*. I may here remark that in defining the latter genus I was in doubt as to the number of the inferior premolars. The discovery of the present genus renders it probable that it has three such teeth, and that the anterior two are each one-rooted.

Char. Specif. The mandible of the *Mixodectes pungens* is about the size of that of the mink. Its inferior outline is straight to below the second premolar, whence it rises upwards and forwards like that of a rodent. The anterior masseteric ridge is very prominent, but terminates below the

* Paleontological Bulletin No. 34, p. 151.

middle of the ramus. Inferior masseteric ridge much less pronounced. The inferior part of the ramus is robust below the base of the coronoid process, but there is no indication of recurvature of the edge. Mental foramina two ; one below the front of the first true molar, and one below the second premolar.

The oval base of the canine is not flattened on either side; that of the second tooth is flattened on the inner side. There is a great difference between the sizes of the last three premolars. The fourth is twice as large as the third, and the second, judging from the space and the size of its alveolus, was much smaller than the third, and the crown was probably a simple acute cone. The crown of the third is of that form, with the addition of a short heel. The long axis of the base of the crown is diagonal to that of the jaw. The fourth premolar has a relatively larger heel than the third, but it is shorter than the diameter of the base of the cusp. Its posterior edge is elevated. The cusps of the anterior pair of the true molars are elevated, but the interior is the most so. The supplementary one is not exactly in the line of the interior border of the crown. Each of the inner cusps are connected with the base of the external by a ridge, which together form a V. The posterior base is nearly surrounded by a raised edge, which rises into cusps at the posterior lateral angles. Of these the internal is the more prominent. The edge connecting these cusps is slightly convex backwards, and evidently bears a part in mastication. The lateral borders of the last molar are somewhat expanded, and the fifth lobe is very short. No cingula on any of the teeth.

Measurements.		M.
Length of dental series from "canine" exclusive		.0265
" true molar series		.0140
Diameters "canine"	longtitudinal	.0040
	transverse	.0030
Long diameter of base of "P-m. i"		.0028
" " " P. m-ii		.0017
Diameters P-m. iv	vertical	.0055
	anteroposterior	.0050
Diameters M. ii	transverse	.0038
	anteroposterior	.0050
Length of crown of M. iii		.0060
Depth of ramus at P-m. iii		.0090
" " M. iii		.0100

Mixodectes crassiusculus, sp. nov.

This mammal is represented by fragments of two mandibles from different individuals ; one less and the other more worn by mastication. The species differs from the last in its greater size, and in the relatively greater length of the last inferior molar. The length of the posterior four molars of the *M. pungens* equals that of the three true molars of the *M. crassius-*

culus; and the last true molar of the latter is half as long again as the penultimate, while in *M. pungens* it exceeds it but little.

The best-preserved true molar is the second. Its most elevated cusps are the anterior and posterior inner, of which the anterior is subconic and more elevated. The anterior external cusp is crescentic in section, and sends crests to the supplementary, anterior, inner and the posterior anterior inner, both of which descend inwards. The posterior crest reaches the posterior base of the anterior inner cusp.

The posterior external cusp is an elevated angle, sending crests forward and backwards. The former reaches the base of the anterior external cusp (not reaching the inner), while the latter passes round the posterior edge of the crown. As in *M. pungens*, it is convex posteriorly, and rises to the posterior internal cusp. In both species its appearance indicates that it performs an important masticatory function in connection with the superior molar. No cingula.

Measurements.		M.
Length of bases of M. ii and iii; (No. 2)		.0125
" base of M. iii; (No. 2)		.0070
Diameters crown M. ii; (No. 1)	anteroposterior	.0056
	transverse	.0050
Depth of ramus at M. ii; (No. 1)		.0100

Periptychus carinidens Cope.

Additional specimens of this species demonstrate that the last inferior molar has a different form from that of the *P. rhabdodon*. While of the same length, it is narrower throughout, conformably with the smaller size of all the other molar teeth.

Phenacodus calceolatus, sp. nov.

This species is founded on fragments of the skull and limbs, with teeth, of a single individual. The teeth consist of two superior and four inferior molars of one side, and a smaller number of those of the opposite side.

The teeth are of the size of those of the *Phenacodus puercensis*, and like that species, there is no median external cingular cusp of the superior molars. In these teeth the external basal cingulum is weak, but there is a strong anterior cingulum, distinct from any of the cusps. No internal cingulum. External cusps conical, well separated; intermediate cusps rather large; internal cusps rather large, close together, but deeply separated. The last superior molar is reduced in size. It has well developed anterior and posterior cingula, a weak external, and no internal cingula. The intermediate tubercles are rather large, and there is one large internal tubercle.

The heel of the last inferior molar is short, wide and rounded. The posterior tubercle is but little behind, opposite the posterior internal tubercle. The latter is separated from the anterior inner by a deep fissure, while the opposite side of the crown is occupied by a large median external cusp, which has a semicircular section. The large anterior cusps are confluent on wearing. No anterior cingulum in the worn crown. The crowns of the first and second true molars of the specimen are rather worn. They show that the posterior median tubercle is very indistinct and probably absent. The bases of the smaller inner cusps are round, and on wearing unite with the larger external cusps. Of the latter the posterior is the larger. Anterior cingulum rudimental or wanting. No lateral or posterior cingula. The principal peculiarity of the lower dentition of this species and the one from which it is named, is the form of the third or fourth (probably third) premolars, both of which are preserved. They have a compressed apex, which descends steeply to the anterior base, without basal or lateral tubercle. The base of the crown spreads out laterally behind, and is broadly rounded at the posterior margin, so as to resemble the toe of a wide and moccasined foot. It is depressed, the surface rising to the apex from a flat base.

Measurements.		M.
Diameters of second superior molar	anteroposterior	.0080
	transverse	.0100
Diameters of last superior molar	anteroposterior	.0067
	transverse	.0085
Length of inferior true molars		.0258
Diameters of M. ii	anteroposterior	.009
	transverse	.008
Diameters of M. iii	anteroposterior	.0085
	transverse	.0068
Diameters of the P-m. iii	anteroposterior	.008
	transverse	.005

About the size of the *P. puercensis*.

Note on the Mammalia of the Puerco and the Origin of the Quadritubercuiate Superior Molar.—It is now apparent that the type of superior molar tooth which predominated during the Puerco epoch was triangular; that is, with two external, and one internal tubercles. Thus of forty-one species of Mammalia of which the superior molars are known, all but four have three tubercles of the crown, and of these thirty-eight triangular ones we may except those of three species of *Periptychus*, 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 Insectivora, and the tubercular molars of such Carnivora as possess them (excepting the plantigrades). In the Ungulates the only traces of it are to be found in the molars of the *Coryphodontidæ* of the Wasatch, and *Dinocerata* of the

Bridger Eocenes. In later epochs it is chiefly 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 posterior base of the crown. Transitional states are seen in some of the *Periptychidæ* (*Anisonchus*) and in the sectorials of the *Procyonidæ*.

On the Brains of the Eocene Mammalia Phenacodus and Periptychus. By E. D. Cope.

(Read before the American Philosophical Society, December 15, 1882.)

PHENACODUS PRIMÆVUS Cope.

A cast of the cranial cavity gives the following as the general characters of the brain. The cerebal hemispheres are remarkably small, each one being less by one-quarter than the cerebellum. They are separated from the latter and from the large olfactory lobes by strong constrictions. The posterior one is occupied by a thick tentorium. In like manner a wide groove for a robust falx separates the hemispheres above, a notch represents the sylvian fissure, and the lobus hippocampi is quite large. The vermis of the cerebellum is quite distinct, and the lateral lobes are large. They are impressed laterally by the petrous bones as in various ruminants. The anterior columns of the medulla are not visible. There are traces of the convolutions on their hemispheres.

The brain displays the following more special features. The olfactory lobes are as wide as long, and they diverge, having two external sides. In section they are triangular, presenting an angle downwards. The hemispheres are depressed, and wider posteriorly. They are well separated from each other and from the cerebellum ; so much so that it is quite probable that the copora quadrigemina are exposed. Their outlines are however not distinguishable on the flat surface which connects the hemispheres posteriorly. No further indication of sylvian fissure can be seen in the cast beyond an entering angle defining the lobus hippocampi anteriorly. The latter is prominent externally, and less so downwards. There are distinct indications of convolutions. There are three on each side above the sylvian convolution, and a fourth extends from the sylvian upwards and posteriorly below the posterior part of the third or external convolution. The sulci separating the convolutions are very shallow. The internal and external convolutions unite anteriorly, passing round the extremity of the median convolution. The space between this gyrus and the base of the olfactory lobe is only three millimeters.