

THE CARBONIFEROUS  
FISHES  
OF  
KANSAS.

by

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A thesis submitted to the Department of Zoology and  
the Faculty of the Graduate School in partial  
fulfillment of the requirements for the  
Master's degree.

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-----  
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April 1 , 1917 .

Crockett, California,  
April 1, 1917.

Doctor Frank Blackmar,  
Dean of the Graduate School,  
University of Kansas,  
Lawrence, Kansas.

My Dear Sir:-

I have the honor to submit to you herewith a thesis on " The Carboniferous Fishes of Kansas ", to satisfy the conditions for a Master of Arts degree.

The subject matter is based on the fish remains in the Natural History Museum of the University of Kansas. In the previous study of the paleontology of Kansas, this interesting field has been largely overlooked.

I am especially indebted to Doctor Roy L. Moodie for counsel and assistance.

very respectfully,



## I L L U S T R A T I O N S .

## PLATE I.

*Campodus variabilis.*

*Campodus corrugatus.*

## PLATE II.

*Physonemus mirabilis.*

*Listricanthus hystrix.*

## PLATE III.

*Cladodus intercostatus.*

Jaw of Small Shark.

*Fissodus bifidis.*

## PLATE IV.

*Petrodus occidentalis.*

*Chomatodus arcuatus.*

## PLATE V.

*Petalodus alleghaniensis.*

*Sandalodus parvulus.*

## PLATE VI.

*Deltodus grandis.*

*Sandalodus carbonarius.*

## PLATE VII.

*Sandalodus carbonarius.*

*Deltodus attenuatus.*

## PLATE VIII.

*Sandalodus laevissimus.*

*Poecilodus cestriensis.*

*Poecilodus carbonarius.*

## PLATE IX.

*Ctenoptychius.*

TABLE OF CONTENTS.

	page
Letter of Transmissal	2.
Acanthodopsis wardi	12, 65.
Carboniferous	8, 9.
Campodus corrugatus	16, 24, 70.
Campodus variabilis	17, 36, 70.
Chomatodus arcuatus	18, 52, 76.
Cladoselache	11.
Cladodus intercostatus	18, 34, 74.
Cladodus zygopus	50.
Cochliodont	11.
Ctenoptychius	26, 88.
Ctenoptychius dentatus	18, 45.
Ctenoptychius lobatus	17, 28.
Ctenoptychius semicircularis	54.
Cyclostomes	7.
Devonian	7, 8, 11.
Deltodus attenuatus	19, 32, 82.
Deltodus grandis	19, 67, 80.
Diplicanthus	66.
Elasmobranch	8.
Fissodus bifidis	19, 58, 74.

	page
Listricanthus hystrix	19, 30, 72.
Mississippian	9, 11, 12.
Mandible	69.
Pterichthys	25.
Pennsylvanian	9, 11.
Petalodont	11.
Petalodus alleghaniensis	19, 47, 78.
Petalodus curtus	20, 50.
Petrodus occidentalis	20, 56, 76.
Physomenus mirabilis	20, 63, 72.
Poecilodus carbonarius	21, 41, 86.
Poecilodus cestriensis	21, 88.
Port Jackson Shark	10.
Sandalodus carbonarius	21, 22, 80, 82.
Sandalodus parvulus	21, 23, 78.
Sandalodus laevisissimus	21, 68, 86.

## INTRODUCTION.

Palaeontology furnishes no clew to the origin of fishes or of the primitive fish like vertebrates found in the Silurian and Devonian rocks of this country and of Europe, especially the Old Red Sandstone. It seems possible that the ancestors of the fishes were soft bodied like the lowest chordates of the present, with no hard parts capable of preservation. Dr. D. S. Jordan in "Guide to the Study of Fishes ", 1905, Vol. 1, p 487 says, "No species belonging to the class of Cyclostomes have been found fossil. We may reason theoretically that the earliest fish like forms were acraniate or lancetlike and that lamprey-like forms would follow these but it cannot be substantiated from the fossils. Lancets have no hard parts whatever and could probably leave no trace in any sedimentary deposit. The lampreys stand between lancets and sharks. Their teeth and fins might occasionally be perceived in the rocks but no structures certainly known to be such have yet been recognized. It is, however, reasonably certain that the modern lamprey and hag fish are descendants, doubtless degraded and otherwise modified, from species which filled the gap between the earliest chordate animals and the jaw bearing sharks ".

Many consider the Fishes proper as having descended from Elasmobranchs, traces of which are found even in the Silurian, but whether these and the fish-like Agnatha have a common ancestry is a matter of speculation.

During the Carboniferous, Fishes were more numerous and varied than in the Devonian. The Elasmobranchs were far more numerous and powerful than the Ganoids and Placoderms which were largely superseded by sharks and driven to the shores and to the fresh water. (see Palaeozoic Fishes of North America by J. S. Newberry p.78 )

In the Silurian, "Onchus" the first of the sharks had spines. Later other fishes developed them and they are commonly found in the Carboniferous. The striking peculiarity of the Elasmobranchs of the Carboniferous is that so many of them were provided with defensive spines. While this was true of some fishes of the Devonian and of some of the Jurassic, defensive spines found in the Carboniferous rocks outnumber ten to one those of any of the other geological ages including the present. A large number of species bore defensive spines which show many modifications for securing great effectiveness. ( see Palaeozoic Fishes of North America by J. S. Newberry 1889.p.79 ).



It might be contended that we have no way of knowing how many defenseless sharks existed. If they did exist they would leave evidence in their teeth and dermal tubercles. These are found in great numbers it is true, but when we group them in genera species we see that the variety of dermal tubercle is far surpassed and that the variety of the teeth is nearly equalled by that of the spines.

The Carboniferous is usually divided into two periods; the Mississippian and the Pennsylvanian. The Mississippian, or sub-Carboniferous, was a period of expansion of the epicontinental sea especially to the westward where the deposits of the period probably underlie the Great Plains. The interior sea probably connected broadly with the Pacific in the west and northwest. The Mississippian closed with an emergence which included at least most of the land east of the onehundredth meridian.

The Carboniferous which followed was a period of great land area for a short time, then a brief submergence followed by a long interval during which the area of the eastern interior maintained a halting attitude, being now slightly above the sea level and now slightly below it.

By the middle of the Mississippian period the marine

fishes had made such relative progress that they were in unquestioned supremacy. (See Geology by Chamberlain and Salisbury vol. 2.p. 535 ) The extension of the seas and the restriction of the land areas probably brought this about. In the seas the sharks soon arose to undisputed supremacy as the great sea reptiles which later preyed on the marine fishes had not yet risen. This made it possible for an immense number of fishes to live and contending with each other may have led to great variation.

At least three fourths of the sharks had crushing or pavement teeth adapted to breaking the shells of mollusks and crustaceans and the trituration of sea weeds. The tooth pavement was formed of large plates of thickness ranging up to one and one half inches, composed of solid dentine below and a thick sheet of enamel above which was fitted, ridged and otherwise roughened to prevent the slipping of the shell fish diet. The multiplication of these conchivorous sharks introduced a new factor into the invertebrate struggle for existence and perhaps accounts for the decline and disappearance of some forms and the modification of others. The larger sharks had often several hundred pavement teeth in each jaw. They were probably placed in an enrolled manner as those of the most direct descendant, the Port Jackson shark, (*Cestracion philippi* ) .

Sharks with piercing teeth were represented at the very opening of the Carboniferous by Cladoselache, and later by Cladodus etc.. Some of these fishes were large and formidable, "armed with teeth in many rows, several hundred in each set". The Petalodonts were a conspicuous group of sharks with peculiar cycloid cutting teeth. The Arthrodirans, which were large and abundant during the transition period from the Devonian, lingered in reduced importance thru the Mississippian and into the Pennsylvanian, when they disappeared. The lung fishes had declined but were represented by Ctenodus. The Holoptychians had disappeared, but the Crossopterygians were represented by several genera, see "Geology by Chamberlain and Salisbury vol. 2, p 489" that took on a closer resemblance to modern forms. Of the fresh water fish, probably the culminating type was Actinopterygian of the order to which the modern gar pike belongs.

During the Pennsylvanian, it is difficult to tell which of the fishes should be regarded as marine, which as fresh water and which as common to salt and fresh water. Probably the larger number of the Coal Measure fish were of fresh water varieties. The Cochliodonts and Psammodonts with their crushing pavement teeth were chiefly marine in all probability while those with cutting teeth were largely marine but not entirely so. (Chamberlain and Salisbury,

Geology, vol. 2, p. 615.)

The Coal Measures proper of Kansas, that is the entire rock mass lying between the Mississippian and the Permian, measure nearly 3500 feet in the southeastern part of the state and in general decrease northward to a little less than 3000 feet along the Kansas River section (Haworth & Bennett, Univ. Geol. Surv. of Kansas vol. 9, p. 73, 1908.) The Mississippian is exposed in only a very small portion of the southeastern part of the state and, as far as I know, has yielded no fish remains in the state.

" The Kansas Coal Measures consist of a series of alternations of more or less barren shales and thin fossiliferous limestone, of which many of the latter can be traced as terraces or escarpments, from the northern side of the state to the southern, and, in addition, several of them have been traced into Nebraska, Missouri and Oklahoma. The shale zones are not generally calcareous and most of them contain locally thin beds or bands of coal or highly carbonaceous shale. The limestones are of marine origin, and such is also true of many of the shales but it is certainly equally true that some of the latter are to be considered as of fresh water origin. The absence of thick zones of coarse sandstone permits the inference that the land was not of great

relief and was probably characterized by sluggish meandering streams which spread layers of mud over their flood plains and deltas. During times of relative stability the delta extended into the sea which the typically marine deposits indicate was at no time of great depth. The shore is probably to be conceived of as a wide mud flat with small shore lakes and swamps, over which the tides swept for greater or less distances. Intermittent submergence would bring from time to time portions of the mud beneath the sea and initiate the deposition of limestone, thus giving rise to an interfingering of marine and continental deposits."

(Twenhofel and Dunbar, Am. Jour. Sci., vol 38, p.161 Aug.1914)

The Coal Measures of Kansas have furnished a large variety of fishes which have been studied by Williston, Branson, Hay, Cope, and Moodie. The remains come largely from the limestone and are probably marine but those like "Listricanthus hystrix from the shale may have been shallow water or even fresh water fish. By far the greater number of remains are pavement teeth. Petalodont teeth are however quite common. The forms are very closely associated with those of Illinois and Indiana as we would expect with marine fishes of the same epicontinental sea. The published descriptions and figures of the Illinois Geological Survey especially have been depended upon in making the determinations

The relations between the Kansas forms and the European forms are very intimate. The remains consist of teeth, spines and dermal tubercles, usually in a limestone matrix but occasionally in calcareous and in limonite nodules. Since the writer has had access to the collection in the Natural History Museum of the University of Kansas, there have been added eighteen fish skulls and other fish remains found in nodules. A general account of these without any systematic descriptions is found in American Journal of Science, vol. 28, August 1914. From this the writer quotes the following, "The vertebrates were submitted to Dr. Moodie and his identifications are as follows :- tooth of Cladodus teeth of Gochliodonts, two teeth of Diplodus, spine of Ctenacanthus, dermal tubercles of fishes, fish coprolites, and eighteen skulls of small fishes, whose systematic position has not been determined. Three of the skulls contain remarkably well preserved casts of the brain - a feature of preservation which Dr. Moodie states 'is unique in the history of vertebrate paleontology' ".

The localities which have furnished fish remains in the Coal Measures of Kansas, are ;Fulton in the Marmaton stage, Iola (and Holt, Mo. ) in the Pottawatomie stage, Baldwin, Leavenworth and Lawrence in the Douglas stage, Deer Creek in the Shawnee stage and Manhattan in the Wabaussee stage.

This gives fish remains from every stage of the Pennsylvanian except the Cherokee stage which is largely shale and yields comparatively few even of invertebrate fossils.

## BIBLIOGRAPHY of CARBONIFEROUS FISHES of KANSAS.

*Acanthodopsis wardi*, Hancock & Atthey.

*Acanthodopsis wardi*, Hancock & Atthey, Magazine of  
Natural History, 1868, Vol. 1, p. 364, plate 1.

*Acanthodopsis*, R. H. Traquar, Proceedings of Royal  
Philosophical Society of Edinburg, 1880, Vol. 5, p. 117.

*Acanthodopsis wardi*, R. H. Traquar, Proceedings of the  
Royal Philosophical Society of Edinburg, 1890,  
Vol. 27, p. 388.

*Campodus corrugatus*, Newberry & Wörthen.

*Orodus corrugatus*, Newberry & Worthen, Geological Sur-  
vey of Illinois, Palaeontology, 1870, Vol. 4,  
p. 358, plate 3, fig. 18.

*Agassizodus corrugatus*, St. John & Wörthen, Geologic-  
al Survey of Illinois, Palaeontology, 1875, Vol. 6,  
p. 323, plate 8, fig. 24.

*Campodus corrugatus*, Chas. Eastman, Science



*Campodus variabilis*, Newberry & Worthen.

*Lophodus variabilis*, Newberry & Worthen, Geology of Illinois, Palaeontology, 1870, Vol. 4, p. 361, plate 4, figures 4-5-11.

*Agassizodus variabilis*, St. John & Worthen, Geology of Illinois, Palaeontology, 1875, Vol. 6, p. 318 figure 1-22, plate 8.

*Campodus variabilis*, A. S. Woodward, Catalogue of Fossil Fishes. 1889

*Ctenoptychius lobatus*, Estridge.

*Petalodus ? lobatus*, R. Estridge, Geological Magazine, 1875, Vol. 2 p. 244, plate 8, figure 5-6.

*Ctenopetalus crenatus*, J. W. Davis, Transactions Royal Dublin Society (2) 1883, Vol. 1, p. 573 plate 61, Figure 9.

*Ctenopetalus crenatus*, J. W. Davis, Quarterly Journal Geological Science, 1884, Vol. 40, p. 623, Pl. 27 Fig. 18.

*Ctenoptychius lobatus*, A. S. Woodward, Catalogue of Fossil Fishes, 1889, Vol. 1, page 50.

*Ctenoptychius dentatus*, Owen.

*Ctenoptychius dentatus*, L. Agassiz, Poiss. Foss.,  
1843, Vol. 3, p. 173. (name only)

*Ctenoptychius macrodus*, L. Agassiz, Poiss. Foss.,  
1843, Vol. 3, p. 383.

*Petalodus dentatus*, R. Owen, Odontography, 1840-5,  
Vol. 1, p. 62.

*Ctenoptychius macrodus*, J. E. Portlock, Report Geology  
London, 1843, p. 467, Plate 14, fig. 7, ( figure  
inaccurate ).

*Harpacodus dentatus*, J. Morris & G. E. Roberts, Quar-  
terly Journal Geological Society, 1862, Vol. 18,  
p. 100. (name only )

*Harpacodus dentatus*, J. W. Davis, Transactions Royal  
Dublin Society, 1883, (2) Vol. 1, p. 514, pl. 61, fig 10

*Cladodus intercostatus*, St. John & Worthen

*Cladodus intercostatus*, St. John & Worthen, Geology of  
Illinois, Palaeontology, 1875, Vol. 6, p. 267, pl 4,  
fig. 11

*Chomatodus arcuatus*, O. St. John.

*Chomatodus arcuarus*, O. St. John, Proceedings of the  
American Philosophical Society, 1870, Vol. 2, p. 435

*Chomatodus arcuatus*, O. St. John, Final Report of  
Geological Survey of Nebraska, 1872, p. 243, pl. 6  
figure 14.

*Chomatodus arcuatus*, St. John & Worthen, Geological  
Survey of Illinois, Palaeontology, 1875, Vol. 6  
plate 10, figure 23.

*Deltodus attenuatus*, Branson

*Deltodus attenuatus*, Branson, Journal of Geology,  
1905, Vol. 8 p. 20 plate 1, figure 6.

*Deltodus grandis*, Newberry & Worthen.

*Deltodus grandis*, Newberry & Worthen, Geological  
Survey of Illinois, Palaeontology, 1866, Vol. 3,

p. 101, pl. 9, fig. 9-9a

*Fissodus bifidis*, St. John & Worthen,

*Fissodus bifidis*, St. John & Worthen, Geological  
Survey of Illinois, 1875, vol. 6 p. 414, pl. 8, fig. 1

*Listricanthus hystrix*, Newberry.

*Listricanthus hystrix*, Newberry, Geological Survey  
of Illinois, Palaeontology, 1870, Vol. 4, p. 372,  
plate 2, figure 3-3a

*Petalodus alleghaniensis*, Leidy.

*Sicarius extinctus*, J. Leidy, Journal of Academy of  
Natural Science, Philadelphia, (2) Vol. 2, 1856, p. 414

*Petalodus alleghaniensis*, J. Leidy, Journal of  
Academy of Natural Science, Philadelphia, (2) Vol. 3  
p. 161, plate 16, figure 4-6 (Specific name  
*extinctus* withdrawn)

*Petalodus destructor*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1866, vol.2, p. 35, plate 2, fig. 1-2-3.

*Petalodus destructor*, O. St. John, Proceedings of the American Philosophical Society, 1870, vol.2, p.433.

*Petalodus destructor*, O. St. John, Final Report of Geological Survey of Nebraska, p. 241, pl.3, fig.5.

*Petalodus alleghaniensis*, J. Leidy, Extinct Vertebrate Fauna Western Territories, (Rept. U.S.G.S. Territories 1873) 1873, p. 312, pl. 17, fig. 3.

*Petalodus alleghaniensis*, J. S. Newberry, Report of Geological Survey of Ohio, 1875, vol.6, p.52, pl.58 figure, 13.

*Petalodus curtus*, Newberry & Worthen,

*Petalodus curtus*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1870, vol. 4, p.355 plate 3, figure 2.

*Petalodus occidentalis*, Newberry & Worthen,

*Petalodus occidentalis*, Newberry & Worthen, Geological Survey of Illinois, 1866, vol.2 p. 70, pl.4, fig.15-16

*Physomenus mirabilis*, St John & Worthen

*Xystracanthus mirabilis*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1875, vol. 6, p. 458, plate 20, figure 1.

*Physonemus mirabilis*, A. S. Woodward, Catalogue of  
Fossil Fishes, 1891, p. 132.

*Poecilodus carbonarius*, St. John & Worthen.

*Poecilodus carbonarius*, St. John & Worthen, Geological  
Survey of Illinois, 1883, vol. 7, p. 139, pl. 8,  
figure 20-21.

*Poecilodus cestriensis*, St. John & Worthen.

*Poecilodus cestriensis*, St. John & Worthen, Geology of  
Illinois, Palaeontology, 1883, vol. 7, p. 135, plate  
8, figure 15-17.

*Sandalodus carbonarius*, Newberry & Worthen.

*Sandalodus carbonarius*, Newberry & Worthen, Geological  
Survey of Illinois, Palaeontology, vol. 2, 1866, plate  
plate 10 figure 4-5

*Sandalodus laevissimus*, Newberry & Worthen.

*Sandalodus laevissimus*, Newberry & Worthen, Geological  
Survey of Illinois, Palaeontology, 1866, vol. 2, p. 104,  
plate 10, figure 6-7-8.

*Sandalodus parvulus*, Newberry & Worthen.

*Sandalodus parvulus*, Newberry & Worthen, Geological  
Survey of Illinois, 1866, vol. 2, p. 102, pl. 10 fig. 1

*Sandalodus carbonarius*, Newberry & Worthen.

*Sandalodus carbonarius*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1886, vol. 2, p. 104, plate 10, figure 4-5.

# 80.2 & 2451, Kansas University Museum of Natural History, Both specimens in limestone matrix with upper third of tooth missing. Kansas City, Mo. Pottawatomie stage.

Posterior left ramus upper tooth.

Triangular in outline or sub-spatulate, strongly arched and very slightly spirally inrolled from within outward. The coronal ridge is quite prominent, one fourth of width of tooth, extending the length of the tooth gradually fading when nearing the inner border and sloping quite rapidly to the anterior lateral margin with the slope to the posterior lateral margin following the outline of the tooth except for a slight furrow near the base. The anterolateral margin is straight, perpendicular and punctate.

The inner margin is of the shape of a quarter of an ellipse of which the posterior lateral is the major axis. Less pointed than *Sandalodus spatulatus*. The surface is finely and evenly punctate; greatest length of tooth 4 cm.

width  $1 \frac{1}{2}$  cm.

*Sandalodus parvulus*, Newberry & Worthen.

*Sandalodus parvulus*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1866, vol. 2, p. 102, plate 10, figure 1.

Small irregular teeth varyingly arched longitudinally and usually quite strongly transversely. One margin quite straight. The other rounds to meet it at the base with an acute angle. The teeth are pointed. The coronal ridge is unusually near the straight margin, broadens at the base falling away toward it while it continues to the point becoming very prominent near there. The broader slope, even in the extreme specimens, does not become flat and usually falls away rapidly. The surface is smooth and is finely and evenly punctate. The teeth show considerable variation.

*Campodus corrugatus*, Newberry & Worthen.

*Orodus corrugatus*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, vol. 4, p. 358, plate 3, figure 18.

*Agassizodus corrugatus*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1875, volume 6, p. 323, plate 8, figure 24.

*Campodus corrugatus*, Chas. Eastman, Science,

#865 University of Kansas Natural History Museum,  
Two large teeth with fragments of smaller ones in matrix of cartilage, Fulton, Kansas, Marmaton stage.

The fine specimen described in the Geological Survey of Illinois, vol. 6, plate 8, fig. 24 was found near Manhattan, Kansas, Wabaunsee stage.

The teeth are very variable in size from 1.5 to 50 millimeters in length and probably form many rows. The largest are arched at an angle of eighty degrees longitudinally and the crown at the same angle transversely. The tooth has a broad massive eccentric cone which in the large specimens has the apex broken in all known. Four sharp ridges reach apparently nearly to the summit. The crown surfaces are strongly and sharply corrugated by a



median longitudinal crest which gives off a branch at right angles to each buttress. The lateral crests or buttresses are beaded or pectinated and more or less of the entire surface is punctate, giving, with the shiny enamel, a high state of ornamentation. The large teeth have strong buttresses on each side, the posterior being a little the stronger. There are three pairs of buttresses on each side of the crown. The crown itself is supported by a pair of very strong buttresses, the sharp ridges of which run nearly to the summit. The cone is eccentric and points backwards at an angle of seventy degrees making it somewhat prehensile.

Length of large teeth 150 mm., width 35 mm., height 35 mm.

## Ctenoptychius -----

# 2458 Kansas University Museum of Natural History,  
one complete specimen of tooth in limestone matrix,  
Forest City, Mo., Shawnee stage.

Two specimens, portions of root and crown, Kansas  
City, Mo., Pottawatomie stage.

Teeth of medium size, The crown is thick at the base but thins to a cutting edge, compressed and laterally strongly curved so that in cross section it is crescent shaped. The anterior and posterior surfaces are highly polished and smooth without striae or pores except where the cutting edge is worn. The sharp cutting edge is imperfectly divided into lobes or denticles, the median strong one being fairly distinct while the others are barely differentiated. The crown has an acute apex making an angle of eighty degrees. The posterior face of the crown is considerably higher than the anterior and has a greater curvature. The root forms a broad shoulder with it which is depressed at the center with a relatively deep conical cavity.

The anterior face forms a deep shoulder with the root and has its basal line broadly and regularly curved

downward in the middle. The lateral margins of the anterior face are acute. The root has the same general shape as the crown as to curvature on both the anterior and posterior sides and is likewise apical, ending in a rather more acute angle than the crown. It is slightly constricted longitudinally just below its union with the anterior face of the crown. The root is slightly roughened on both faces.

*Ctenoptychius lobatus*, Estridge.

*Petalodus? lobatus*, R. Estridge, *Geological Magazine* (2) volume 2, page 244, plate 8, figure 5-6.

*Ctenopetalus crenatus*, J. W. Davis, *Transactions of the Royal Dublin Society* (2) 1883, vol. 1, p. 573, plate 61, figure 9.

*Ctenopetalus crenatus*, J. W. Davis, *Quarterly Journal of Geological Science*, 1884, vol. 40, p. 623, plate 27, figure 18.

*Ctenoptychius lobatus*, A. S. Woodward, *Catalogue of Fossil Fishes*, 1889, volume 1, page 50.

One specimen in limestone matrix, a well preserved tooth. Leavenworth, Kansas, Douglas stage.

Tooth small, crown compressed, arched but not acuminate. The specimen here described is an unsymmetrical lateral tooth with nine denticulations increasing regularly from very fine on one side to relatively coarse on the other. The serrations are obtuse and the larger worn ones show crenulations due to the calcigerous tubes.

The concave crown face is long, ellipsoid in outline and broadly rounded at the extremities. It is scarcely arched vertically but slightly so laterally. It is

covered with a thin smooth enamel. The base line is apparently slightly arched downward in the middle.

The root is the distinctive part. It is about half the width of the base of the crown and tapers to an acute point, being slightly constricted at about two thirds of the way down. This causes it to bear the same relation to the other species of the genus as *Petalodus alleghaniensis* does to the other species of its genus. This tooth shows a strong relation to *Petalodus*. The outline except the denticulations suggests a miniature *Petalodus alleghaniensis*. Length of crown 10 mm., height 5 mm., length of root 5 mm.

*Listricanthus hystrix*, Newberry.

*Listricanthus hystrix*, Newberry, Geological Survey of Illinois, Palaeontology, 1870, volume 4., page 372, plate 2, figure 3- 3a.

# 2460 University of Kansas Museum of Natural History, eight specimens of spines on black shale, Rosedale, Kansas, Pottawatomie stage.

One specimen of a spine in a nodule, Girard, Kansas, Marmaton stage.

One specimen of a spine in a nodule, Baldwin, Kansas, Shawnee stage.

" Spines small, delicate, thin, flattened below, rapidly narrowed above, gently arched in outline, both edges set with sharp spiny teeth directed upward, the sides marked with fine longitudinal ridges which successively terminate above in the margin. The base is obliquely truncated and expanded like a trumpet mouth, indicating that it was set on the surface of the body or head and was not inserted in the integuments."

In this respect these spines resemble those of *Climatius* as well as those of more recent scaled fishes ( *Gasterosteus* etc. ) and may be considered as modified scales or cranial scutes. They probably served both as ornaments and weapons of defense.

The specimens range from 15 to 60 mm. in length.

Those from various Kansas localities as well as a specimen from Vermillion County, Indiana show a remarkable similarity, no difference worthy of note being found.

One well preserved specimen found in a nodule from Baldwin, Kansas is very interesting as it shows that the longitudinal ridges are due to two sets of hollow thin walled tubes, a set on each side of the spine. The inter-tubular spaces are about equal in width to that of the tubes. The tubes number from twelve to fourteen.

Associated with the spines on the same pieces of shale were found numerous fragmentary impressions of fins but all seem very small to go with the spines, being from a half to a centimeter in length. Most of them are nearly circular fins with from six to ten fin rays in their upper part spaced well apart and apparently ending as sharp spines protruding a little beyond the skin. The posterior part is made up of integument without fin rays. The others are narrow fins with a main fin ray from which branches project at an angle of forty degrees.

*Deltodus attenuatus*, Branson.

*Deltodus attenuatus*, Branson, *Journal of Geology*, 1905, vol. 8, page 20, plate 1, figure 6.

# 80.28, Kansas University Museum of Natural History, Specimen complete except part of postero-lateral margin, in limestone matrix. Type specimen. From Kansas City, Mo., Pottawatomie Stage.

Other specimens in the collection are well preserved but no locality has been recorded.

" Posterior right ramus lower tooth, triangular arched somewhat from under margin to point. The large ridge from the outer to the inner border is two thirds of the width of the tooth, nearly flat, of the same general outline as the tooth but fades out toward the inner border of the tooth. From this ridge at the posterior lateral margin the surface drops rapidly and becomes flat while toward the inner margin it becomes even somewhat recurved. The antero-lateral margin is perpendicular and punctate while the inner margin is cut under. The posterior-lateral margin becomes very thin and so is often not well preserved. The surface is strongly and evenly punctate, the pores being



large and oval! Other specimens in the collection show that in the type specimen a portion of the posterior-lateral margin is gone and a depression extends between the alation and the main part of the tooth for about half the length of the tooth. In one specimen this alation has a well developed ridge at its outer margin. These differences can be clearly seen in plate # 7 where the type specimen is photographed with the other specimens. The teeth are very thin in this depression and when in the matrix a broken outline is hard to detect. This makes an interesting addition to the knowledge of this species.

*Cladodus intercostatus*, St. John & Worthen.

*Cladodus intercostatus*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1875, volume 6, page 267, plate 4, figure 11.

One specimen, tooth with part of the base and the upper part of the central cone missing. Exact locality unknown.

Teeth of medium size. The base is semi-elliptical in outline and moderately thick. The posterior margin is broadly rounded, while the extremities are obtusely rounded. The anterior face has a broad sinus occupying two fifths of that side. The inferior surface of the base is moderately excavated, the superior surface moderately convex. Near the posterior edge back of each set of lateral denticles is a low prominence three millimeters in diameter. The posterior edge thins rather abruptly. The crown is obscurely defined behind. The median cone is symmetrical, elliptical in cross section, but broadly rounded behind while somewhat flattened in front. The sinus causes the anterior part of the base to be somewhat excavated. The sides are not very sharply angulated at the junction of the anterior and the posterior faces. Posteriorly the

surface is marked by numerous sharp costae which end in the margin, some of them being implanted. The anterior face has several costae at the base but only two which run nearly to the top. They are spaced a little closer to each other than to either edge of the crown. The lateral denticles are two in number on each side, the outer ones being much stronger than the inner ones, divergent and recurved as much as the median cone. They are subcircular in cross section with several sharp costae. The inner pair are slightly produced in front and supported by a slight protuberance of the base at each side of the sinus. They are, like the lateral cones, ornamented by a few sharp costae and are recurved. This species strongly resembles *Cladodus zygopus*.

Lateral diameter of the base 17 mm. , anterior-posterior diameter 8 mm. , height 17 mm.

*Campodus variabilis*, Newberry & Worthen.

*Lophodus variabilis*, Newberry & Worthen, Geological Survey of Illinois, palaeontology, 1870, vol. 4, p. 361, plate 4, figure 4, 5, 11.

*Agassizodus variabilis*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1875, volume 6, page 318, plate 8, figure 1-22.

*Campodus variabilis*, A. S. Woodward, 1889, Catalogue of Fossil Fishes.

# 2454 Four teeth in matrix of cartilage, sigmoidally curved teeth of median portion of lower jaw. exact locality unknown.

# 2455, Portions of two large median teeth in matrix of cartilage. Iola, Kansas., Pottawatomie Stage.

# 2449, Small anterior teeth., Kansas City, Missouri., Pottawatomie Stage.

Portion of median tooth in matrix of limestone, Baldwin, Kansas.

This is probably the best known of all the cestrationt dentitions. In Osage County, Kansas in 1873 was found a part of the lower jaw with three hundred teeth in their

natural position and in 1874 another specimen found in the same locality was apparently the anterior portion of the ramus of which the former was the posterior two thirds.

In the Geological Survey of Illinois, volume 6, page 313 the following description is based on the Kansas specimens. " The teeth are disposed in serial rows having a convoluted inrollment from the inner to the outer border and gradually increasing in size from the posterior extremity to the row of large median teeth anterior to which the rows diminish as regularly as toward the symphysis. Posterior to the median row, the ramus presents six to nine rows, the extra three rows apparently not reaching the extreme outer borders but spreading over the inner surface of the jaw : the extreme posterior rows diminish to half the vertical extent of the fourth in the series, the mature teeth of which present no perceptible difference, except in their diminished size, to the teeth of the outer rows. These teeth are remarkably uniform in their shape. They may be described as laterally elongated, very slightly arched along the obtuse angle of the crest and slightly curved forward, the anterior end slightly more thickened than the opposite extremity, but without a well defined mesial prominence. The crown is therefore very uniform in proportion and robust. The middle portion of the ramus

is occupied by a row of proportionately very large teeth which differ from the posterior teeth in having the outline of the crest quite strongly arched vertically between the extremities and produced into a strong, obtusely conical, eccentric prominence which culminates at a point more or less posterior to the middle of the tooth. The teeth of the posterior contiguous row also show faint indications near their posterior extremities of an apical culmination from which point the crown tapers anteriorly. The teeth of the anterior portion of the ramus are very similar to those situated posterior to the median row off which there are eight or possibly nine rows gradually diminishing in size anteriorly or in the reverse order to that mentioned above. The teeth of the row immediately in front of the median row are distinguished from the teeth of the corresponding row next behind the median teeth by their slightly greater length and more slender proportions, very slightly curved forward and the more marked definition of the eccentric apical culmination which is situated about a third or less of the distance from the posterior extremity. The teeth of the other rows do not show the latter feature so distinctly tho it extends to the third or fourth row and with the latter there is a tendency to irregularity in the more central position of the obscure apical point. The teeth of the several rows as

mentioned in connection with those of the posterior portion of the jaw present but slight differences from one another, until reaching the extreme anterior rows where they appear to assume irregularities which give rise to considerable diversity especially in the presence in the extreme anterior row of minute, nearly circular teeth which exhibit in the form of the crown and its sculpturing strong likeness to *Petrodus*. The single ramus above described shows about 450 individual teeth, with, in a perfect state probably 500 making probably 1000 teeth for both jaws. A large number of detached teeth found in South Western Iowa differ considerably from these and are referred to the upper jaw. The normal teeth are more or less compressed anterior-posteriorly and obliquely produced downward and backward; vertically arched below with a more or less prominent transverse ridge beneath the coronal border; extremities angular, one or more produced laterally. anterior face vertically concave, interrupted along the upper borders by the supports of the coronal buttresses which originate in the basal surface. Inferior surface well defined flattened in nearly the same plane as the crown with which it agrees in proportionate outline.

relatively narrower anterior-posteriorally, plain or faintly channeled, smooth or obliquely striated. The coronal region is enveloped in an enamel like layer which is almost universally of a light color, often of a lustrous white. "

This specimen illustrates well the difficulties in determining species known only from scattered teeth and the possibility of making several species where but one existed in nature.



*Poecilodus carbonarius*, St. John & Worthen.

*Poecilodus carbonarius*, St. John & Worthen, 1883, Geological Survey of Illinois, Palaeontology, vol. 7, p. 139, plate 8, figure 20-21.

# 2449, Kansas University Museum of Natural History.

One specimen in limestone matrix; a well preserved tooth.

Locality, Kansas City, Mo., Pottawatomie stage.

" Teeth of medium size. Posterior teeth of the maxillaries in general outline elliptical, rather strongly and spirally inrolled, broadly arched outward along the inner margin with a slight concavity in the region of the median coronal depression; postero-lateral border terminating in a sharply rounding angle, thence gently and regularly curved in its rapid convergence toward the point of inrollment, the relatively strong enamel fold imbeveled to the basal rim from which it is defined by a very narrow groove; antero-lateral border very oblique outward and forward to the inner margin. Coronal contour regularly and rather strongly arched longitudinally, moderately so transversely, posterior or principal ridge occupying half the lateral diameter of the tooth, rather strongly convex transversely, posterior slope moderate and uniform to the postero-lateral border, opposite slope steeply descending with slight concavity into the narrow median depression which corresponds

in the extreme obliquity to the course of the anterior articular border. Anterior ridge culminating in a sharply rounded crest toward the outer margin flanked by the nearly vertical concave slope of the median depression, the border opposite the declivity more gently descending to the antero-lateral border along which it is slightly depressed and marked by faint longitudinal undulations which obliquely descend from near the crest toward the oblique anterior portion of the inner margin,"

The surface is very finely and evenly punctate.

Length of tooth 20 mm., width 7 mm.

*Poecilodus cestriensis*, St. John & Worthen.

*Poecilodus carbonarius*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1883, vol. 7, p. 135, plate 8 figure 15-17.

# 2449 and 2452, Kansas University Museum of Natural History. Both specimens are in a limestone matrix and are teeth only. # 2449 is from Kansas City, Mo. Pottawatomie stage. The locality from which # 2452 came is unknown.

Mandibular posterior tooth right ramus. Tooth small

"having the general trapezoidal outline of *Cochliodus*, a great transverse diameter compared with that in the di-

rection of the strongly arched inrollment. Anterior lateral border comparatively short, a distinct furrow defining the narrow enamel fold from the shallow basal rim, sharply inrolled spirally at the extremity; inner margin very oblique in front joining the articular border at a very obtuse angle, suddenly rounded at anterior ridge and more broadly so in passing the base of the principal ridge, moderately incurved in the intermediate space, and again so on extending into the somewhat produced posterior angle. Postero-lateral border moderately arched and rapidly converging toward point of inrollment, coronal enamel forming a relatively strong fold defined by a deep, narrow sulcus from the inferior basal rim which projects posteriorly beyond the coronal limits terminating in a more or less produced spur. Anterior coronal ridge nearly as prominent but narrower than that behind, culminating in a sharply rounded crest with steep slopes descending to the anterolateral border on the one hand and into the deep, narrow median depression in the other; principal ridge situated about equidistant between the angles of the inner margin, broadly arched transversely over the inner third of its extent but more sharply rounded in the outer portion, the posterior slope abrupt and as in the parallel ridge somewhat deeply excavated, posterior depression deep and broad,

the transverse slightly concave surface steadily rising into the wide posterior alation which comprises about one third the lateral diameter of the crown, surface enveloped in a glassy enamel layer beneath which the minute densely crowded punctae are distinctly visible ".

The two examples in the collection are exact duplicates of the type specimens above described.

*Ctenoptychius dentatus*, Owen.

*Ctenoptychius dentatus*, L. Agassiz, Poiss. Foss., 1843,  
volume 3, page 173. (name only)

*Ctenoptychius macrodus*, L. Agassiz, Poiss. Foss., 1843,  
volume 3, page 173, & 383

*Petalodus dentatus*, R. Owen, Odontography, 1840-45,  
volume 1, page 62.

*Ctenoptychius macrodus*, J. E. Portlock, Report of Geology,  
London, 1843, page 467, plate 14, figure 7, (figure  
inaccurate ).

*Harpacodus dentatus*, J. Morris & G. E. Roberts, Quarterly  
Journal of the Geological Society, 1862, volume 18,  
page 100 (Name only)

*Harpacodus dentatus*, J. W. Davis, Annals and Magazine  
of Natural History, 1881, (5) volume 8, page 426.

*Harpacodus dentatus*, J. W. Davis, Transactions of the  
Royal Dublin Society, 1883, (2) volume 1, page 514, plate  
61, figure 10.

# 2449 One specimen in a limestone matrix, a tooth  
with the anterior face of the crown and most of the root  
showing. Kansas City, Mo. Pottawatomie stage.

Tooth medium size, crown thin, compressed, very slightly curved laterally, straight vertically, surface smooth and polished without striae or pores except on the cutting edge. The superior margin forms a cutting edge divided into seven or more irregular dentations often incompletely separated, broad with a broad obtuse angle at the vertex. The middle one is the largest and the best formed. The denticulations show crenulations when worn at all. The posterior face is probably the higher. The superior margin of the crown is rounded and slightly acuminate. The lateral margins round rapidly. The anterior surface bears a slight basal ridge which is almost straight.

The root, which is poorly preserved, is apparently of the same general shape and size as the crown but is not scalloped. It is the same width as the crown.

This specimen resembles *Ctenoptychius serratus* in the fact that the denticulations are often incompletely separated and crenulated at the summit but does not have the base line of the crown as sharply curved. It differs from the typical *Ctenoptychius dentatus* in that the denticulations when worn at least are not smooth and are more irregular. Also it probably does not have a "root markedly tumid below." This specimen shows the close relation between *Ctenoptychius* and *Petalodus*.

*Petalodus alleghaniensis*, Leidy.

*Sicarius extinctus*, J. Leidy, Proceedings of the Academy of Natural Science, Philadelphia, 1856, vol.7, p.414

*Petalodus alleghaniensis*, J. Leidy, Journal of the Academy of Natural Science, Philadelphia, 1856, (2), vol.3. page 161, plate 16, figure 4-6 (specific name *extinctus* withdrawn).

*Petalodus destructor*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1866, volume 2, page 35, plate 2, figure 1-3.

*Petalodus destructor*, O. St. John, Proceedings of the American Philosophical Society, 1870, volume 11, page 433.

*Petalodus destructor*, O. St. John, Final Report of the Geological Survey of Nebraska, 1872, p. 241, pl. 3, fig. 5.

*Petalodus alleghaniensis*, J. Leidy, Extinct Vertebrate Fauna of the Western Territories, ( Report U.S.G.S. Territories, 1873 ), 1873, page 312, plate 17, figure 3.

*Petalodus alleghaniensis*, J. S. Newberry, Report of the Geological Survey of Ohio, 1875, volume 2, part 2, plate 58, figure 13.

# 2449, One complete tooth; separate crowns and roots, Kansas City, Mo., Pottawatomie stage.

# 2452, One complete tooth, Turin, Missouri.

Many of the teeth in the collection agree in every detail with the figure and description given by Newberry & Worthen in volume two of the Geological Survey of Illinois.

" Teeth large, crown compressed, more or less arched laterally, rhomboidal in form with curved outlines, somewhat acuminate at the apex, cutting edge very sharp, crenate anterior face smooth and polished, broadly rhomboidal, lateral angles very acute. Posterior face one third to one half higher than anterior face, smooth and polished, terminating below like the anterior face in a band of five or six imbricating folds which are broader and more strongly marked behind than before; root nearly smooth, broad, compressed above, narrowed and thickened below where it is rounded and deflected forward; posterior face about the height of the posterior face of the curve ; anterior face one third higher."

The calcigerous tubules of the enamel are much larger near the cutting edge, and, being opposite on the anterior and posterior faces, their junctions produce depressions



which are very regular in young specimens but in the older worn teeth disappear and the tubes may be exposed for some distance. The edges are always sharp due to the teeth of the upper and the lower jaws closing like shears.

Some of the teeth have a root that is quite spongy and not well ossified. The root in many of the specimens is relatively much shorter than that above described, more "V" shaped, not being so much truncated and less deflected forward, this deflection being normally in the lower third of the root. In some specimens the apex shows no thickening, but in some is noticeably strengthened by a vertical swell on both the anterior and the posterior face. This strengthening always maintains an acute apex. This species is found in both the Mississippian and the Pennsylvanian.

*Petalodus curtus*, Newberry & Worthen.

*Petalodus curtus*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1870, p. 355, plate 3, figure 2.

# 2449 One nearly complete tooth, Kansas City, Missouri, Pottawatomie stage.

The teeth are of medium size, crown and root are relatively thin. The crown is broadly arched being concavo-convex laterally and vertically. The crest is moderately acuminate and serrated at the termini of the calcigerous tubes. The anterior face of the crown is without imbricating folds and is one half as high as the posterior face. The posterior face is moderately excavated, bordered by a prominent basal band composed of six enameled regular imbrications slightly arched. The root is short and thin. It is one half the height of the posterior face and folds. The sides are nearly straight, width less than that of the crown. Bottom arched and somewhat three lobed, strongly neveled off so as to form a blunt edge on the anterior and longer side. The width of the crown 22 mm., height of posterior face including basal folds 11 mm., and of root 5 mm.

This tooth resembles *Petalodus hybridus* but is much smaller and the basal imbrications do not arch down in the center. The extremities are not acute. It differs from *Petalodus linguifer* in being much smaller, having a crown only twice as broad as high, being more arched laterally and in having a less number of folds at the base of the crown and in having a shorter root.

*Chomatodus arcuatus*, O. St. John.

*Chomatodus arcuatus*, O. St. John, Proceedings of the American Philosophical Society, 1870, volume 11, page 435.

*Chomatodus arcuatus*, O. St. John, Final Report of the Geological Survey of Nebraska, (U. S. G. S. ), page 243, plate 6, figure 14.

*Chomatodus arcuatus*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1875, volume 6, plate 10, figure 23.

# 2449, one complete specimen of tooth in limestone matrix. anterior side exposed, Kansas City, Missouri, Pottawatomie stage.

Teeth small, crown and root relatively thin, broad and the low crown five times as long as high. The margin is slightly arched with coarse uneven denticulations and acuminate. The crown is concavo-convex, broadly arched laterally, rapidly so vertically. The crown has the same relation to the root as the typical *Petalodus* crown.

The calcigerous tubes practically parallel the surface so that they are exposed for the greater part of their length in worn specimens. The anterior face of the crown is strongly deflected backwards, is slightly wider in the middle and rounds rapidly at the ends. The posterior face is only slightly higher than the anterior. From the base of it at an angle of one hundred and twenty degrees a " V " shaped butress extends giving the tooth a firm hold in the jaw. The root is short and of the same width as the crown. Two rather strong plications show on the anterior face opposite the posterior basal butress, the upper one, which forms the lower limit of the crown, being much the more prominent.

This tooth is sufficiently *Petalodus* like to justify A. S. Woodward's classification of *Chomatodus* as synonymous with *Petalodus*.

Length of tooth 19 mm. , height of crown 3 mm. ,  
root 7 mm. , width of butress 2 mm..

*Ctenoptychius semicircularis*, Newberry & Worthen.

*Ctenoptychius semicircularis*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1866, volume 2, page 72, plate 4, figure 18.

*Peripristis semicircularis*, O. St. John, Final Report Of the Geological Survey of Nebraska, ( U. S. G. S. ) 1872, page 242, plate 3, figure 3-4; plate 4, figure 20.

*Ctenoptychius semicircularis*, J. S. Newberry, Report of the Geological Survey of Ohio, Palaeontology, 1875, volume 2, page 52, plate 58, figure 1a.

Two specimens of teeth nearly complete in limestone matrix, Baldwin, Kansas, Douglas Stage.

Two specimens of teeth, half of crown. Kansas City, Missouri, Pottawatomie stage.

Teeth of medium size, crown fairly thin, compressed. It receives its name from the fact that the crown is so laterally curved that it forms nearly a semicircle but some specimens lack so strong a curvature.

The posterior surface is but little higher than the anterior both are smooth and highly polished. No striae or pores show even on the cutting edge which is sharp and divided into nine or ten lobes. The central lobe is the largest, the others diminishing gradually. They are usually blunt but sometimes acute. Often there are four on one side of the central lobe and five on the other. The anterior face of the crown shows a basal ridge closely resembling that of *Petalodus*. It is not sharply curved and has no basal folds. The root is much thicker than, but not as wide as, the crown and is of a similar general shape. The anterior crown face forms with it a deep shoulder.

*Petrodus occidentalis*, Newberry & Worthen.

*Petrodus occidentalis*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1866, volume 2, page 70, plate 4, figure 15-16.

#, 2463, Three specimens, dermal tubercles, two in shale matrix, Rosedale, Kansas, Pottawatomie stage.

# 2460 Two dermal tubercles in matrix, Kansas.

# 2462, two dermal tubercles, Vermillion Co., Ill.

Dermal tubercles circular, subcircular, or elliptical in outline, base flat or slightly convex below, thin, terminated in an abruptly sharpened finely crenulated edge. The diameter of the base is a half greater than that of the base of the crown. The crown is broadly conical, rounded to elliptical in outline with a summit acute in unworn specimens. From the circumference of the base of the crown, arise ten or twelve strong ridges, which ascend to or nearly to the apex. They are often forked at the base.

Most are inclined to believe as suggested by Professor Agassiz that these bodies are not teeth but are dermal tubercles since they resemble Cretaceous tubercles



and those of living plagiostomous fishes, particularly the rays. They are very similar to the dermal tubercles of *Raja pumamata*, the Upper Cretaceous ray figured in "Catalogue of Fossil Fishes" page 86, figure 3, plate 4.

Newberry & Worthen in "Geological Survey of Illinois" volume 2, page 71 speak of "a large subtriangular, nearly smooth specimen exhibiting some peculiarities which may be of specific value". In the collection are two specimens which carry this idea still farther. The base forms practically an equilateral triangle the posterior side of which is nearly a straight line and the other two sides are arcs of circles. The crown rises to a height of two-thirds of the length of one side. From the posterior or straight side a slightly concave face rises vertically to the point of the crown which forms a beak projecting slightly posteriorward. The concave side is arched considerably along the basal line of the crown probably to enable the succeeding tubercle to fit more closely. The base line of the other two sides is coarsely wavy. The surface of one specimen is entirely smooth and shiny while that of the other is comparatively smooth near the apex but toward the base has numerous small irregular wrinkles. The walls are quite thin and the base is probably hollow to a considerable extent.

*Fissodus bifidis*, St. John & Worthen.

*Fissodus Bifidis*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1875, volume 6, page 414, plate 8, figure 1-2.

# 2447, Four specimens of teeth in limestone matrix, Kansas City, Missouri, Pottawatomie stage.

# 10115, One specimen of tooth in matrix of limestone, Holt, Missouri, Pottawatomie Stage.

One specimen in matrix, Baldwin, Kansas, Douglas Stage.

# 2447, One specimen, probably *Fissodus tricuspидatus* with part of crown and root missing, Kansas City, Missouri, Pottawatomie Stage.

" Teeth small, convex crown face very low, sublunate in general outline, gently arched laterally and more strongly so along the compressed crest which is deeply cleft midway forming two strong acutely pointed lobes, basal fold indistinct, gently arched downward in the middle and strongly curved downward terminating in the articulate lateral angles, concave face gently depressed, faintly swollen above in the coronal cusps and again in the basal region which is

deeply and somewhat angularly arched downward, abruptly defined from the root below and occupied by a relatively wide coronal belt composed of from three to five narrow imbrications, which become exceedingly attenuated ascending the diverging lateral margins toward the acutely produced lateral edges of the crown where they are usually obsolete; coronal surfaces invested with a smooth polished enamel layer which on being worn away along the crest exposes to view a vertical striato-punctate structure.

Inferior or basal surface of tooth irregularly oval or subcircular in outline; moderately convex and more or less uniform with the convexity of the convex crown face from which it is faintly defined by a slight sulcation extending along and just beneath the very narrow coronal fold; lower surface slightly flattened and suddenly produced into a long narrow tapering root which is flattened in the same plane as the crown, somewhat deeply excavated in the inner face and flanked by rather prominent lateral bosses which shade into slight lateral ridges along either margin of the root towards the lower extremity which is slightly rounded or truncated; basal region slightly roughened or quite smooth, Lateral diameter of tooth .29 in., vertical diameter .38 in., elevation of convex crown face .08 in., or about half the length of the convex crown face. "

The teeth in the collection show considerable variation from that typically described. Some of the smaller ones agree exactly in size and outline but others undoubtedly *Fissodus* are from .44 to .56 in. in lateral diameter and have a total length of .75 to 1.00 in. . The vertical height of the crown is often more than half the width of the tooth and in one case is highly ornamented. Some of the teeth are nearly straight but others have the crown and upper part of the root bent varying in the extreme to a right angle to the main part of the root. The crown is uniformly bifid altho one specimen shows it but slightly. The basal fold varies from indistinct to quite pronounced but otherwise as described. In the root there is considerable variation, from that described to those with a root tapering slightly from the crown and suddenly truncated. In one specimen the root slightly constricted at two thirds of its length from the crown.

One specimen which is probably *Fissodus tricuspidatus* has a part of the crown gone. It is peculiar in that the anterior face of the root has three faces or planes; a broad median one parallel to the compression and two

lateral ones at angles of sixty degrees. About half way down the root, the median face is crossed by three rather prominent furrows and the lateral faces at an angle by four furrows. These furrows cross the posterior face also but cannot be distinctly traced in the specimen at hand. One highly ornamented specimen shows a very small but distinct lobe near the base of one of the larger lobes.

*Physonemus mirabilis*, St John & Worthen.

*Xystracanthus mirabilis*, St. John & Worthen, Geological Survey of Illinois, Palaeontology, 1875, volume 6, page 458, plate 20, figure 1.

*Physonemus mirabilis*, A. S. Woodward, 1891, Catalogue of Fossil Fishes, page 132.

# 61, One specimen, a spine in a limestone matrix, base complete with pulp cavity showing but upper third of spine gone. exact locality unknown. Kansas.

The spine is moderately large and quite strongly curved with a regular taper, much laterally compressed, the sides being only gently arched, obtusely rounded in front, abruptly defined along the obtuse posterior lateral angles of the gently arched posterior face which is rather strongly keeled with slightly channeled spaces on either side. The sides slope at an angle of thirty five degrees.

The pulp cavity is regularly elliptical, the axes being in the ratio 3 : 5 . It lies in the posterior half of the spine and terminates just below the point of insertion of the spine.

The lateral and the posterior walls are of medium thickness. The anterior wall has a thickness of half the anterior-posterior diameter of the spine. The length of the base is about one third of the length of the spine. It continues of the same width as at the insertion terminating with an abrupt rounding from the posterior side. " The superficial tubercles are variable in size in different parts of the spine, arranged in close longitudinal rows which increase by implantation near the base where they are of the same size as those at the apex ". Geological Survey of Illinois, vol.6, p.458.

In general the larger tubercles are constricted slightly at the base, rising abruptly with a rounded upper surface, probably symmetrical in unworn specimens but, in the specimen at hand, with the part of tubercle nearer the base of the spine the higher. The tubercles are elliptical in outline with the greater diameter usually not quite parallel to the rows, sometimes even at right angles to them. They are ornamented by irregular sharp carinae. On the anterior side near the base, the median line is occupied by a row of relatively large narrow tubercles which extend which extend two inches above the dorsal line of insertion, flanked on either side by a row of similar denticles.

Behind this are two rows of similar but smaller tubercles which occur on either side followed by numerous rows which successively diminish in size to the posterior-lateral angles; the last row being composed of slightly larger denticles than the preceding. Near the base in this specimen are thirty five rows of denticles with half that number at half the distance to the apex.

The insertion of this spine is peculiar and distinctive. The line of insertion makes an angle of forty five degrees with the cross section plane, extending from the concave curved side upward so that the insertion must have been the opposite insertion in relation to the curvature of the spine to that commonly found. Of the two possible insertions, the wear on the tubercles would indicate that the side with the lateral angles would be the anterior. This would reverse the use of the words anterior and posterior to that found in St. John & Worthen's description. Length of spine  $11\frac{1}{2}$  cm., width at insertion 18 mm., pulp cavity ellipse cavity axes 5 and 3 mm., base to middle of insertion line 4 mm.



*Acanthodopsis wardi*, Hancock & Atthey.

*Acanthodopsis wardi*, Hancock & Atthey, Magazine of Natural History (4)1868, volume 1, page 364, plate 15, figure 6

*Acanthodopsis*, R. H. Traquar, Proceedings of the Royal Philosophical Society of Edinburg, 1880, volume 5, page 117.

*Acanthodopsis wardi*, R. H. Traquar, Proceedings of the Royal Philisophical Society of Edinburg, 1890, vol. 27, p.388

One specimen in nodule, a spine and clavicle, Baldwin, Kansas, Douglas Stage.

Left pectoral fin strongly compressed, wider at posterior than at anterior edge, smooth without denticles, quite strongly arched. The clavicle is relatively large, arched each way from the articulation with the spine and projecting well back from this articulation to articulate with the basal cartilage which is " V " shaped, joining the spine for a half of its length.

Length of spine 25 mm., clavicle 15 x 9 mm..

## Diplacanthus -----

One specimen in nodule, a spine, Baldwin, Kansas,  
Douglas Stage.

Pectoral spine compressed without dermal tubercles. Two to three faint ridges on each side. A well defined sulcus on the anterior margin with a depression beginning one half of the distance from the base of the posterior side and running at an angle so as to cross the spine a little before the point is reached. The spine is slightly arched. This spine strongly resembles *Diplicanthus longispinus* of the Old Red Sand Stone.

Length of spine 30 mm. width at base 6 mm.

*Deltodus grandis*, Newberry & Worthen.

*Deltodus grandis*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1866, volume 2, page 101, plate 9, figure 9-9a .

One specimen in limestone matrix. exact locality unknown. Kansas.

Teeth of large size, triangular in outline, very strongly arched and spirally inrolled, anterior lateral border straight; inner margin forming an angle of one hundred and twenty degrees with the antero-lateral margin, broadly rounded, straight or with a slight sigmoidal and undercut curvature on nearing the slightly produced posterior angle of the alation; Postero-lateral border gradually converging toward the outer margin and slightly convex. Crown sharply arched over the principal ridge which occupies the greater part of the arc of the tooth. The crown falls away steeply to the antero-lateral border and nearly as rapidly to the interior margin and less rapidly to the postero-lateral margin. The surface is smooth and finely and evenly punctate. A cross section near the middle of the tooth shows the under surface to form a semicircle.

Lower left mandibular tooth, inner margin 35 mm., postero-lateral 70 mm. .

*Sandalodus laevissimus*, Newberry & Worthen.

*Sandalodus laevissimus*, Newberry & Worthen, Geological Survey of Illinois, Palaeontology, 1866, volume 2. page 104, plate 10, figure 6-7-8.

One specimen, a tooth, in a limestone matrix, exact locality unknown, Kansas.

Teeth large, subtriangular with a long narrow somewhat inrolled point making the tooth arched in both directions. Coronal ridge prominent and sharp near the point, soon broadening forming two slight ridges with a broad area between.

The crown descends steeply to the antero-lateral margin, slopes gradually to the inner margin which is very much undercut and slopes rather rapidly to the postero-lateral margin. There is no alation. The surface is finely and evenly punctate; punctae larger on lower parts of the slopes. Postero-lateral margin 40 mm.,

### Mandible.

One specimen from shale, a mandible with one tooth, Rosedale, Kansas, Pottawatomie stage.

Lower left mandible of a small shark armed with a single tooth at the anterior end. The tooth while well defined from the mandible is so firmly set as to seem almost a part of the jaw. The tooth is compressed and triangular. The cutting edges are strongly serrated and sharp. Fine carinae or ridges run from the base to the apex. The enamel covering is smooth. The lower anterior half of the jaw forms a sharp ridge. Only the dentary is present but the articulations are plain.

Dentary 80 mm. long, 18 mm. at widest; tooth 8 mm. high, 15 mm. wide at the base.

PLATE I.

CAMPODUS VARIABILIS, Newberry & Worthen.

Iola, Kansas ; Pottawatomie Stage.

1. Posterior-superior view.
2. Anterior view.

CAMPODUS CORRUGATUS, Newberry & Worthen.

Fulton, Kansas ; Marmaton Stage.

3. Superior view.
4. Lateral view.



1.



2.



3.



4.

P L A T E II.

PHYSONEMUS MIRABILIS, St. John & Worthen.

Exact locality unknown, Kansas.

I. Lateral view.

LISTRICANTHUS HYSTRIX, Newberry.

Rosedale, Kansas ; Pottawatomie Stage.

I. Lateral view.





I.



2.



3.

P L A T E    I I I .

CLADODUS INTERCOSTATUS, St. John & Worthen.

Exact locality unknown, Kansas.

1.    Anterior view.
2.    Posterior view.

Jaw of Small Shark.

Exact locality unknown, Kansas.

3. Lateral view.

FISSODUS BIFIDIS, St. John & Worthen.

Kansas City, Missouri; Pottawatomie Stage.

4.    Anterior view.



1.



2.



3.



4.

PLATE IV.

PETRODUS OCCIDENTALIS, Newberry & Worthen.

Rosedale, Kansas; Pottawatomie Stage.

Dermal Tubercle

1. Posterior view.
2. Superior view.

CHOMATODUS ARCUATUS, O. St. John.

Kansas City, Missouri; Pottawatomie Stage.

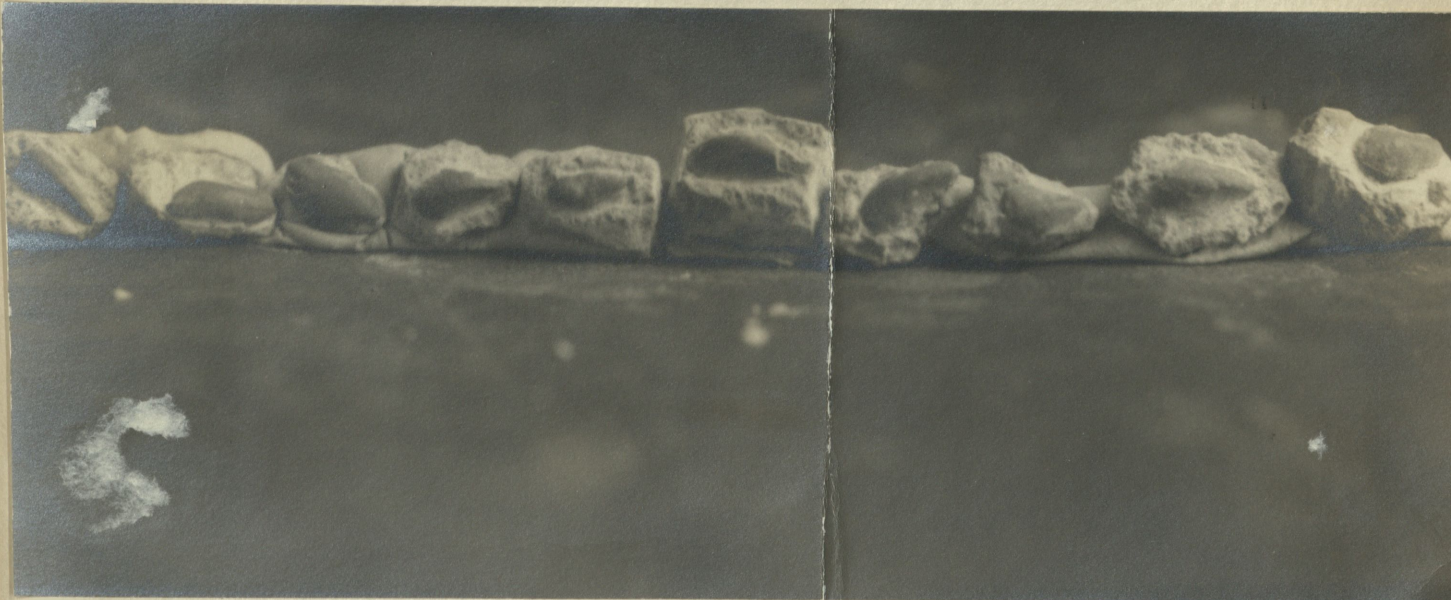
3. Anterior view.
4. Posterior view.



1.



2.



3.

PLATE V.

PETALODUS ALLEGHANIENSIS, Leidy.

Kansas City, Missouri; Pottawatomie Stage.

Immature tooth.

1. Posterior view.

2. Lateral view.

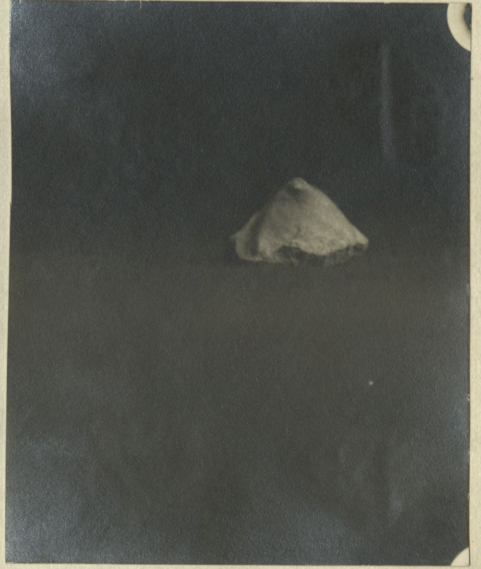
SANDALODUS PARVULUS, Newberry & Worthen.

Kansas City, Missouri; Pottawatomie Stage.

3. Several small teeth in matrix.



1.



2.



3.



4.

P L A T E      V I .

DELTODUS GRANDIS, Newberry & Worthen.

Exact Locality unknown, Kansas.

1. Cross Section.
2. Superior View.

SANDALODUS CARBONARIUS, Newberry & Worthen.

Kansas City, Missouri,; Pottawatomie Stage.

3. Superior view of three teeth.

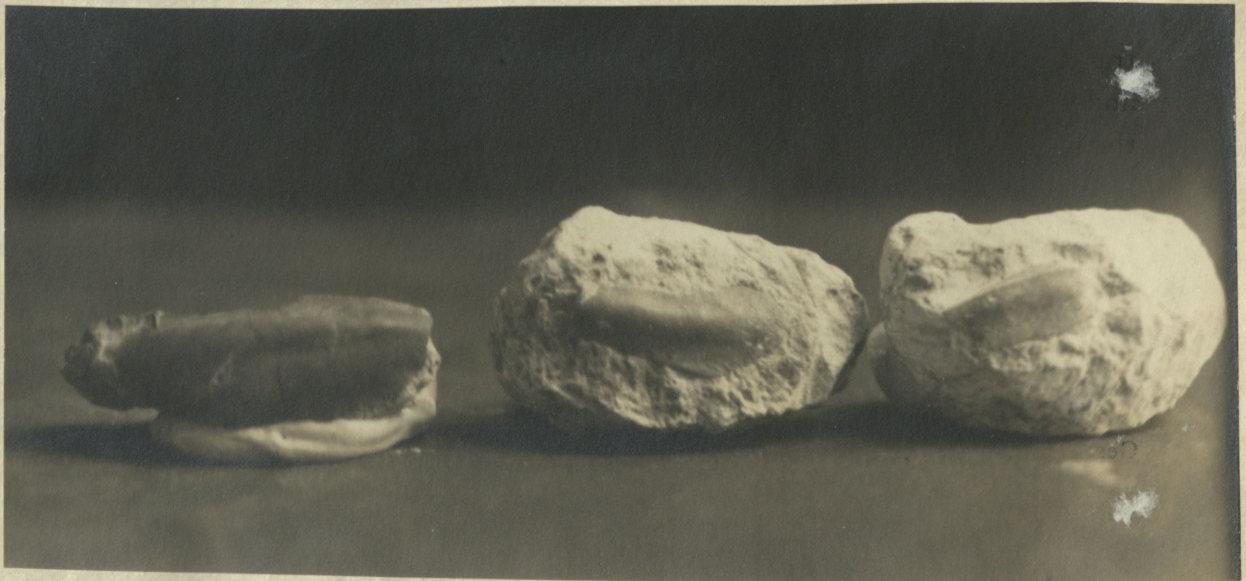




1.



2.



3.

P L A T E   V I I .

SANDALODUS CARBONARIUS, Newberry & Worthen.

Kansas City, Missouri ; Pottawatomie Stage.

1. Superior view.

2. Superior view.

DELTODUS ATTENUATUS, Branson.

Kansas City, Missouri ; Pottawatomie Stage.

3,4,5. Superior view.

6. Type specimen.



1.

2.



3.

4.

5.

6.

P L A T E VIII.

SANDALODUS LAEVISSIMUS, Newberry & Worthen.

Exact locality unknown, Kansas.

1. Superior view.
2. Lateral view, antero-lateral margin.

POECILODUS CARBONARIUS, St. John & Worthen.

Kansas City, Missouri ; Pottawatomie Stage.

3. Anterior view.
4. Lateral view.
5. Superior view.

Plate VIII.



1.



2.



3.



4.



5.

P L A T E IX.

POECILODUS CESTRIENSIS, St. John & Worthen.

Kansas City, Missouri ; Pottawatomie Stage.

I. Superior view.

CTENOPTYCHIUS -----

Forest City, Missouri ; Shawnee Stage.

2. Superior view.

Plate IX.



1.



2.