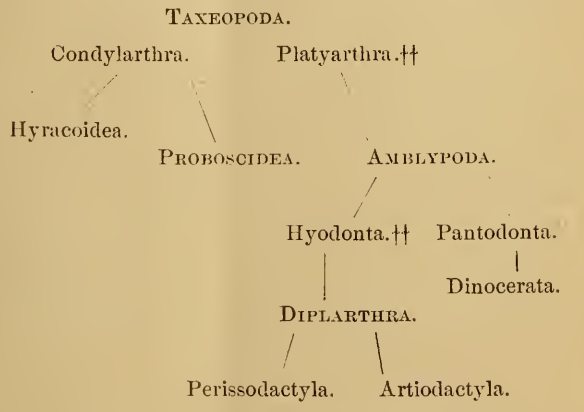
The preceding paragraphs were written in May of the present year. On my return home, September 1st, after an absence of three months, I find that various parts of the skeleton of *Periptychus** have reached my museum. On examination, I find that the astragalus of that genus fulfils the anticipation above expressed. *It is without trochlea*, and nearly resembles that of *Elephas*. As it agrees nearly with that of *Phenacodus* in other respects I only separate it as a family from the *Phenacodontidæ*. One other type remains to be discovered which shall connect the *Periptychidæ* and the hypothetical *Hyodonta*, and that is a Taxeopod without a head to the astragalus,—unless, indeed, the "*Hyodonta*" should prove to have such a head. I think the latter the less probable hypothesis, and hence retain the term *Platyarthra* for the hypothetical Taxeopod without trochlea or head of the astragalus.

These relations may be rendered clearer by the following diagram :




*Third contribution to the History of the Vertebrata of the Permian formation of Texas. By E. D. Cope.*

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

Since the publication of my second contribution to this subject,‡ I have described four additional species. These are, in Bulletin of the U. S. Geological Survey of the Territories ;§ *Pantylus cordatus* and *Dimetrodon semiradicatus;* in the American Naturalist,‖ *Eryops reticulatus* and *Za-*

* See American Naturalist, October, 1882

†† Hypothetical.

‡ Paleontological Bulletin, No. 32, Proceedings American Philosophical Society, 1880; the plates, 1881.

§ Vol. vi, 1881, p. 79.

‖ 1881, p. 1020.

*trachys apicalis.* The last two were not included in my catalogue of the Permian Vertebrata published previously* in the same year. The present paper adds some important points to this remarkable fauna, and explains the hitherto obscure relations of several genera.

## DIADECTIDÆ.

The pelvis and sacrum of a species of this group are preserved in my collection, and they indicate further peculiarities of this group,

The sacrum consists of two vertebræ only, and is thoroughly united with the pelvis by its transverse processes. The latter are decurved on the inner side of the iliac bones, and the sutures which distinguish them from the latter and from each other, are not serrate. The inferior arch is robust, but very narrow anteroposteriorly. The acetabulum is entire in every respect, so that it is probable that both pubis and ischium are united undistinguishably in the arch. The pubis is perforated by the usual internal femoral foramen. The posterior edge is grooved, and it might be suspected that this marks the articulation of an ischium. The anterior edge is however grooved in the same way, so that the appearance is rather the position of muscular insertion. The spines of the sacral vertebræ are distinct, and have the usual form seen in *Diadectes.*

The two sacral vertebræ and the absence of obturator foramen, are characters of the suborder *Pelycosauria* in which the latter differs from the *Dicynodontia.* I am still inclined to question whether the extraordinary characters of the cranio-vertebral articulation I have described, justify the separation of the *Diadectidæ* as a third sub-order of the *Theromorpha,* which I have called the *Cotylosauria,*† or whether they are not due to the loss of a loosely articulated basioccipital bone.

## EDAPHOSAURUS Cope, genus novum.

Apparently allied to *Puntylus.* Temporal fossæ not overroofed; surfaces of cranial bones not sculptured. Mandibular and maxillary teeth subequal. Posterior half of the mandibular ramus expanded inwards and supporting numerous closely arranged teeth. Pterygoid, or perhaps an internal expansion of the malar bones, supporting a dense body of teeth, corresponding to those of the lower jaw. Teeth subconical.

The single species of this genus in my possession shows the following characters of systematic importance. An arch extends from the parietal plane posteriorly and downwards to the external base of the quadrate. The specimen is not yet in a condition to show how much of this is parietal, and how much squamosal or opisthotic. The proximal half of the posterior part of this arch is a distinct element, perhaps a transverse process of the supraöccipital. A distinct element connects the basioccipital on each side with the quadrate. The articular extremity of the latter has

* American Naturalist Feb., 1881.

† American Naturalist, 1880, p. 304.

a deep anteroposterior concave emargination. There is a flat bone extending from it anteriorly which is apparently pterygoid rather than quadratojugal. The tooth bearing portion terminates opposite the middle of the basisphenoid.

The occipital condyle is undivided, and the basisphenoid presents the usual two divaricating protuberances to the basioccipital.

EDAPHOSAURUS POGONIAS, sp. nov.

Represented by the followsng portions of a skull; basis cranii with portion posterior to the middle of the parietal bone; left maxillary with dental plate, left mandibular ramus entire; various flat bones undetermined. There is also a body which may be the atlas with its arch somewhat dislocated. These pieces are in part covered with a thin layer of the red deposit of the Permian bed in which they occur.

The facial plate of the *os maxillare* is subvertical, so that the orbit is lateral. The latter is rather small. The malar bone is narrow, and is continuous with the dentigerous bone of the palate. The latter has a thickened posterior edge, which commences below the anterior part of the orbit, and extends posteriorly to the middle of the basisphenoid. Thence the border turns forwards. Its anterior edge is below the anterior border of the orbit, and the general form is a longitudinal oval. The maxillary teeth are somewhat weathered and obscured by a thin layer of matrix. The posterior ones are compressed-conic; the premaxillaries are four in number on one side, and are more nearly conic, and have incurved apices. The median premaxillary suture is, however, not clearly defined, so that the number of premaxillaries remains uncertain. The centre of the probable nostril measures one-third the distance from the premaxillary border to the anterior edge of the orbit. There are eight rows of (?) pterygoid teeth at the posterior fourth of the series. The teeth are subequal and obtuse, increasing a little anteriorly.

The mandibular ramus is robust, and the external face slopes inwardly and downwards. The external border rises a little above a few of the posterior teeth, but it is injured at the posterior of the coronoid process, so that its existence cannot be ascertained. The border then descends and turns inwards to the articulation, which is condyloid at its internal extremity. The inferior edge of the anterior part of the ramus becomes a median ridge below the condyloid region, and terminates in a short, compressed angular process. The symphysis is not coössified, and is convex downwards and forwards. The inferior part is subhorizontal, and forms the edge of a transverse plate which is separated from the vertical part of the ramus by a deep groove. The inner vertical face of the ramus is strongly convex, as is the corresponding edge of the symphyseal suture. The apices of the teeth are worn, but they were probably conic, the posterior gradually smaller and more obtuse. The interior face of packed teeth begins at the posterior two-fifths of the external series, and expands in-

wards posteriorly. It contains six longitudinal rows opposite the antepenultimate dentary tooth.

All the bony surfaces are smooth.

| *Measurements.* | M. |
|---|---|
| Length of mandibular ramus (straight) | .162 |
| " symphysis of do. (straight) | .038 |
| " external dental series | .077 |
| Width of ramus at dental pavement | .040 |
| " skull at ends of OO. quadrata | .138 |
| " extremity of O. quadratum | .024 |
| " occipital condyle | .018 |
| Length of superior dental pavement | .065 |
| Width of basisphenoid posteriorly | .029 |

The supposed axis vertebra is longer than wide, and the centrum is deeply excavated posteriorly. Anteriorly it appears to have lost a piece—the centrum of the atlas, which, while fitting it closely, was not co-ossified with it. There is a flat horizontal convex ala in the place of a diapophysis, and an obtuse median hypapophysial angle. The neural spine is compressed, except posteriorly, where it is transversely expanded, terminating above in a short obtusely accuminate apex. From this apex an obtuse rib passes down the median line, and disappears above the neural arch, where the spine is somewhat narrower. The postzygapophyses are well developed and look downward.

| *Measurements of axis.* | M. |
|---|---|
| Length of centrum below | .020 |
| Width, including diapophyses | .035 |
| Elevation of spine from postzygpophysis | .038 |
| Width of do., posteriorly | .020 |

*Remarks.*—This interesting form is probably allied to *Pantylus*, which I have hitherto regarded as a Batrachian. The two genera may be placed in a special family of the Pelycosauria, to be called the *Edaphosauridæ*. This family will be distinguished from the *Clepsydropidæ* by the presence of more than one series of teeth on parts of the jaws. It is possible that *Helodectes* must be placed in it.

## ECTOCYNODON Cope.

Paleontological Bulletin No. 29, p. 508.

A species now before me resembles in generic characters the type of this genus, *E. ordinatus*. That species was described as having the canine tooth near the middle of the maxillary bone, while in the present one it is near the anterior part of it, as in some other genera. In the typical species, as in the species to be described, the cranial bones are sculptured, and the temporal fossæ are overroofed. The sculptured surface as well as the canine teeth distinguish *Ectocynodon* from *Pariotichus* Cope and *Procolophon* Owen, which genera are otherwise related.

ECTOCYNODON AGUTI, sp. nov.

This reptile is much larger than the *Pariotichus brachyops*, and the anterior part of the cranium has a different form. The general shape of the head is much like that of a rodent mammal of the genus *Dasyprocta*. It is rather wide at the temporal regions, flat above, and narrowed and compressed anterior to the orbits. The muzzle is narrowed and obtuse, and the nostrils are terminal, and are lateral and a little anterior in direction. The maxillary alveolar edge is nearly straight, but the premaxillary edge, beginning below the posterior border of the nares, descends forward at an angle of 45°. Viewed from the front, the premaxillary border is a festoon, strongly convex downwards, and below the anterior part of the nostril. The suture separating the premaxillaries is distinct. The orbits are of moderate size, as in an aguti, and invade the superior frontal plane in a slight degree. The frontoparietal fontanelle is rather large.

The mandible is robust, and presents a short angle. It closes up behind the premaxillary lobate edge. Its teeth are concealed in the specimen. The maxillary teeth increase rapidly in size forwards. The premaxillaries commence smaller next the maxillaries, and increase in size to the first, which is a little larger than the anterior maxillary. The crowns are weathered away. The sculpture on the maxillary and malar bones consists of closely placed shallow fossæ. On the posterior part of the frontals there are strong ridges radiating posteriorly, and situated close together.

| *Measurements.* | M. |
|---|---|
| Length of skull to end of angle of lower jaw | .090 |
| " " frontoparietal fontanelle | .056 |
| " " orbit, above | .026 |
| " ramus mandibuli | .082 |
| Depth of skull at orbit | .033 |
| " ramus " | .019 |
| Width of skull posteriorly | .068 |
| " " between orbits | .017 |
| " " between external nares | .0105 |
| Diameter of first premaxillary tooth | .003 |
| " second maxillary tooth | .003 |
| Six fossæ of the malar bone | .005 |
| Seven grooves of the frontal bone | .005 |

This species is much larger than the *Ectocynodon ordinatus* Cope, and the canine tooth has a more anterior position.

Discovered by W. F. Cummins.

## DIPLOCAULUS Cope.

Paleontological Bulletin No. 26. p. 187, Nov. 21st, 1877. Proceedings American Philos. Society, 1877, p. 187.

This genus was characterized by me at the places cited, as follows: "Vertebral centra elongate, contracted medially, and perforated by the

foramen chordæ dorsalis, coössified with the neural arch, and supporting transverse processes. Two rib articulations, one below the other, generally both at the extremities of processes, but the inferior sometimes sessile. No neural spine nor diapophysis ; the zygapophysis normal and well developed."

This diagnosis was derived from the vertebræ of a single species from the Clepsydrops shale of Illinois, the *D. salamandroides*, and since that description was written, no additional specimens have come under my observation. In the Catalogue of the Vertebrata of the Permian I placed the genus as the type of a family, the *Diplocaulidæ*, among the Pelycosauria. I am now, however, through the energy of Mr. W. F. Cummins, in possession of specimens of a number of individuals of a second species of *Diplocaulus*, found by him in the Permian beds of Texas. From them I derive that the genus and family must be referred to the Stegocephalous Batrachia. It is, however, exceptional among these in the fauna of which it is a member, in not belonging either to the Rhachitomi* or to the Embolomera, since the vertebral centra are not segmented, nor are the intercentra present in any form. Under these definitions it must be referred to the suborder which includes *Oëstocephalus*, *Ceraterpeton*, etc., for which I have adopted Dawson's name Microsauria. The division includes genera with simple amphicœlous vertebral centra, and teeth without inflections of the dentine. The following characters must be added to *Diplocaulus :*

Vertebræ with a more or less perfect zygosphen articulation ; centra shorter in the anterior than in the median part of the column ; axis and atlas solidly united by a long zygosphen, which is not roofed over by the zygantrum. Neural arch continued as a short tube into the foramen magnum. Atlas unsegmented, and, like the axis, without free hypapophysis. Cervical vertebræ not distinguished from dorsals, and with two-headed ribs.

Orbit separated from the maxillary bone by the union of the lachrymal and malar. Either the malar, or more probably the quadratojugal, extends much posterior to the quadrate bone. It is bounded above by the squamosal, which extends anteriorly to the distinct postfrontal, thus covering over the temporal fossa. Posteriorly it extends into a long, free process, like the operculum of *Polyodon* ossified. This horn does not appear to consist of the epiotic as appears to be the case in *Ceraterpeton*. The quadrate bone is extended very obliquely forwards and its extremity is divided into an hourglass-shaped condyle. In other words the condyle consists of two cones with apices continuous. The internal cone is the smaller, and its base is overlapped from before by a flat bone, probably the pterygoid. The cotyli of the mandible correspond. Mandible without angle ; symphysis short.

The teeth are of about equal size, and are rather slender and with conical apex. Their surface is not inflected at any point. The superior series is

* American Naturalist, 1882, p. 334.

double, forming two lines between which the mandibular teeth close. This superior series stands near the external edge of the vomer, palatine and pterygoid bones successively. I have not been able to find any larger teeth in the jaws in this genus. Some fragments mingled with those here described, display such teeth, but I think they pertain to a species of another genus. I know nothing of the limbs of this genus.

DIPLOCAULUS MAGNICORNIS, sp. nov.

The species is indicated by fragments of a number of crania, and portions of several vertebral columns. These were collected at two different localities by Mr. W. F. Cummins.

The skull is very peculiar in the great extent of the parts posterior to the orbits as compared with the portion anterior to them. The posterior border not being complete, the proportions cannot be exactly given, but the part anterior to the orbits is two-thirds the length of the part extending from their posterior border to near the base of the lateral horn, and one-fifth the distance from the orbit to the extremity of the horn. The part of the border of the orbit preserved indicates that the latter is of fair size. It is separated from the maxillary border by at least its own diameter. The external nares are peculiarly situated. They are nearer the orbit than the end of the muzzle, and are close to the maxillary border, being separated from the mouth by a narrow strip of bone only. They are round, open nearly laterally, and are removed from the edge of the orbits by the diameter of the latter.

The malar or quadratojugal bone is protuberant at the canthus oris and projects laterally beyond the mandible at its posterior part. It also projects beyond the extremity of the quadrate bone. This border is continued as that of the external base of the horn, but the portion which belongs to this element is soon distinguished from the superior element (squamosal) which composes the horn, by a groove. This groove is decurved, and bounds the apex of the element, which is a decurved, low tuberosity. The horn is produced backwards in a horizontal plane, forming a long flat triangle which contracts gradually with straight sides. The apex is narrowed, obtuse, and a little incurved. Near and at the extremity the horn is flat above and convex below.

The mandibular quadrate cotylus consists of two fossæ, which together form an approximate figure $\infty$, of which the internal fossa is the smaller, and opens internally. The external one is nearly transverse. The superior border of the ramus posteriorly is straight. The greater part of the superior aspect is occupied by a huge fossa which opens upwards.

It is uncertain whether the horns meet at an entering angle on the middle line posteriorly or not, but the width of the base of the horn indicates that such is the case. The extremity of the muzzle is depressed, and is broadly rounded.

The external surface of the skull is sculptured in the form of fossæ so distributed that the narrow ridges separating them do not form straight

lines, except in a few places on the superior face of the horn. This sculpture is strongly impressed, and is of medium coarseness. It extends on the inferior face of the quadratojugal (?) posterior to the quadrate, and on the inferior side of the horn at the edges. It is most extended below from the interior edge, and for the terminal inch of the horn, is as well marked as on the superior face. Elsewhere the sculpture of the inferior side passes into punctæ before disappearing. A groove marks the superior boundary of the maxillary bone, which divides when it reaches the superior surface. One branch descends behind the nostril, the other passes transversely across the lachrymal bone and shallows out before reaching the middle line of the muzzle. The mandible is even rougher than the superior surfaces, and has a longitudinal groove below the dental line, to near the symphysis, where it runs out on the alveolar edge. The internal and external sides of the mandible posteriorly, are smooth. On the malar and other facial bones there are four fossæ in 9 or 10 mm.

The atlas is peculiarly flattened above, the neural arch being a tube, without neural spine. Its anterior tubular prolongation is not long, and is deeply notched below. The condyloid fossæ are widely spread transversely and nearly flat, except that their surface is carried forwards on the neural tube. They are well separated below. There is a strong hypapophysial keel, which diminishes and runs out anteriorly. There are prezygapophysial facets, but the postzygapophyses exist. Their superior edge is however carried posteriorly to form the sides of the huge embracing zygantrum. These side processes, which I will call zygantropophyses, extend as far posteriorly as above the posterior end of the centrum of the axis, embracing almost the whole of the neural arch. There is another short median superior process, which notches the extremity of the zygosphen. The side of the atlas between the postzygapophysis and the condyloid facet is wrinkled, and the inferior face finely punctate.

In the axis, the hypopophysis is a large ridge with a horizontal truncate edge. The costal heads of the diapophysis are not split to the base of the latter and the superior is the more robust (extremities broken off). Centrum concave posteriorly, and on each side of hypopophysis with reticulate surface. A short zygantropophysis ; zygantrum not large. Exposed summit of zygosphen (nearly equal neural arch) without neural spine. In both the axis and other cervical vertebræ, the superior diapophysis is connected with the zygapophyses fore and aft, in accord with the shortness of the centra. In the more posterior vertebræ they become separated on account of the increasing length of the centrum.

The third vertebra is like the axis, except in having a keel-shaped neural spine, and a short obtuse zygosphen continued from its base anteriorly. With increasing length of centrum the diapophysis becomes longer, and the hypapophysial ridge becomes wider, and coëxtensive with the inferior face of the centrum. It is separated by an angle from the sides in the longer vertebræ ; in those of intermediate length, the inferior face is

convex. All of them retain the delicate lines and punctæ of the inferior surface. The neural spine on the more elongate vertebræ is a rather elevated keel, with horizontal superior edge. Its posterior extremity forms a wedge-like zygosphen. The zygantrum is a deep V-shaped cavity, opening posteriorly and not roofed over at any point unless for a small part of its fundus. The zygapophyses are well spread, and have horizontal faces. Each of the columns of the diapophysis sends a ridge forwards, which enclose a groove between them.

| *Measurements of vertebræ.* | M. |
|---|---|
| Length of atlas below | .015 |
| " " at zygantropophyses | .029 |
| Expanse " " condyloid facets | .034 |
| " of centrum atlas behind | .0145 |
| Depth of atlas at middle | .019 |
| Length of axis below | .015 |
| " " at zygantropophyses | .016 |
| Width of zygosphen above | .011 |
| Expanse of postzygapophyses | .024 |
| Width of centrum posteriorly | .012 |
| Depth " " | |
| Length of centrum of another (No. III) | .018 |
| " " " (No. IV) | .022 |
| Expanse of postzygapophyses of do | .018 |
| Length of centrum of No. V | .022 |
| Diameters centrum V anteriorly { vertical | .013 |
| Diameters centrum V anteriorly { transverse | .012 |
| Expanse prezygapophyses | .021 |
| Elevation of neural spine from centrum | .011 |
| Diameters centrum No. VI { anteroposterior | .023 |
| Diameters centrum No. VI { vertical | .011 |
| Diameters centrum No. VI { transverse | .013 |

The vertebræ of this species are very much larger than those of the *D. salamandroides*, and the diapophyses do not originate so low down on the centrum. Otherwise they are much alike. The cranium of the Illinois species is yet undetermined.

The *D. magnicornis* was discovered by W. F. Cummins.

## ACHELOMA. Cope, genus novum.

Order Rhachitomi; family Eryopidæ,* differing from *Eryops* in the absence of notch of the posterior border of the skull between the epiotic and quadrate or squamosal bones, and in the absence of condyles of the humerus.

Mandible without angular process. Teeth of the jaws subequal, rather larger anteriorly; some large ones on the *os palatinum* at different points

* American Naturalist, 1882, p. 335.

along the external margin. Pterygoid bone ending in a free decurved edge anterior to the quadrate bone. Palatines and pterygoids narrow, leaving a wide palatal foramen. Vertebræ in their principal features as in *Eryops*. The humerus is unlike any of those enumerated in my synopsis of Permian humeri,* but resembles the one figured by Gaudry as belonging to *Actinodon*, except that in *Acheloma* there are no condyles, and there is an epicondylar foramen. This is the first time I have observed the foramen in a Batrachian, though it is universal, so far as known, in the Pelycosauria. As in *Actinodon*, there is a short process above the external epicondylar angle.

The absence of humeral condyles in this genus is paralleled by the same feature in *Clepsydrops natalis*. It looks as though the animal were young, and had not yet attained to the coössification of epiphyses. This theory may account for the condition of the humeri in the two species mentioned. It occurs equally in the *Trimerorhachis insignis*. As all these species show every other indication of maturity, and as I have never yet observed free epiphyses in any of my numerous Texan collections, I am disposed to look on this condition of the humeri as a case of permanent incompleteness, of which the Batrachia present so many instances.

ACHELOMA CUMMINSI, sp. nov.

This animal is represented by a greater part of a skull and vertebral column, with both humeri and scapulæ and various other bones of the limbs, including phalanges. All of these remains look a good deal like *Eryops megacephalus*, and they might be supposed on hasty examination to belong to the young of that species. On a full investigation the following differences appear, besides those already mentioned in the generic diagnosis.

The muzzle is relatively much shorter, and the extremity is less depressed; the length from the supraöccipital forwards, is a little less than the total width at the same point. In agreement with this, the mandibular rami, after diverging strongly from the symphysis, are strongly incurved to the quadrate, a form not found in *E. megacephalus*. The sculpture is more sharply defined in the present species. In the vertebræ, although the intercentra have the same degree of ossification as in the *E. megacephalus*, the neural spines have not the expanded head of those of the larger species, but look as though they had lost an epiphysis, as in the case of the humeri. They are erect, with subquadrate section, and not oblique and grooved as *Trimerorhachis insignis*. The diapophyses are more elongate than in *E. megacephalus*, and their extremities frequently have a subround or suboval section, and but few have the narrow surface seen in *E. megacephalus*. The ribs are short and flat, and have the distal extremities expanded paddle-shape. Laid backwards such a rib reaches to the posterior edge of the third diapophysis posterior to the one to which it is attached.

* Proceedings American Philos. Soc., 1878, p. 528.

The form of the skull is triangular, with rounded apex or muzzle, and a slight contraction behind the nostrils. The latter are near the edge of the jaw and open equally laterally and superiorly. The orbits are of medium size, and are as far from the edge of the jaw as the width of the interorbital space, which is about as wide as the diameter of an orbit. The posterior "table" is flat with decurved lateral edges, which rest in a squamosal suture on the squamosal or quadratojugal and quadrate bones. Its posterior angle is produced downwards and backwards to near the distal extremity of the quadrate. The latter slopes posteriorly and downwards. The quatratojugal region is strongly convex in vertical section. The mandibular ramus is strongly incurved posteriorly, from a point opposite the free extremity of the pterygoid. The symphysis mandibuli is short.

The sculpture is distinct on all the superior surfaces of the skull, and consists of fossæ of medium size, bounded by irregular narrow ridges. There are three fossæ in 10 mm. The fossæ are obsolete on the extremity of the muzzle and on the anterior part of both jaws.

The teeth are a little longer on the premaxillary than on the maxillary bone. There are five on each, or six, if the tooth below the nostril belongs to the premaxillary bone, The palatine teeth are much larger. The first, perhaps standing on the external edge of the vomer, is a little posterior to the line of the external nostril. The second is half way between the nostril and orbit, and the third is alongside of and just posterior to it. The fourth is opposite a point a little posterior to the middle of the orbit. Their surface is as yet obscured by a thin layer of fine indurated mud, which in some instances cannot be removed without destruction of the tooth surface.

The intercentra of the vertebræ are, as in *Eryops megacephalus*, ossified so as to nearly cut off the chorda dorsalis, but unlike that species they are not notched on one side of their lateral apices. The extremities of the neural spines are subquadrate, rounded behind, and flattened anteriorly. The edges of the postzygapophyses are prominent and flared upwards.

The scapula is robust and flat, having the posterior-external border longest, and concave, and the superior-posterior, convex. In my specimens the thin anterior edge is broken. The coracoid appears to be coössified with the proximal external edge of the scapula, and is directed downwards and backwards. Its extension is small, and terminates in an apex posteriorly, and a thick double edge inferiorly. The glenoid cavity borders this edge, and is small. The epicoracoid if it existed, is lost. The thick inferior edge of the coracoid and scapula, is similar to those of the humerus and vertebral processes, which suggest a cartilaginous cap. The position of the scapula and coracoid is peculiar. If the glenoid cavity is directed outwards, the ribs adherent to them fit their extremities, from which they have been broken, which adhere to the vertebræ. This is probably the natural position. When thus placed, the plate of the scapula is horizontal transversely, and inclined upwards and posteriorly at 30°. The coracoid

is vertical. When in place, there is a large tuberosity above and anterior to the glenoid fossa, immediately behind which is a wide shallow fossa.

The curve of the proximal extremity of the humerus is a semicircle. That of the distal end is less convex, being flattened at the middle. Viewed proximally the proximal end is a little concave on one side, and one extremity of the articular surface is expanded and rounded. Viewed distally, the distal extremity is angulate concave, the middle portion being straight and the extremities bent in the same direction, one being longer than the other, and neither expanded. The entire extremity makes an angle of 90° with the plane of the proximal end. The epitrochlear foramen is protected by a strong bridge.

*Measurements.*

| *Skull.* | M. |
|---|---|
| Length to line of angles of mandible | .188 |
| " posterior edge of supraöccipital | .168 |
| " line of posterior edge of orbit | .121 |
| " " anterior edge nares | .017 |
| " " extremity of pterygoid | .142 |
| Width of skull at angles of mandible | .134 |
| " " , greatest | .158. |
| " " just behind nares | .051 |
| " " at nares | .054 |
| " of cranial table at middle | .086 |
| " between orbits | .030 |
| Length of a premaxillary tooth | .011 |
| Diameter of base of do | .004 |
| Length of a median maxillary tooth | .007 |
| Diameter of base of do | .004 |
| Length of a median palatine tooth | .021 |
| Diameter of same at base | .009 |
| Depth of ramus mandibuli at angle | .015 |

*Vertebræ and Ribs.*

| | | |
|---|---|---|
| Diameters of intercentrum | transverse | .018 |
| | antroposterior | .010 |
| Total elevation of same vertebra | | .027 |
| Elevation of neural spine above postzygapophysis | | .005 |
| Total expanse of diapophyses of same | | .027 |
| Length of diapophysis from postzygapophysis | | .0095 |
| Diameter of end of neural spine | | .206 |
| Diameter of end of diapophysis | transverse | .004 |
| | vertical | .006 |
| Length of rib of 5th vertebra in advance of the vertebra measured | | .038 |
| Width of rib distally | | .027 |

| *Scapular arch.* | M. |
|---|---|
| Length of scapula on anterior face | .069 |
| Width do. at antero-internal distal angle, transversely | .032 |
| " of coracoid and epicoracoid at glenoid cavity, from edge of scapula | .023 |
| Length of epicoracoid and coracoid | .037 |
| " humerus | .064 |
| Width of shaft at middle | .016 |
| Diameters proximal end { long | .039 |
| Diameters proximal end { short at middle | .010 |
| Diameters distal end { long | .039 |
| Diameters distal end { short at middle | .010 |
| Length ungual phalange | .004 |
| " second " | .0075 |
| " first " | .0135 |
| Width do. { proximally | .010 |
| Width do. { distally | .008 |

This species was discovered by Mr. W. F. Cummins, to whom I dedicate it with much pleasure.

## ANISODEXIS Cope, genus novum.

Class Batrachia; order Rhachitomi; family Eryopidæ. Teeth on premaxillary, maxillary, and dentary bones of unequal lengths, some very large, others very small. Dentinal inflections straight, nearly reaching the pulp cavity. Cranial surfaces sculptured.

This genus differs from all the others of the *Eryopidæ*, in the great and abrupt inequality of the teeth of the external series of the mouth, resembling in this respect some of the Saurians of this deposit, rather than the batrachia. Whether it possesses long palatine or pterygoid teeth such as most of the latter exhibit, is not rendered clear by the specimens, but appearances indicate the presence of one near the anterior part of the maxillary. Mandibular series simple.

ANISODEXIS IMBRICARIUS Cope, sp. nov.

Founded on numerous fragments of the skull with jaws, and a vertebral arch and spine found in connection with the remains of the *Diplocaulus magnicornis*. These pieces indicate a larger species than the latter, and are nearly equal to the *Eryops megacephalus*. The jaws are not preserved entire, but portions from different parts of the length display the dental characters.

The sculpture of such parts of the superior surface of the skull is a coarse reticulation, coarser than in any other species known to me. Near the edges, some of the bones become smoother, and the ridges flatten into overlapping laminæ. The entire sculpture of the dentary bone is of this imbricate character, the apparent overlapping being from before back-

wards, and below upwards. This is totally different from what is observed in the other known species of *Eryopidæ, Trimerorhachidæ*, and *Diplocaulidæ*. The teeth are round in section, but become lenticular near the apex, developing low cutting edges. The basal grooves are fine, but distinct, and extend half way to the apex, or farther. One large, and one medium sized teeth stand on each dentary bone near the symphysis, and there are two similar ones at a point further back on the same bone. Near the anterior part of the maxillary, below the ? nostrils, is a huge tooth, with a graduated series of small teeth posterior to it, and a very small one anterior to it.

The neural arch of a vertebra has a well developed vertical spine. Its neurapophysis rested in an oval fossa of the centrum which probably was divided into pleurocentra. The prezygapophyses are very small, and look directly upwards. The postzygapophyses are much larger, and look obliquely outwards and backwards. The spine is not expanded at the summit, and is granular, as though it was protected by a cartilaginous cap. Its section is anteroposteriorly lenticular, with acute edge (angle) posteriorly, and a very narrow truncate edge anteriorly. The latter is bounded below just above the root of the neural arch by two little fossæ. The posterior keel is bounded below by a corresponding single fossa. The posterior acute edge of the spine is dentate, and the surface on each side of it, is beveled with rabbeted surfaces as though for a coarse squamosal suture. But the appearance of suture is fallacious, and is simply due to contraction of the transverse diameter of the spine. The neurapophysis is much narrower anteroposteriorly than the neural spine.

| *Measurements.* | M. |
|---|---|
| Depth of maxillary bone at large anterior tooth | .037 |
| " dentary at symphysis | .025 |
| " " near middle | .021 |
| Width " " " | .015 |
| Diameter of base of large maxillary tooth | .010 |
| " " small maxillary tooth | .0035 |
| Length " " " " | .008 |
| " of large mandibular tooth near symphysis | .016 |
| Diameter of base of crown of do | .006 |
| Elevation of neural arch | .037 |
| Diameters neural spine { vertical | .029 |
| Diameters neural spine { at apex { anteroposterior | .019 |
| Diameters neural spine { at apex { transverse | .012 |
| Width neurapophysis anteroposteriorly | .010 |

From Mr. W. F. Cummins' collections.

I had thought at one time that this species might be referable to the genus *Leptophractus* of the Coal Measures. No trace of the vertebræ of the Rhachitomous order has yet been found in that formation in this country, nor have any of the Coal Measure genera of Batrachia yet been found in

the Permian of the United States.* It is not improbable that such occurrence of genera may yet be substantiated, but the identification of an order hitherto unknown in a formation, on uncertain characters, is not a safe proceeding. The vertebræ of *Leptophractus* although not certainly known, are supposed to be of the Labyrinthodont type. The teeth are much more compressed and trenchant than in the present species, nor do there appear to be any long ones near the symphysis mandibuli. I consider the question of reference to Leptophractus to be still an open one.

The family *Eryopidæ*, though abundant in individuals, is not represented by many species. They are presumably as follows :

*Anisodexis imbricarius* Cope.
*Acheloma cumminsi* Cope.
*Eryops reticulatus* Cope.
*Eryops ferricolus* Cope (*Parioxys olim*).
*Eryops megacephalus* Cope.
*Actinodon frossardi* Gaudry.
*Zatrachys serratus* Cope.
*Zatrachys apicalis* Cope.

But the occipital condyles are unknown in *Acheloma* and *Zatrachys*.

I may add here that through the courtesy of Messrs. Scott and Osborne, I have seen, in the Museum of Princeton College, vertebræ of some species of the Rhachitomi from Saarbrücken, along with *Archegosaurus*, with entire centra, from the same locality.

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## *Synopsis of the Vertebrata of the Puerco Eocene epoch. By E. D. Cope.*

(*Read before the American Philosophical Society, October 20, 1882.*)

### REPTILIA.

### CROCODILIA.

*Crocodilus* sp.
*Crocodilus* sp.
*Crocodilus* sp.

### TESTUDINATA.

*Plastomenus ? communis* Cope.
*Dermatemys* sp.
*Compsemys* sp.
*Emys* sp.

* *Peplorhina arctata* Cope, from the Illinois Permian is not a *Peplorhina*, but a Theromorph Saurian.