PALÆONTOLOGICAL REPORT

OF

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CHAPTER I.

PALÆONTOLOGY.

DESCRIPTION OF NEW SPECIES OF ORGANIC REMAINS.

During the progress of the Geological Survey of the State, many new and interesting fossil forms have been discovered, which, with those previously in the possession of the members of the geological corps, of new and undescribed genera and species would, were they all described and figured, make an extensive and valuable addition to the science of Palæontology. A few only of those most characteristic or remarkable, for the present publication, have been selected. They form but a small part of those deemed worthy of being carefully studied and described.

The sub-carboniferous limestone, the Coal Measures, and the transition beds of intercalated limestone near the base of the millstone grit, of western Kentucky, abounds in fossils of remarkable and beautiful forms. The living inhabitants and the dead individuals of those ancient seas, both contributed, with the wasted materials of the subjacent lands, to the formation of the sedimentary strata then in process of deposition which now serve as a guide to the student of Stratigraphical Geology, pointing out with certainty the period and geological position of rocky beds wherever found, and with great certainty indicating equivalent geological measures, which, but for these truthful histories of the past, would never be recognized as of the same age—one district presenting rocky masses, which in another are entirely changed in physical appearance and chemical composition.

In Crittenden county the sandstone of the millstone grit and associated limestones have a great thickness downward, from the productive Coal Measures, to the principal mass of the sub-carboniferous limestone on which it rests.

At the distance of two hundred feet above the base of this mass of sandstone is to be found a bed of earthy, calcareous, and shaley materials, one hundred and fifty feet thick. The lowest sixty feet of this intercalated bed, is of a drab color, filled with innumerable fragments of

Retepera Archimedes, spread out horizontally, and almost constituting the entire mass. Further from the base of the bed are found segregations, broken and irregular bands and patches of earthy ferruginous limestone. This alternation of limestones and shale beds continues to the top of the mass.

It is from the segregated masses, at the top of the first sixty feet of this intercalated calcareous bed, that some of the fossil forms selected for description were obtained; and, so far as it is at present known, certain remarkable forms of this bed have never been found extending either above or below its geological horizon.

The vertical range of the first organic form which will be described is not more than five or six feet. Two crushed specimens were found in 1845, others, again, in 1852. Having recently obtained some quite perfect specimens, it is proposed to describe them under the name of *Pentremites obesus*.

CRINOIDEA.

GENUS PENTREMITES. *Say.*

In the year 1820 the genus *Pentremites* was proposed by Mr. Thomas Say,* in which were placed certain fossil forms, then, for the first time, described. Since the erection of the genus it has been generally recognized, and many species have been added by different authors. One of the latest authorities, Messrs. De Koninck and Le Hon, state the genus under the following formula, viz:

Basal pieces,	3,	one less than the two others.
Radial pieces,	1×5,	forked, large.
Interradial,	1×5,	small lanceolate.
Pseudambulacræ,	1×5,	
Mouth,	1,	central.
Anal,	1,	lateral.
Ovarial openings,	2×5,	situated around the mouth.

By a careful examination of well preserved specimens, (not silicified,) of the different species of this genus, including the typical species, upon which the genus was founded, it may be seen that the formula above quoted should be amended. *Pentremites florealis, globosus, py-*

*See vol. ii, Silliman's Journal, p. 36, and American Journal of Science and Arts, vol. 2.

riformis, and others, have severally three small plates or pieces, distinctly separated from the pieces heretofore designated as the "*Basal pieces;*" these three pieces form the base of the cup, and as they lie below the pieces heretofore recognized as basal, are true basal pieces, and the others necessarily become first radials. It is therefore proposed to amend the generic description, and the following formula is offered:

GENUS PENTREMITES. *Say.*

Generic Formula:

Basal pieces,	1×3,	short, broad, and nearly of equal size.
First radial pieces,	1×3,	two hexagonal, perfect; one pentagonal, and imperfect.
Second radial pecies,	1×5,	nearly of equal size, long, forked.
Interradial pieces,	1×5,	small, lanceolate, nearly equal in size.
Pseudambulacræ,	1×5,	long, filling the forked pieces, and terminating around the mouth.
Mouth,	1,	central.
Ovarial openings,	2×5,	situated around the mouth.

Column, cylindrical, perforated, segments luaeq size and thickness.

PENTREMITES OBESUS. *Lyon.*

(Plate II. fig. I, 1 *a*, 1 *b*, 1 *c*, 1 *d*.)

Body, elliptical half its heighth, rounded at the summit; the lower part has the form of a broad inverted cone; the diameter is to the heighth as 4 is to 5, (nearly.) *Basal pieces*, of equal size, sub-quadrangular, of similar form, low, broad; sides diverging upwards from the columnar articulation; greatest heighth at the line of junction with each other; irregularly concave, upper margin, into which the first radials are fitted, regularly concave at their junction with the column; when joined, they form a low cup, concave at the base, the upper margin forming an unequal sided triangle.

First radials two, of equal size, hexagonal; the third pentagonal, and a little larger than half the size of the hexagonal pieces; this unequal piece probably indicates the anal side of the pentremite; the three pieces, when joined, present a broad shallow cup, the superior margin of which is marked by five broad angular points, between which are three angular, and two irregular, concave depressions, the latter being upon the summits of the hexagonal pieces.

Second radials five, divided two-thirds their length, swelling rapidly from their junction with the first radials to the inferior end of the pseudambulacral fields; twice as long as wide, the branches increasing in width from their junction with the interradials toward the base; obliquely truncated above, the truncation being by a sigmoid line, (not straight as is usually the case,) meeting and fitting upon the interradials by a lap, being beveled from within, the beveled surface being about three times as long as the thickness of the pieces; abutting squarely at their lateral margins against each other, two resting upon the complete hexagonal fist radials, and the other three resting upon the beveled sides and in the notches formed by the junction of the first radials; the line of junction of the sides occupies the center of a deep elliptical grove.

Interradial pieces five, half as broad as long, (externally;) angularly pointed above, and roundly pointed below; $\frac{4}{5}$ as long as the second radials; within the body they are prolonged, and extended under the second radials, and terminate in a long point on either side, forming part of the wall of the pseudambulacral areas; the centre is also extended downwards and pointed, laping under the suture, marking the junction of the second radial pieces.

The interradials are marked by fine striæ, (lines of increment,) which conform to the external form of the piece in its different stages of growth.

The first and second radials are also marked by lines of increment. In the first radials the lines conform to the sides and upper margins of the pieces; the second radials are marked with lines extending entirely around them, except around the margin of the fork, into which are inserted the pseudambulacral fields. All the pieces are divested of the epidermis and muscular coat. The true external markings are unknown.

Pseudambulacral areas extend from the mouth, at the centre of the summit, a little below the centre of the length of the body, gradually increasing in width by a curved line on either side from below upwards, to the centre, when they diminish in width until they reach the summit, they are composed of a double row of thin plates, about twelve times as long as thick, about as broad as long, joined together by their broad faces, terminating at the centre margin of the field, at a

foramen which divides these pieces; the divided sides of the foramen pieces diverge slightly, and join a similar diverging side from an adjoining foramen piece, with which it unites and forms a ridge, which continues to the margin of the field to which they are joined. The field is divided longitudinally in the centre, by a deep groove, the foramen pieces are marked by a slight groove, which crosses them near the centre of their length, and runs the whole length, dividing the field into four bands. Where the foramen pieces are crossed by this slight groove, they are frequently indented by a furrow, which sometimes continues the whole length of the pieces; it is frequently nearly obliterated, and then presents a rounded, oval, or lozenge shaped dent or hole. These marks have the appearance of the imperfectly closed sides of two pieces having grown together. At one state of their growth they were, probably, in separate pieces. In the best preserved specimens the broad faces are seen to be furrowed or grooved transversely; the ends of these grooves are seen presenting small punctures, while the sides of the grooves present a double row of little knobs, standing opposite each other, and joining the two adjacent pieces, which touch each other at these ridges. The ends of the foramen pieces abutting against the centre furrow of the field, are flattened and rounded, the rounding on the inferior side of the piece being greatest. The flattened ends are ornamented by eight or ten diverging ribs, forming on the ends of the pieces a series of beautiful fan-like ornaments, each slightly concave. The foramen pieces number from sixty to seventy to the inch—one specimen having one hnndred and fifty on each side of the field; another (young,) having only forty-three, or eighty-six in each pseudambulacral space.

Mouth. The mouth is irregularly rounded, small externally, increasing in size as the opening passes downward into the body; it is formed of five pieces, lying immediately within the ovarial openings; it was, doubtless, capable of being opened and largely expanded, by the opening of the five petal-like parts into which the body is divided. There is a deep indentation opposite to, and lying between, the lower ends of the pseudambulacral fields; this indentation probably marks the limit of the flexibility of the petals.

Ovarial openings five, nearly round; one much larger than the others; the large opening on the point nearly opposite the imperfect

first radial. *Column* cylindrical, formed of pieces of equal thickness, articulating by radiated surfaces, the rays covering the entire surface; perforated; opening small; pentelobate; side arms at irregular intervals, frequently opposite each other, formed of similar pieces to the column.

This species differs from all others heretofore described, being much larger; the whole character is coarse and strong; the pieces are remarkably thick—in the young, of a similar sized specimen, being twice the thickness of any known species. The general form is nearest that of *P. floreales. Say.*

Length of specimen under description, - -	2.$\frac{35}{100}$ inches.
Breadth of specimen under description, - -	2.$\frac{05}{100}$ inches.
Vertical circumference, - - - -	6.$\frac{15}{100}$ inches.
Transverse circumference, - - - -	6.$\frac{00}{000}$ inches.

In the largest specimen observed, the pseudambulacral field is 1.$\frac{95}{100}$ inches; that of our specimen is 1.$\frac{75}{100}$ inches; length of smallest specimen, one inch; the field of this specimen is $\frac{50}{100}$, (half an inch.)

The pieces forming the pseudambulacral areas, are thiner than those of the *globosus* or *pyriformis*, (small species.)

GENUS ASTEROCRINUS. *Lyon.*

Gen. char.—Column, cylindrical, perforated; base, bilobate; primary radials five; secondary radials, first series, ten; second series, twenty; lobe pieces, five; arms twenty, formed of a double row of joints.

ASTEROCRINUS CAPITALIS. *Lyon.*

(Plate III. fig. 1, 1 *a*, 1 *b*, 1 *c*, 1 *d*, 1 *e*, 1 *f*, 1 *g*, 1 *h*, 1 *i*, 1 *k*.)

Specific description.—Body, viewed from above, presents somewhat the form of an irregular five-pointed star*; viewed in profile, erect, it has much the form of a corinthian capital, slightly contracted near its base.

Column, cylindrical, composed of numerous, unequal-sized, thin, circular pieces. The articulating facets are striated around their margins—the elevated ridges of one joint fitting into corresponding depressions in those which adjoin it. At a short distance from the body these pieces are arranged into the column in sets of three, between two

*The specimen figured, is slightly crushed, therefore the star-like figure is not so remarkable.

quite thick pieces, those adjoining the thick pieces are quite thin, with one much thicker between; nearer the body the pieces are alternately larger and smaller; their edges are slightly rounded.

Basal pieces, two of equal size, nearly alike; united they form a shallow elliptical cup, the upper margin being indented by four concave and two angular notches, swelling below the margin of the cup. The inferior surface presents an imperfect elliptical depression, in the centre of which lies a deep circular pit, concave at the bottom; the outer margin of which is marked around its circumference by grooves and ridges, by which it is joined to the column.

Primary radials five, differing in form; the piece opposite the anal side is slightly concave on the upper margin; the ends are nearly parallel to each other; twice as broad as high; the inferior margin is angularly pointed—the point being about the centre of the width of the piece, at which point it is twice as high as at the ends. The four other primary radials are convex below, and fit into the concave indentations of the basal pieces; they are low and broad; not quite as high as the first pieces; two are concave above, the lower and upper margins being nearly parallel; the other two have two concave depressions above, of unequal size; the ends of the four pieces are obliquely diverging from below upwards—the ends joining the anal piece having the greatest divergency.

Secondary radials. These are in two series, the first consisting of ten pieces, no two of which are alike; those resting on the first radial opposite the anal side are convex below; as broad as high, the upper margin of each having two concave indentations; the junction of these pieces with each other is square, the opposite ends terminating in an angular point. The secondary radial pieces resting upon the first radial piece, to the right of the anal piece, are terminated at both ends by angular points; from one of these rise three secondary radials of the second series; from the other, only one.

The next secondary radials to the right are, probably, broken, and in our specimen are represented by four quadrangular pieces of unequal size. The other four pieces are nearly of equal size, sub-quadrangular; twice as broad as high, having two concave notches in the upper margin of each.

Secondary radials. The secondary radials are twenty in number;

nearly equal in size; sub-quadrangular; as broad as high. From each of these the arm takes its origin.

Anal piece. Lozenge shaped; small; rising from the smallest angular depression in the basal pieces.

Lobe pieces. These remarkable appendages are five in number; unequal in size; thick, rounded, and club-like; twice as broad as thick at the superior extremity, tapering downward, and ending in a broad fan-like manner, at the inferior extremity. They are divided into three unequal parts, the union of the parts being marked by sutures; the upper part not unlike a seed vessel, (when first discovered by the country-people these parts were supposed to be petrified seeds, and were called "petrified coffee-nuts;") it is more than one-third the length of the whole lobe piece; with the middle piece it makes two-thirds the length; the lower part is irregularly serrated, and marked by the impression of muscular attachments; it fits into and is attached to the inside of the basal pieces.

Arms. Our species has twenty arms, in sets of four, rising from the second series of secondary radials; they are composed of a double series of joints, beautifully articulating with each other—the salient angles of one set filling the re-entering angles of the adjoining set; the arms are regularly tapering from their insertion to the end, where they terminate in a point, rising about one-fourth their length above the highest point of the lobe pieces; each set is separated into pairs by the lobe pieces, which embrace them on either side. It is not certainly known that the arms are provided with cillia.

This remarkable crinoid is found in the lower intercalated calcareous beds of the millstone grit of Crittenden county, associated with *Pentremites obesus, &c.* The vertical range of this species is somewhat greater than that of that fossil. It was very abundant; immense numbers of the fragments of the lobed pieces are found, especially of that part forming its upper extremity. It is evident that they were easily separated, for amongst the multitude of fragments only one specimen has been found sufficiently perfect to show the arrangement of the parts composing it; this is slightly flattened by pressure, and is so much weathered that no surface markings can be discovered. By the fragments of the lobe pieces the lower intercalated limestone of the millstone grit may be identified.

Its proportions are as follows:

Heighth,	$1.\frac{25}{100}$ inches.
Greatest breadth across the lobe pieces,	$1.\frac{55}{100}$ inches.
Greatest breadth at the top of calyx—narrow side,	$.\frac{75}{100}$ inch.
Greatest breadth at the top of calyx—wide side,	$.\frac{85}{100}$ inch.
Heighth of calyx,	$.\frac{40}{100}$ inch.
Heighth of radials,	$.\frac{15}{100}$ inch.
Heighth of basal pieces,	$.\frac{25}{100}$ inch.
Long diameter of basal pieces,	$.\frac{60}{100}$ inch.
Short diameter of basal pieces,	$.\frac{40}{100}$ inch.

The genus *Asterocrinus*, by its lobed basal pieces, is allied to *Dichocrinus*, also by the number of its primary radials Here the analogy ceases. *Dichocrinus* partakes much of the character of the *Platycrinites*. The primary radials are generally longer, and the calyx high; the radials of all known species of *Dichocrinus* are higher than the basal pieces, while in *Asterocrinus* the breadth of the radials are equal to twice their hight. In the remarkable lobe pieces it is distinguished and separated from all known genera. It is evident the species under consideration had no vaulted covering to the stomach, as the lobe pieces rise from the basal pieces, (to which they are attached,) and nearly fill the cavity of the body. The lobe pieces are free, except at the point of attachment at the base, were expansile, and are indeed auxiliaries of the arms, probably serving in part to sieze and crush its food. Fixed to the base by a muscular ligament, articulating by joints, they were evidently capable of opening with, or even independently of the arms. Our specimen is closed; the arms are folded between the lobe pieces. Six half sets of the arms have their entire length, and are folded toward the centre of the summit, which they do not reach, leaving the junctures of the lobe pieces exposed.

In a paper read before the Academy of Sciences, at St. Louis, Missouri, in 1857, our specimen is referred to, and classed with *Dichocrinus;* we differ from the author of that paper, and hold that our species is essentially different, and should be separated from *Dichocrinus.*

ASTEROCRINUS (?) CORONARIUS. *Lyon.*

(Plate I. fig. 1, 1 *a*.)

It is with a considerable hesitation that this remarkable and hitherto unknown fossil is refered to *Asterocrinus*, as it has neither basal, radial, or arm pieces. This unique crinoidal fragment was found, with others, associated with *Pentremites obesus*, *Asterocrinus capitalis*, &c., in the lower intercalated calcareous bed of the millstone grit of Crittenden county. This specimen is evidently the summit and part of the abdominal cavity and walls of a crinoid, and is provisionally referred to *Asterocrinus*, which it greatly resembles, by the arrangement of the tumid star-like points; seen in profile it resembles a ducal coronet or crown. The body is pentagonal, having equal sides; the angular corners are removed; an angular notch is provided, into which three of the point pieces are inserted into the body. The point on the right of the oral opening is joined to the body by an irregular line, nearly straight; that on the left is joined by a curved line, with an angular deflection near the side farthest from the mouth. The marginal borders of the pointed pieces are raised, and the pieces are fluted about two-thirds their length; they are thick, heavy, and solid; curved on the lower side, and when resting upon the upper surface, present the appearance of a thick last, from the instep to the toe. Within the pointed pieces are arranged twenty-five polygonal pieces—those immediately surrounding the mouth are convex, the others are concave; the outer series are larger; two are hexagonal; the others are imperfect rhombs; those within the point to the right of the mouth are small and long; the others are still smaller, of pentagonal, hexagonal, and triangular forms. A few of the small pieces surrounding the oral opening have been lost.

Mouth, sub-central.

Lower surface. Between the pointed pieces are three angular prominences, and four angular depressions; these are probably the articulating surfaces to which the lower part of the body and calyx were joined; above these notches and prominences, and on the surface between the pointed pieces are rounded and grooved impressions, probably produced by the pressure of the arms (?) No surface markings are found on the specimen, which has evidently lost its dermal covering; they would have been lost had they existed upon it.

Size of the specimen. Length of the pointed pieces, (the longest piece,) - - - - - - - - - $\cdot\frac{70}{100}$ inch.
Length of the pointed pieces, (shortest piece,) - $\cdot\frac{55}{100}$ inch.
Longest diameter across the points, - - $1.\frac{95}{100}$ inches.
Longest diameter of body, upper side, - - $\cdot\frac{75}{100}$ inch.
Longest diameter of body, lower side, - - $\cdot\frac{80}{100}$ inch.
Height of body to junction of pointed pieces, - $\cdot\frac{55}{100}$ inch.
Height of body to highest point of pointed pieces, $\cdot\frac{75}{100}$ inch.
From mouth to nearest side, - - - - $\cdot\frac{30}{100}$ inch.
From mouth to most distant side, - - - $\cdot\frac{50}{100}$ inch.

GENUS GRAPHIOCRINUS. *DeKoninck and LeHon.*

De Koninck and LeHon, who established this genus, have given the generic formula as follows, viz:

*Basal pieces,	5.
Radial pieces,	2×5.
Anal pieces,	1.
Interradial pieces,	0.
Arms,	10, not divided.

GRAPHIOCRINUS—14 BRACHIALIS. *Lyon.*

(Plate I. fig. 1, 2 *a*, 2 *b*.)

The anatomical structure of our species corresponds so nearly to this genus that it is confidently referred to it.

Column. A short piece of the column, still attached to our specimen, is composed of thin circular pieces, rounded on the margin, differing considerably in size—alternately a larger and smaller one; perforated; the form of the perforation cannot be distinctly made out.

Basal pieces five; long lanceolate; thick at the outer point; divided by deep well defined sutures, from the inferior point of the primary radials, to the opening of the columnar-pit, where the pieces join evenly together; the superior points curved upwards, from the columns outward; the pieces are grooved by a broad concave furrrow, which termi-

*From the figure given by De Koninck and LeHon, I have much doubt if these are the true basal pieces. Species of kindred form are found with fine basal pieces within the columnar depression; these are generally covered by the column; always alternating with the basal pieces, as recognized in the above formula. There are another class of crinoids having a pentagonal basal piece, not indented, divided by five sutures running from the columnar pit to the centre of the sides, forming the pentagon. *Zeacrinites Magnoliaformis—Troost*, is thus distinguished.

nates at the commencement of the upward curvature of the points of the pieces. The piece to the right of the anal pieces is larger than the others, and the first primary radial rises from its truncated point; in this respect the drawing is imperfect—the side toward the anal pieces should be more elevated. The surface of all the pieces is smooth.

Primary radials five; somewhat heart-shaped; concave above, roundly pointed below; the pieces on either side of the anal pieces are not symetrical—the side of the left hand one having lost a portion of its edge, against which rests one of the anal pieces, while that on the right side has lost a portion of its inferior left margin, which joins the largest anal piece.

The primary radials of the second series* are five in number; subquadrangular; width, equal twice the greatest heighth; differing in form and size; sides square and vertical; swelling rapidly from the sides toward the center; curved upwards on the superior margin, and terminating in a rounded prominent knob, at or near the center of the pieces.

Secondary radials (*axilary, Miller,*) ten; four are larger than the others; similar in form to the primary radials of the first series inverted; boldly prominent, each supporting two secondary radials of the second series; the six others differ in form, and are less than half the size of the first four, each supporting a single piece of the secondary radials; slightly prominent.

Secondary radials, second series, consists of fourteen subquadrangular pieces, differing slightly in size; less prominent than the first series, from which the arms take their origin.

Arms fourteen, composed of a double row of pieces, slightly rounded, fitting deeply into each other—the salient angles of the right hand row entering the retreating angles of the opposite row.

Remarks.—Our specimen has been slightly crushed; the superior ends of the arms are broken off; the calyx is remarkable for the depth of the columnar depression, and the prominence of the rounded knobed terminations of the pieces forming it, also, in having fourteen arms—the typical form of the genus having only ten. It was found in the calcareous beds, near the base of the millstone grit of Crittenden county, associated with *P. obesus, Asterocrinus capitalis, A. coronarius,* &c. Ranging rather higher in the bed than either of the others. The vertical range is not known. It has not, so far as we are informed, been discovered in any other geological horizon.

* The primary radials of the second series are here equivalent to the *scapular* pieces of *Miller*, corresponding to the *scapular* pieces of *Encrinites moniliformis.*

ACTINOCRINUS. *Miller.*

This genus was established by Miller in 1821, and was defined as follows:

"A crinoid animal, with a round column, perforated by a round alimentary canal. At the summit of the column is placed a pelvis, formed of three plates, on which five costals, and one irregular, adhere; which are succeeded by the second costals and intercostals, and the scapulae, from whence five arms proceed, forming two hands, with several tentaculated fingers.

Round side-arms proceed at irregular distances from the column, which terminates at the base in a fassicular bundle or roots of fibres."

Recently De Koninck and De Hon, in treating of this genus, have adopted a different nomenclature. The *Actinocrinus,* as defined by these authors, is as follows:

Generic Formula:

Basal pieces,	3, of a quadrangular form.
Radial pieces,	3×5.
Interradial pieces,	3×4.
Anal pieces,	6.
Brachial pieces,	1, or 2×5.

Column, cylindrical; canal, pentagonal.

ACTINOCRINUS ABNORMIS. *Lyon.*

(Plate IV. fig. 1, 1*a*, 1*b*.)

Body. The general form of the most symetrical of this species is sub-globular; others are quite shallow; saucer shaped; with a very low, irregular; covering in others the circle of the body, at the insertion of the arms, is deeply emarginate. The form of the inferior part of the calyx is constantly that of a shallow rounded cup, slightly indented around the columnar pit. The basal pieces, and the radials of the 1st and 2nd series, are also constant characteristics.

The superior surface has a continuous covering, composed of small pieces; the spaces opposite the junction of the arms with the body have

generally prominent tubercles, usually rounded and low, sometimes long and sharp-pointed; an additional knob or point usually marks the summit, which is sub-central and near the anal side; around these prominent pieces, are arranged, in a circular manner, small polygonal pieces of various sizes, and the interspaces between these circular patches are filled with pieces of irregular forms; in some of the best preserved several knobs are joined by the interspace, having a central piece, around which are arranged, circularly, small pieces—one piece of the circle forming the connection between the centers of the adjoining circles.

Our description is that of a single specimen, differing in many particulars from all others of the species; yet it is believed that no accurate observer could fail to roorganize every specimen of the species, by features they have in common, which distinguishes them from other species.

Basal pieces. The basal pieces, when undivided, presents an oblong hexagonal space—the middle perforation being sub-central; when divided, the sutures from the central opening terminate at the center of the inferior margin of the alternate radial pieces of the first series; by this division producing two pieces nearly equal in size, and one generally smaller than the others.

Radial pieces, 1st series. Consists of six hexagonal pieces, (one of these pieces is sometimes pentagonal or obscurely hexagonal,) differing somewhat in size and form; slightly concave—the concavity extending over the whole area of each piece; when arranged in the cup they are nearly horizontal, being only slightly curved.

Primary radials, 2nd series, five; usually four hexagonal and one pentagonal; not unfrequently one of the radials is abnormal, and rises between two of the radials of the first series. Fig. 1b, plate IV, exhibits this anomalous arrangement. Fig. 1a, plate IV, shows all the pieces in a normal condition (hexagonal.)

The 3rd series of primary radials consist of four pieces septilateral, and one hexagonal; nearly equal in size.

Secondary radials, 1st series, consists of eleven pieces, varying in size and form—some being heptagonal, hexagonal, and one being pentagonal; this last piece rises from the anomalous ray. (Fig. 1b, plate IV.)

Interradial fields. The interradial fields are four in number, each filled with six pieces, differing in form and size; arranged by one forming the base; from the sloping upper sides of this rise two others; between these latter and their outer upper side, three others; upon these rest the interaxilary pieces, eleven in number; these vary much in form and size in different specimens.

Nearly all the pieces composing the 2nd and 3rd primary radials, and the interradial fields are flattened or slightly concave; this is characteristic and common to the species.

Anal pieces. The anal pieces vary much in different specimens—from 14 to 18 of irregular form; being neither constant in form nor number.

The *Arms* vary in number from ten to fourteen, at their insertion into the calyx; they are very irregular in their arrangement, sometimes coming off in five regular pairs; again three pairs—one set of three, and one set of one, making ten; again, three sets of four each, one set of three, one of two, and a single arm, standing by itself, making fourteen.

Amongst the great number of the species that have come under our observation, no two have ever been observed with precisely the same arrangement in the zone forming the region of the arms—sufficient difference frequently existing, in different specimens, to warrant a separation of the species if the technical arrangement should be relied upon. By the low calyx, concave surface of the pieces, and general appearance, they will, however, be referred o1 species.

Dimensions:

Greatest heighth of calyx, - - -	$\cdot\frac{65}{100}$ inch.
Least heighth of calyx, - - - -	$\cdot\frac{30}{100}$ inch.
Heigth from base to summit, - - -	$\cdot\frac{90}{100}$ inch.
Greatest breadth, - - - - -	$1.\frac{50}{100}$ inches.
Least breadth, - - - - -	$1.\frac{30}{100}$ inches.

Position and locality. Very abundant in the limestone immediately at the base of the "Devonian black slate," and above the beds of Hydraulic cement stone. In the vicinity of Louisville, about fifty feet above the range of *Catenepora escharoides* bed. *Actinocrinus abnormis* is especially abundant in the bed above alluded to, exposed at the quarries, on the south fork of Bear grass creek; at Rock Island, near

the old Tariscon's mill, at the foot of the falls of the Ohio; and at the crossing of the Jeffersonville and Columbus railroad, on Silver creek, Clarke county, Ia. It has not been found extending beyond this bed—which varies in thickness from five to twelve or thirteen feet. Of the numerous specimens obtained by collectors, most of them are mere fragments; very few have more than half or three-fourths of the head complete—many not so much. This is the most abundant fossil form of the bed at the locality on Beargrass.

GENUS DOLATOCRINUS. *Lyon.*

Gen. char.—*Column*, round; composed (near the body) of alternate large and small pieces; perforation pentalobate; rather large; basal pieces five; pentagonal; small; sometimes covered by the column.

First radials five, hexagonal; *second radials* five, quadrangular; *third radials* five, pentagonal; *first secondary radials*, ten or eleven, generally hexagonal; *second secondary radials* quite irregular, varying from ten to thirteen; *interaxilarys*, those rising from the radials from five to seven, whilst those which rise from the interradial fields vary from ten to twelve; *interradials*, *first series*, five, large nonagonal; the *second series*, of five, differing in form; *arms* ten, formed of circular pieces of equal thickness, tapering rapidly toward the superior end; *mouth* sub-central proboscidate; *summit* covered by small polygonal pieces.

DOLATOCRINUS LACUS. *Lyon.*

Plate IV. fig. 2, 2*a*, 2*b*, 2*c*.

Specific character.—*Body* sub-globose; truncated below; columnar-pit broad and deep; summit somewhat conical, prolonged by a proboscis; column round; near the body composed of alternate large and smaller pieces articulating by flat radiated surfaces; the upper joint of the column is hemispherical, and partially fills the columnar-pit, nearly and sometimes quite concealing the basal pieces; columnar perforation rather large and pentalobate.

Basal pieces five;* pentagonal; nearly of equal size; not quite as

*The basal pieces are only seen in fragments and crushed specimens; from these we are led to believe that the basal pieces are five in number; should future investigation determine that the base is divided into only three parts, the base would then resemble that of *Platycrinus*, *Miller*, not *Austin* Being now fully pursuaded that this arrangement of five basals, alternating with five first radials, is the structure of the animal, we have so described it.

high as wide; lying deep in the columnar-pit, and frequently concealed by the insertion of the columns, as in fig. 2c, plate IV.

First radial pieces five; hexagonal; nearly equal in size; twice as broad as high; ornamented by sculptured ridges, which terminate at a longish or rounded knob, near the margin of the columnar depression.

Second radial pieces five; sub-quadrangular; wider than high; nearly of the same size; the center of the pieces are ornamented by a knob, which terminates at this upper margin. In specimens of the aged of this species the knob is frequently prolonged, and assumes the form of a sharp ridge.

Third radials five; pentagonal; broader than high; same size, ornamented near their center by a knob.

Secondary radials, first series ten of irregular form; as large as or larger than the third primary radials; principally hexagonal—sometimes one or more are pentagonal.

Secondary radials, second series, varying in number from ten to thirteen; irregular in form and size. *Interaxilary pieces*; these pieces are variable, differing in form and size, and are distinguished as triangular and quadrangular—the triangular pieces having their origin in the radial pieces; eight in number; those originating from the interradial piece of the second series are quadrangular; twelve or more in number.

Interradials five; very large; nonagonal; angularly pointed below; truncated on the superior margin; from these rise the secondary radials, five in number, four of which are pentagonal; pointed at the summit; inferior margin as wide as the superior margin of the first interradials on which they rest; the other piece is quadrangular.

The *arms* are ten in number, rising in pairs; rather short; tapering rapidly; composed of ovoid flat pieces, of equal thickness—one side exhibiting the articulating surfaces from which tentaculæ have been detached; the form and arrangement of the tentaculæ are unknown.

Summit. The summit is covered by rather large polygonal pieces, various in form; generally ornamented by small granular prominences.

Proboscis or oral tube. In its complete form it is unknown; judging from the fragments found attached to the specimens, it is small compared with the same appendage in other crinoids; composed of small polygonal pieces.

External markings. The body is adorned by a most beautiful network of raised triangular figures; the points of the principal triangular figures rise from, and terminate at, the centre of the first interradial pieces; a subordinate set of figures terminate at the centre of all the pieces below the arms. In some specimens the lines are continuous, in others, interrupted. The summit pieces are sometimes adorned by a single prominent granule; in other specimens, many of the pieces are ornamented by a number of granules, arranged in lines across some of the pieces in nearly parallel rows, or in a circular band around a more prominent central one.

Geological position and locality. Found in great numbers in the limestone immediately over the hydraulic cement beds, Jefferson county, Kentucky, on Beargrass creek; same beds on Rock Island, Falls of the Ohio river, and Silver creek, Clarke county, Indiana.

In the neighborhood of Louisville, resting on the hydraulic cement bed, and below the black slate of the Denovian period, occurs a thin bed of limestone, its base resting on the cement stone bed; in this is to be found a partial bed of conglomerate, of ferruginous gravel; a similar bed of conglomerate exists below the cement bed. The cement bed at Beargrass creek is from four to six inches thick. Northwsetwaardly, three and a half miles, at the foot of the Falls, on the Indiana side of the river, this stone is eighteen feet thick; from the bed, at the foot of the Falls, large quantities of hydraulic cement is manufactured, of superior quality. Resting on the cement bed, as before stated, is a bed of limestone from four to eight feet thick; the inferior two feet abounds in *crinoidæ*, in fact, the bed is literally made up of the remains of these animals. Then succeeds, about two feet abounding in *fossil corals*, amongst which are a few *entrochites;* these are again succeeded by *Crenoidea, Brachiopoda, and Trilobites.* Upon the whole rests a bed of black slate, variously estimated from one hundred to one hundred and forty feet thick.

A few individuals of our genus, and probably of the same species, occur at the base of the hydraulic beds; these are seldom well preserved; should these prove to be our species, the vertical range of the species will be about twenty-five feet; should they prove to be different, the range will be only about two and a half or three feet.

GENUS VASOCRINUS. *Lyon.*

Gen. char.—Body vase shaped; twice as wide as high; *basal pieces* five; pentagonal; pointed at their superior margin; *primary radials* five; rising between the points of the basal pieces; *secondary radials* five; broad; irregularly pentagonal; *arms* five; single; composed of cylindrical pieces; *anal piece* one; hexagonal; large; summit unknown; *column* unknown.

VASOCRINUS VALENS. *Lyon.*

(Plate IV. fig. 3, 3 *a*.)

Basal pieces five; low, broad; pointed at their summit; swelling at the base; forming a shallow cup, with perpendicular sides; bottom slightly concave; superior margin divided by obtuse points into five broad, shallow, angular notches; the base articulates with the column by a surface marked by striæ, radiating from a small circular opening.

Radial pieces five; smooth; sub-hexagonal; differing slightly in size; higher than wide; rising between the basal pieces.

Secondary radials five in number; smooth; pentagonal; nearly twice as wide as high; the median line of these pieces are nearly horizontal; the truncated face, for the insertion of the arms, eliptical, concave, perforated near the centre, deeply sulcate above the perforation; the sides are joined together, curving upward and terminating on the summit between the arms; the piece on the left of the anal piece is much larger than either of the others, and covers the points of two of the radials, whilst that on the right of it is much smaller than the others, and rises from the point and left side of the primary radial, beneath it. The *anal piece* is large, sub-hexagonal, rising between two of the primary radials, and extends above the lower margin of the axillary face of the second primary radials.

Arms composed of cylindrical pieces, their legnth and diameter being nearly equal; perforated and deeply sulcate on the superior side.

Dimensions:

Diameter of the base,	$\cdot\frac{45}{100}$ inch.
Height of the base,	$\cdot\frac{27}{100}$ inch.
Height of the body,	$\cdot\frac{55}{100}$ inch.
Greatest diameter,	$1.\frac{05}{100}$ inches.
Diameter of the axillary articulation,	$\cdot\frac{27}{100}$ inch.

Remarks. This remarkable crinoid was obtained several years since at the quarries on Beargrass creek, near Louisville, where it was found associated with *Actinocrinus. Dolatocrinus*, &c. It is very rare—this specimen is the only one of this species heretofore obtained.

VASOCRINUS SCULPTUS. *Lyon.*

(Plate IV. fig. 3*b*, 3*c*, 3*d*, 3*e*.)

Body small; vase shaped; section at the junction of the arms pentagonal; side of pentagon above the anal pieces nearly twice as long as either of the others; the surface is roughened by raised sculpture; the center of the pieces below the arms are all prominent. On either side of the sutures marking the junction of the basal pieces is a raised rib, which terminates at the center of the first radial pieces lying above the sutures. Similar ribs cover the body, extending from near the center of each to the center of all the contiguous pieces, (except the basal pieces,) thus dividing the surface into nearly equal-sided triangular spaces, deeply depressed at the center, and curving up to the ribs which define them; at the end of the ribs the triangular spaces are joined by a narrow grooved avenue, not quite so deep as the center of the spaces.

Basal pieces five; pentagonal; as high as wide; extending beneath to the columnar perforation; junction with the column slightly concave.

Radial pieces five; hexagonal; four of equal size; as high as wide; one much larger than the others, rising between the points of the basal pieces.

Secondary radials (*scapulæ*, *Miller*) five; irregularly pentagonal; nearly equal in size, except the piece on the left of the anal pieces, which is nearly twice as large as either of the others; articulating facet of the arms uneven; perforated; sulcated upon the upper side; the pieces curve upwards at their line of junction, and terminate upon the summit above the line of the arms.

Anal pieces two; hexagonal; one equaling in size the first radial pieces; the other is quite small.

Arms five; single; structure beyond the first joint unknown; they start from the body in a horizontal direction.

Column unknown.

Geological position and locality. Found in the limestone about five feet beneath the Devonian black slate, and above the beds of Hydraulic cement-stone, Jefferson county, and in the same geological position on the falls of the Ohio. It does not appear, from what is known of it, to have a very great vertical range, probably not more than three or four feet.

OLIVANITES VERNEUILII. *Troost.*

Ref. and Syn. Pentremites Verneuilii, Troost, sixth report on the Geology of the State of Tennessee, Nashville, 1841. *Pentremites Verneuilii* (*Beadle*) *d'Orbigny Prodrome de Pal., Stratigr* 1, *p.* 102.

Elæacrinus Verneuilii Roemer. Monographie der Fossilen Crinoiden familie der Blastoideen, &c., Berlin, 1852, *p.* 59.

This fossil is found in great abundance in rocks of the Denovian period, at the Falls of the Ohio river, and on Beargrass creek near Louisville, Jefferson county, Kentucky, and in other localities.

Professor Troost distinguished this fossil in 1841, as *Pentremites Verneuilii*. In a list of fossil crinoids of Tennessee, published in the proceedings of the American Association for the Advancement of Science; of the meeting held at Cambridge, Boston, 1850, the learned professor has removed it from *Pentremites;* having erected a new genus for its reception, and distinguished it as *Olivanites Verneuilii*. In a private letter, written August 3d, 1849, to a distinguished lady of Tennessee, Professor Troost removes *Pentremites Verneuilii* to *Olivanites.*

Dr. Fred. Roemer, in an elaborate and able work on the Family Blastoidea, referred to above, has re-described this fossil under the generic title of *Elæacrinus*, (retaining Prof. Troost's specific name,) with excellent figures by Hugo Troschel. For want of well preserved specimens, both the figures and description are defective in many respects.

For these reasons, and possessing quite perfect specimens, it is proposed to describe these, and restore the name proposed by that pioneer of western geology, Dr. Troost.

During the last seventeen years hundreds of these curious forms, known as "Petrified Hickorynuts," have passed through our hands, having been distributed to collectors at home and abroad. Dr. Roe-

mer's description was probably made from some of those furnished by us during his visit to this country.

Of the multitudes collected we have now over three hundred specimens, and out of this large number, not more than five or six expose the true structure of the body, especially the arrangement of the base, and only two exhibit the pieces at the summit of it.

OLIVANITES VERNEUILII. *Troost.*

(Plate V. fig. 1, 1 *a*, 1 *b*, 1 *c*, 1 *d*.)

Description.—The body is illipsoidal; the usual proportion between the height and width is as 4 to 3; in the more globose it is sometimes as 3 is to $2\frac{8}{10}$. The whole surface in well preserved specimens, shows a remarkable fine sculpture. The cup, below the ambulacral fields, consists of eleven pieces; above the cup and between it and the summit are four interradial lanceolate pieces, one anal piece, five pseudambulacræ, and ten large pieces; one on either side of these, making thirty-six prominent pieces, exclusive of those at the summit; making in all about fifty pieces. Only very short pieces of the column having been found attached, little of its structure is known; the small part found attached is round or imperfectly pentagonal. The columnar perforation is pentalobate.*

The *Basal pieces*, three in number, are very minute; lozenge shaped or quadrilateral; situated at the bottom of the columnar-pit; always concealed when the column is present.

Primary radials are also three in number; small; situated within the columnar pit; two are hexagonal, and one somewhat lozenge-shaped; nearly of equal size; each piece is ornamented by three tuburcles, one on either side of the sutures, near the outer margin of the joined pieces, and one near the center of the pieces; they are usually entirely concealed by the column—a single specimen has been seen that exhibited a part of these pieces when the column was present.

Primary radials, second series. These pieces are five in number; forked; one-sixth wider, at the spread of the branches, than high; the inferior margin is deflected within the columnar-pit, and rests on the outer or superior margins of the first radials, as in *Pentremites*, with this difference, one of the second radials rises from an angular point of

*A single specimen, out of many, exhibits this structure; nearly all the specimens are partially silicified, and the structure partially obliterated.

one of the hexagonal pieces. The bending or angular deflection of these pieces, into the columnar-pit, is most remarkable, forming, as they do, a margin about equal to their thickness around the external margin of the columnar-pit, around the column presenting the appearance as if their junction with the first primary radials was against their inner face, and not by the inferior margin of the pieces, as is usually the case with crinoidea. The sides of the pieces or branches of the forks are nearly of equal width, tapering or curving slightly from within the fork outward; the lateral margins are straight; their summits are variously truncated, sometimes by a straight line from within the fork outward and downward; again, by an additional corner removed from the point within the fork, and sometimes they are found irregularly rounded from the center of the branches to either side; all these forms are seen in a single specimen. The angular indentation between the branches of the fork terminates in a prominent cup, from which proceeds, upward, on either branch of the fork, defining the space between them, a sharp prominent margin marking the limit of the branches of the fork. The branches of the second primary radials are also marked with lines of increment, which conform to the upper and outer margins of the pieces. The lines are prominent, and are probably the remains of the processes marking the margins of the pieces above alluded to.

Interradial pieces—(No. 4, fig. 1, plate v.) These five pieces are long, (seven times as long as their greatest width;) lanceolate, rising from the notched and curved superior margins of two adjacent branches of the second primary radial pieces, and terminating at the summit of the body, between the ovarial (?) openings; they are divided longitudinally by a line from which fine depressed striæ diverge at an angle of abont 60° (upward and outward,) dividing the parts of the piece on either side of the center line into flat bands, equal in width to the ribs on the pieces on either side of the pseudambulacral fields, and the pieces composing these, the ambulacræ—sixty of which are contained in an inch.*

The parts here designated interradial pieces, in the best preserved

* Dr. Roemer's figure represents this part, which is the middle of his "*deltoid* pieces," as covered with punctures, ("*chagrinartig bedect.*") In the above description this part is called interradial piece, and is separated from the pseudambulacral fields, and from the spaces on either side of them. In no specimen, of thousands, has this punctured surface been observed; it is probably the effect of cleaning with a pointed instrument. It has been observed in some so clean ed.

specimens, are separated from the pieces on either side of the pseudambulacræ, by a sharply defined angular ridge, surrounding the whole piece except at the junction with the branches of the radials below it.

Anal piece. This piece is wider than the interradial pieces; nearly equal in width in its whole length; rounded at its summit, having a circular notch in its upper margin, the sides of which are frequently truncated obliquely downward from the sides of the notch, above which is situated the large ovoid opening. It rises from the summits of the second radials, like the interradial pieces, and like those it is marked with striæ. This piece has much irregularity in form and adjustment with reference to the body, in different specimens, being disposed above the general surface at its superior extremity, and sometimes below it; frequently the circular notch occupies the whole summit of the piece, which is then very prominent, and prolonged above the summit of the body, while in other specimens it terminates a considerable distance below the summit.

The pseudambulacral fields, five in number, rise from the angular notch in the summits of the second radials, and terminate at the summit; they are alike in size and arrangement of parts; each field consists of three parts, the middle of which is the longest; rising from the bottom of the notch, as before stated, it is continued to the openings around the summit, which it divides, and is continued beyond them toward the center of the crown, and is lost under the small pieces arranged within the openings. It is divided by a line into equal parts running its whole length, each of which is again divided into a line of pores, and a ridge. In some states of specimens the mesial line is deeply grooved, on either side of which is a rounded ridge, equal in width to the line of pores; thus each field is divided into four parts of equal width—i. e., two lines of pores and two ridges lying between them. In large specimens their width is $.\frac{15}{100}$ of an inch. The pores are ovoid, the long diameter lying transversely with the specimen, about 60 to the inch; they terminate at the reniform larger openings at the summit. The openings at the summit have their long diameter parallel to the length of the pore pieces.

The sides of the suture dividing the pore pieces is beautifully ornamented by fan-like figures, lying nearly opposite the pores; they are nearly triangular in form, composed of six diverging ridges, having a

common origin opposite the pores; these are divided by grooves of unequal depth, increasing in size and depth from the origin of the ridges to the bottom of the groove, quite analogous to the same part in *Pentremites obesus*.

The pores communicate with the interior of the body. On either side the pore pieces are supported by a piece, two to each field, ten in all, of equal width, nearly of the same form, ornamented with grooves and ridges. The grooves rise at a pore, and cross the pieces transversely, and terminate against the interradial pieces, the whole surface of the pieces being covered by grooves and ridges, which are equal in size to the pore, or the division between the pores, against which they severally originate. These are again crossed obliquely from the outside of the pieces upward, by a set of ribs which rise against the interradials and anal piece, and cross the supporting pieces of the pseudambulacræ.

The summit within the circle of the large pores (ovarian openings ?) is divided into about twenty-two small pieces, six of which are disposed around the seventh, which occupies the centre of the crown. They are nearly of equal size, polygonal or nearly circular; without the line of the six pieces, and falling into the indentations around the circle formed by them, are smaller pieces, and on either side of the outer circle of the ovarian (?) openings are small linear pieces, abutting against the small pieces outside of the first circle; all the pieces exept the linear ones are studded with a number of small prominent granules.

Specimens of this fossil are found ranging from $.\frac{30}{100}$ in inch, to an inch and $.\frac{50}{100}$ in length.

The relative proportion of one of the medium sized, rather globose specimens is as follows:

Greatest length,	$1.\frac{26}{100}$ inches.
Length from bottom of columnar-pit to summit,	$1.\frac{15}{100}$ inches.
Greatest diameter,	$1.\frac{15}{100}$ inches.
Least diameter,	$1.\frac{10}{100}$ inches.
Length of second primary radials,	$.\frac{25}{100}$ inch.
Length of first primary radials,	$.\frac{12}{100}$ inch.
Length of basal pieces,	$.\frac{09}{100}$ inch.
Greatest length of the pieces,	$1.\frac{20}{100}$ inches.
Greatest width of pseudambulacral fields,	$.\frac{50}{100}$ inch.

Greatest width of interradial pieces, - - $\cdot\frac{15}{100}$ inch.
Greatest length of interradial pieces, - - $1.\frac{07}{100}$ inches.
Greatest width of anal piece, - - - - $\cdot\frac{30}{100}$ inch.
Greatest length of anal piece, - - - $1.\frac{06}{100}$ inches.
Diameter of columnar pit, - - - - $\cdot\frac{15}{100}$ inch.

Geological positiom and locality.—Found in rocks of the Denovian period, about five or six feet below the hydraulic cement-beds, in a rock of peculiar physical character, distinguished as the *Olivanite* bed; the bed varies in thickness from one inch to two feet. The space between the *Olivanite* bed and the hydraulic cement beds, abounds in fragments of *Spirifer cultrajugatus*, and affords very few fossils, except a few washed and rolled corals. The *Olivanite* bed is rather local, although these fossils have a large horizontal range, the beds are in interrupted patches. The beds at the Falls of the Ohio have probably been the most productive. They have also been found on Beargrass creek, Jefferson county, near Louisville; on Silver and Fourteenmile creeks, Clarke county, Indiana; and near Columbus, Ohio.

OLIVANITES ANGULARIS. *Lyon.*

The preservation of the specimens of this species is such, that a distinct character cannot be traced of the fine external markings. The general arrangement of the parts, however, are distinctly visible, warranting the opinion, that the generic character is that of *Olivanites*, although some of the parts are not distinctly preserved.

Specific Character—Plate V. fig. 2, 2 *a*, 2 *b*.

Description.—The body is sub-ovoid; the diameter of the specimen under consideration, from the anal side, transversely, to the highest point on the opposite side, is $\cdot\frac{65}{100}$ of an inch; the diameter parallel with the flattened anal side $\cdot\frac{75}{100}$ of an inch; the height being $\cdot\frac{75}{100}$ of an inch. The anal side between the pore pieces, on either side of it, is nearly twice as wide as either of the other sides. The outline is very much inflated on the line of the pore pieces, whilst the interradials are deeply seated in the groove between them. The pseudambulacral fields rise sharply angular from the interradial pieces, which are much wider, and consequently have a much more rapid taper than the same pieces in *Olivanites Verneuilii*. The pseudambulacral fields are also narrower in proportion than in that species; the summit and basal

extremity are broader and flatter. The first series of primary radials are prominent, and raise out of the basal pit, which they do not in *Olivanites Verneuilii*. Viewed from either end, this species presents an irregularly sided pentagon, the bounding lines of which are concave toward the body of the specimen. This striking difference of section transversely, will at once distinguish this from *O. Verneuilii*.

Geological position and locality.—A few specimens of this species have been found in the rocks of the Denovian period, lying between the black slate and the hydraulic cement beds at Rock Island, at the foot of the Falls of the Ohio; on Beargrass creek, near Louisville; also, on Silver creek, Clarke county, Indiana. They have a limited vertical range, and are only found near the base of the beds in which they occur. *Olivanites Verneuilii* does not, so far as our observation extends, rise into the beds above the hydraulic beds, in which it is not found.

CODASTER ALTERNATUS. *Lyon.*

(Plate 3, 3 *a*, 3 *b*.)

Body long; irregularly conical; summit level in the centre; sloping slightly toward the outer end of the pseudambulacral fields; horizontal section at the lower extremity of the fields pentagonal, the angles of the pentagon being at the ends of the pseudambulacral field.

Basal pieces three; pentagonal; of equal size; gibbous; when joined forming a minute triangular cup, larger than the inferior extremity of the joined first radials fitting upon it; perforated in the centre by a very small circular opening.

Radial pieces three—two hexagonal complete, one pentagonal, and incomplete, (as in *pentremites*); the upper margin of the hexagonal pieces are concave in the centre, the corners obliquely truncated, forming, with the pentagonal piece, a deep cup, having the upper margin indented with two concave and three angular notches, from which rise five radials of the second series, two fitting upon the concave notches at the summits of the complete pieces; the other three rising from the angular notches between the three pieces.

Radial pieces, second series, five; reaching the summit; twice as long as wide; the summit of each indented by an angular notch, broader than deep; rising from the base of each, and tapering to a point at the inferior extremities of the notches, is an elevated rounded

rib, ornamented transversely by fine rounded striæ, while the margins of the pieces are similarly ornamented, by coarser striæ, lying parallel with the margin of the pieces, and terminating against the sides of the rib which occupies the middle. The sides of the second primary radials are sometimes closed upon the summit, nearly obliterating the triangular field between the pseudambulacral fields. The mesial line is always straight. The mouth seems to be situated at the centre of the summit, from which proceed five minutely granulated, porous, pseudambalacræ, terminating at the angular corners of the summit, in the notch of the second primary radials, forming a prominent ridge, divided, longitudinally, into four equal parts by three indented lines, the deepest of which rises within the mouth. The spaces on either side of the middle suture are divided by small prominences, diverging from the suture, and terminating within a circular depression, on the inner margin of the outer spaces. Around the mouth, at the junction of the ambulacral fields, are five rounded prominent tubercles—above the ovarial opening, in some specimens, another is added, which is still more prominent; from four of these tubercles diverge four prominent ridges, tapering from the mouth outward, one to the middle of four of the straight sides, the fifth space is without a ridge, being occupied by an ovate or circular (ovarial or anal) opening. The depressed, triangular intervening spaces are filled with seven or more thin pieces, lying parallel to the pseudambulacral fields, articulating with the summit of the second radial, and the prominent ridge lying between the pseudambulacræ. These pieces were evidently capable of being compressed or depressed; the point at the lateral junction of the second radials is in some specimens folded over toward the mouth so much as to entirely obscure these triangular spaces by covering them.

The ovarial or anal opening is always over the radial, to the right of the incomplete first radial.

Columnar facet small, round, or obscurely pentagonal. *C. alternatus* differs from *C. acutus* and *trilobatus, McCay*, in its greater length, and the rib ornamenting the second radials; also, by the much greater delicacy, (judging from McCay's figure,) of the ridge between the ambulacræ. This species is found much below either of the species of McCay.

Geological position and locality. Found in earthy partings between chrystalline limestone, about eight feet below the hydraulic cement beds,* and below the *Olivanite* horizon at the falls of the Ohio, and in the same geological position on south fork of Beargrass creek, Jefferson county, Kentucky.

Length of specimen, - - - - - $\cdot\frac{75}{100}$ inch.
Greatest diameter, - - - - - $\cdot\frac{38}{100}$ inch.

For valuable hints and assistance our thanks are due to Dr. D. D. Owen; also, to Samuel Casseday, for the use of his cabinet of *Crinoidea* and *Olivanites*.

SIDNEY S. LYON,
Assistant Geologist.

*These rocks belong to the Devonian period.

Explanations of the Plates.

PLATE I.

ASTEROCRINUS CORONARIUS. *Lyon.*
Volume 3, *page* 476.

FIG. 2. View of the summit.
FIG. 1a. Basal view of same specimen, natural size.

GRAPHIOCRINUS—14 BRACHIALIS. *Lyon.*
Volume 3, *page* 479.

FIG. 2. Generic figure, representing the parts laid out upon a horizontal surface. 1. Basal pieces. 2. First radial pieces. 3. Second radials. 4. Secondary radials. 5. Arms. 6. Anal pieces.
FIG. 2a. Profile view, same specimen.
FIG. 2b. Basal view, same specimen, natural size.

PLATE II.

PENTREMITES OBESUS. *Lyon.*

Volume 3, *page* 469.

FIG. 1. Basal view.
FIG. 1a. View of the summit, same specimen.
FIG. 1b. Profile view, same specimen.
FIG. 1c. Basal pieces.
FIG. 1d. Fragment showing the interradial pieces, drawn the size of nature.
FIG. 1e. Generic figure, reduced one diameter—
1. Basal pieces. 2. First radial pieces. 3. second radial pieces. 4. Third radial pieces. 5. Interradial pieces. 6. Pseudambulacral fields.

PLATE III.

ASTEROCRINUS CAPITALIS. *Lyon.*

Volume 3, *page* 472.

FIG. 1. Profile view, (all the figures are the size of nature.)
FIG. 1a. View of one of the club-like lobes, presenting its smallest surface.
FIG. 1b. View of same part, presenting its greatest surface.
FIG. 1c. View of the summit.
FIG. 1d. Basal view.
FIG. 1e. Generic figure—
1. Basal pieces. 2. Radial pieces. 2a. Anal piece. 3. Secondary radials.
FIG. 1f. End view of the base, anal side presented.
FIG. 1g. External view of the base.
FIG. 1h. Internal view of the base.
FIG. 1i. End of the base, opposite the anal side.
FIG. 1k. End view of the base, showing the long diameter.

PLATE IV.

ACTINOCRINUS ABNORMIS. *Lyon.*

Volume 3, *page* 479.

FIG. 1. Profile view, natural size.
FIG. 1a. Basal view, same specimen.
FIG. 1b. Generic view, extended from the anal pieces to the knob at the center o the summit.

DOLATOCRINUS LACUS. *Lyon.*

Volume 3, *page* 482.

FIG. 2. Generic figure.
FIG. 2a. Summit view.
FIG. 2b. Basal view, same specimen, size of nature.

VASOCRINUS VALENS. *Lyon.*

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FIG. 3. Generic figure, size of nature, the pieces arranged around the columnar facet.
FIG. 3a. Profile view, *vasocrinus valens*.
FIG. 8b. *Vasocrinus sculptus*, from which the external sculpture has been removed, anvl side front, natural size.

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FIG. 3c. Profile view, natural size, different specimen.
FIG. 3d. Basal view of same specimen.
FIG. 3e. Summit view of same specimen, natural size.

PLATE V.

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FIG. 1. *Olivanites Verneuilii*, natural size, anal side front.
FIG. 1a. *Olivanites Verneuilii*, natural size, side opposite the anal side.
FIG. 1b. Generic figure—1. Basal pieces (lighter colored.) 2. Primary radials, 1st series. 3. Primary radials, 2d series, (forked pieces.) 5. Interradial pieces. 4. Pseudambulacral fields, and supporting pieces on either side. 4^1. Anal piece, with the large opening at the summit. 6. Small pieces at the summit.
FIG. 1c. Summit view, natural size.
FIG. 1d. Basal view, natural size.

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FIG. 2a. *Olivanites Angularis*, anal side front, natural size, from a large specimen.
FIG. 2b. *Olivanites Angularis*, summit view.
FIG. 2. *Olivanites Angularis*, side opposite the anal side.