REPORT

ON THE

GEOLOGICAL SURVEY

OF THE

STATE OF IOWA:

EMBRACING THE RESULTS OF INVESTIGATIONS MADE DURING PORTIONS OF THE YEARS 1855, 56 & 57.

BY

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VOLUME I.

PART II: PALÆONTOLOGY.

PUBLISHED BY
AUTHORITY OF THE LEGISLATURE OF IOWA.
1858.

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2964

PRINTED BY CHARLES VAN BENTHUYSEN.

CHAPTER VIII.

PALÆONTOLOGY OF IOWA.

General Remarks — Fossils of the Hamilton group — Fossils of the Chemung group — Fossils of the Burlington limestone — Fossils of the Keokuk limestone — Fossils of the St. Louis limestone — Fossils of the Kaskaskia limestone — Fossils of the Coal measures.

I had proposed, in this part of the Report, to illustrate by descriptions and figures some of the most characteristic fossils of each of the several groups and formations which constitute the geological series occurring in Iowa. Since, however, it was necessary to limit the work within a moderate compass, the entire series could not be satisfactorily exhibited, and I have chosen therefore to devote the means at my disposal to a more full illustration of certain portions which I considered more important in the present state of our knowledge.

The sequence of the Lower Silurian and Upper Silurian formations have, for the most part, been described and illustrated in the Reports of Dr. D. D. Owen; while the higher groups, especially the Carboniferous limestones, have received less attention. Moreover, as I have already shown in a published paper, and more in detail in Chapter III of this volume, the Carboniferous limestone formation of the Mississippi valley will admit of several subdivisions (some of which have not before been recognized), each one being readily determined by its fossil remains, and which seem to me to be as restricted in their geological range as are those of any established groups of the Silurian and Devonian periods.

An examination of the fossils from the geological horizon of the Hamilton and Chemung groups of New-York (and which is in fact a continuation of the same beds) shows, that while there are many species identical with those of the same group in its eastern localities, there are a still larger number of new species; and which, since the physical conditions of the mass were not essentially different, can only be attributed to the influence of geographical distance. Having partially the means of illustrating in the fossils the changes which have taken place in the fauna of these epochs, I have given, to some extent, both the already known and the new species.

The Hamilton and Chemung groups, after being traced almost continuously from the western slopes of the Appalachians, is recognized in the Mississippi valley, both by lithological features and by fossil remains; and we take up again in Iowa our investigations of the fossils of these groups, after an interval of nearly fifteen degrees of longitude.

Among the Carboniferous limestones, the Burlington limestone has given ample materials for the illustration of its ancient fauna. The Keokuk limestone has also proved prolific of characteristic fossils; while the St. Louis limestone has afforded, comparatively, so few species that I have been constrained to go beyond the limits of the State for many of the characteristic examples of its fossils. The Kaskaskia limestone, so well developed at Kaskaskia and thence along the river bottom to Chester and as far as Fountain bluff, is unknown up to the present time within the limits of the State of Iowa. I have, nevertheless, felt it my duty to illustrate in some measure its fossil remains, in order to prove its distinctness from the Keokuk limestone, with which it has heretofore been erroneously identified as the "Archimedes limestone". The fossils selected for this purpose are of the same class, and represent the forms, chiefly, of Crinoideæ and Brachiopoda, which are most commonly found in these limestones. No species common to the two limestones have been observed by myself; and though probably such do occur, they are certainly not numerous, nor among the prominent forms which every where mark the two rocks.

Besides the collections which I have been able to procure, I have availed myself in many instances of those already made. Mr. A. H. WORTHEN very kindly offered me the use of his extensive and magnificent collection of Crinoideæ, as well as of other fossils; and but for this liberality, the work would have been far less fully illustrated. Such collections can only be accumulated by the devoted attention of many years; and in expressing my own indebtedness to Mr. WORTHEN, I may express the obligations under which geology rests for this contribution, and which will be gladly acknowledged by every student and votary of the science.

The collections made by Mr. WHITNEY and Mr. HUNGERFORD from the Hamilton group on Lime creek near Rockford, possess peculiar interest; inasmuch as they present us with forms more nearly allied to those of Central Europe, than the species which occur in more eastern localities of the same formation. The collections made by these gentlemen, and by Mr. WORTHEN at Independence and other centrally situated localities, show that in progressing in a northwesterly direction, changes are observed which can only be attributed to climatic or geographical influences.

The explorations both in the Hamilton and Chemung groups, as well as in the Carboniferous limestones, are yet very incomplete towards the northern part of the State, and we have reason to believe that discoveries of much interest will be made in these formations in that direction.

The surveys of the Desmoines valley in 1856 proved the Gypsum formation to lie above the productive Coal measures;

and I had hoped, before the conclusion of this Report, to be able to present some fossil remains from this group. The examinations yet to be made will be more especially directed to the region occupied by the Coal measures and the Gypsum formation, and we may hope to present some more extended information regarding these formations in a succeeding Report.

FOSSILS OF THE HAMILTON GROUP.

CORALS.

GENUS ACERVULARIA (SCHWEIGGER).

"CORAL compound, fasciculate, or more often massive, increasing by calicular budding; cells presenting two separated walls as in *Aulophyllum;* rays well developed between the walls, but much less in the central area; no columella; transverse septa little developed".— EDWARDS and HAIME, Mon. Polyp. Fos. p. 414.

Acervularia davidsoni?

PLATE I. FIG. 8 *a*, *b*.

Acervularia davidsoni : EDWARDS and HAIME, Monograph des Polypiers fossils, etc. pa. 418, pl. 9, f. 4, 4 *a* & 4 *b*.

CORAL astræiform; surface plane or subhemispherical; cells irregularly polygonal, unequal, the walls slightly zigzag; interior wall scarcely defined, and often marked only by the abrupt downward bending of the rays, which form within this area a deep cup; rays 32 to 40 in the outer division of the full-grown cells, often 20 in the younger cells, distinctly denticulate towards the sides, less distinctly towards the centre, in which there is sometimes a papilliform elevation which rises as high as the outer walls. In the unworn cells the inner wall rarely presents any interruption to the rays, some of them dying out or becoming less distinctly denticulate within this area.

The specimen figured is much weathered, and its outer area exhibits a gently inclining surface and a deep depression within the inner wall, with a scarcely elevated point in the centre. Other specimens, with the cup entire, are less depressed; and some specimens, which do not appear to have been worn before imbedding, are scarcely depressed within the inner walls.

Although these differ in some slight degree from the figures and descriptions cited above, I am inclined to regard them as identical, more particularly since specimens from different localities in Iowa show a considerable variation in external appearance as well as in the prevailing number of rays. The cells range in their greatest diameter from one-quarter to one-half an inch, presenting upon the surface of large specimens every degree of development.

Fig. 8 *a*. A weathered fragment of this species.
Fig. 8 *b*. An enlargement of one of the cells.

Geological formation and locality. In limestone of the age of the Hamilton group of New-York : Near Davenport, Rockingham, New-Buffalo, Pine creek, Iowa city and other places in Iowa ; Hamburgh, etc. in Illinois.

Acervularia profunda (n. s.).

Plate I. Fig. 7 *a*, *b*, *c*.

Coral astræiform, subhemispheric ; cells irregularly polygonal, unequal in size, often somewhat circular in the young and half grown conditions ; walls thin, scarcely undulating ; inner wall undefined ; cup abruptly and deeply depressed from a little within the outer wall ; centre marked by a papilliform node : rays thin, slender, from 36 to 46 in each cell (41 to 46 in full grown individuals), denticulate on the sides from the margin to the base of the cup ; some of the rays disappearing between the margin and the centre.

This species, in general aspect and in details of structure, is very distinct from *A. davidsoni*. The cells are less compactly arranged, and the outline is often somewhat circular, particularly in the young state. The cells are very unequal in dimensions, even in the same specimen, and this difference in the size is not always accompanied by a corresponding difference in the number of rays. The walls of this species are less strong than those of the preceding species, and scarcely undulating; while the rays are much more slender, and the denticulations more regular.

Fig. 7 *a*. Part of a large hemispheric mass, showing several young cells, some nearly circular : natural size.

Fig. 7 *b*. Transverse section of a cell, enlarged, from a polished surface. The inner wall is not defined, and many of the rays are continuous to the centre of the cup.

Fig. 7 *c*. A portion of a cell, enlarged, showing the denticulated rays.

Geological formation and locality. In limestone of the age of the Hamilton group of New-York : Independence, Iowa.

Genus Cladopora (Hall).

"Coral ramose or reticulate; branches cylindrical or slightly compressed, terminations terete : coral composed of a series of tubes or cells radiating equally on all sides from the axis, and opening upon the surface in rounded or subangular expanded mouths; cells more or less closely arranged, but not always contiguous, and apparently destitute of septa or rays".— Pal. N.Y. Vol. ii, p. 137.

Cladopora dichotoma (n. s.).

Plate I. Fig. 5.

Coral ramose; branches round, dichotomizing, ascending; cell apertures in unworn specimens somewhat expanded and broader below, in worn specimens round; cells arranged in alternating or somewhat quincunx order, distance from each other greater than the diameter of the cell, sometimes more closely arranged : surface smooth or granulate.

This species bears a distant resemblance to some of the Niagara species of this genus; but is much more robust, with the cells much larger and more distantly arranged.

Geological formation and locality. In calcareous rocks of the age of the Hamilton group : New-Buffalo, Iowa; Hamburg, Illinois.

Genus Striatopora (Hall).

"Coral ramose, corolla solid; stems composed of angular cells; apertures of cells opening upon the surface in expanded angular cup-like depressions; interior of the cell rayed or striated; striæ extending beyond the aperture of the cell".—Pal. N.Y. Vol. ii, p. 156.

Striatopora rugosa (n. s.).

PLATE I. FIG. 6.

CORAL ramose, frequently bifurcating; branches very gradually tapering; cells somewhat distant, arranged in alternating series, subcylindrical below and gradually expanding towards the aperture, with the walls much elevated on the basal and lateral margins.

This species is much more robust than the *S. flexuosa* of the Niagara group, with stronger and more rigid branches : the cell apertures are smaller, less angular, and more distantly arranged.

The specimens examined are all more or less worn, and the surface characters not well preserved. Some of the cells show the interior striation which characterizes the genus. There is a similar species in the shales of the Hamilton group in New-York.

Fig. 6. A fragment of this fossil : natural size.

Geological formation and locality. In shaly limestones of the age of the Hamilton group of New-York : New-Buffalo, Iowa.

CRINOIDEÆ OF THE HAMILTON GROUP.

GENUS ACTINOCRINUS (MILLER).

[SUBGENUS] MEGISTOCRINUS (OWEN & SHUMARD).

BODY depressed, subspheroidal or broadly urnshaped: basal plates three, usually anchylosed, and scarcely extending beyond the edge of the column; second series of plates (often appearing as the basal series) six, five radials and one anal : radial plates three in five series, interradial plates six to ten or more in five series; anal plates seven to thirty or more; each upper radial supporting two and sometimes three supraradial plates : from each upper sloping side, supraradials, often in double series above the first plate; brachial plates numerous; arms composed of numerous thin joints arranged in double series; subaxillary plates none to six or nine.

The successive ranges of plates in the species known, present the number of three in the first, six in the second, twelve in the third, etc.

The species of this type have so much the structure of ACTINOCRINUS, that a little extension of the generic characters of that genus would include them. Our specimens, however, approach more nearly the Genus PRADOCRINUS of DE VERNEUIL, to which they are closely allied in structure; but having a scarcely visible calyx, they do not correspond with the description and figures given.

The Genus MEGISTOCRINUS, proposed by OWEN and SHUMARD in 1852, has essentially the structure of the species under consideration, in the basal, second and third series of plates, as well as in the relations of the parts of the calyx.

A farther comparison of specimens, however, shows that these forms are but modifications of the typical generic form of ACTINOCRINUS, and do not appear to me to be separable upon fundamental structure. The illustrations under the Genus ACTINOCRINUS of the Burlington limestone, in this volume, will show more clearly the relations here indicated.

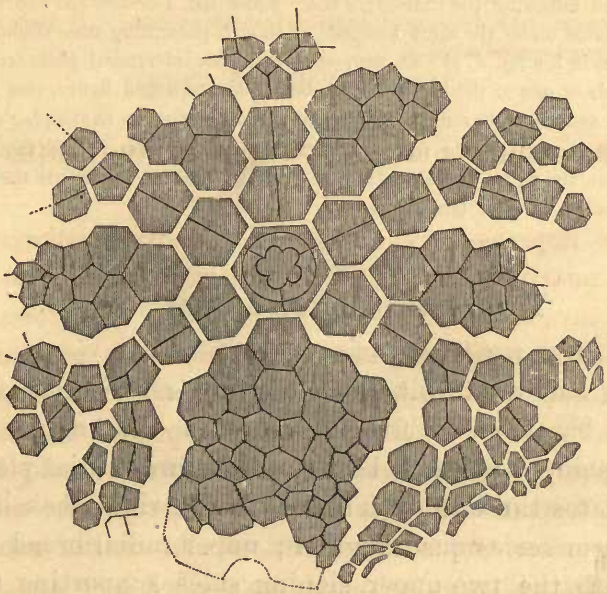
Actinocrinus (Subgenus Megistocrinus) latus (n. s.).

PLATE I. FIG. 1 *a*, *b*.

BODY depressed spheroidal or broadly urnshaped : base broad, nearly flat or slightly concave towards the column ; base composed of three closely joined or anchylosed plates, presenting a flat hexagonal disk which barely extends beyond the column. First radial plates hexagonal, wider than high, base and upper margins straight and parallel, the base a little the longer ; second and third radials hexagonal (one pentagonal), base straight. Each third radial supports on its upper sloping sides two superradials, which, in the anterior and antero-lateral rays, are each succeeded by a second superradial in the same series, and in the postero-lateral rays each first superradial supports a pair of diverging second superradials, and each of these, two others in the same direction, giving four ranges of superradials in those rays : these are succeeded by the brachial and arm-plates, giving, apparently, but four arms to the postero-lateral rays, while each of the other rays has the same number. First interradials hexagonal, as large as the second radials, succeeded by two others, each of which is as large or larger than the third radial plate; a third, fourth, fifth and sixth series of smaller interradial plates. First anal plate as large as the first radial plates, supporting one central large plate, and on the outer sloping edges of each side a series of two plates of the same dimensions as the second and third radials, while above and within these are several series of smaller plates to the number of more than thirty.

Dome broad, depressed hemispheric, composed of a great number of small plates with a subcentral proboscis or spine.

FIG. 53.—Diagram of the plates composing the body, below the arms, of *Megistocrinus latus*.



This species resembles one in the Hamilton group of New-York, but is larger and the basal plates more extended beyond the column: the form and proportion of the plates also differ in some degree. The surface of each plate is distinctly depressed in the New-York species, and the margins at their junction form an elevated ridge; while the plates of the Iowa species are individually convex.

Fig. 1 *a*. The summit of the specimen. Fig. 1 *b*. Basal view of the same.

Geological formation and locality. In the calcareous shales of the age of the Hamilton group of New-York: New-Buffalo, Iowa.

GENUS TAXOCRINUS (PHILLIPS).

BASAL plates five, small; radial plates three in five series; arms subdividing upon the third radial, and frequently dichotomizing above this point; arms and branches composed of a single series of joints. Interbrachial and axillary plates.

The definitions and illustrations of this genus, which have fallen under my observation, are not as clear as could be desired; and it is evident that the genus, as recognized in Great Britain, contains a heterogeneous assemblage of species.

PICTET has selected the *Cyathocrinus tuberculatus* of MILLER as the type of this genus; and following the characters there presented, I believe the following species may be placed under the same designation, though presenting some slight differences. GOLDFUSS, in his fig. *A*, pl. 58*, represents a double interradial plate truncating the upper angle of one of the basal plates; but in the enlarged figure, this plate is represented as lying between the second radials and resting on the sloping edges of two adjacent first radials. The figure of PICTET is like the first named figure of GOLDFUSS, while the figure in MURCHISON'S Silurian System represents the interradial plate as in the fig. *B* of GOLDFUSS.

Taxocrinus interscapularis (n. s.).

PLATE I. FIG. 3.

BODY narrow, turbinate below the first bifurcation of the arms: basal plates five, short, with the angular summit much pointed upwards between the lower radial plates; radial plates three in each series, much wider than high, the two lower series quadrangular; upper radial broad pentagonal, with the two upper sloping sides supporting a double series of arm-plates; interbrachial plate narrow, resting the base slightly on the second radial plates, with its upper extremity lying between the second arm-plates.

Arms ten; those on the exposed side bifurcating on the fifth plate above the base, and the adjacent parts again bifurcating upon the eighth and tenth plates respectively, while the outer divisions of the same arms continue simple

* Petrefacta Germaniæ, plate lviii.

to the fifteenth or seventeenth plate. The arms (outer side of the figure), have their first bifurcation on the eighth plate from the base.

A small axillary plate is intercalated between the arms at the first, and sometimes in the second bifurcation.

This neat and symmetrical species differs sufficiently from the known *Cyathocrinus* in the character of its base, and resembles none of the previously described American crinoids, so far as I know.

Fig. 3. View of a specimen imbedded in argillaceous limestone.

Geological formation and locality. In shaly limestone of the age of the Hamilton group : New-Buffalo, Iowa.

GENUS SYNBATHOCRINUS.

For generic description, see SYNBATHOCRINUS under the head of Crinoideæ of the Burlington limestone.

Synbathocrinus matutinus (n. s.).

PLATE I. FIG. 2.

BASAL plates undivided, forming a slightly projecting disc in the specimen : first radial plates wider than long; second radials longer than wide, obtusely angular along the centre; brachial plates quadrangular, and subangular longitudinally along the centre : column round, composed near the base of alternating larger and smaller rings.

The only specimen seen is a fragment, imperfect at the upper extremity, with the surface much broken, and particularly the basal and first radial plates, while the surface of the arm-plates has been exfoliated. The structure, therefore, is not very satisfactorily determined, though the peculiar form of the crinoid and the succession and arrangement of the plates are sufficient to distinguish it from any other established genus of crinoids.

Fig. 2. View of an imperfect specimen imbedded in shaly limestone.

Geological formation and locality. In shaly limestone of the age of the Hamilton group, associated with *Strophodonta demissa:* New-Buffalo, Iowa.

GENUS PENTREMITES (SAY).

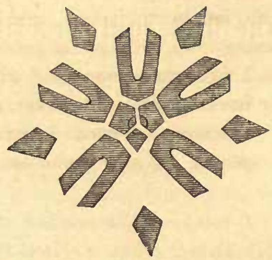


FIG. 54.— GENERIC FORMULA.

Basal plates 3, of which one is smaller than the others.
Radial plates 1 X 9, forked, large.
Interradial plates 1 X 5, lanceolate, small.
Pseudo-ambulacral areas 1 X 5, covered by pinnules.
Mouth 1, central.
Anal aperture 1, lateral.
Ovarian apertures 2 X 5, arranged around the mouth.

"BODY variable, globose, ovoid, pyriform, or clavate : basal plates three, one smaller and quadrangular, the other two equal in size and pentagonal; radial plates five, equal in form and size, two resting each on one of the sides of the two pentagonal plates, while the three others are alternate and in contact each with two of the basal plates. The little quadrangular basal plate does not correspond, as might be supposed, with the anal side, but with a regular side, as in PLATYCRINUS. These radial plates are divided in the middle by a sinus more or less wide and deep, giving them the form of a two-pronged fork : this sinus contains the pseudo-ambulacral areas. The forks of the radial plates alternate with five little interradial pieces, which are lanceolate, subtetragonal, more or less elongate, and meeting at the superior central opening.

"The pseudo-ambulacral areas are composed of three series of plates superimposed upon each other. The middle is filled with a series of compressed tubes disposed parallel to the sides of the forks of the radial plates, and succeeded by a single median lanceolate or linear plate, ornamented on each side by a great number of little transverse poral plates, alternating with transverse groups of still smaller plates (supplementary poral pieces). Filiform and articulate appendages, like the pinnules of the arms of other crinoids, and corresponding in number and in their bilateral arrangement with those of the lateral pores, complete the series of poral pieces.

" A central pentagonal opening is seen on the summit : this corresponds to the mouth of the animal. It is surrounded by four other smaller openings in the summit of the interradial pieces, and divided in the middle by a longitudinal lamella : the opening in the fifth radial piece, a little larger than the four others, has two lamellæ, which form three canals, of which the middle one corresponds to the *anus*, and the two lateral ones, as those of the other radial pieces, to *oviducts* of the animal.

" The stem is formed of little cylindrical articulations, having a very small circular opening : it appears to have been very short."

Pentremites subtruncatus (n.s.).

PLATE II. FIG. 3.

TURBINATE or reversed pyramidal, the base round, gradually becoming angular above, distinctly pentangular at the base of the pseudambulacral spaces; base small, almost pointed, apex broad subtruncate above ; basal plates small, less than half the length of the body; radial plates less than once and a half as long as the basal plates, slightly divided above for the reception of the pseudambulacral plates; interradial plates small, rising above the centre when complete; summit convex, flattened in the centre; pseudambulacral spaces short, abruptly convex in the middle; poral plates fifteen or more in each series ; ovarian apertures small, round.

This species belongs to the same type of form as *P. reinwardti*, from which the one here described differs in having relatively a much shorter base, is more rapidly expanding above, the summit less elongated and much more obtuse, there being little contraction from the pseudambulacral spaces to the summit of the interradial plates. The pseudambulacral spaces in *P. reinwardti* are much narrower and the sides more nearly parallel; the poral plates present a flattened or depressed line, while in this one they form an abrupt convex area.

A similar species *P. striatus*, from the Corniferous limestone, has the plates deeply striated parallel to their margins, and the pseudambulacral areas broader and less abruptly convex, and the interradial plates less extended.

Geological formation and locality. In the calcareous shale of the age of the Hamilton group of New-York : New-Buffalo, Iowa.

BRACHIOPODA OF THE HAMILTON GROUP*.

Orthis suborbicularis (n. s.).

PLATE II. FIG. 1 *a – e*.

SHELL depressed orbicular ; valves almost equally convex, length and breadth about as four to five; hinge line very short. Dorsal valve regularly convex, a little flattened at the cardino-lateral margins; beak elevated and slightly incurved beyond the plane of the area. Ventral valve slightly the more convex, most convex near the umbo ; beak slightly more elevated than the opposite, scarcely incurved : area about one third as high as wide : foramen large ; width and height about equal.

SURFACE finely striated ; striæ increasing by implantation, gradually curving outward towards the margin, and bending upward to the hinge line, crossed by fine concentric striæ, and sometimes by imbricating lines of growth.

Interior marked near the margin by strong striæ which are faintly visible half way to the beak; the entire surface finely punctate. Ventral valve with strong cardinal teeth, and muscular impressions limited by the dental lamellæ. Dorsal valve with strong brachial processes and a small cardinal process.

This species bears some resemblance externally to *O. vanuxemi* of the Hamilton group, as it occurs in its more circular forms in New-York; but is proportionally broader, and the valves more equally convex. In its muscular and vascular impressions it is conspicuously distinct, as well as in the cardinal process and strongly marked ridge down the centre of the dorsal valve. It bears, also, much resemblance to a species of the Lower Helderberg limestone, but careful comparisons show it to be distinct.

The specimen figured is somewhat compressed towards the margins, so that a profile view does not present the true form of the shell.

Fig. 1 *a, b*. Dorsal and ventral views of an entire individual.
Fig. 1 *c*. Cardinal view of the same enlarged.
Fig 1 *d*. Interior of a dorsal valve, showing the brachial and cardinal processes.
Fig. 1 *e*. Interior of a ventral valve of a small individual, showing the cardinal teeth.

* For generic descriptions of the Brachiopoda, see pages following the specific descriptions at the end of the volume.

Geological formation and locality. In calcareous shales of the age of the Hamilton group : Rock-island (Illinois), opposite Davenport (Iowa).

Orthis vanuxemi.

PLATE II. FIG. 2 *a – i*, 3 *a – f*.

Orthis vanuxemi : HALL, Report of the Regents of the University on the N.Y. State Collections of Natural History for 1856, p. 95.

SHELL depressed orbicular, varying from circular to transversely broad oval, and rarely a little longer than wide, resupinate. Ventral valve most convex near the beak, gradually depressed below and flattened towards the front ; beak elevated, scarcely incurved. Dorsal valve most convex a little above the centre, an undefined depression down the middle, which expands into a broad flattened space, sometimes giving the base a straight appearance ; beak scarcely defined : length of area about one-third the width of the shell : foramen broad, partially filled with the strong cardinal process.

SURFACE marked by fine closely arranged radiating tubular striæ, which increase by bifurcation and implantation, and are crossed by very fine concentric lines, and towards the margins by imbricating lines of growth ; striæ with frequent tubular openings upon the surface.

Interior surface finely punctate. Interior of ventral valve marked by a large foliate or flabelliform vascular impression, and in older shells a strongly defined impression of the adductor muscles a little above the centre of this, and a prominent cardinal process which is continued below in a ridge along the centre of the valve. Margins crenulate with the radiating striæ, which are sometimes visible more than half way to the beak of the shell.

The specimens of this species from Rock-island are usually longer than wide : in other localities, they are more nearly circular; and notwithstanding the variation from the prevailing form of the New-York specimens, there appears to be no specific difference.

Fig. 2 *a, b, c.* Ventral, dorsal and profile views of a specimen of the usual form of the species in its more northwestern localities.

Fig. 2 *d.* Cardinal view, enlarged, to show area and foramen.

Fig. 2 *e, f.* Dorsal and ventral views of a specimen from the same geological position in Missouri.

Fig. 2 *g, h.* Interior of ventral and dorsal valves.

Fig. 2 *i.* Enlargement of striæ.

Fig. 3 *a, b.* Ventral and profile views of a specimen of medium size, from the shales of the Hamilton group in New-York.

Fig. 3 *c, d.* Interior of ventral and dorsal valves from New-York specimens; the ventral valve showing some slight differences in form and divergence of the teeth from 2 *g.*

Fig. 3 *e.* Interior of a large ventral valve from the Hamilton group of New-York, showing the vascular and muscular impressions : the teeth are broken.

Fig. 3 *f.* Enlargement of the striæ, showing the punctate surface and more distinct tubular openings.

Geological formation and localities. In calcareous shales of the age of the Hamilton group : near Davenport and New-Buffalo, Iowa ; Rock-island, Illinois, and several localities in Missouri; the Hamilton group in Central and Western New-York.

Orthis iowensis.

Plate II. Fig. 4 *a – i.*

Shell resupinate, transversely oval or subglobose, with a deep sinus in front; hinge line less than two-thirds the greatest width of the shell. Ventral valve much the less convex, greatest convexity near the beak, and flattened towards the margins, with a deep sinus from the middle to the base of the valve ; beak elevated slightly above the opposite, pointed, not incurved. Dorsal valve extremely gibbous, greatest convexity about the centre of the valve, and sloping abruptly to the sides ; umbo arched ; beak prominent, slightly incurved over and projecting beyond the hinge line. Area small ; foramen narrow.

Surface marked by fine closely arranged radiating tubular striæ which increase by bifurcation and interstitial addition, and are crossed by fine concentric striæ and a few imbricating lines of growth ; radiating striæ presenting numerous tubular openings upon the surface, and marked by fine pores or punctæ over the entire surface.

Interior of ventral valve marked by strong muscular impressions, which are limited by the dental lamellæ and divided in the centre by a strong ridge, presenting a quadrangular area below the hinge line, the vascular impression proceeding in radiating impressed lines from the base of this quadrangular area : teeth strong, prominent. Dorsal valve deeply concave, with strong prominent brachial processes, and a median cardinal process which is sometimes bilobate. Entire interior of shell punctate ; striæ marking the inner margins of both valves, but rarely extending far beyond.

This species is closely related to *Orthis propinqua* of the Upper Helderberg limestone, to *O. tulliensis* of the Tully limestone, and to *O. multistriatus* of the Upper Pentamerus limestone. It may, however, be distinguished from all these by its shorter area and more pointed, as well as more arched, beaks, as also by the form of the muscular impressions of the ventral valve and the cast of the same, as well as the direction and division of the vascular impressions below.

Fig. 4 *a, b*. Ventral and dorsal views of a specimen of this species.

Fig. 4 *c*. Front view of the same.

Fig. 4 *d*. Profile view of specimen.

Fig. 4 *e, f*. Cast of the ventral valve of a young and of a full-grown individual.

Fig. 4 *g*. Cast of the dorsal valve of 4 *f*.

Fig. 4 *h*. Interior of dorsal valve, showing the brachial and cardinal processes.

Fig. 4 *i*. Interior of ventral valve, showing the teeth and the form of the muscular impressions, with indistinct radiating lines below, indicating the course of the vascular impressions.

Geological formation and localities. In calcareous shales of the age of the Hamilton group : at New-Buffalo, Independence, Lime creek and other places in Iowa ; Rock-island (Illinois), etc.

Orthis iowensis, var. furnarius.

PLATE II. FIG. 5.

SHELL resupinate, depressed orbicular, gibbous, with a shallow sinus in front. Ventral valve moderately convex, greatest elevation near the beak, sloping gradually to the margins, and becoming depressed in a broad undefined sinus. Dorsal valve gibbous in the middle, arched on the umbo, with the beak slightly curved over the hinge line : area narrow.

SURFACE finely striated ; substance of the shell minutely punctate.

The exterior of numerous specimens from a single locality offers little positive difference from the *O. iowensis* : they are less gibbous, and the sinus in front less deeply marked than in the Iowa specimens; but the form of the muscular and vascular impressions in the cast of the dorsal valve is so different, that I have separated these forms as a distinct variety, which may perhaps be found specifically distinct.

Fig. 5. Cast of the dorsal valve.

Geological formation and locality. In limestone of the age of the Hamilton group : Bakeoven, Illinois.

Orthis inequalis.

PLATE II. FIG. 6 *a*, *b*, *c*.

SHELL subplano-convex, or depressed hemispherical, semi-elliptical in outline ; hinge line equalling the greatest width of the shell. Dorsal valve very gibbous, greatest convexity near the centre ; umbo prominent ; beak scarcely elevated above the hinge margin. Ventral valve nearly plain, slightly convex towards the beak, flattened at the lateral margins, and slightly concave towards the basal margin, which is not sinuate : area long, narrow ; foramen broad.

SURFACE marked by alternating larger and smaller striæ, and sometimes nearly equal bifurcating striæ, which in the casts appear to be fasiculate near the margins : striæ curved upwards on the margin of the convex valve, but not running out on the hinge line.

In the cast, the impressions of striæ near the margin present one strong one with two or three finer ones between.

This species is closely allied to one in the Chemung group of New-York, and may be identical. It differs conspicuously from *O. iowensis* in its longer hinge line, the nearly flat ventral valve, and absence of sinus in front.

Geological formation and locality. In fine-grained sandstone of the age of the Chemung group : at Burlington, Iowa.

Orthis pravus.

SHELL semielliptical, distorted from adhesion by the beak of the ventral valve. Ventral valve convex, gibbous towards the beak ; area high, equal the greatest width of the shell.

SURFACE marked by fine subequal elevated striæ, which are crossed by very fine well defined concentric striæ and some imbricating lines of growth.

This species is similar to *Orthis perversa* of the Hamilton group of New-York, but differs in the arrangement and character of the striæ.

A single ventral valve only has been observed, and it is noticed here to call attention to its occurrence in Iowa.

Geological formation and locality. In calcareous shales of the age of the Hamilton group : Lime creek, Worth county, Iowa.

GENUS STROPHODONTA.

Strophodonta : HALL, Palæontology of New-York, Vol. ii, p. 63.

SHELL depressed expanded, semielliptical, semicircular or subquadrate, transverse or elongated (external surface striated); hinge line straight, usually as long as the width of the shell : ventral valve convex or concave; dorsal valve following the curves of the opposite, often abruptly bent downwards along the middle or towards the margin; area more or less common to both valves, more developed on the ventral valve, crenulated on the inner edges; fissure none or partial, a linear callosity sometimes marking the centre of both areas.

In the ventral valve the teeth are much reduced or nearly obsolete, a central more or less prominent bilobed process usually occupying the centre of the area in place of the triangular fissure of STROPHOMENA. Muscular impressions strongly marked, semielliptical or subreniform, separated in the middle by a depressed line, and sometimes margined by a semicircular ridge, which is an extension of the lamellæ from either side. Vascular impressions foliate or flabellate, extending beyond the areas towards the base of the shell.

Dorsal valve with the muscular and vascular impressions strongly marked : cardinal process bifurcate from the base, with each branch bilobed at the extremity by which it is articulated to processes beneath the area of the opposite valve, receiving between its forks the cardinal process of the opposite or ventral valve, which is bilobed or grooved for the passage of the peduncle. Entire interior surface papillose.

The species of this genus have the general form of STROPHOMENA or LEPTÆNA, and are similarly striated, in all the variety of simple, bifurcating and fasciculate striæ. The area, which is common to both valves, is usually entire, in the species known, with the margins distinctly crenulated. There is sometimes a linear callosity along the centre of the area of each valve, in the place of the triangular foramen; and in some specimens of *L. demissa,* there is a triangular space on the area of each valve, but which is solid like the other parts, and to which are affixed the cardinal processes. In some species there is sometimes a small semicircular opening at the base of the area of the ventral valve; and in one individual of another species, I have seen a triangular foramen with a round opening between the forks of the cardinal process of the dorsal valve, while the cardinal process of the ventral valve projected downwards, interlocking with the opposite one, and forming one side of the circular foramen.

The muscular and vascular impressions of true STROPHODONTA are in general more like those of CHONETES or PRODUCTUS; and are for the most part distinct from STROPHOMENA; while the crenulated margins and absence of triangular foramen, character of the cardinal processes, etc. furnish ready means of distinction.

Strophodonta arcuata (n. s.).

PLATE III. FIG. 1 *a*, *b*, *c*, and FIG. 2 *a*, *b*, *e*, *f*

SHELL semielliptical; hinge line scarcely equalling the greatest width of the shell near the cardinal extremities. Ventral valve hemispheric, gibbous in the middle, sometimes with an obtuse undefined elevation along the centre, the cardinal extremities usually a little recurved. Dorsal valve deeply concave; area common to both valves, that of the ventral valve larger and deeply striated vertically: foramen none, or rarely an opening at the base of the area.

SURFACE marked by fascicles of strong striæ, or which sometimes consist of a few strong ones near the beak, bifurcating below, while the general character of surface marking is that of strong, sharply elevated striæ, with three, four or five smaller ones between: worn surface punctate or striato-punctate.

Interior of shell papillose. In the ventral valve the impressions of the adductor muscles are small but well defined, the vascular impressions small and margined by an elevated ridge : cardinal teeth obsolete; cardinal process small; area indented by the bifurcate cardinal process of the opposite valve.

This small species is well marked by its strong shell, extremely arcuate form, recurved (sometimes) subauriculate hinge extremities, strongly striated area, which usually presents the entire absence of foramen, and has two deep indentations on each side of the central cardinal process of the ventral valve, which are filled by the two horns of the cardinal process of the other valve. This feature is often conspicuous when the area does not appear to have been worn. In a single individual, there is a subtriangular opening in the base of the ventral area, and a circular foramen between the forks of the cardinal process of the dorsal valve on one side, and the cardinal process of the opposite valve on the other.

Fig. 1 *a, b, c.* Dorsal, ventral and profile view of a specimen : natural size.

Fig. 2 *a.* Interior of ventral valve, showing the muscular and vascular impressions, the central cardinal process, and the indentations of the area made by the cardinal process of the opposite valve.

Fig. 2 *b.* A portion of the same enlarged, showing the parts described.

Fig. 2 *e, f.* Enlargement of the striæ from two specimens, showing in 2 *f* the prevailing character, while some specimens present the features of 2 *e.*

Geological formation and locality. In shales of the age of the Hamilton group : Lime creek above Rockford, Iowa.

Strophodonta lepida (n. s.).

PLATE III. FIG. 3 *a, b, c.*

SHELL semielliptical or subquadrate, broader than long; hinge line scarcely equalling the width of the shell. Ventral valve moderately convex, somewhat flattened towards the hinge and more abruptly curving in front, the greatest elevation being somewhat transversely along the middle. Dorsal valve moderately and uniformly concave : area principally confined to the ventral valve, striated longitudinally.

SURFACE smooth, or marked only by a few imbricating lines of growth.

Interior of ventral valve marked by strong elevated spaces for the attachment of muscular impressions, with broad flabelliform and bilobate vascular impressions, which are limited above by a thickened margin. Interior of dorsal valve showing a few strong crenulations upon the inner edge of the area : cardinal process small; muscular impressions subreniform, with three elevated oval spaces near the centre of the valve. Entire inner surface papillose.

This species bears much external resemblance to *S. nacrea* of the Hamilton group of New-York, but the internal structure is very different.

Fig. 3 *a*. Exterior view of a ventral valve of large size.

Fig. 3 *b*. Interior of the ventral valve, showing the muscular and vascular impressions.

Fig. 3 *c*. Interior of a dorsal valve, showing the crenulated hinge line and muscular impressions.

Geological formation and locality. In calcareous shales of the age of the Hamilton group : Rock-island, Illinois.

Strophodonta reversa (n. s.).

Plate III. Fig. 4 *a* – *d*.

Shell resupinate, semicircular or semielliptical, width greater than the length; hinge line extended beyond the width of the shell below. Ventral valve slightly convex in the middle towards the beak, flattened along the hinge and concave below, the shell being abruptly deflected near the margin. Dorsal valve flat on the umbo and slightly concave near the beak, abruptly bent downwards or almost geniculate below the centre : area common to the two valves, that of the ventral valve a little higher towards the middle; foramen none.

Surface strongly striated : striæ simple, strong and angular near the beak, and dichotomizing once, twice, or thrice before reaching the centre of the shell, increasing also by implantation. Entire surface punctate.

Interior of ventral valve marked by small reniform muscular impressions, which are sometimes not distinctly limited : vascular impressions large flabelliform or double ovate areas, which in the upper part are defined on their margins by a thickening of the shelly matter, while ramifying linear impressions are continued to the margin of the valve : cardinal process prominent, bilobed, with a deep depression beneath it, and an indentation on each side in the area margin, with deep pits beneath for the reception of the two horns of the cardinal process of the opposite valve.

This species resembles in external markings the *S. demissa,* but the striæ are stronger and more angular towards the beaks. The resupinate form and abruptly deflected margins distinguish it from other species.

This one and the preceeding species show the indented outline of the cardinal area, produced by the impressions of the cardinal process of the opposite valve.

Fig. 4 *a*. Dorsal view of a specimen having the margin somewhat irregularly plicated, which is apparently due to accident during the life of the animal.

Fig. 4 *b*. Ventral view of the same.

Fig. 4 *c*. Profile view.

Fig. 4 *d*. Interior of ventral valve, showing the indented margin of area, bilobed cardinal process, the muscular and vascular impressions.

Geological formation and locality. In calcareous shales of the age of the Hamilton group : Lime creek above Rockford, Iowa.

Strophodonta demissa.

PLATE III. FIG. 5 *a – k*.

Strophomena demissa : CONRAD, Journal Academy Natural Sciences, Philadelphia, 1842, Vol. viii, pa. 258, pl. 14, f. 14.

Strophodonta demissa : HALL, Report of the Regents of the University of New-York, upon the State Collections of Natural History, for 1856, p. 137.

SHELL semielliptical, usually wider than high ; hinge line usually equalling or greater than the width of the shell below, the extremities often prolonged into mucronate tips, and sometimes the margins are contracted below, giving a subauriculate character to the shell. Ventral valve very regularly convex, sometimes gibbous or ventricose : area well defined, strongly striated vertically, the inner margin crenulate. Dorsal valve regularly concave, and following the curvature of the opposite valve : area sublinear, common to both valves ; inner edges strongly crenulate.

SURFACE marked by strong subangular striæ, which are several times dichotomized before reaching the base of the shell, and varying considerably in number and strength in different individuals. Fine concentric striæ mark the surface of well-preserved specimens, and, under a lens, the entire surface is punctate.

The description above applies to the Iowa specimens; while those of New-York, which are regarded as identical, present some differences. The shell in the latter is usually stronger, and more convex on the ventral valve, while the dorsal valve is often nearly flat in its upper half, and bent upwards towards the margin : the area is likewise broader, being nearly double the width; the cardinal extremities less salient, and the striæ more subdivided and finer in the middle and lower parts of the shell.

Having no specimens from Iowa which show the interior structure, I have illustrated these parts from specimens from the Hamilton group of New-York.

Fig. 5 *a*, *b*. Ventral and dorsal views of a specimen of ordinary form and size, from Iowa.

Fig. 5 *c*. A specimen where the cardinal extremities are more salient.

Fig. 5 *d*. Profile showing the convexity of the specimen.

Fig. 5 *e*. Interior of the ventral valve of a specimen from New-York, showing the bilobed cardinal process in the centre of the area, and the muscular and vascular impressions.

Fig. 5 *f*. Enlargement of the area surface, showing the deeply striate character.

Fig. 5 *g*. Interior of the dorsal valve of a specimen from New-York, showing the muscular impressions and the double cardinal process.

Fig. 5 *h*. The same enlarged, showing the crenulate dental lamella on each side of the base of the cardinal process.

Fig. 5 *i*. Enlargement of a portion of the area and cardinal process of the dorsal valve, looking from the outside. In this individual there are no prominent crenulated lamellæ, as in fig. 5 *h*.

Fig. 5 *k*. A similar view of another individual, showing, at the base of the cardinal process, the indentations made by the two lobes of the process from the ventral valve, and the lateral crenulated lamellæ.

Geological formation and localities. In calcareous shales of the age of the Hamilton group of New-York : New-Buffalo, Pine creek, Independence, Lime creek, and other places in Iowa ; Rock-island (Illinois), and in the shales of the Hamilton group in Erie county, New-York.

Strophodonta fragilis.

PLATE III. FIG. 6 *a*, *b*, *c*.

Strophodonta fragilis : HALL, Report of the Regents of the University of New-York, on the State Collections of Natural History, for 1856, p. 143.

SHELL thin, fragile, semielliptical, usually wider than high; hinge line extending beyond the width of the shell below, and the margins often abruptly contracted just beneath the cardinal extremities. Ventral valve very slightly convex, or nearly flat. Dorsal valve flat or scarcely concave : area entire, very narrow, linear, almost entirely confined to the ventral valve, striated vertically, and crenulated on the inner margins throughout its entire length.

SURFACE covered by slender closely arranged radiating striæ, crossed by finer elevated concentric lines which become more prominent on the radiating striæ of the ventral valve, giving a minutely nodulose or granulose character to the entire surface when well preserved. The radiating striæ of the dorsal valve are more evenly rounded, and increase mainly by bifurcation; while those of the opposite valve increase by interstial additions (this character may be subject to variation), and are crossed by even, raised, concentric lines which produce no granulations on the surface.

Internally the ventral valve shows a very small, scarcely conspicuous central cardinal process. The muscular impressions are usually slightly marked, and the vascular impressions double, foliate or flabellate, with a scarcely defined separating ridge, and margined by a slight elevation of the lamellæ proceeding from the hinge line.

This species may be recognized by its extreme tenuity and the narrow space between the two valves, which scarcely exceeds the thickness of the shell. The area presents no appearance of a triangular foramen or a deltidium, though there is sometimes a slight sinuosity in the margin. In the New-York specimens, the central cardinal or dental process of the ventral valve is conspicuous, while in the Iowa specimens it is very subdued. The Iowa specimens occur chiefly as single valves, the ventral valve only being usually preserved, while rarely there occur specimens retaining the two valves.

Fig. 6 *a*. View of the ventral valve.

Fig. 6 *b*. Interior of ventral valve, showing the foliate vascular impressions, entire area, etc.

Fig. 6 *c*. Enlargement of the striæ.

Geological formation and localities. In calcareous shales of the age of the Hamilton group of New-York: New-Buffalo and Independence in Iowa, and Rock-island in Illinois.

Productus dissimilis (n. s.).

PLATE III. FIG. 7 *a, b, c, d e.*

SHELL semielliptical in outline; length and breadth nearly equal. Ventral valve extremely convex, gibbous in the middle and towards the beak; umbo elevated above the hinge line; beak incurved; hinge extremities slightly auriculate.

Dorsal valve deeply concave, following the curvature of the opposite valve : a small space or area? between the margins of the two valves, along the hinge line.

Surface of ventral valve marked by fine radiating striæ and a few concentric imbricating lines of growth, which become wrinkles on the cardino-lateral margins : a few scattered nodes, or bases of tubular spines mark the surface at irregular intervals. Dorsal valve marked by regular concentric imbricating lines, without visible radiating striæ.

This species is proportionally narrower than any of the Productideæ (which I know) in the rocks of this age, and the strongly marked difference in the character and direction of the striæ on the two valves is a very characteristic feature of the shell. In general form and the character of the striæ of the ventral valve, it bears some resemblance to *P. undiferus* of De Koninck, but the concentric striæ of the dorsal valve are quite distinctive.

Fig. 7 *a*, *b*. Dorsal and ventral views of the shell.

Fig. 7 *c*. Profile of the same.

Fig. 7 *d*. Enlargement of the striæ from the surface of the ventral valve.

Fig. 7 *e*. Enlargement of concentric striæ from the surface of the dorsal valve.

Geological formation and locality. In calcareous shales of the age of the Hamilton group : Lime creek above Rockford, Iowa.

Productus pyxidatus (n. s.).

Plate III. Fig. 8 *a* – *e*.

Shell semielliptical, breadth greater than the height; cardinal extremities somewhat rounded, the hinge line being shorter than the greatest width of the shell. Ventral valve broadly convex, somewhat flattened and a little recurved at the cardinal extremities, gibbous on the umbo and beak recurved. Dorsal valve broadly concave, a little flattened at the cardinal extremities; concavity less than the convexity of the opposite valve.

Surface marked by close concentric striæ, and more conspicuous imbricating lines of growth : the ventral valve sometimes having elongated spiniferous tubercles or ridges, which are arranged in alternating series; the dorsal valve sometimes with indistinct radiating ridges, which are not spiniferous.

The prevailing character of the species, in its surface markings, is that of a concentric imbricating or lamellose structure; while in some specimens we have, in addition to this, the elongate spiniferous tubercles towards the umbo, and elongate ridges in the lower part of the shell.

There is no visible area in several specimens examined, when the two valves and hinge line are entire; and the interior of the dorsal valve shows a strong bilobed cardinal process, without sockets for the cardinal teeth of the opposite valve as in true STROPHALOSIA.

Fig. 8 *a*. Ventral valve, showing a few spiniferous tubercles on the upper part of the valve, while the ridges which usually characterize the lower part in such specimens are not perceptible. This specimen is proportionally narrower than the prevailing forms.

Fig. 8 *b*. Ventral valve of the ordinary form, without spiniferous nodes or ridges.

Fig. 8 *c*. Dorsal valve of another individual, with some undefined radiating ridges upon the surface.

Fig. 8 *d*. Profile view of a specimen.

Fig. 8 *e*. Interior of a dorsal valve, showing the cardinal process, muscular impressions, etc.

Geological formation and localities. In calcareous shale and in limestone of the age of the Hamilton group : Hamburgh (Illinois), and Louisiana (Missouri)*.

Productus shumardianus (n. s.).

PLATE III. FIG. 9; and PLATE VII. FIG. 1.

SHELL semielliptical, wider than long; hinge line about equal to the width of the shell. Ventral valve very convex, gibbous in the middle and towards the umbo; beak incurved. Dorsal valve moderately concave; extremities flattened, subauriculate.

SURFACE marked by fine concentric striæ and strong spiniferous tubercles, which are sometimes crowded near the cardinal extremities of the ventral valve.

This species has been referred to *P. subaculeatus* and *P. murchisonianus*; but it differs from the former in the smaller and less rounded character of the bases of the spines, and from the latter in its smaller size, less numerous and less regularly arranged spiniferous tubercles, and the absence of the strong radiating ridges shown in the figures of the dorsal valve.

Fig. 9. The interior of a dorsal valve, showing the marks of the spiniferous ridges upon the inner surface.

* At the time these specimens were figured, I regarded certain other forms from near Burlington (Iowa) as identical with them : a farther comparison, however, shows the propriety of separating these specimens from those of that locality.

PLATE VII.

Fig. 1. The ventral valve of the same species.

Geological formation and localities. In limestone of the age of the Hamilton group, at Clarkesville (Missouri); and in the fine sandstones of the age of the Chemung group, at Burlington (Iowa).

Productus subalatus (n. s.).

PLATE III. FIG. 10 *a*, *b*, *c*.

SHELL semielliptical or semicircular, usually much wider than high; hinge extremities equalling or less than the width of the shell. Ventral valve ventricose in the middle, gibbous on the umbo and towards the beak, extended, flattened and auriculate at the hinge extremities; beak incurved over the hinge line.

SURFACE marked by fine concentric undulating striæ, and towards the lateral margins by strong wrinkles, and ornamented by numerous round tubular spines which are often somewhat crowded near the cardinal margin on each side of the beak, and sometimes arranged in a continuous line upon the umbo: towards the beak the spines are smaller, and become stronger towards the margins of the shell.

The shell is often unsymmetrical, one of the ears being much more extended than the other, and sometimes both are so much extended as to have an alate appearance. The character of the spines, or the bases which usually remain, bear some resemblance to *P. subaculeatus;* but they are less regularly disposed, and the shell is remarkably distinct from any other species in our rocks, so far as I know.

Fig. 10 *a*. Ventral valve of a specimen of medium size, with few spines, and preserving the usual characteristics of the species.

Fig. 10 *b*. Ventral valve of a larger specimen, showing the irregular distribution of the spines.

Fig. 10 *c*. Profile view of fig. 10 *b*.

Geological formation and locality. In calcareous shales of the age of the Hamilton group of New-York: Rock-island (Illinois), opposite Davenport (Iowa).

Spirifer hungerfordi (n. s.).

PLATE IV. FIG. 1 *a – k*.

SHELL inequivalve, semielliptical, transverse or elongated, varying with the age of the animal. Dorsal valve regularly convex, the greatest convexity above the middle, and curving gently on all sides; beak incurved slightly beyond the hinge line: no defined mesial fold. Ventral valve in the young and half grown shells semielliptical, gibbous above the middle, having twice as great an elevation as the opposite valve, the beak much extended above the hinge line and slightly incurved; hinge line equalling or extending beyond the width of the shell; sinus shallow, scarcely defined above the middle, and producing a slight sinuosity in front: area large and well defined, principally confined to the ventral valve and limited by an obtuse margin, striated vertically; foramen narrow, acute above, and extending quite to the apex of the shell, the margins or dental lamellæ often a little thickened or projecting.

SURFACE marked by fine simple radii, a few only of which dichotomise on the mesial sinus and elevation, and rarely on other parts of the shell. Radii about equal to the spaces between them, and both are again finely striated in the same direction by microscopic lines, and the whole crossed by fine concentric striæ which give a granulate appearance to the unworn surface.

In old shells, the proportions of length and breadth vary so that they become longer than wide, the hinge line and area are less than the greatest width of the shell, the valves become more gibbous, the beak of the ventral valve more incurved, and the area contracted: at the same time the sinus becomes better defined towards the base, the mesial fold distinctly elevated towards the margin, and the radii more strongly developed.

This species bears much resemblance to the *Spirifer pachyrynchus* of De Verneuil (Russia and the Ural mountains, pa. 142, pl. iii, f. 6); but the area in that species is smaller and more contracted at its upper margins, particularly in old shells, which are also quite free from striæ.

Fig. 1 *a*, *b*. Dorsal views of two individuals, showing the form of shell, proportion of area, etc.

Fig. 1 *c*, *d*. Ventral views of two individuals.

Fig. 1 *e*. Profile view of 1 *b*.

Fig. 1 *f*. Front view, the ventral valve being above.

Fig. 1 *g*, *h*. Dorsal and profile views of an old shell.

Fig. 1 *i*. Ventral view where the shell has been ground off to show the internal spires.

Fig. 1 *k*. Interior of the ventral valve, showing the foramen and dental lamellæ which extend downwards to the middle of the shell.

Geological formation and locality. In calcareous shale of the age of the Hamilton group : Lime creek above Rockford, Iowa.

Spirifer whitneyi (n. s.).

Plate IV. Fig. 2 *a*, *b*, *c*, *e*.

Shell of medium size, transverse, semielliptical or pentagonal; height and width about as three to four. Ventral valve gibbous towards the beak and curving abruptly to the base; beak elevated above that of the opposite valve, and incurved over the area : mesial sinus well defined at its margin by stronger plications, curvilinear or subangular, beginning at the beak and regularly deepening towards the base, where it is often produced in a rounded or angular projection. Dorsal valve gibbous in the centre, and sloping abruptly to the sides; mesial fold elevated, prominent, rounded and well defined, sometimes subangular; beak incurved; hinge line equal to or exceeding the width of the shell : area moderately large, concave, vertically striated; a narrow defined area on the dorsal valve : foramen broad at base and open to the summit; a narrow defined groove marks the junction of the dental lamellæ with the area.

Surface of the mesial elevation and sinus marked by dichotomizing striæ, of which twelve to fifteen may be seen on the margin, and three or four at the summit; lateral portions of the shell marked by twenty-four to thirty slender simple rounded plications on each side, which are larger than those in the mesial sinus and elevation; these gradually diminish in size, till they become extremely slender on the extremities of the shell : depressions between the plications narrower than the plications themselves, except those bordering the mesial fold, which are broader and deeper than the others. Entire surface marked by extremely fine radiating striæ, which cover alike the plications and the spaces between them : these sometimes give the plications a grooved appearance under a lens. Equally slender concentric undulating striæ mark the whole surface; and along these are arranged minute granulations, which are only visible under a lens : a few more distinct imbricating lines of growth are sometimes seen.

This species bears a close resemblance to *Spirifer archiaci* of MURCHISON, as described and figured in the Geology of Russia and the Ural mountains, Vol. ii, pa. 155, pl. iv, f. 5 *a, b, c;* and by DE KONINCK, Descriptions des Animaux fossiles de Belgique, pa. 254, pl. xiv, f. 5; but our specimens do not show the variety of form observed in the European species.

A comparison of several specimens shows that the plications, as well as the mesial sinus and elevation, are more angular, and the foramen narrower in the European than in the American specimens, while the former still retain some remains of fine radiating striæ. In the American specimens the plications are directed towards the beak, a few of the outer ones only running out upon the hinge line ; while in the European specimens a larger number of plications terminate on the hinge line before reaching the beak. These differences, which are perhaps too slight to be generally regarded as deserving of specific distinction, are, nevertheless, of importance when regarded in connection with the wide geographical separation of the Russian, Belgian and Iowa specimens, and the absence of knowledge regarding the exact parallelism of the deposits in the two countries.

Fig. 2 *a, b*. Ventral and dorsal views of a specimen of medium size.
Fig. 2 *c*. Cardinal view of the same.
Fig. 2 *e*. Enlargement, showing fine striate and granulose surface.

Geological formation and locality. In calcareous shales of the age of the Hamilton group : Lime creek above Rockford, Iowa.

Spirifer submucronatus (n. s.).

PLATE IV. FIG. 3 *a*, *b*, *c*.

Spirifer indet. : OWEN, Report on Wisconsin, Iowa and Minnesota, pl. iii, f. 9.

SHELL small, somewhat semicircular, gibbous in the middle; the hinge line variable in length, often extending into mucronate points. Ventral valve gibbous towards the beak, abruptly sloping towards the front and sides; mesial sinus deep, subangular. Dorsal valve moderately convex, sometimes a little gibbous, and often nearly flat; mesial fold strongly elevated and flattened on the summit : area moderately high, and in some specimens proportionally higher than in others.

SURFACE marked by eight to twelve or more strong abrupt or subangular plications on each side of the mesial fold or sinus; mesial fold flattened or a little depressed in the centre, and an incipient fold in the bottom of the sinus. In well preserved specimens the surface is marked by sharp elevated concentric laminæ which arch abruptly upwards on the plications, and which undulate on the mesial fold and sinus corresponding to the line of depression and elevation.

This species bears much resemblance to the *S. mucronatus* of the Hamilton group of New-York, and is often mistaken for that species; but all the specimens which have fallen under my observation are much smaller; the plications are more elevated, and often flattened upon the summit ; the imbricating lamellæ are stronger, more closely araanged and more arched, while the area is proportionally higher.

This species is apparently identical with that figured by Dr. D. D. OWEN, pl. iii, f. 9, cited above ; since I know of no other similar species occurring in the locality named by him.

Fig. 3 *a*, *b*. Dorsal and ventral valves of a specimen having one hinge extremity more produced than the other.

Fig. 3 *c*. Cardinal view of the same specimen.

Geological formation and locality. In calcareous shales of the age of the Hamilton group of New-York : at Independence, New-Buffalo and Rockingham (Iowa), and Rock-island (Illinois).

Spirifer inutilis (n. s.).

PLATE IV. FIG. 4 *a*, *b*, *c*.

VENTRAL valve semicircular or subpentangular, gibbous in the middle and towards the beak; cardinal extremities somewhat produced; beak short, scarcely incurved; mesial sinus deep, strongly defined at the margins, curved in the bottom. Area moderately high, abruptly concave, defined above by a sharply angular margin; foramen narrow, reaching to the beak, with a pseudo-deltidium.

SURFACE marked by twelve or more strong rounded plications, which rapidly decrease in size as they recede from the mesial sinus; plications crossed by fine concentric undulating lamellæ.

This species differs from the last in the greater elevation of the beak, the shorter hinge extremities, and the sinus without indications of a central fold. The character of the plications, or concentric lamellæ, offers no important differences from *Spirifer submucronatus*.

Fig. 4 *a*. View of the ventral valve.
Fig. 4 *b*. Cardinal view, showing the area and foramen.
Fig. 4 *c*. Enlargement of the surface of fig. 4 *a*.

Geological formation and locality. In calcareous shales of the age of the Hamilton group: Independence, Iowa.

Spirifer fimbriatus.

PLATE IV. FIG. 5 *a* – *e*.

Delthyris fimbriata: CONRAD, Jour. Acad. Nat. Sciences, Vol. viii, p. 263.
Spirifer (n. s.?): OWEN, Report on Wisconsin, Iowa and Minnesota, pl. iii, f. 7.

SHELL transversely subelliptical: valves often almost equally convex; hinge line less than the width of the shell; extremities rounded. Ventral valve transversely elliptical, with the upper part and the umbo round, prominent and very gibbous; beak incurved: area high and short, the exterior of the shell encroaching largely upon the space within the beak; foramen very large; mesial sinus rounded, shallow. Dorsal valve most convex in the middle; beak and margin of the shell slightly arching over the area; mesial fold broadly rounded, moderately elevated, and defined on each side by a groove broader than those between the plications.

SURFACE marked by from four to six (often three in young specimens) rounded and very moderately elevated plications which are separated by shallow depressions between, the whole becoming obsolete before reaching the beak and hinge line; concentrically marked by fine closely arranged striæ and more distant imbricating lamellæ, upon the edges of which are arranged, in regular concentric undulating lines, short longitudinal elevated striæ, or more properly the elongated bases of minute semitubular spines, which ornament the lower edges of each successive imbrication, and are formed by the contraction and separation of the extended edges of the lamellæ.

This is the only species to which I can refer the description given by Mr. CONRAD of *Delthyris fimbriata*. The species occurs in the Upper Helderberg limestone and in the Hamilton group of New-York; and I have seen a specimen of; apparently, the same species in the Oriskany sandstone. The western specimens are usually smaller than those of New-York; though the one figured by Dr. OWEN, pl. iii, f. 7, is equal in size to the larger specimens observed in any localities.

There are rarely six, and still more rarely seven, defined plications upon each side of the mesial fold and sinus: commonly there are no more than four, sometimes two or three, and in one specimen of more than half-an inch in diameter there are no defined plications. In rare examples the plications are defined nearly or quite to the beak. The short semitubular spines are rarely preserved, though the bases are well marked. In the absence of external characters, the elliptical form of the shell, with the broad round plications, even in casts, will generally serve to distinguish the species.

Fig. 5 *a*. A fragment of a ventral valve, in which the sinus is subangular.

Fig. 5 *b*. Cardinal view of the same, showing the broad foramen which occupies a large part of the area.

Fig. 5 *c*. Dorsal valve of a small individual, preserving the spiniferous bases.

Fig. 5 *d*. Profile view of a small specimen from the Hamilton group of New-York.

Fig. 5 *e*. Enlargement of the surface as it usually appears when the bases of the spines are preserved.

Geological formation and localities. In calcareous shales of the age of the Hamilton group of New-York: Davenport, New-Buffalo (Iowa); Rock-island (Illinois).

Spirifer bimesialis (n. s.).

PLATE IV. FIG. 6 *b, c, d.*

SHELL extremely transverse; width more than twice the length of the shell; hinge line extremely extended and produced into mucronate points; front emarginate. Ventral valve gibbous in the middle, curving to the front, and sloping gently towards the lateral extremities, where it is nearly flat; beak much elevated above the opposite valve and very slightly incurved; area concave, moderately high, and much extended laterally; sinus strongly defined, subangular, with a simple plication in the bottom. Dorsal valve less elevated than the opposite, convex in the middle, curving towards the beak; mesial fold divided by a slight depression along the centre, and emarginate in front for the reception of the mesial extension of the opposite valve.

SURFACE marked by about twelve or thirteen, or more, simple plications on each side of the mesial fold and sinus: plications abruptly rounded on the upper side, crossed by closely arranged imbricating lamellose striæ which are abruptly arched on the plications and in the mesial sinus, while they are doubly arched upon the mesial fold.

This species bears considerable resemblance to *S. submucronatus*, fig. 3; but the specimens are less gibbous, and the cardinal extremities less abruptly but more extremely extended. It bears some resemblance to *S. muralis* (DE VERNEUIL, Russia and the Ural mountains, pa. 171, pl. v, f. 5); but the hinge extremities are less abruptly mucronate, the area less high, and the mesial fold double or depressed in the middle.

Fig. 6 *b*. Dorsal valve of an apparently full-grown specimen.

Fig. 6 *c*. Cardinal view, showing the area, foramen, and part of the dorsal valve.

Fig. 6 *d*. Ventral valve of another specimen, showing the small plication in the centre of the mesial sinus.

Geological formation and locality. In calcareous shales of the age of the Hamilton group: Independence, Iowa.

Spirifer aspera (n. s.).

PLATE IV. FIG. 7 *a, b, c, d.*

SHELL semielliptical, width about twice the length; hinge line equalling the greatest width of the shell, and abruptly angular at the extremities. Ventral valve triangular pyramidal, extremely elevated at the umbo, and sloping abruptly to the lateral and anterior margins; mesial sinus shallow, strongly defined at the edges, sides straight, flattened within, sometimes curvilinear : area straight and flat, abruptly defined at its margins, equal or less in height than the length of the valve, transversely and vertically striate; foramen proportionally narrow, extending to the beak, and partially closed within by a pseudo-deltidium; beak not incurved. Dorsal valve nearly flat or moderately convex; mesial fold strongly defined at the margins, and rounded above.

SURFACE, in full-grown specimens, marked by twenty or more simple rounded and moderately elevated plications on each side of the mesial fold and sinus. Plications often fifteen to eighteen in ordinary specimens, four or five only of which reach the beak, the others running out along the hinge line and margins of the area; concentrically marked by fine imbricating lines of growth, which are sometimes very conspicuous. Entire surface granulose; granules closely arranged, sometimes visibly following the concentric striæ, and in other parts apparently scattered without order.

This species approaches in form the *S. macronotus* of the Hamilton group of New-York, and may be regarded as its western representative. This one differs in its less cardinal extension, more abrupt elevation of the ventral valve and proportionally higher area, fewer plications and granulose surface. It bears a close resemblance in form to the *S. tenticulum* (MURCHISON and DE VERNEUIL, Russia and the Ural Mountains, pa. 159, pl. v, f. 7); but the sinus of that species is plicated.

Fig. 7 *a*. Ventral valve of a specimen less than the full size.

Fig. 7 *b*. Cardinal view of the same, showing the area and foramen, which is partially filled with the pseudo-deltidium.

Fig. 7 *c*. Dorsal valve of a larger individual, which shows about twenty striæ on each side of the mesial fold.

Fig. 7 *d*. Enlargement of the surface, showing the granulose character, with a few distinct imbricating lines.

Geological formation and localities. In calcareous shale of the age of the Hamilton group : Independence (Iowa) ; Rock-island ? (Illinois).

Spirifer parryanus (n. s.).

Plate IV. Fig. 8 *a*, *b*.

Shell subglobose, transversely subelliptical ; cardinal extremities usually rounded ; valves almost equally convex. Ventral valve gibbous in the middle and on the umbo ; beak slightly incurved ; mesial sinus well defined from the beak and broadly expanded below, with the margins less strongly defined, curvilinear within : area high, extending to the hinge extremities, and limited by a sharp angle above ; foramen large, and open to the apex of the shell. Ventral valve very gibbous in the middle, strongly arcuate towards the baso-lateral margins, and abruptly curved at the umbo ; mesial sinus prominent, rounded, much elevated and deeply emarginate in front for the reception of the projecting mesial extension of the opposite valve.

Surface marked by about seventeen, eighteen or more simple broadly rounded and little elevated plications on each side of the mesial fold and sinus, which are separated from each other by very narrow shallow grooves. In perfect specimens, the entire surface of plications and mesial fold and sinus are covered by extremely minute radiating striæ, and crossed by equally fine concentric striæ and a few imbricating lines of growth.

This species bears considerable resemblance to the *S. granulifera* of the Hamilton group of New-York, but it is a smaller shell, the mesial fold is not depressed in the centre, and there is no elevation in the sinus as in that species; while in well preserved specimens, the granulose surface of the one, and the finely striated surface of the other, contrast sufficiently to afford a ready means of distinction.

The *S. granulifera* is not known in the Mississippi valley up to this time. The *S. eatoni* and *S. clintoni* of the Hamilton group of New-York resemble this shell in some respects.

Fig. 8 *a*. Dorsal view, showing the beak of the ventral valve, the area in part, with the foramen projecting beyond the hinge line of the dorsal valve.

Fig. 8 *b*. Ventral valve of the same specimen.

Geological formation and locality. In calcareous shale of the age of the Hamilton group of New-York : New-Buffalo, Iowa.

Spirifer pennatus.

PLATE V. FIG. 1 *a – i*.

Spirifer pennatus and *S. ligus* : OWEN, Geological Report of Wisconsin, Iowa and Minnesota, pa. 585, pl. iii, f. 3, 4 and 8.

SHELL variable in form from subglobose to transverse and broadly triangular, often inequilateral; hinge line extremely extended into wing-like expansions; valves often nearly equally convex. Ventral valve very gibbous in the middle and on the umbo; beak much elevated above the hinge line, more or less pointed and slightly incurved; mesial sinus strongly defined at the margins, widely spreading towards the base, and produced in an angular extension in front: area concave and very large, extending to the extremities of the hinge line, striated vertically and longitudinally; foramen large, open to the apex, and forming an equilateral triangle. Dorsal valve very gibbous in the middle and upon the umbo, which is abruptly incurved, regularly curved towards the baso-lateral margins, and more or less compressed towards the lateral extremities; mesial fold strongly elevated, sometimes a little flattened on the top, and often subangular towards the front and slightly depressed on each side.

SURFACE marked by about fourteen to twenty-six or more rounded plications on each side of the mesial fold and sinus; those near the centre, to the number of ten or twelve, being much stronger than those upon the extremities, which become finally very slender. Plications crossed by closely arranged concentric undulating laminæ of growth; and the entire surface, in perfect specimens, ornamented by slender radiating striæ, which become granulose at their junction with the concentric striæ.

This species presents considerable variety of aspect and of surface marking; but after examining a large number of specimens from Rock island, New-Buffalo and Independence, I cannot find means of separation, and am compelled to regard for the present the *S. pennatus* and *S. ligus* of OWEN as only varieties of the same species in different stages of development and different degrees of preservation. The species assumes various phases, from the extremely gibbous form with short hinge extremities as in fig. 1 *f*, *g*, to the most extravagant forms produced by extension of the hinge line, sometimes upon one and sometimes upon both sides. The surface is often marked by ten, twelve or fourteen strong plications, beyond which there is a distinct winglike extension on which the folds are much more slender; and when this extension is not so well marked, there is the same change from the larger to the smaller plications. The concentric lamellæ are sometimes quite conspicuous, and the radiating striæ subdued or worn so as to be scarcely visible; while in the other extreme, the radiating striæ, with granulose elevations, cover the concentric striæ, and sometimes both are equally preserved. The granulose points are doubtless the bases of slender spines or setæ, which originated at the edge of the laminæ. The following are illustrations of a few of the phases of form, which might be much increased without exhausting the variety.

Fig. 1 *a*. Dorsal valve of a young specimen of this species.

Fig. 1 *b*. Cardinal view of a larger individual.

Fig. 1 *c*, *d*. Dorsal and ventral views of a large individual, in which one side is much more extended than the other.

Fig. 1 *e*. Cardinal view of the same, showing the extension of the area to the right where the shell is broken off. The shell has probably extended an inch beyond the present termination.

Fig. 1 *f*, *g*. Cardinal and dorsal views of a more gibbous specimen, where the extremities are much less extended.

Fig. 1 *h*. Profile view of the preceding specimen.

Fig. 1 *i*. Enlargement of the surface, showing the radiating and concentric striæ, which presents only one of several characters of surface of the specimens, in various degrees of perfection or conditions of preservation.

Geological formation and localities. In calcareous shales of the age of the Hamilton group : New-Buffalo and Independence, Iowa ; and Rock island, Illinois.

Spirifer marionensis.

PLATE VI. FIG. 1 *a*, *b*, *c*.

Spirifer marionensis : SHUMARD, Geol. Report of Missouri, 1855, pa. 203, pl. C, f. 8.

SHELL nearly semicircular, moderately gibbous, length about equal to two-thirds the greatest width ; valves almost equally convex ; hinge line extended into acute mucronate points. Ventral valve broadly semielliptical or semicircular, greatest convexity above the middle ; umbo gibbous ; beak pointed and incurved ; sinus well defined, narrow and angular at the beak, becoming broad and shallow below, and marked by two or three dichotomizing plications : area narrow ; sides nearly parallel and extending to the hinge extremities, striated transversely ; foramen broadly triangular, the base greater than the height. Dorsal valve regularly convex, flattened towards the hinge extremities; mesial elevation very moderate, marked by two plications above, which dichotomize, becoming four or five below.

SURFACE marked by from twelve to twenty rounded and little elevated plications on each side the mesial fold and sinus. Plications irregularly dichotomizing, sometimes near the beak and sometimes near the base ; concentrically marked by fine lamellose striæ : the entire surface granulose, with close slender radiating striæ.

This species is described and figured by Dr. SHUMARD in the Missouri Report for 1855. The fossil presents in different localities some varieties of surface markings, according to the description cited above and a comparison of specimens in our collection. The narrow linear area, mucronate cardinal extremities, shallow sinus and slight mesial elevation which are covered by dichotomizing plications, serve to distinguish it from most other species. *Spirifer parryanus,* however, simulates this one in its dichotomizing plications on the mesial fold and sinus; while the plications on the lateral portions of the shell are always simple, so far as observed. From this similarity, I had at one time supposed the *Spirifer marionensis* to be found among the Burlington fossils; but a later comparison has not shown any specimens.

Fig. 1 *a*, *b*. Ventral and dorsal view of a specimen of medium size, in which one of the cardinal extremities is produced into a mucronate point, the other being being broken off.

Fig. 1 *c*. Cardinal view of the same, showing the narrow linear area.

Geological formation and localities. In limestone of the age of the Hamilton group : Louisiana and Hannibal, Missouri.

Cyrtia umbonata (n. s.).

PLATE V. FIG. 2 *a*, *b*, *c*.

SHELL somewhat semiglobose, with the hinge extremities more or less salient. Ventral valve very gibbous in the middle, arcuate ; beak incurved ; sinus broad, shallow above and deeper below, limited on each side by a rounded or obtusely subangular fold, and produced in front; lateral extremities auriculate : area broad, concave ; foramen narrow, closed by a pseudo-deltidium. Dorsal valve semielliptical, more or less produced and flattened at the cardinal extremities; mesial fold very prominent, rounded above, scarcely reaching to the beak.

SURFACE marked by six or seven rounded plications on each side of the mesial fold and sinus, which become obsolete before reaching the beak, leaving on the ventral valve a convex, smooth, or nearly smooth umbo; concentrically marked by close imbricating lines of growth, the entire shell finely punctate.

This species is very distinct, from any one of the genus known to me, in its arcuate and incurved umbo and beak, and the absence of plications on the upper part of the valve. When imbedded in the shale, and the umbo alone appearing above the weathered surface, it resembles very closely the *Orthis umbonata* of the Hamilton group of New-York. A farther examination, however, shows the lower part of the valve to be furnished with plications, and the area to be of the character of CYRTIA. From having been worn previous to imbedding in the shale, the surface is sometimes free or nearly free from plications. The shell varies in form, and the sinus is sometimes quite narrow.

Fig. 2 *a*. Ventral valve of a worn specimen, with surface free from plications, and having a narrow sinus.

Fig. 2 *b*. Interior of ventral valve, showing the central septum, and the closed foramen with the tubular opening between the dental lamellæ and pseudo-deltidium, which, at its upper extremity, opens just beneath the beak.

Fig. 2 *c*. A larger and more perfect individual, showing the broad subangular sinus, the surface plications and auriculate cardinal extremities.

Geological formation and localities. In calcareous shale and shaly limestone of the age of the Hamilton group: New-Buffalo (Iowa), Rock-island (Ill.).

Cyrtia triquetra (n. s.).

SHELL small, pyramidal; cardinal extremities somewhat salient. Ventral valve extremely elevated, the beak slightly incurved; sinus deep, angular or subangular, bounded on either side by strong plications: area large, forming a nearly equilateral triangle, the base being scarcely longer than the sloping sides; foramen narrow, slightly open at base, and closed for half its length by a pseudo-deltidium. Dorsal valve depressed convex, semicircular or semioval, with a strongly elevated mesial fold which is bounded by a deeper groove than those separating the plications.

Surface marked by seven or eight plications on either side of the mesial fold, and by nine on either side of the mesial sinus, and these are crossed by fine imbricating lamellose striæ : the entire surface granulose or punctate.

This shell resembles the *Cyrtia acutirostris* described by Dr. Shumard in the Geological Report of Missouri for 1855, pa. 204, pl c, f. 3 *a, b, c;* but the plications are about twice as numerous : there is also no perceptible dilatation of the foramen near the base, as in that species.

Geological formation and locality. In calcareous shale of the age of the Hamilton group of New-York : Rock-island, Illinois.

Pentamerus occidentalis (n. s.).

Plate VI. Fig. 2 *a, b, c.*

Shell ovoid, gibbous. Ventral valve arcuate, very gibbous on the umbo, with the beak strongly incurved; foramen large and the cavity deep. Dorsal valve much smaller than the ventral, moderately convex.

Surface of the upper part of the shell smooth, or marked only by concentric striæ; middle and lower part of shell is marked by strong rounded or subangular plications, about two, three or more of which are elevated upon the mesial fold, the concentric striæ being strongly arched in passing over them.

This species bears some resemblance to *Pentamerus papilionensis* of the Hamilton group of New-York; but the beak of the ventral valve is more produced, and the plications fewer and stronger. The specimen figured is an imperfect ventral valve.

The *Pentamerus* is among the most rare of the fossils of the Hamilton group in New-York : it is usual to meet with no more than one or two among a thousand specimens of other fossils, and frequently a collection of several thousand specimens has not shown a single *Pentamerus.* Although no very extensive collections have been made in Iowa, we nevertheless observe that the *Pentamerus* is very rare, less than half a dozen individuals having been observed in all the collections yet made.

Fig. 2 *a.* Ventral view of an imperfect specimen.
Fig. 2 *b.* Profile of the same.
Fig. 2 *c.* Interior, showing the hinge, the triangular cavity, etc.

Geological formation and locality. In calcareous shale and in limestone of the age of the Hamilton group : Independence, Iowa.

Atrypa aspera, var. occidentalis.

Plate VI. Fig. 3 *a*, *b*, *c*, *d*.

Terebratula aspera : Schlotheim, Petrefactenkunde, pa. 263, pl. xviii, f. 3.
Atrypa spinosa : Hall, Geological Report Fourth District New-York, 1843.

This species, as it occurs in Iowa, presents some variations from the prevailing form in New-York and elsewhere in eastern localities. The ventral valve is but slightly convex near the beak, concave and deeply sinuate in front; beak very small, perforate and closely incurved over the opposite; ventral valve extremly gibbous or ventricose in old specimens, emarginate in front : surface marked by ten or twelve strong dichotomizing plications upon each valve, crossed by strong thickened concentric laminæ of growth, which are elevated at intervals into spinelike processes. The young shells have the valves often nearly equal, the inequality increasing by age till it becomes very extreme. The number of plications is only about half as many as in full-grown specimens of this species in the shales of the Hamilton group of New-York; and the entire shell, in all its stages of growth, is coarser and stronger. The western specimens approach more nearly the European forms of this species, judging from those I have seen, which are intermediate in form and in strength of plications.

Fig. 3 *a*. Dorsal valve of a specimen below the medium size.
Fig. 3 *b*. Dorsal valve of a very ventricose specimen.
Fig. 3 *c*. Ventral valve of the same.
Fig. 3 *d*. Profile of the same specimen, showing the extreme convexity of the ventral valve, and small elevation of the other valve near the beak.

Geological formation and localities. In calcareous shale of the age of the Hamilton group : New-Buffalo, Davenport, and Independence, Iowa ; Rock-island, Illinois, etc.

Atrypa reticularis.

Plate VI. Fig. 4 *a*, *b*, *c*; and Fig. 5 *a*, *b*, *c*.

Anomites reticularis : Linne, 1767.

For synonomy and references, see Palæeontology of New-York, Vol. ii, p. 72.

Shell depressed suborbicular in its young state, becoming gibbous and sinuate in its mature condition ; hinge line often nearly straight, and almost equalling the width of the shell ; valves nearly equally convex in the young state, the dorsal valve becoming more gibbous as the shell advances in age, and sometimes acquiring an undefined mesial lobe down the centre. The ventral valve, in the young state, has the beak nearly straight and perforate at the apex, becoming incurved and finally closely bent over the beak of the opposite valve : a narrow false area is sometimes observable. Shell broadly and deeply sinuate in front.

The specimens from Iowa, in their young and half-grown condition, are usually more finely striated than those from the Hamilton group in New-York. In older specimens the difference in this respect is scarcely observable, though there is always a difference in the proportions and general expression of the shell.

Our specimens resemble very closely the figures of *Terebratula zonata* (Dunker and Von Meyer's Palæontographica, pl. 24, f. 6).

Fig. 4 *a, b*. Dorsal and ventral views of a small specimen.

Fig. 4 *c*. Ventral view of a larger individual.

Fig. 5 *a, b, c*. Dorsal, ventral and profile views of a very large individual.

Geological formation and localities. In calcareous shales of the age of the Hamilton group : New-Buffalo, Independence, Lime creek and other places in Iowa ; Rock-island, Illinois.

Euomphalus cyclostomus (n. s.).

Plate VI. Fig. 6 *a, b, c*.

Shell discoid, depressed convex above, broadly and deeply umbilicate below ; volutions about five or six, gradually increasing from the apex, regularly rounded ; aperture circular ; umbilicus broader than the mouth.

Surface marked by fine striæ of growth, which, from interruption in growth, are arranged in fascicles or wrinkles.

This species is common in several localities of the rocks of the age of the Hamilton group, and is, I presume, the same species mentioned in Dr. D. D. Owen's Report, but I am not aware that it has ever been described.

Fig. 6 *a*. View of the summit of a specimen of the ordinary size.

Fig. 6 *b*. View of base of the same.

Fig. 6 *c*. Profile view, showing the elevation of the spire.

Geological formation and localities. In calcareous shale and in a ferruginous limestone of the age of the Hamilton group : Pine creek, Fairport and New-Buffalo, Iowa.

FOSSILS OF THE CHEMUNG GROUP.

BRACHIOPODA.

Chonetes fischeri.

PLATE VII. FIG. 1 *a*, *b*, *c*.

Chonetes fischeri : NORWOOD and PRATTEN, Transactions of the Philadelphia Academy of Natural Sciences, 1854, Vol. iii, p. 25.

SHELL semielliptical; hinge line slightly less than the width of the shell. Ventral valve moderately convex, somewhat gibbous in the middle, and often nearly flat at the umbo and along the hinge line, scarcely auriculate; hinge line furnished with from five to seven nearly straight tubular spines on each side of the beak.

SURFACE marked by fine radiating striæ and equally fine concentric striæ; beneath which is a textile appearance, caused by a double set of diagonal lines, which are broader but usually less prominent than the radiating striæ. Dorsal valve moderately concave, following the curvature of the opposite valve, covered with close radiating striæ.

This shell can be readily distinguished, even in the condition of casts, by the peculiar diagonal lines which give a textile aspect to the whole surface, irrespective of the radiating and concentric striæ, which, when entire, partially obscure the marking beneath. Although this character is not mentioned by Messrs. NORWOOD and PRATTEN, I can have no doubt of the identity of the species, having collected those described at the same locality.

Fig. 1 *a*. A specimen in sandstone, which preserves no radiating striæ.
Fig. 1 *b*. A specimen in limestone, which partially preserves the radiating striæ.
Fig. 1 *c*. Enlargement of the surface, showing the radiating striæ and diagonal lines.

Geological formation and locality. In yellow sandstone of the age of the Chemung group, and in a band of limestone associated with the same rock.

Productus concentricus (n. s.).

PLATE VII. FIG. 3.

SHELL small, semielliptical; hinge line scarcely so long as the greatest width of the shell. Dorsal valve deeply concave, abruptly curved and almost geniculate in front; cardinal extremities slightly contracted : upper half of shell marked by strong concentric wrinkles and somewhat distant spiniferous tubercles; lower half of shell marked by elongate spiniferous ridges. Ventral valve unknown.

This species differs from *P. pyxidatus* in the less extended hinge line, and the spiniferous and strongly wrinkled dorsal valve; while its greater concavity, narrower form and less extension on the hinge line seem to offer sufficient characters to distinguish it from *P. shumardianus*.

Fig. 3. View of the interior of the dorsal valve of this species.

Geological formation and locality. In sandstone of the age of the Chemung group : at Burlington, Iowa.

Productus arcuatus (n. s.).

PLATE VII. FIG. 4 *a*, *b*.

VENTRAL valve much elevated, longer than wide, very gibbous, extremely arcuate, the beak recurved upon itself so that the hinge line is nearly opposite the centre of the back of the shell; hinge line shorter than the width of the shell; cardinal extremities produced into small angular ears.

SURFACE marked by strong radiating costæ which bifurcate upon the umbo and below, and sometimes coalesce towards the base of the shell : entire surface covered by fine undulating concentric striæ, and, in the upper part, a few strong wrinkles which are conspicuous on the ears and umbo. A few marks of the bases of spines are noticed, but they appear to have been irregularly distributed, and in one specimen do not appear at all. Dorsal valve and interior unknown.

This species, in the character of its surface markings, its costæ and concentric wrinkles, resembles the *P. semireticulatus* : it is, however, a much smaller shell, the costæ are more slender and the hinge line less extended, while there is no flattening or depression of the centre of the valve.

Fig. 4 *a*. View of the ventral valve. Fig. 4 *b*. Profile view of the same.

Geological formation and locality. In limestone—below the Burlington limestone—of the age of the Chemung group : Burlington, Iowa.

Spirifer biplicatus (n. s.).

PLATE VII. FIG. 5 *a*, *b*.

SHELL somewhat semicircular; valves nearly equally convex; width from two and a half to three times as great as the length; hinge line often greatly extended, and produced into mucronate points. Ventral valve convex in the centre; beak incurved; sinus angular above, shallow and less strongly defined below, and marked by one, two or more plications: area narrow, slightly concave; foramen broad. Dorsal valve regularly convex in the middle, and somewhat flattened at the extremities; mesial fold rising but little above the plications on each side, from which it is separated by grooves deeper than those which separate the plications themselves, marked by two dichotomizing plications above, which become four and sometimes five or six below the middle.

SURFACE marked by fourteen to sixteen simple rounded plications on each side of the mesial lobe and sinus; and these are crossed by fine concentric undulating striæ of growth, which are granulose on their edges.

I have no well preserved specimens of this species; and a single one only exhibits, with some degree of perfection, the lamellose striæ and granulose surface. In general feature it resembles the *S. marionensis*; but the specimens observed are smaller and less robust, and also much more extended on the hinge line, and the shell shorter. The plications are simple from their origin, except in a single specimen, where those on either side of the mesial fold are dichotomized just below the beak.

In the yellow sandstones of Burlington, and other places, where this species occurs in the form of casts, it resembles the *S. mucronatus* of the Hamilton group of New-York; but is distinguished from that by the distinct plications of the mesial lobe and sinus, and the wider area, as well as the more rounded plications and less conspicuous laminæ of growth.

Fig. 5 *a*. Dorsal valve from the Oolitic beds below the Burlington limestone.
Fig. 5 *b*. Cast of a dorsal valve from the Yellow sandstone.

Geological formation and localities. In yellow sandstone and oolitic limestone, Burlington (Iowa); in oolitic limestone, Quincy (Illinois).

Spirifer extenuatus (n. s.).

PLATE VII. FIG. 6.

SHELL in form of a segment of a circle; width more than two and a half times the length. Dorsal valve gibbous in the middle, flattened at the sides, and much extended on the hinge line; mesial lobe prominent, rounded above, well defined, free from plications, deeply emarginate in front.

SURFACE marked by about twenty-two or more small simple rounded plications on either side of the centre.

The specimen described is the cast of a dorsal valve, showing the remains of closely arranged concentric striæ and apparent granulations. The cardinal extremities are much extended in mucronate points, which, in the whole shell, would make the width equal to three times the length.

Fig. 6. Dorsal valve of this species.

Geological formation and locality. In yellow sandstone of the age of the Chemung group of New-York : Burlington, Iowa.

Spirifer capax (n. s.).

PLATE VII. FIG. 7 *a – d*.

Spirifer euruteines, in part : OWEN, Report on Wisconsin, Iowa and Minnesota, pa. 586, pl. iii, f. 2, 2 *a*.

SHELL subglobose or subhexahedral, very gibbous; extremities usually salient, sometimes rounded. Ventral valve subpyramidal, very gibbous towards the umbo; beak slightly incurved, abruptly sloping to the base; sinus strongly defined, angular above, becoming broad and curvilinear below, sometimes flattened in the bottom : area forming a broad triangular space; foramen large, reaching to the apex of the shell, the height equal to once and a half the width of the base. Dorsal valve very gibbous in the middle, sloping abruptly towards the base, and flattened towards the hinge extremities; mesial fold strongly defined, rapidly expanding towards the base, plain or without plications.

SURFACE marked by sixteen to twenty simple rounded plications on each side of the mesial fold and sinus. The finer surface markings unknown.

This species has only been found as casts, and is apparently identical with one from the same locality, figured by Dr. Owen as *Spirifer euruteines ;* but the original of that species is, I believe, from the limestone of the Falls of the Ohio, and the species from Pine creek here figured is quite distinct from those of the limestone. It becomes, therefore, necessary to separate this one under a distinct designation.

The species most nearly approaching this, are *S. textus* and *S. carteri* of the Yellow sandstone of the Chemung group in Ohio; but the differences are well marked.

Fig. 7 *a*. Dorsal valve of a large individual.
Fig. 7 *b*. Ventral valve of the same.
Fig. 7 *c*. Profile view.
Fig. 7 *d*. Cardinal view, showing height of area and foramen.

Geological formation and locality. In yellow sandstone of the age of the Chemung group : near the mouth of Pine creek.

Spirifer subrotundatus (n. s.).

Plate VII. Fig. 8 *a*, *b*.

Shell subglobose; extremities very conspicuously rounded; hinge line much less than the width of the shell. Ventral valve very gibbous, or subventricose; umbo large; beak incurved; cardinal margins much incurved; mesial sinus shallow, not defined, and covered by dichotomizing plications like those on the other parts of the shell : area high, comparatively narrow, diminished by the incurved cardinal margins of the valve; foramen large. Dorsal valve the less convex, gibbous in the middle, and gradually and uniformly curving towards the margins; mesial fold not defined and scarcely elevated above, becoming more elevated but still undefined towards the base.

Surface covered by fine radiating, dichotomizing striæ, about ten or twelve of which occupy the mesial fold and sinus, and as many as thirty on either side, the plications becoming inconspicuous towards the margins of the casts.

This species is sufficiently characteristic in form and surface markings to be readily distinguished from all others known to me in the rocks of the West.

Fig. 8 *a*. Cast of the dorsal valve of this species.
Fig. 8 *b*. Cast of the ventral valve, showing the narrow, elongate muscular impressions below the beak.

Geological formation and locality. In yellow sandstone of the age of the Chemung group, and overlying the Oolitic limestone : Burlington, Iowa.

LAMELLIBRANCHIATA OF THE CHEMUNG GROUP.

Avicula circulus.

PLATE VII. FIG. 9.

Avicula circulus : SHUMARD, Geol. Report of Missouri, 1855, pa. 206, pl. *C*, f. 14 *a*, *b*.

SHELL suborbicular, slightly convex; cardinal line less than two-thirds the width of the shell; length and width nearly equal; beak small, pointed and slightly elevated above the cardinal line; ears small, acute; posterior slope a little depressed; basal and baso-lateral margins regularly rounded; posterior side, from hinge extremity, somewhat straight.

SURFACE marked by fine, closely arranged, concentric striæ, and equally fine radiating striæ.

The specimens examined are not entire, but the hinge line sometimes appears to be less than the proportion given above.

Fig. 9. The right valve of this species.

Geological formation and locality. In the Oolitic limestone of the age of the Chemung group : Burlington, Iowa.

Cardiomorpha ovata (n. s.).

PLATE VII. FIG. 10 *a*, *b*, *c*.

SHELL ovoid or subcordiform; valves ovate, slightly oblique, a little longer than wide, very gibbous in the middle and towards the umbo; beak extended and incurved.

SURFACE marked by numerous fine radiating striæ.

The anterior marginal slope is sometimes nearly straight above and broadly rounded towards the base; differing from pressure, and also without apparent cause. The posterior slope is broadly rounded and expanded; an obtuse subdefined ridge sometimes extending from the beak, on the anterior side, towards the base.

Fig. 10 *a*. The right valve of a specimen, which shows an obtuse ridge from the beak towards the base.

Fig. 10 *b*. A similar valve, where the surface is more uniformly convex, and without a ridge.

Fig. 10 *c*. Profile of the same specimen.

Geological formation and locality. In yellow sandstone of the age of the Chemung group of New-York : Burlington, Iowa.

Cardiomorpha ? rhomboidea (n. s.).

SHELL slightly oblique, subrhomboidal, wider than long, moderately convex, somewhat gibbous near the umbo; beak moderately incurved.

SURFACE marked by fine radiating striæ, and towards the beak, by a few concentric wrinkles.

The specimen described is a cast, preserving the radiating striæ, which are closely similar to those of the preceding species : the concentric wrinkles on the umbo are the only indications of concentric striæ. The beak is extended and incurved, as in other species of this genus.

Geological formation and locality. In Yellow sandstone of the age of the Chemung group : Burlington, Iowa.

Euomphalus obtusus (n. s.).

SHELL discoid, planorbiform. Spire little elevated, consisting of five or six volutions which increase in size very gradually from the apex : largest outer volution very obtusely angular on the upper side towards the outer margin, and below this somewhat flattened to the periphery of the shell below, where it is very regularly and symmetrically rounded; upper side, from the obtuse angle to the suture, flat on the inner volutions, and slightly sloping inward on the outer volutions : aperture straight above, circular below.

SURFACE marked by fine, closely arranged striæ of growth.

This species sometimes attains a diameter of an inch and a half, though usually smaller. It is distinguished from a somewhat similar form in the Burlington limestone, by the obtusely angular character of the volutions, the angle being also farther from the periphery; while the upper side is depressed, instead of being elevated towards the suture : the volutions are more prominently rounded and the umbilicus deeper, and the striæ are more regular and less imbricating than in *E. latus*.

Geological formation and locality. In the Oolitic limestone of the age of the Chemung group : Burlington, Iowa.

FOSSILS OF THE BURLINGTON LIMESTONE.

CRINOIDEÆ.

In the following descriptions of the Crinoideæ, I have adopted with slight modifications the terminology proposed by De Koninck and Le Hon in their "*Recherches sur les Crinoides du Terrain carbonifère de la Belgique*"; this being better adapted to a strict designation of the parts, than the momenclature of Miller, or any modifications of that which have been proposed. Some latitude is necessary in the generic descriptions, unless we would multiply genera to an unnecessary extent.

The species of the Genus Actinocrinus assume such a variety of forms, with such modification of the rays, that it becomes necessary to extend the terms designating the parts. We have among the *Actinocrinides*, those where the arm-plates rest directly upon the last or third radial plate; and we have others where but a single plate intervenes; while beyond this are various modifications involving a subdivision of the series beyond the third radial plate, with one, two, three, or more plates intervening between these, and those which can be strictly denominated arm-plates. As these intermediate plates form an essential part of the body, and, as I believe, belong to the true radial series, I have designated them supraradial plates. The supraradial series is sometimes again subdivided on one or both branches of the ray, as in those designated by Drs. Owen and Shumard *Megistocrinus*, as well as in some other forms which are so clearly the type of Actinocrinus proper, that no separation would be proposed. In these forms the interradial and anal plates are greatly increased in number, beyond those forms where the radial plates are succeeded directly by the arm-plates. There are, likewise, in the species illustrated, great variations in the development of the basal plates, which, from being large, and projecting over the column in a broad rim, are in other species so little developed as to be almost entirely hidden by the summit of the column.

In its fundamental structure, the Genus Agaricocrinus of Troost does not differ essentially from *Actinocrinus;* the chief variation being in the interradial and anal plates, while all the species known have extremely small basal plates, scarcely reaching beyond the column. In all species the brachial plates proceed from the third radial, and the arms are always in pairs from each ray.

Variations of type and modifications of generic form will be found to mark the species of the successive limestone formations, each one of which is well characterized by the remains of very distinct species of this family of fossils.

Among the species described in the Keokuk and Chester limestones, it gives me great pleasure to be able to recognize several which are published in Dr. Troost's Catalogue, but of which no descriptions have heretofore been given. I have, in these cases, adopted without hesitation the name given by that author.

Genus Platycrinus (Miller, 1821).

"Pelvis composed of three unequal plates, supporting five "scapula."

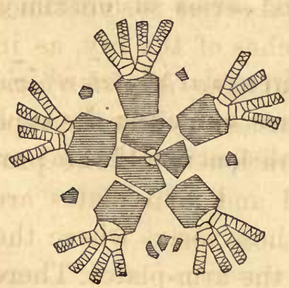


Fig. 55.— GENERIC FORMULA, according to De Koninck.

Basal plates, 3.

Radial plates, 2 × 5, the first series large and the second small.

Anal plates, 1 large and 3 small.

Interradial plates, 1 × 4.

Number of arms, 10, 20, 25, 30, 35 [and 40, 45], according to the species.

The base is composed of three pieces, of which one is quadrangular and smaller than the others, the other two pentagonal; the whole usually soldered together at their sides, and presenting the form of a flat disk, or a more or less shallow vase-like form. The first radials are large, the lower sides nearly straight, and the lateral margins joining from the base nearly to the upper angles, which are truncated for the reception of the interradial and for the anal plates. The second radial, or more properly a subbrachial plate, is inserted upon the excavated upper margin of the first radial, or upon this and a projecting callosity which is more or less distinctly thickened at the margin, and presenting a semielliptical or semicircular concave articulating surface for the attachment of the succeeding plates. The second radial (subbrachial) plate is often very small, and occupies but a part of the articulating surface of the first radial, allowing the arm-plates to rest in part directly on the first radial on either side, as shown in *P. wortheni*. This plate may be either triangular or pentagonal, and is succeeded by two series of arm-plates, which may bifurcate once, twice or more, giving origin to a number of arms varying from two to eight or nine from each ray. The arms are ordinarily composed of a double alternating series of plates, which support on their outer edges a series of jointed tentacula.

In some species the arms extend horizontally, and consist of an alternating series of strong articulations, from the upper side of which proceed a series of arm-plates, which are furnished with tentacula as in the arms of ordinary species of this genus.

Dome composed of numerous small irregular plates which are usually tuberculiform or subspiniferous, and often elevated into a proboscidiform extension : anal aperture lateral or subcentral.

Platycrinus cavus (n. s.).

PLATE VIII. FIG. 1 *a, b*.

Compare *Platycrinus corrugatus*, OWEN and SHUMARD, Geology of Iowa, Wisconsin and Minnesota, pa. 589, pl. V A, f. 2 *a* – *d*.

GENERAL form of the calyx a shallow vase, the basal plates scarcely extending above the plane of the margin of the second range when viewed in profile. Basal plates forming a pentagon, with the sutures closely united; the line of junction often indicated by a shallow groove, gradually depressed from near the margin to the centre, which is perforate. First radial plates moderately expanding above, length and width about as three to four; slightly excavated above, with a semicircular articulating scar for the reception of the second radial plates; length of the articulating portion less than half the length of the plate, limited below and at the sides by a strongly elevated ridge; lines of the sutures marked by a distinct angular groove. Second radials and arms unknown.

SURFACE marked by concentric lines of nodes or granules, which are sometimes confluent. About two or three ranges of nodes parallel to the margins mark the basal plates outside of the circular depression, with a more distinct row running to each angle of the plate. Surface of radial plates marked in like manner by two or three ranges of nodes parallel to the basal and lateral margins, with a distinct row of confluent nodes from the lower angle towards the articulating scar. A plain space, equal to the granulate portion, lies between the latter and the elevated ridge bounding the second radial.

This species bears much resemblance to the *P. corrugatus* of OWEN and SHUMARD; but the form and proportions of the calyx are different, and also the character of the articulating cicatrix, as well as the form of the first radial plate The surface markings in this species are distinct nodes or granules in regular rows or lines, reaching but half way from the base of the first radial to the base of the second, leaving a smooth finely granulose surface of equal width; while in the *P. corrugatus*, the rugose character extends to the base of the second radial. There are in the collection some separate first radial plates which more nearly correspond with the description of *P. corrugatus* given by OWEN and SHUMARD; but in our specimens they differ not only in other respects, but they are much more contracted at the summit.

Fig. 1 *a*. The calyx in profile.

Fig. 1 *b*. View of the base, natural size.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus pocilliformis (n. s.).

PLATE VIII. FIG. 2 *a*, *b*.

GENERAL form of the cup elongate hemispheric; greatest diameter a little above the centre of the first radial plates, the base being somewhat flattened. Basal plates large, unequal in size, the entire base equal to the diameter of the inside of the cup at the summit of the first radial plates; central area very slightly depressed (with a small perforation in the middle), curving upwards towards the edges, the upper margins nearly straight. First radial plates inserted almost vertically upon the basal plates, a little wider in the middle than at the base; upper margins scarcely excavated; articulating scar small, semioval, and margined by a moderately thickened rim.

SURFACE marked by prominent rounded nodes or short spines, which, on the basal plates, are arranged in double or triple rows, and a line of three extending from the margin of the central area to each angle of the plate : on the radial plate, a row of three or four extend from the outer angles inwards towards the base of the second radial; and within this space, three or four other tubercles, and outside the converging lines are two or three on the lateral margins of the plates.

This species differs from *P. cavus* in the proportional size of the base, which is much larger; the cicatrix for attachment of second radial or arm-plates is far less prominent, and the character of tubercles is very distinct. It may be compared with *P. granulatus* of MILLER; but the tubercles are less numerous, and the cup less expanded above. Our species more nearly resembles *P. americanus* of OWEN and SHU-

MARD; but it is larger, with proportionally larger basal plates and a wider and less depressed central area, while the tubercles are much more distant and more elevated than in that species, which is likewise wider at the summit of the first radials than at any point below.

In the engraved figures, the radiating lines of tubercles are not given with sufficient force and precision.

Fig. 2 *a*. View of the base.

Fig. 2 *b*. Profile, showing elevation, form of first radial plates, and cicatrix for the attachment of the second radial.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus pileiformis (n. s.).

PLATE VIII. FIG. 3 *a*, *b*, *c*.

GENERAL form of the body cup-shaped, or broadly subturbinate, gradually spreading above. Basal plates unequal, very convex exteriorly, and curving upwards at the margins, which are concave for the reception of the succeeding plates; length about equal to two-thirds the length of the first radial plate : column area small, depressed, strongly striated, with a small central perforation. First radial plates gradually expanding above, slightly curved on the base, a little wider above than below (in a well preserved specimen, two are of the same width at base and summit, and three are wider above). Summit of plates slightly concave, the articulating surface semioval, deep, well defined ; the margin of the cicatrix limited by a sharp salient rim, which extends downwards from the top scarcely one-fourth of the length of the plate. A broad undefined depression is traceable along the basal and radial plates a little distance within the margin. [The line representing this, in the engraved figure, is too strongly defined.]

Second radial or subbrachial plates small triangular, the arm-plates of the first pair resting on its upper sloping sides, and upon the articulating surface of the first radial; armplates small; bifurcations unknown beyond the first division.

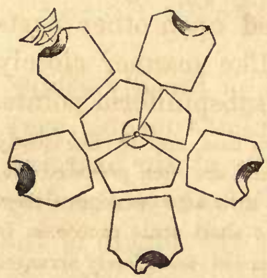
SURFACE smooth or finely granulose, without ornament : sutures plain.

This species resembles *P. planus* of OWEN and SHUMARD; but differs in the form of the base, and in the absence of raised lines on the exterior or depressions on the interior. The first radial plates are proportionally shorter, and the excavations for the insertion of the arms are much smaller and more shallow. Our species corresponds more nearly with *P. pileatus* of GOLDFUSS, as figured by DE KONINCK and LE HON ("*Crinoides du Terrain carbonifère de la Belgique*", pl. vi, f. 3); but is less expanded above, and the basal plates are proportionally longer, while the articulating surface for attachment of the arms is smaller.

Fig. 3 *a*. View showing the elevation of the basal plates, the first radial plates, with the base of one pair of arms attached.

Fig. 3 *b*. Basal view of the same specimen: the two lower radial plates of the figure, and the radial on the left side, are represented as too protuberant.

FIG. 56.



The accompanying diagram exhibits the form and proportions of the plates, the small subbrachial plate and first arm-plates, the outer side of which, for half their length, rest upon the articulating surface of the first radial plate.

Geological formation and locality. In the Burlington limestone: Burlington, Iowa.

Platycrinus wortheni (n. s.).

PLATE VIII. FIG. 4.

CALYX broad cup-shaped, and truncate at the base; the arms spreading somewhat abruptly from the bases to the second bifurcation, and thence continuing vertically. Base pentagonal, sutures not visible, concave from near the outer margin which is slightly convex. Radial plates about as long as wide, truncate at the base, with the sides gradually expanding above, and having a general quadrangular aspect. Articulating surface for the insertion of the arms broad and deep, with a scarcely salient margin: sutures between the radials, and between the radial and basal plates canaliculate. Interradial plates narrow. Second radial or subbrachial plates small, triangular, supporting two short wide arm-plates, each supporting a pentagonal plate, on which the arms subdivide a second time; each inner division again subdivides, one into three and the other into four, making altogether nine arms from a single ray. Arms composed of a double alternating series of plates which are abruptly wedgeform at their interlocking edges, and furnished on their outer margin with slender jointed tentacula.

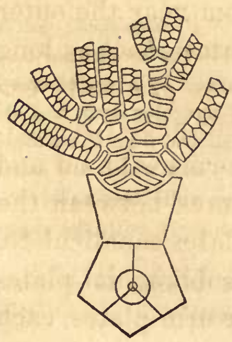
SURFACE of plates covered by prominent granulations which are sometimes lamellose, and usually subspiniform; often arranged in one or two rows parallel to the edges of the plates, and somewhat irregularly crowded upon other parts of the surface. Joints of the arms in like manner closely covered by fine granulose or ascending subspiniform points.

This species is remarkable for its flattened or concave base, and the fine closely arranged granulations which cover the entire surface, and are often produced into subspiniform points on the arm-plates, and especially at their adjacent edges: these points are often much extended obliquely upwards into short acute processes. In one specimen these are confluent, and produce thin, extended, and closely arranged lamellæ.

In some respects this species resembles one which I have referred to *P. yandelli*; but the form of the cup is different, and the granulations always closer and smaller, while the substance of the plates is thin and fragile. The great number of arms is quite sufficient to distinguish the species. It may also be compared with *P. granulatus* of MILLER (DE KONINCK and LE HON, pl. vi, f. 5); but the granulations on the plates of that species are always larger, and to some extent arranged in lines radiating from the angles of the plates; the base is more convex, and the excavation in the summit of the plates for the reception of the arms is much narrower.

Fig. 4. A specimen preserving the base, with two of the radial plates, and the arms of two series nearly entire.

FIG. 57.



The mode of bifurcation of the arms, and the relation of the radial and arm-plates is shown in the accompanying diagram.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus shumardanus (n. s.).

PLATE VIII. FIG. 5.

CALYX somewhat discoid ; base comparatively small, pentagonal, without visible suture lines ; margin bevelled, and without this edge the entire plate concave. Radial plates subquadrangular, spreading abruptly outwards below, and turning abruptly upwards at the middle ; edge conspicuously bevelled, leaving the sutures broadly canaliculate : upper margins scarcely concave, the cicatrix of attachment being a broad semicircular scar on the side of the plate, which occupies half its length, and is bounded by a strong thickened margin. Arms dividing upon a large, strong, subbrachial plate which fills the entire articulating space on the face of the radial, each division producing at least three ramifications, making altogether six arms from each ray composed of a double series of thin plates which are wedgeform at their interlocking edges. Tentacula undetermined.

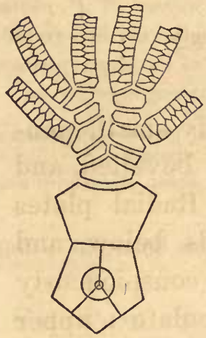
SURFACE of plates marked by irregular rounded, elongated or confluent nodes, which are often arranged in lines parallel to the margins of the plates. The arm-plates are marked by longitudinal rounded ridges. Column of medium size, composed near the body of alternating thicker and thinner joints.

The calyx of this species resembles in some degree that of *P. discoideus ;* but it is proportionally smaller, and the radial plates are higher, while the bevelled surfaces are less broad, and the inner margin on the basal plates marked by a row of small nodes. The nodes of the surface are often elongated, and of irregular form, and always abruptly elevated from the surface. It is readily distinguished from *P. wortheni* by the character of the surface, as well as form of radial plates which are much thicker, and by the number of arms and narrower arm-plates; while the simple, subdued, thread-like lines marking the arm-plates contrast strongly with the sharp spinose elevations on the arms of that species.

The specimen figured is somewhat distorted at the base of the arms by pressure, while these appendages are all converged together at the summit.

Fig. 5. Lateral view, showing the cup with fragment of column, the edges of the concave base, the radial plates and arms which are somewhat broken and distorted.

FIG. 58.



The accompanying diagram illustrates the form of the basal and radial plates and the mode of bifurcation of the arms.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus planus ?

PLATE VIII. FIG. 6 *a*, *b*.

Compare *Platycrinus planus*, OWEN and SHUMARD, Report of the Geology of Wisconsin, Iowa and Minnesota, pa. 587, pl. V *A*, f. 4.

CALYX elongate, cylindrical above and subturbinate below; base cupform, pentagonal with the angles prominent and the intermediate spaces concave ; area for the attachment of the column abruptly depressed, striate : surface of base marked by three distinct shallow grooves, which indicate the divisions of the basal plates, and along which the suture is sometimes distinctly marked. Radial plates large, heptagonal; width and height about as ten to thirteen; the cicatrix for attachment of arms strongly marked, and the upper edge of plate slightly concave. Interradial plates hexagonal, somewhat irregular in form. Summit rounded above, ventricose, composed of numerous plates of unequal size. Arms double at their origin, and bifurcating to six or eight divisions from each radial.

SURFACE finely granulose; the basal and radial plates marked by numerous concentric undulations.

This species possesses so many characters in common with *P. planus* cited above, that I hesitate to regard it as distinct; although there are many points of difference, particularly in the ridges marking the suture of the basal plates, as well as in the deeply excavated upper margins of the radial plate of the original of *P. planus*. The plates of the two specimens examined are nearly smooth, the fine granulations having been worn off; but in some parts of the surface of the larger plates of fig. 6 *a*, *b*, and especially in the plates of the summit, this marking is preserved.

Fig. 6 *a*. Lateral view, showing form of cup on one side, radial plates with points of attachment to arm-plates, interradials, and plates of summit.

Fig. 6 *b*. View of opposite side, showing similar features in the lower plates with some remains of the arms above.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus tuberosus (n. s.).

Plate VIII. Fig. 7 *a*, *b*.

General form elevated-hemispherical; base subpentagonal; cup discoid with the outer edges of the basal plates, the radials and first arm-joints nearly in the same plane; base deeply concave; sutures distinct, outer edges bevelled, not as prominent as the convex portion of the radial plates. Radial plates subhexagonal, the base and lower lateral margins nearly equal in length, and equal to the width of the upper or brachial articulating margin. Interradial plates three, the central larger and hexagonal, one of the lateral heptagonal. Central anal plate truncate at the summit, making it heptagonal, or sometimes with a small plate adjoining making it octagonal. Subbrachial plate large, pentagonal, giving origin to a double series of arm-plates which continue to spread in a horizontal direction. Supra-axillary plates numerous. Crown ventricose, composed of numerous prominent hexagonal and pentagonal plates, the more central of which are larger, and elevated into prominences. Anal opening about half way between the base and summit, and surrounded by eight or nine small plates.

Surface finely granulose. Column very small.

Fig. 7 *a*. Anal and postero-lateral view, showing the incurved upper margins of the radial plates, the bases of the arms, and the plates of the summit with the anal opening.

Fig. 7 *b*. View of the base of the specimen, showing the basal, radial, and first arm-plates, with the interradial plates.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus discoideus.

PLATE VIII. FIG. 8 *a*, *b*.

Platycrinus discoideus : OWEN and SHUMARD, Report on Geology of Wisconsin, Iowa and Minnesota, pa. 581, pl. V A, f. 1.

CALYX discoid, somewhat decahedral, shallow, height about one-third the diameter; base pentagonal, bevelled towards the margin, with a broad and deep depression towards the centre, the limit between the two upper slopes marked by a subnodose or irregular ridge, with indentations along the lines of the sutures. Radial plates massive, straight upon their base, and gradually expanding above : lateral and basal margins of plates bevelled so that the line of suture is marked by a broad shallow groove. Nearly one-third the width of the radial plates lies almost in the same plane with the basal plates, being bent abruptly upwards at the sides. Articulating surface of the arms broad, semicircular, and margined by a prominent, thickened ridge.

SURFACE marked by rugose ridges which are more or less parallel to the margins of the plate, and somewhat irregularly disposed over the central portions. Column and arms unknown.

I have referred the specimens of the above type to this species of OWEN and SHUMARD, though there are some slight differences between the description given and the characters exhibited in our specimens. Separate plates, belonging apparently to this species, are not uncommon, though the calyx is rarely found. In the specimen figured the surface is imperfect.

Fig. 8 *a*. Basal view of the specimen.

Fig. 8 *b*. Profile view, showing the elevation of the side of the cup.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus subspinosus (n. s.).

PLATE VIII. FIG. 9 and 10.

GENERAL form of body depressed, semiorbicular. Calyx discoid, decahedral, flat below. Basal plates anchylosed; the sutures marked by simple lines, broadly and deeply depressed towards the centre, edges bevelled. Radial plates subhexagonal, extending for half their length almost in the same plane with the base, or at right angles to the axis, where they are suddenly bent upwards at the sides : margins (especially of the base) bevelled, producing a groove along the sutures. Subbrachial plate resting upon the truncated extremity of the radial plates, and continued in the same horizontal plane. Interradial plates five or six-sided : anal plate eight or nine-sided; anal orifice (which is imperfect) bordered by numerous minute plates. Axillary plates small, six-sided. Supra-axillary plates in two ranges : plates of the summit produced in the centre into short, obtuse spines.

SURFACE very finely granulose. Column comparatively large, round at the summit.

This species is closely related to *P. tuberosus*, but is smaller, less ventricose above, with the plates of the summit produced into short thick spines instead of rounded tubercles; and there are also minor differences in the form of the interradial plates, and in the proportional size of the column. It resembles *P. discoideus* in the discoid calyx; but, besides being more extended in the plane of the base, the surface is not rugose.

Fig. 9. View of a small specimen, showing the base and first arm-joints.

Fig. 10. Profile view, showing the surface of attachment for the second arm-plates, the anal aperture, and the spiniform extension of the plates.

Geological formation and locality. In the Burlington llmestone : Burlington, Iowa.

Platycrinus sculptus (n. s.).

PLATE VIII. FIG. 11.

BASE basin-shaped; sides spreading nearly straight, very distinctly pentagonal; margins very slightly concave, somewhat abruptly depressed at the centre with edges of the depression salient. Column at point of attachment small.

Surface marked by transversely elongated nodes or lamellose ridges, arranged principally in lines parallel to the upper margins of the plates, with a radiating line of nodes extending from the base to each angle of the basal plates.

Superior plates unknown.

The form of the basal portion of this fossil is so unlike any of the granulose or ornamented forms here described, or any of those described by Drs. Owen and Shumard, that it will be easily distinguished. The basal portion resembles *P. planus* in form, but is less convex or gibbous in contour, while the surface ornamentation is entirely distinct from any other species noticed.

Fig. 11. Basal view, showing the depressed area for attachment of column, form of plates and surface ornaments. [The nodes are often more confluent than shown in the figure.]

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

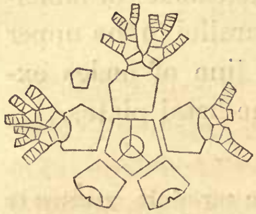
Platycrinus truncatus (n. s.).

Body small. Calyx broadly cup-shaped, flat in the bottom : externally the base is truncate, the truncation extending to the margins of the basal plates. Radial plates one-fourth wider than long, scarcely spreading above, notched in the middle of the upper edge, the articulating scar being semicircular, with a thickened elevated margin, which extends about one-third the length of the plate downwards, and below which is a depression of the surface. Sutures between radial plates, and between these and the base, abruptly canaliculate. Interradial plates small, hexagonal. Subbrachial plates comparatively large, pentagonal, supporting on the upper sloping sides two arm-plates, which dichotomize again on the second or third plate above.

Surface marked by simple fine granulations, so far as can be observed.

Several specimens of this species have been examined, and they are all small and of nearly uniform size.

Fig. 59.



The accompanying diagram illustrates the form and proportions of the plates of the body and lower part of the arms.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

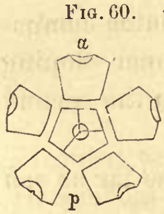
Platycrinus truncatulus (n. s.).

Body small, basin-shaped, somewhat hemispheric ; base truncate, the truncation extending nearly to the margin of the basal plates, a slight depression in the centre for the attachment of the column. Radial plates wider than long, regularly convex, gradually spreading from the base, slightly concave on the upper side, the articulating scar being on the upper margin : subbrachial or first arm-plate quadrangular ; sutures plain, or with a callosity along the radial sutures.

Surface finely granulate, without nodes or inequalities.

This species differs from the preceding, which it resembles in general form, in the truncation of the base which does not extend to the margins of the basal plates, and in the absence of grooves along the suture lines. The articulating face for the arm attachments is mainly on the upper edge, and does not occupy the side of the plate as in *P. truncatus;* while the first plate above the radial is of quadrangular form with a single groove on the inside, showing that there was no bifurcation from this plate.

Fig. 60.



The figure illustrates the form and proportions of the basal and first radial plates, and shows the quadrangular first arm-joint attached to one of the rays.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

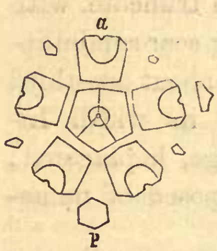
Platycrinus exsertus (n. s.).

Body small, ovoid, robust, the plates exceedingly thickened; base pentagonal, truncate below with a small depression for the reception of the column; sutures marked by a shallow depression; margins extremely thickened, giving it the appearance of protruding beyond the radial plates. Radial plates as wide as long, very gibbous, with a broad articulating scar above, occupying two-thirds the width and one-third the length of the plate : upper margins truncate with a narrow notch in the centre; sutures marked by a broad deep groove. Interradial plates hexagonal : arms originating in double series from a small triangular subbrachial, which does not fill the entire depression in the radial plate.

Surface concentrically granulose striate.

This species is well characterized by its extremely thickened plates, and the protruding base which appears as if having been pressed outwards, and is quite unlike any other species of *Platycrinus* which has fallen under my observation.

Fig. 61.



The accompanying figure illustrates the form and proportions of the plates of the body and arms, as far as they exist in the specimen examined.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus canaliculatus (n. s.).

Body small. Calyx depressed cup-shaped : base truncate, depressed in the centre for the reception of a moderately large column; line of suture marked by a distinct groove, and a corresponding less deep groove extending to the two remaining sides of the basal plates; edges of the plates projecting.

Radial plates one-fourth wider than long, slightly concave on their upper margins, with a small short semioval articulating scar which is margined by a moderately thick callosity; margins abruptly bevelled, and sutures canaliculate.

Surface marked by strong prominent elongated nodes which radiate to the margins of the basal plates, and converge on the radials towards the base of the arms, below which there is a plain space.

This is a very well marked species in its truncate base with canaliculate sutures and elongate nodose markings, differing very essentially from *P. truncatus*, which resembles it only in the character of its sutures.

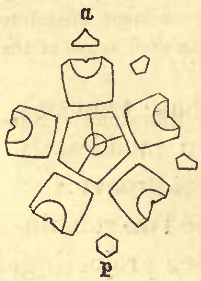
Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus nucleiformis (n. s.).

Body nucleiform; base gibbous, uniformly convex except the central small striated depression for the attachment of the column; sutures plane. Radial plates wider than long, thickened and gibbous in the middle and curving towards the lateral and basal margins; upper margin truncate, with a small notch in the centre; the articulating scar semielliptical, oblique, strongly marked and extending about one-third the length of the plate, and occupying half its width. Interradials hexagonal, small : anal plate large, heptagonal; anal opening somewhat proboscidiform, composed of numerous small plates.

Surface marked by fine, delicate granulations.

Fig. 62.



The figure illustrates the form and proportions of the plates of the body, the quadrangular subbrachial plate and the small articulating scar on the upper margins of the radial plates, which are distinguishing features of this species.

This species is distinguished by the gibbous base, which curves gently to the central depression, and to the outer margins ; while the greater gibbosity of the individual radial plates, and their contraction at the lateral margins give it the appearance of being much larger; so that when reversed, the base appears like a rounded prominence set upon a larger pedestal. I have been disposed to refer this to *P. burlingtonensis ;* but the pelvis or base is much larger in proportion to the body, and the attachment for the column is relatively smaller.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus nodulosus (n. s.).

Base broad, obtusely pentagonal, the centre abruptly depressed for the reception of the column, moderately convex, sloping towards the margins, and somewhat channelled or doubly-bevelled near the upper edges; lines of suture slightly grooved. Radial plates somewhat heptagonal, gradually expanding from the base, as wide at the top as the length of the plate ; the articulation scarcely more than one-third the width of the plate, wider than long, the upper margin scarcely concave.

Surface of base marked by one or two rows of rounded pustuliform nodes inside the bevelled margin ; those directed towards the angles most prominent, similar ones on the radial plate in converging lines from the outer basal angles to the base of the arm, with others included between and outside of those, the whole arranged somewhat in concentric lines.

This species is clearly distinct from any other known to me in this rock, and may be recognized in the basal pieces by the round, more or less prominent pustulose processes, the abrupt depression in the centre, and the doubly bevelled edges of the plates.

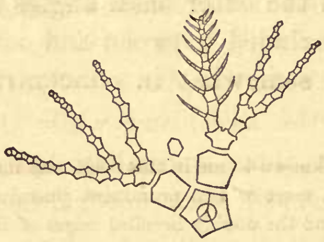
Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Platycrinus nodobrachiatus (n. s.).

Body small, abruptly spreading from the base, gibbous at the sides; base nearly flat, depression for the column margined by a thickened rim. Radial plates gibbous in the middle; articulating scar small. Subbrachial plates elongate, somewhat pentagonal, thickened and slightly bilobed at the upper extremity from which the arms bifurcate; one of the divisions again dichotomizing on the second plate above the first: joints of the arms comparatively long, and thickened at their upper extremities; the upper alternating edges projecting very prominently for the articulation of the tentacula, giving the arms an apparent zigzag direction or nodosity at each joint. Tentacula composed of numerous joints, which are also thickened at the articulating extremities.

Surface granulose. Column small, composed of short alternating thicker and thinner joints near the body, and, at a greater distance, of elongated joints, which are thickened at the articulations, and furnished with nodes or branchlets just below each articulation.

Fig. 63.



The accompanying diagram will illustrate the form of plates, character of arms, etc.; the whole being enlarged two diameters. There are about twenty joints visible in each arm, fourteen of which are shown in the figure; and on one of the arms, the tentacula are shown extended.

Geological formation and locality. In the Burlington limestone: Burlington, Iowa.

ZEACRINITES (TROOST, *Catalogue of Crinoideæ*).

Among the Crinoideæ of the Carboniferous limestone there is a group of species which possess the general characteristics of POTERIOCRINUS, but which have a less robust habit. The base is always rotund, more or less depressed, and often deeply concave in the centre : the basal plates are usually hidden by the column, while there is not unfrequently some irregularity in the subradial plates. The arms are usually closed. The general form of body and arms is terete or subcylindrical, often contracted at the base of the arms, and sometimes spreading above from the frequent branching.

In several specimens examined there is an irregularity in the anterior ray, and a greater number of plates by one or two or more below the first bifurcation, than in the other rays. In all the species of this character the mode of articulation of the plates agrees, and differs from the true POTERIOCRINUS; and we find at the same time, that the radial series always presents two plates in succession below the first bifurcation of the arms : and it might, with propriety, be described as having radials 2×5, while the mode of articulation of the radial and arm-plates is so different from the typical forms of that genus that it furnishes a characteristic distinction.

The line of articulation between the radial plates is slightly concave or nearly rectangular to the axis ; and while the edges are in contact along the centre, there is usually a hiatus between the plates on the outer edge, as if the space had been filled with cartilage, which has decayed, leaving the present unoccupied space.

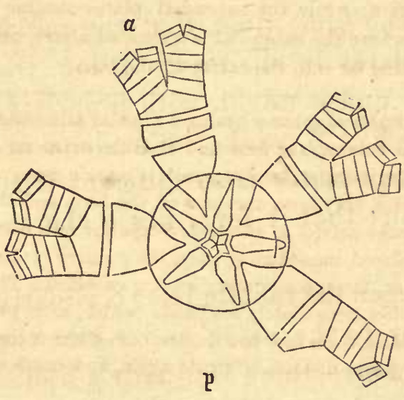
For a well marked species of this type, the late Dr. TROOST proposed the name of ZEACRINITES, and the species occurs in his Catalogue as *Zeacrinites magnoliæformis*. No generic description accompanies the description of the species ; but

Dr. Troost remarks, "If the number of plates which com-
" pose the body of an encrinite determine its genus, then
" the one under consideration must perhaps be placed in that
" of Cyathocrinites; but if the arrangement of these plates
" is also necessary to determine its genus, then this crinoid
" cannot belong to the *Cyathocrinites*, and forms a new genus,
" to which I have applied the name of *Zeacrinites*"*.

Genus Zeacrinus (Troost).

Basal plates five, usually small and hidden by the column. Subradial plates five, pentagonal or hexagonal, rarely with six subradials: first radial plates five, pentagonal; second radials five, of the same form as the first, relatively reversed, with one or two more in the anterior ray; interradial plates none: anal plates four, six or more. Summit unknown.

Fig. 64.



The accompanying diagram (fig. 64), of the original specimen of Dr. Troost, will illustrate in part the characters above given. The basal plates are hidden by the column in the deep cavity of the base. The subradials are extremely narrow and elongated, their length indicating very nearly the depth of the cavity of the base. The first radial plates are much elongated, narrowed and pointed below, and very wide upon their upper margins. The second radials are short and broad, an intermediate one coming in on the anterior ray†.

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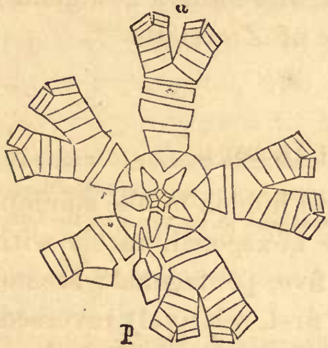
* I have transcribed these observations, as well as the specific description of this species, from the MS. of Dr. Troost's memoir upon the Crinoideæ, which is to be published in the Smithsonian Contributions to Knowledge; having been permitted to make such references and citations as would enable me to verify any of the genera and species which I might describe in the Iowa Report. By this means, although Dr. Troost's paper has not yet been published, he has the precedence which belongs to him.

† The following is the description of *Z. magnoliæformis* as given by Dr. Troost:
"Elongated, cylindrical. Pelvis small pentagonal? divided? This supposed pelvis lies

Another individual* from Chester (Illinois), which I have received under the designation of *Zeacrinus magnoliæformis*, has a narrower and less rotund base, with the cavity much less deep, and the subradial and first radial plates proportionally shorter and the latter narrower; while the anterior ray has two intermediate radial plates, with other slight differences in the bifurcation of the arms.

FIG. 65.



The accompanying diagram (fig 65) will illustrate the characters mentioned, and also show the relations of the anal plates. The parts within the circular line in this and the preceding figure are those occupying the exterior depression or cavity of the base.

In the *Cyathocrinus depressus*, TROOST (the basal and first radial portions known), which is a species of the Genus ZEACRINUS, the proportions of the parts are still more extravagant. In one specimen, the five small plates of the base are shown in the bottom of the very abrupt basal depression; while the subradial plates assume a spatulate form, except on the anal side, where the subradial is truncated above, and a large anal is inserted on one side reaching far into the cavity of the base.

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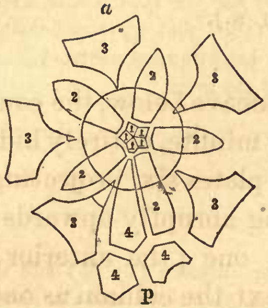
in a deep cavity, and is supported by a cylindrical column having a circular alimentary canal. The cavity being mostly filled by the column, the form and even the existence of the pelvis is very uncertain. Costals five, subtriangular, tumid; superior margin concave, and lower convex; and being bent inwardly, they form the base of the body and the sides of the cavity, in the bottom of which the pelvis? is situated. Scapulars five, compressed, pentagonal; four of them being placed immediately upon the concave surface of the costals, and one upon an interscapular, the superior margin being cuneiform. The scapulars support five arms, upon which follow immediately ten hands, which, after two or three joints, have a cuneiform joint dividing them into two fingers, one of which continues single; while the others, about five joints distant, bifurcate again, and continue then without any further division''.

* This is apparently a species distinct from *Z. magnoliæformis*, with shorter first radials extending little above the plane of the base, and arms much shorter and less robust; for which I propose the name *Zeacrinus wortheni*.

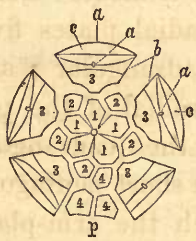
FIG. 66.



The form and proportions of parts in this species are shown in the accompanying diagram.

These illustrations suffice to show the characteristics of the genus, which begins its existence, so far as known, in the Burlington limestone, and continues to the Chester limestone, becoming far more abundant and extravagant in its forms in the latter period.

FIG. 67.



The diagram fig. 67 illustrates the interior of the calyx of *Zeacrinus depressus* (TROOST), of which fig. 66 is the exterior. The basal plates (1), which are extremely small in the exterior basal cavity, are, on the inner side, much larger than the subradials, and are truncated at their upper extremities by the first radial plates. The subradial plates (2) present, on the interior, an extremely small quadrangular face compared with the elongate spatulate form of the exterior, and, instead of joining at their lateral edges, are entirely separated from each other by the basal and first radial plates. The first radial plates (3) are short, hexagonal in form, with the lower side very narrow, as well as the two adjacent sides. The inner face of the plate is the space included in the lines surrounding the figure (3) : the remaining portion is the thickened articulating margin, the central space of which, marked *a*, is higher than the inner or the outer areas marked *b* and *c* respectively, the latter having been occupied by a softer yielding substance; while the plates have been in actual contact with the succeeding range along the small central area connected by a tendinous fibre, as is indicated by the little oval pit or cicatrix on the inner edge of this part of the plate.

The *Poteriocrinus maccoyanus* of DE KONINCK and LE HON possesses the characters of ZEACRINUS, in the concave base and minute basal plates hidden by the column, as well as in the character of the anal plates.

The *Cyathocrinus maniformis* = *Poteriocrinus maniformis* (YANDELL & SHUMARD), which is probably identical with the *Cyathocrinus gracilis* (TROOST), belongs to ZEACRINUS, as well as the *Cyathocrinus florealis* = *Poteriocrinus florealis* of the same authors.

The species form a very characteristic group, and are readily distinguished by general form and habit from the ordinary forms of *Poteriocrinus* of the same strata.

Zeacrinus elegans (n. s.).

PLATE IX. FIG. 1 & 2.

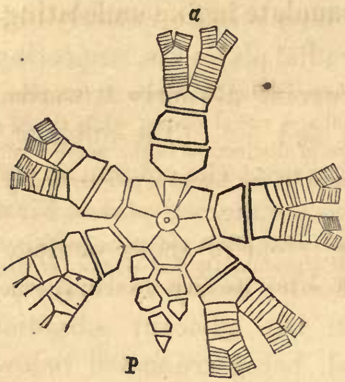
BODY subglobose, contracted above, concave below, the concavity filled by the column. Basal plates minute, entirely hidden by the base of the column. Subradial plates six, projecting rectangularly from the base and curving abruptly upwards; three pentagonal, two hexagonal, and one (the anterior) quadrangular [regarding the margins next the column as one side], the latter placed between two pentagonal plates. First radial plates five, wider than long: four of them pentagonal, being truncate above, with the sides nearly vertical, and the sloping lower sides resting on two adjacent subradial plates; the anterior one hexagonal, being truncated below by the quadrangular subradial. Second radial plates five; four pentagonal, and the anterior one quadrangular: anal plates five. Arms dividing on the second radial of the postero-lateral and antero-lateral rays, while the quadrangular second radial of the anterior ray supports a short pentagonal third radial or brachial plate upon which the arm-plates subdivide, each division again dichotomizing three times before reaching the summit; the branches coming off upon the adjacent sides of the two arms from the same radial, while those parts from the outer sides of the radials continue without branching on that side throughout their entire length. Plates near the base of the arms unequally quadrangular; those above, except the bifurcating plates which are pentagonal, very short, quadrangular. Arms and branches composed of a single series of plates: first bifurcations usually on the 6th, 8th, or 9th plate from base, varying in the different rays.

SURFACE finely granulose. Column round, apparently composed of nearly equal thin plates.

This beautiful species may be readily recognized by the peculiar arrangement of its subradial plates; and should the quadrangular plate be only an individual and not a specific character, the body and base of arms, as well as their mode of dichotomizing, is peculiar.

Fig. 1. Anterior side of specimen.
Fig. 2. Posterior side, showing the anal plates.

Fig. 68.



The accompanying diagram (fig. 68) illustrates the form and arrangement of the plates in the subradial and radial series; as also of the arms of the second bifurcation or first above the radial, showing the supernumerary plate in the anterior ray.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Zeacrinus ramosus (n.s.).

PLATE IX. Fig. 3.

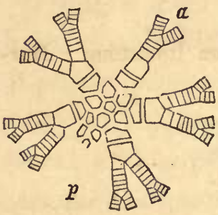
Body small, cupform, concave below, with arms spreading. Basal plates unknown. Subradial plates concave towards the column, becoming thickened and gibbous in the middle and towards the upper margin. First radials short, pentagonal, the two sides resting upon the sloping edges of two adjacent subradial plates. Second radials a little longer than the first, pentagonal, the anterior one quadrangular. Arms resting on the pentagonal radials, double from their origin, and bifurcating again on the sixth plate above ; and again bifurcating twice, with eight or nine plates intervening between each, the bifurcations coming off on the inner adjacent sides of the two divisions from the same ray. Arm from the quadrangular anterior second radial simple to the fourth joint, where it dichotomizes ; each branch again dichotomizing upon the eighth and tenth joint respectively above. Arm-joints in single series, having the edges thicker on one side than on the other. Tentacula originating from the thicker sides of the arm-plates, tapering somewhat abruptly from the base, and becoming slender and numerously jointed.

SURFACE finely and beautifully granulate in fine undulating and somewhat radiating striæ.

This pretty species is clearly congeneric with the preceding *Z. elegans*. It is a more slender species, with some differences in the basal and radial plates; while the bifurcations of the arms offer more palpable means of distinction in the number of plates between each bifurcation. The plates of the arms are likewise proportionally longer.

Fig. 3. Antero-lateral side of specimen, showing the radial plates and the anterior ray on the left side of figure, with arms and tentacula. On that side two of the subradial plates are partially broken off, so that the figure does not give the form of these plates entirely.

FIG. 69.



The accompanying figure illustrates the structure of the body and lower part of the arms of this species, the anterior ray showing the irregularity already noticed. The base is too small to admit of marking the lines of subdivision.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Genus POTERIOCRINUS : Subgenus Scaphiocrinus*.

Associated with the ZEACRINUS there is another group of species, which differ in general aspect sufficiently to be readily recognized, but which, on strict comparison, do not differ in their essential structure from that genus. Like that, they begin their existence in the Burlington limestone period, where the first noticed form has the aspect and character of GRAPHIOCRINUS.

This species is figured on Plate ix, fig. 10; and, as shown under the description, possesses one series of plates more than GRAPHIOCRINUS, having five subradials above the five basal plates; and while the arms in this species are not bifurcated above their origin on the second radial, in another species, having the same structure of body, the arms dichotomize at a point about half way from the base to the summit. Farther comparison has shown other species having the arms more or less bifurcating, but preserving generally a slender elongate form. The base is not concave as in ZEACRINUS, and the five small basal plates are often quite conspicuous in a lateral view.

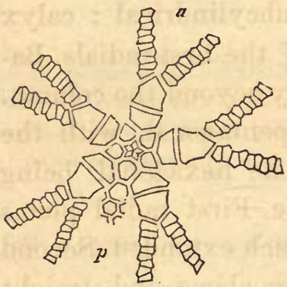
* For generic descriptions and illustrations of the Genera CYATHOCRINUS and POTERIOCRINUS, see under Crinoideæ of the Keokuk limestone.

The base, instead of presenting the rotund outline with central depression, is turbinate or basin-form, gradually enlarging to the base of the arms. The radial and second radial plates are articulated in the same manner as in ZEACRINUS; and a marked feature, of at least half a dozen species, is, that the second radials, which are often long, are concave or compressed at the sides, swelling out above and below, while the lateral articulating margins are thin and spreading at the sides beyond the convex portion. The arm-plates, though arranged in single series as in ZEACRINUS, are nevertheless more nearly wedgeform, by having one side much longer than the other. The anal plates range from one to six, or perhaps more; while no interradials have been observed.

From the differences of habit, and certain peculiarities, I have thought proper to propose a distinct generic term to include these species.

SUBGENUS SCAPHIOCRINUS (n. g.).

FIG. 70.



GENERIC FORMULA*.

Basal plates, 5.
Subradial plates, 5.
Radial plates, 2 × 5 = 10.
Anal plates, 1 to 6 or more.
Interradial plates, 0.
Arms, 2 × 5 = 10, two from each ray, simple or bifurcating.

BASAL plates five, small : subradial plates five, small, hexagonal except that on the anal side, which is truncated above by the first anal plate. First radial plates pentagonal, with the upper side straight or slightly concave : second radial plates pentagonal with the lower side straight, often much elongated and the plate contracted or concave on each side. Anal plates four or more. Interradials none.

Arms double from their origin, or, rarely, with the anterior one simple for some distance above the upper radial, consisting of a single series of plates which are longer on one side than the other, and often wedgeform with tentacula originating on the longer side.

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* The accompanying diagram is an illustration of the structure of *S. simplex*, which I have selected as the type of the group.

The line of articulation between the first and second radials, and between the second radial and the arm-plates, and also between the plates of the arms, is usually more or less gaping exteriorly, and the edges of the plates rounded, as if the space had been filled with some cartilaginous or muscular substance during the life of the animal.

The species at present known to me are, two in the Burlington limestone, one in the Warsaw limestone, two or more in the St. Louis liestone, and four or more in the Chester limestone. One species is described by Dr. TROOST as *Agassizocrinus gracilis;* the reference to the latter genus having been induced by the imperfect condition of the base, by which the characters are obscured*.

Scaphiocrinus simplex (n. s.).

PLATE IX. FIG. 10.

GENERAL form of body and arms subcylindrical : calyx shallow, spreading to the upper edge of the first radials. Basal plates minute, and projecting slightly beyond the column. Subradial plates five : four of them pentagonal, with the lateral and superior margins equal; one hexagonal, being truncated above by the first anal plate. First radial plates short pentagonal, with the upper side much extended. Second radials somewhat pentagonal, wedgeform above, and straight below. Anal plates six, the lower one the larger, and octagonal.

---

* For purposes of comparison, I subjoin from the work of DE KONINCK and LE HON the generic description and illustrative diagram of GRAPHIOCRINUS. The name was proposed to designate a peculiar crinoid from the Upper Carboniferous limestone of Belgium.

Genus Graphiocrinus (DE KONINCK & LE HON).

"The summit of this genus when complete, is very elongate, nearly cylindrical, and represents very well the form of a pencil or paint-brush : this distant resemblance suggests the name.

"CALYX short, composed of five small basal lozenge-form pieces, and producing together a five-rayed star : between the rays of this star are placed the five first radial plates. These are pentagonal, connected by their lateral edges, and disposed in the same manner as the basal pieces. The second radials are placed vertically upon the first, and connected by their lateral edges, forming a little cup. A single anal plate, of ovoid form, is interposed between two rays, and adjacent to four other pieces which enclose it, and

Arms double from their origin on the second radial plate, rounded below and subangular above, in some parts having small nodes upon the back; each arm consisting of a single series of joints which are wider than long, with nearly parallel faces in the lower part, while towards the summit they become distinctly wedgeform; the thicker side of each plate, near its upper edge, showing the point of attachment for tentacula.

In the *Graphiocrinus* figured by De Koninck, the plates are proportionally longer, and have the articulating faces parallel quite to the summit, or as far as represented.

Fig. 10. Anal side of specimen described.

Geological formation and locality. In the Burlington limestone: Burlington, Iowa.

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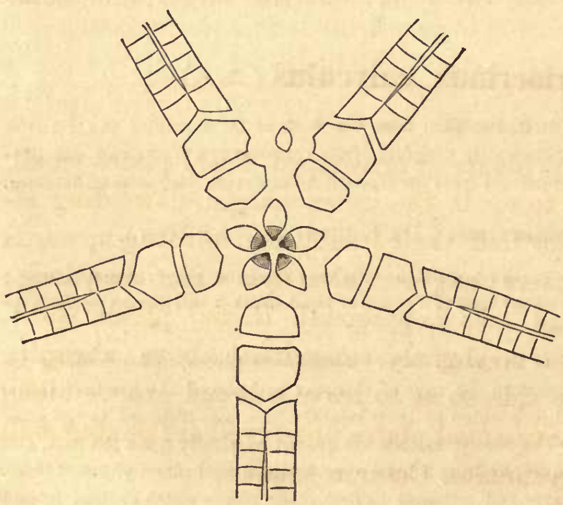
have thus each a part of one of the lateral edges sloping. The second radials are cuneiform or pentagonal, each giving origin to a pair of arms which are not bifurcating, but composed of articulations with the articulating surfaces parallel to each other, and furnished interiorly with fine and short pinnules''.

Recherches sur les Crinoïdes du Terrain carbonifère de la Belgique, p. 115.

The following diagram illustrates the structure of the typical form of the genus as given by the authors cited above.

Fig. 71.



GENERIC FORMULA.

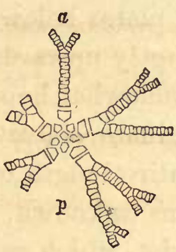
Basal plates, 5.
Radial plates, 2 × 5.
Anal plate, 1.
Interradial, 0.
Arms 10, not bifurcated.

Scaphiocrinus dichotomus (n. s.).

BODY small. Basal and subradial plates small. First radial plates pentagonal, wider than long. Second radials pentagonal, much longer than wide, rounded and contracted in the middle, swelling out at the extremities Arm-plates resting on the upper sloping sides of the second radial plate : arms double from their origin, and bifurcating upon the tenth, eleventh or twelfth plate above, and thence continuing simple to their extremities. Plates wedgeform, and furnished with tentacula on the broader margins. Anterior ray simple to the twelfth plate, where it bifurcates.

SURFACE roughly granulated.

FIG. 72.



The accompanying diagram illustrates the structure of the body and several of the arms as far as the first bifurcation, showing the simple anterior ray and the arms from the antero-lateral ray, of which one does not bifurcate, so far as observed. The base is too minute to admit of the lines of subdivision.

Geological formation and locality. In the Burlington limestone : Quincy, Illinois.

Poteriocrinus calyculus (n. s.).

PLATE IX. FIG. 6 *a*, *b*, *c*.

BODY small, subturbinate or urnshaped. Basal plates small, slightly depressed towards the inner margin, extending almost horizontally for half their length, and turning upwards in the line of the lateral angles. Subradials wider than long; three hexagonal and two heptagonal. Radial plates short, pentagonal, truncate or slightly emarginate above, abruptly bent inward at the side so as to leave a broad groove along the suture line. The two anal plates preserved are pentagonal.

SURFACE finely granulate. Column small.

The small calyx does not show any very strong distinctive characters : the base is somewhat abruptly rounded on the edges, and the sides are regularly sloping nearly direct to the radial plates, which are a little more spreading.

Fig. 6 *a*. Anal side of calyx.

Fig. 6 *b*. The anterior side.

Fig. 6 *c*. Basal view of another specimen, where the basal plates are wanting.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Cyathocrinus malvaceus (n. s.).

PLATE IX. FIG. 4 *a, b*.

BODY small, depressed subglobose, concave in the centre below, spreading and gibbous at the base and contracted towards the upper margin. Basal plates minute, pentagonal. Subradial plates pentagonal, the length equal to the greatest width, projecting horizontally beyond the basal plates below, very gibbous in the middle, and bending abruptly upwards from the lateral angles. Radial plates small, somewhat heptagonal, width greater than the height, emarginate above; the articulating scar reaching one-third the entire length of the plate. Anal plate small, quadrangular. Arms unknown.

SURFACE marked by somewhat granulose striæ, which radiate towards the margins of the plates. Column small.

In this specimen the surface is much worn, and appears to be nearly smooth, a single plate showing the radiating striæ.

Fig. 4 *a*. The anal side of the specimen.

Fig. 4 *b*. View of the base, showing the depressed centre and minute basal plates.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Cyathocrinus divaricatus (n. s.).

PLATE IX. FIG. 5.

BODY small, depressed subglobose, broader than high, greatest diameter through the centre of the subradial plates. Basal plates moderately large, not depressed in the centre, scarcely rising above the plane of the base of the succeeding plates. Subradial plates hexagonal (except the one on the anal side), wider than long, prominent in the middle. Radial plates subheptagonal, wider than high : articulating scar deeply impressed, and margined by an elevated ridge. Arms composed of a single series of joints which are sometimes of unequal length, bifurcating on the second joint from the base, and again upon the second joint above the first bifurfurcation; branches divaricating, their number unknown.

SURFACE finely granulose. Column composed of alternating longer and shorter joints of unequal size near the body, becoming much longer and of nearly equal length below : articulating surfaces coarsely and deeply striated.

This species differs from *C. malvaceus* in the larger basal plates and less gibbous subradials, which are obtusely angular in the middle, rather than broadly rotund : the articulating scar on the radial plates is proportionally deeper, and the surface markings are quite distinct.

Fig. 5. An individual preserving a portion of the column and several of the arms to the second bifurcation. The upper angles of the basal plates should be shown in the figure.

Geological formation and locality. In Burlington limestone : Burlington, Iowa.

Cyathocrinus rotundatus (n. s.).

PLATE IX. FIG. 7 *a, b*.

BODY subglobose, somewhat inequilateral, being longer on the anal side. Basal plates moderately large, the lateral and superior sides equal. Subradial plates hexagonal; length and breadth equal, except that on the anal side, which is heptagonal and longer than the others : the lateral and superior sides equal in all. Radial plates pentagonal; the lateral and basal sides equal, and each equal in length to the upper side : width across the middle a little greater than the length, gradually narrowing from the lower lateral angles, indented upon the upper margin and marked with a small articulating scar, which occupies about half the width of the upper margin and extends downward about one-third the length of the plate, and bordered by an elevated rim. The single anal plate remaining is heptagonal.

SURFACE marked by minute pustulose granulations. Column small.

Fig. 7 *a*. Anal side of specimen (on some of the plates imperfectly represented).

Fig. 7 *b*. Base of the same (the lines of division between the basal plates are not clearly shown in some of the impressions).

Geological formation and locality. In the Burlington limestone: Quincy, Illinois.

GENUS RHODOCRINUS (MILLER).

FIG. 73.

GENERIC FORMULA.

Basal plates 5, united in a regular pentagon.
Subradials 5, hexagonal.
Radial plates, 3 × 5.
Brachials one or two, united to the calyx.
Interradial plates, 6 to 8 × 4.
Anals, 10 to 12.
Interaxillaries, 1 × 5.
Arms 10 to 20, which are bifurcated two or three times in the course of their length.

THESE characteristics, together with the description of the following species, will serve to distinguish this generic form among all the other carboniferous crinoids.

The basal plates are often small, and may be overlooked. The interradial, anal and interaxillary plates are subject to variation in number.

Rhodocrinus wortheni (n. s.).

PLATE IX. FIG. 8 *a*, *b*, *c*.

BODY subglobose, very gibbous or ventricose below and somewhat contracted above; base a little flattened. Basal plates small, regularly pentagonal. Subradial plates hexagonal, about as long as wide, abruptly curving upwards in the middle. First radials heptagonal, a little longer than wide. Second and third radials much smaller. First interradials pentagonal, smaller than the first radials, supporting two smaller interradials of the second series, except on the anal side, where the first interradial is hexagonal, and supports three plates in the second range. Third series of interradials two, and supporting a fourth series of two very narrow plates enclosed between the brachial plates. Brachial plates two, resting in part on the upper sloping edges of the third radials and the edges of the adjacent interradials, except on the anal side, where the arrangement is modified by the larger number of plates. Brachial plates indented on their upper edges, the articulating scar reaching nearly to their base. Arms unknown. Surface finely granulate. Column small.

This, so far as I am aware, is the first species of this genus found in the country, and I take pleasure in dedicating it to the discoverer.

Fig. 8 *a*. View of anal side.
Fig. 8 *b*. Basal view of same specimen.
Fig. 8 *c*. Enlargement, showing more distinctly the form and arrangement of the plates.

The diagram used for the generic illustration above is of this species.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Genus Ichthyocrinus (Conrad).

GENERIC FORMULA.

Basal plates, 5.
Radials, 3 × 5.
Arms 10, which are frequently bifurcated.

The basal plates are small, and sometimes entirely hidden by the column, and there are sometimes three other rudimentary plates within the five basal plates.

Ichthyocrinus burlingtonensis (n. s.).

Base regularly and broadly convex : column small. Basal plates very minute, showing a triangular form beyond the margin of the column. First radial plates very irregularly six-sided, the upper side concave : second radials very wide, irregularly six-sided, the lateral angles being truncated : third radials five-, six- or seven-sided, depending on the truncation of the lateral angles. Arm-plates quadrangular, resting on the upper sloping sides of the third radials. Structure beyond the first arm-plates unknown.

This species is noticed here for the purpose of calling attention to the occurrence of the genus in carboniferous rocks, the only species hitherto known being in rocks of Silurian age*.

Fig. 75.

The accompanying figure illustrates the form and proportions of the plates remaining in this specimen, affording the means of comparison with the other known species.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

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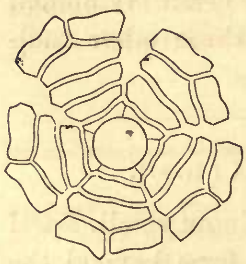
* Prof. Troost has described a species of this genus under the name of *Cyathocrinus tiaræformis* = *Ichthyocrinus tiaræformis*, from White's Creek Springs in Davidson county, Tennessee, which may be presumed to be of Carboniferous age.

Ichthyocrinus tiaræformis (Troost).

Description. Entire body globose, narrower at the base and somewhat flattened on the summit. Column large : basal plates not visible. First radial plates adjoining and surrounding the column : first and second radials somewhat hexagonal, concave above : third radials six-sided, with the upper central angle extended in a projecting point between the bases of the first arm-plates; the anterior side with four radial plates. Arms dichotomizing on the third radial, and again on the third or fourth plate above, making twenty arms at their summit.

Fig. 74.

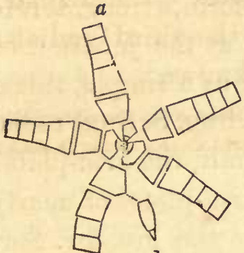


The accompanying diagram illustrates the form and proportions of the plates to the first arm divisions, affording the means of comparison with the Niagara and Burlington species.

The base is more rotund, and the column much larger and more impressed within the base, than in the Burlington species; while it differs conspicuously from *I. lævis* of the

GENUS SYNBATHOCRINUS (PHILLIPS).

FIG, 76.



GENERIC FORMULA.

Basal plates 3, usually united as one piece.
Radials 2 × 5 = 10.
Anal plates 1, 2, or more.
Interradials plates 0.
Arms simple (double?), and composed of plates in single series.

THE species of this genus are distinguished by a generally elongated, cylindrical, or subfusiform character. The base is usually small, consisting of three plates which are often so closely united as to appear as a single piece. Of the first radials, two are quadrangular, two pentagonal, and the fifth is sometimes slightly truncated on one of its upper angles by the anal plate. Second radials quadrangular. Arms simple (or double?) : plates with the articulating surfaces parallel, very gradually tapering.

Prof. PHILLIPS has described this genus as having a solid base. Prof. TROOST, in his Memoir on the Crinoideæ, has described the base as composed of three pieces in the young state; and Dr. SHUMARD has made the same observation. In the specimens before us, we have evidence confirming the truth of these observations.

In general form, the species of this genus resembles GRAPHIOCRINUS; but the solid base, or three basal plates constitute a distinguishing feature.

Niagara group, in its rotund base, impressed column area, absence of basal plates, much shorter arms, and general globose form of the whole body.

Dr. TROOST does not decide the position of his species, but remarks that it was found among the disintegrated materials of Carboniferous and Devonian strata at White's Creek Springs. Many of the species of ACTINOCRINUS, and others from this locality, are from the horizon of the *Keokuk limestone*; and from the absence of the Burlington limestone in the southwest, we may presume that *I. tiaræformis* is of the age of that formation.

Synbathocrinus wortheni (n. s.).

PLATE IX. FIG. 9.

BODY and arms extremely elongate, fusiform, strong, terete towards the summit; greatest diameter at the junction of the radial and arm-plates. Base appearing as a simple, thick, pentagonal piece. First radial plates spreading. Second radial plates long, contracted towards their summit, the arm-plates resting directly upon their upper edges. Arm-plates of nearly equal breadth and height; length a little the greater. Surface granulate. Column, near the body, composed of alternating longer and shorter joints.

The general form of the base is turbinate, swelling out at the summit of the radial plates, and again contracting above, and, with a slight enlargement in the centre of the arms, tapering above to a rounded extremity.

The specimen described presents an apparently solid base, and exhibits all the characters of the genus given by its author.

I have named this remarkably fine species in honor of Mr. WORTHEN, whose researches in the Carboniferous rocks of the Mississippi valley have brought to light so many new crinoids and other fossils of these strata.

Fig. 9. View of the specimen, natural size.

Geological formation and locality. In the Burlington limestone : Jersey landing, Illinois.

GENUS AGARICOCRINITES (TROOST*, MS.).

" *Generic characters.* Pelvis hexagonal, divisible into three " parts. Column cylindrical, with striated articulating sur- " face, and pentapetalous alimentary canal. Costals six, " hexagonal. Scapulars five, pentagonal. Interscapulars seven, " subhexagonal".

* In a catalogue of Crinoideæ published by Dr. TROOST in the Proceedings of the American Association for the Advancement of Science in 1849, p. 60, we find the name of *Agaricocrinus tuberosus*; and the same name has been published elsewhere on the

"This crinoid differs so much in its form from the gene-
"rality of these fossils, that even without regard to the
"peculiar combination of its plates, its form alone would
"entitle it to rank as a new genus. The column being at-
"tached to the bottom of an inverted basin, and all the
"plátes proceeding from the pelvis which forms the centre
"of this basin, running downwards, gives it the appearance,
"when a stem is attached to it, of a parasol or mushroom,
"(*Agaricus*, whence its name). The coronal integument
"which surrounds this basin is composed of hemispheric
"tubercles, and has the form of a cone or of a pentagonal
"pyramid."

The above description does not fully express the character of the crinoid under consideration; for an examination of the species described by Dr. TROOST shows a basal series of three small plates with five radial series of three each, showing its analogy with ACTINOCRINUS, as will be seen in the following formula :

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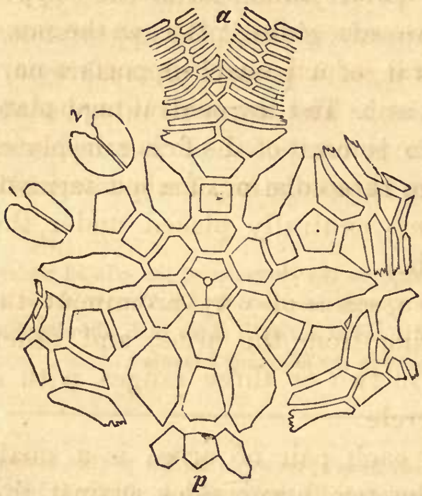
authority of Dr. TROOST. The name, proposed as new, occurs in the MS. of that author in a "Monograph of the Crinoideæ" transmitted to the Smithsonian Institution in 1850, the typical species being *Agaricocrinus tuberosus*. Subsequently to that date, Dr. F. RŒMER published in Bronn's Lethea Geognostica, Vol. ii, 1852 – 54, p. 250, the same fossil, refering it to the Genus AMPHORACRINUS, as *A. americanus*. This genus was separated from ACTINOCRINUS by AUSTIN in 1848; and if these differences be admitted as of generic importance (which I am not disposed to do), there are still stronger reasons for separating the *Agaricocrinus*, which differs quite as strongly from the typical form of *Amphoracrinus* as that does from *Actinocrinus*. For this reason I retain the name *Agaricocrinus* for the species under consideration, as well as for that designated *A. tuberosus* by Dr. TROOST.

I have before me at the present time, in the collection of the late Dr. TROOST and from other sources, specimens which indicate the existence of half a dozen species of this genus. I have already described four species; leaving the indication of the others till I have ascertained more fully to what extent variations of form, relations, and proportions of the plates of the body, may occur in the same species.

Genus Actinocrinus :

Subgenus? Agaricocrinus (Troost).

Fig. 77.



GENERIC FORMULA.

Basal plates, 3.
Radial plates, 3 × 5 = 15.
Anal plates, 4 to 7 or more.
Interradial plates.
Brachial plates, 2 or more.
Arms dividing on the last radial, and composed above the brachial plates of a series of short, wide plates.

Agaricocrinus bullatus (n. s.).

Plate IX. Fig. 11 *a*, *b*.

General form convex hemispheric above, and deeply concave beneath : basal plates hidden by the column. First radial plates five, hexagonal, about as long as wide, abruptly bent upwards on their inner margins, and closely embracing the column. Second radial plates quadrangular, nearly twice as wide as long. Third radial plates pentagonal, the length about two-thirds the width, the two upper oblique sides supporting each brachial plate, and these two supporting four other arm-plates. First interradial plate elongated, resting below on the upper oblique sides of the adjacent first radial plates, reaching nearly to the summit of the brachial plates, and supporting upon its short upper side two narrow interradial plates which rest between this and the adjacent brachial plates. First anal plate resting against the column, hexagonal, truncated above and supporting on its narrow summit an elongate subspatulate heptagonal plate which widens rapidly above, and upon its upper lateral faces two smaller elongated plates : those, on the outer side, lie against the upper radial and the brachial plate. The central upper anal plate supports in part two succeeding plates in the same series, and each of the lateral second anals supports a narrow plate lying between the arms and the central anal plate of the second series. From the summit of the first arm-plates to the anal opening there are three distinct arched series of small plates, with two others centrally placed under the crown of the two lower arches.

The dome is composed of a series of very prominent tuberculiform plates converging from the arms, and other smaller intervening plates in two or three ranges, with a very prominent central tubercle.

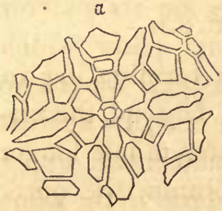
At the base, and within each pair of arms, is a small pentagonal plate, resting the two lower sides against the lower ranges of arm-plates, and supporting on its upper side a large prominent tubercle. Above this, and arranged somewhat on each side are two small plates supporting a second tuberculiform plate, which, with other similar plates, surrounds the apicial tubercle, except on the anal side, where there are several smaller plates. These rows of tuberculiferous plates divide the crown into five spaces occupied by smaller plates, four of which are equal to each other, while that on the anal side is much larger.

This species differs sufficiently from *Agaricocrinus tuberosus* to be readily distinguished. The base is more abruptly and deeply depressed, while the arms spread less horizontally. The number of plates on the anal side is less numerous, and the range of tuberculiferous plates between the base of the arms and the summit is two instead of three.

Fig. 11 *a*. View of the anal side, seen a little from above.

Fig. 11 *b*. Base of same specimen.

FIG. 78.



The accompanying figure illustrates the structure of the base, and affords means of comparison with *A. tuberosus*. It will be observed that in one of the antero-lateral rays there are but two radial plates, which is probably an accidental feature.

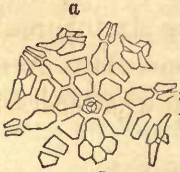
Geological formation and localities. In the Burlington limestone : Burlington, Iowa ; Quincy, Illinois.

Agaricocrinus stellatus (n. s.).

THIS is smaller than the preceding species, the base less concave, and the whole body more depressed. The basal plates extend beyond the column for more than half the width of the latter. The first radial plates are shorter; the second radial longer, and the third less gibbous than in *A. bullatus*; while the interradial plates are much broader, and the second series much better developed, owing to the greater space between the arms. The second plate above the base of each arm is tuberculous, and also the central plate of the summit. Arms originating in pairs on the second brachial plate; each arm consisting of a double series of plates, which are twice as wide as long, obtusely wedgeform at their interlocking edges, and tentaculate from their upper outer margins.

This species corresponds to another species in the Keokuk limestone; while the preceding corresponds to *Agaricocrinus tuberosus* of the same limestone.

FIG. 79.



The accompanying diagram illustrates the form, proportions and arrangement of the plates of the lower part of the body and bases of the arms.

Geological formation and locality. In the Burlington limestone : Quincy, Illinois.

Actinocrinus pyramidatus (n. s.).

Body depressed pyramidal, with the apex terminating in a short acute spine. Basal plates not visible beyond the circumference of the column. First radial plates much longer than wide, deeply concave towards the column, the outer margins thickened and prominent, and, together with the thickened second radials, forming the plane of rest where the body is deprived of the column. Second radials short, quadrangular. Third radials pentagonal, each one supporting on its upper sloping sides two succeeding simple brachial plates, which are in turn succeeded by a double series of arm-plates, making one pair of arms at the base from each radial. Interradial plates in general form ovate, resting on the upper sloping edges of the adjacent radials : each one is supported on its sides by the second and third radial, and on it supper slopes by the two simple brachial plates; its upper short side supports a narrow second interradial or interbrachial plate. First anal plate much longer than the first radial plates : second, third and fourth ranges consisting of three plates each; and above this, two or three ranges of small plates surrounding the aperture which lies just below the base of the apicial plate. The centre of the entire anal area, from the first plate to the apex, is elevated in a distinct rounded ridge.

Summit short pyramidal : a range of two or three prominent tuberculous plates extends from the upper side of the arms to the apicial plate; those from the anterior pair of arms being surmounted by two plates, making six tuberculiform plates surrounding the apicial spiniferous plate. Arms two at their origin from each ray. Surface somewhat coarsely granuliferous.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus corniculus (n. s.).

Plate X. Fig. 1 *a, b, c.*

Body somewhat urnshaped below, convex above, with a central spine : base small, the inner half of the plates abruptly depressed, forming the cavity for the attachment of the column. First radials and first anal plate extended horizontally, and on the same plane with the lower edges of the basal plates. First and second radials diverging, and, with the supraradial and brachial plates, lying in one plane from the outer edge of the first radial. Plates all thickened and rising above the suture lines in nodose or tubercular extensions, with short somewhat inconspicuous ridges reaching to the sides of the plates. First anal plate hexagonal, supporting three heptagonal plates in the second series; and above this, several series of smaller plates to the aperture, which is lateral, but near the summit : anal area prominent. First interradial plates nine- or ten-sided, resting on the upper lateral edges of the adjacent first radial plates, bounded laterally by the second and third radials, and on the upper oblique sides by the first arm-plates, and on the summit by the two narrow second interradials or interbrachials which lie between the brachial plates. Arms two from the summit of each ray, composed of a double series of plates. Crown composed of numerous small plates, which are arranged in arches from the summit of each arm. Surface strongly granulose.

This is one of a small group of species of the Genus Actinocrinus, of which the *A. unicornis* of Owen and Shumard may be regarded as the type, or rather as expressing the extreme of certain characteristics in one direction, by which the species are allied to the more ordinary forms of Actinocrinus. On the other hand, the gradation through the species fig. 1 and fig. 3 of Plate x show an approach to the Agaricocrinus, which is still farther exhibited in *Actinocrinus pyramidatus,* which is in some respects intermediate between *Act. brevis* and the *Agaricocrinus stellatus* and *Ag. bullatus.* In fig. 1 *c*, Plate x, the basal plates form a narrow rim around the column; while in fig. 3 *b* of the same plate they are quite inconspicuous, as they are in *Actinocrinus pyramidatus,* which in this respect corresponds to *Agaricocrinus bul-*

latus; while *Ag. stellatus,* a little farther removed from that type, shows faintly the basal plates projecting beyond the column.

Fig. 1 *a*. Anterior side of specimen.

Fig. 1 *b*. The anal side of specimen.

Fig. 1 *c*. The base, showing the narrow rim of basal plates surrounding the column, and the first radial plates in the same plane.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus brevis (n. s.).

PLATE X. FIG. 3 *a, b*.

BODY vertically depressed, convex above, flattened or scarcely convex below, concave in the centre; the basal plates hidden by the column. First radial plates hexagonal (the base following the curve of the column), longer than wide. Second radials small, quadrangular. Third radials small, pentagonal, succeeded by two or more brachial plates from each upper oblique side. First interradials ten-sided, supporting two long, narrow second interradials which lie between the bases of the arms, and are more properly interbrachials. Arms double from their origin, or two from each radial, giving ten arms at the base. First anal plate large, and supporting three other large plates of heptagonal form; and above these, six ranges of small plates below the anal opening, which is separated from the apicial plate by two ranges of small plates. Superaxillary plates prominent, about two or three in a line from the arm to the centre. Summit composed of numerous small plates : apicial plate elevated into a rounded tubercle. All the plates below the arms with short abrupt ridges at the lines of junction. Surface granulose.

In the flattened base, absence of visible basal plates, and elongation of some of the plates, this species approaches the character of AGARICOCRINUS: in aspect it also resembles it, in the depressed summit and incipient tuberculose plates. It differs sufficiently from any species of this formation, to be readily distinguished.

Fig. 3 *a*. Anal side of the specimen. Fig. 3 *b*. Basal view of the same.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus unicornis.

PLATE X. FIG. 5 *a, b, c.*

Actinocrinus unicornis : OWEN and SHUMARD, Geological Report of Iowa, Wisconsin and Minnesota, 1852, pa. 593, Tab. V A, f. 12.

BODY turgid, somewhat elongate-spheroidal : base truncate, and summit crowned by a strong pointed spine ; base distinctly tripartite, depressed in the centre and margined by a thickened rim, which is notched at the junction of the three plates. First radial plates heptagonal, massive, tumid, and angularly tuberculiform in the centre. Second radial plates quadrangular, twice as wide as long. Third radials small pentagonal, each supporting on its upper oblique sides two simple brachial plates upon which rest the arms. First interradial plates nine- or ten-sided, tuberculiform, resting on two adjacent first radials, and supported laterally on each side by the second and third radials ; while the first brachial and sometimes the second brachial plates rest upon the upper sloping sides, and the truncated summit supports a narrow second interradial, which is, perhaps, sometimes divided. The anal group consists of one, three, and three plates ; the two lateral plates of the third series supporting each a superaxillary plate, and the central one lying between. Anal area pointed upwards, very turgid, covered by numerous small plates ; the last series consisting of six, and resting directly against the base of the apicial spine. Plates of the summit tuberculiform ; the series below the apex consisting of six, besides those connected with the aperture. Arms three from each ray adjoining the posterior area, and two from each of the others. Surface granulose.

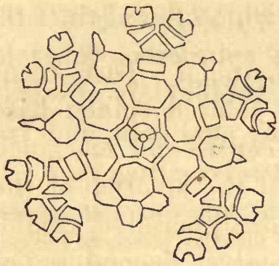
This species is not rare : it presents some variations in character, particularly in the prominence of the plates, which are usually protruded in the centre in the form of nodes or tubercles. It differs from all the other spiniferous species which I have observed, in the character of surface, and in the close proximity of the anal opening to the central spine, its upward direction, and great proportional elevation above the bases of the arms.

Fig. 5 *a*. Anal side of specimen. Two arm-bases only on each side are shown in the figure.

Fig. 5 *b*. Anterior view of same specimen.

Fig. 5 *c*. Base of the same.

FIG. 80.



The accompanying diagram illustrates the structure of the body of this species, to the summit of the brachial plates. The narrow second radials form a peculiar feature.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus tricornis (n. s.).

BODY subglobose, truncate at base and spiniferous at the summit. Basal plates concave in the centre, with projecting margins, and broadly notched at the sutures; with edges between the sutures emarginate in the middle, but less deeply than at the sutures. First radial plates thick, turgid, tuberculiform, and abruptly truncated on the upper sides; width about once and a half the length. Second radials very short, more than twice as wide as long. Third radials short, pentagonal, each side with a simple plate on the upper oblique side, which supports a brachial plate; those adjoining the anal side supporting two brachial plates. First interradial plate ten-sided, presenting the form of an angular tubercle, resting on the upper sloping edges of the first radials, and supported on the sides by the second and third radials; its supralateral edges supporting the supraradial plates, and its superior plates supporting two narrow second interradials which lie between the brachial plates. First anal plate large, tuberculiform : second range consisting of three plates, the middle one largest; above this a prominent line of three successive plates, the lateral ones of each series concealed in a deep groove between the anal ridge and the prominent arm-plates : above these are three series of small plates, the last one surrounding the aperture, which lies against the subcentral apicial spine. A prominent spiniferous tubercle, on each side of the anal opening, projects obliquely upwards. Arms three from each ray adjoining the anal area, and two from each of the other rays, making twelve altogether.

This species differs conspicuously from *A. unicornis* in the outline of the basal plates, and the greater prominence and angularity of the other plates, as well as in the character of the spines. The plates of the summit, also, are more pointed; while the plates above each pair of arms, and more especially those above the triple arms, are distinctly spiniform.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus subaculeatus (n. s.).

PLATE X. FIG. 2 *a*, *b*.

BODY symmetrically rounded below, abruptly conical above, with an acute spiniform apex : base rounded, and depressed in the centre for the reception of the column. Basal plates gently curving upwards at their extremities, so as to be barely visible when the specimen is viewed laterally. First radials heptagonal, about as long as wide. Second radials quadrangular or pentagonal. Third radials pentagonal, supporting on each side, in the postero-lateral rays, two supraradials, and in the others one supraradial and a brachial plate. First anal plate large heptagonal, and supporting three comparatively large hexagonal plates in the second range, the third range consisting of three smaller plates; and above this, three other ranges of small plates below the anal aperture. Summit composed of two series, having about ten in the lower and six in the upper series, surrounding the apicial plate, which is prolonged into a short acute spine. Interradial plates hexagonal, the second range sometimes but partially developed. Arms four from each ray on either side of the anal space, and three from each of the other radials, making altogether seventeen. Surface, in perfect specimens, somewhat strongly granulose striate.

This species differs from the associated forms in the comparatively smooth plates, rounded base, regular curvilinear surface, and abruptly conical summit with few plates. The third radials and second interradials are sometimes partially or entirely obsolete or modified.

Fig. 2 *a*. Anal side.

Fig. 2 *b*. Anterior side, viewed against the left interbrachial space.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus brevicornis (n. s.).

Plate X. Fig. 4 *a*, *b*.

Body urnshaped, depressed convex above and truncate below, the sides much extended. Basal plates small, little extended beyond the area of the column, which is slightly depressed. First radial plates wider than long; three hexagonal and two heptagonal. Second radials slightly smaller, and having the same proportions as the first; four of them hexagonal and one heptagonal. Third radials pentagonal, and supporting on their upper oblique edges two brachial plates, from which the arms proceed; making five pairs from the origin, each composed of a double series. Interradial plates in three series of one, two, and three respectively. Anal plates consisting of one in the first series; three, four, four, and six in the successive series; above which, a series of smaller plates surround the base of the proboscidiform aperture which lies in the plane of the upper side of the brachial openings. Summit depressed convex, composed of numerous small plates arranged in systematic series; the apicial plate excentric posteriorly, prolonged into a short spine. The sutures of the plates of the body below the arms are canaliculate, giving relief to the individual plates. Surface granulate or granulose-striate. Arms and column unknown.

Fig. 4 *a*. Anal side of specimen. Fig. 4 *b*. Anterior side of the same.

FIG. 81.

The accompanying diagram illustrates the structure of this species to the base of the arms and lower arm-plates, showing a slightly different structure in the postero-lateral rays.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus superlatus (n. s.).

BODY unsymmetrically urnshaped, the crown very broad and almost flat, gradually enlarging towards the bases of the arms. Base pentagonal, depressed in the centre and elevated between the centre and the margin, which is depressed. First radial plates prominent, wider than long. Second radials hexagonal. Third radials pentagonal, supporting on each of the upper sloping sides a simple brachial plate, succeeded by a second similar plate, which constitute a part of the walls of the body. Interradial plates in successive series of one, two, one, two, and two; the last lying in the interbrachial spaces. Anal plates consisting of a series of one hexagonal, supporting one central heptagonal and two lateral hexagonal plates; the third series consisting of four, and above these are smaller plates surrounding a proboscidiform aperture which lies a little below the plane of the arms, causing a slight depression on that side of the summit. Summit composed of numerous small plates; the apicial plate posteriorly excentric, extended into an elongated tubercle.

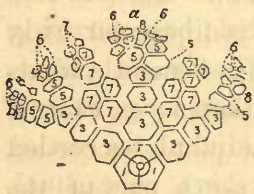
ARMS in pairs from each ray, each consisting of a double series of slightly interlocking plates, which begin to diverge from the plane of the body on about the sixth plate above their bases.

This species is more extended and flattened on the summit than the *A. brevicornis*, with fewer plates in the anal series, and the aperture consequently lower : at the same time there is an additional simple plate at the base of each arm, thus raising the walls of the body on all sides except the posterior, which is much depressed. The form of the base differs, and the plates of the body are less elevated, the lines of suture being less deeply marked : the apicial tubercle is also much shorter.

The three associated species, *A. brevicornis*, *superlatus* and *minor*, diverging from the ordinary forms of ACTINOCRINUS, approach the MEGISTOCRINUS of OWEN and SHUMARD in form, though the body is less extended. The *A. brevicornis* shows the first step in the progress of development in the radial series, having one simple super-radial plate; while the development of the series is carried to its greatest extent in *Megistocrinus evansi*, and in *M. latus* (Plate I, fig. 1 of this Report).

The same departure from the typical form of ACTINOCRINUS, so far as regards the number of plates in the radial series, is as clearly shown in some of the succeeding forms for which no separation has ever been proposed ; and when we institute a careful comparison between these and MEGISTOCRINUS, the difference will be found to lie in the broad rotund or depressed spheroidal form and smooth plates of the latter, rather than in any differences of fundamental structure.

FIG. 82.



The accompanying diagram illustrates the structure of the anterior and antero-lateral rays, with the brachial and lower arm-plates.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus minor (n. s.).

BODY small, urnshaped; summit slightly convex; base truncate. Basal plates concave towards the centre, with the edges projecting; line of suture between the base and first radial plates deeply channelled. First radial plates prominent, wider than long. Second radials hexagonal, about as wide as long. Third radials pentagonal, supporting on each of the upper oblique sides a simple brachial plate, upon which rest the second brachials, and upon these the arm-plates in double series. Interradial plates in series of one, two, two, and two, with a little irregularity, the last series interbrachial. Anal plates in series of one, three, five, and an interrupted series of six surrounding the aperture, which lies at the base of a distinct series extending from the apicial node, below the plane of the range of the arms. Arms two from each ray. Summit composed of numerous small plates; the apicial plate a little excentric posteriorly, and extended into a conspicuous tubercle. Plates of the body all tuberculous. Surface granulose.

This species resembles *A. brevicornis;* but the plates differ slightly in form and arrangement, with fewer anal plates, and the anal aperture placed much lower on the posterior side.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus symmetricus (n. s.).

PLATE X. FIG. 8 *a, b.*

BODY rotund subpyriform; summit rounded; base narrowly truncate. Basal plates large, heptagonal. First radials large, hexagonal and heptagonal, a little wider than long. Second radials short, hexagonal, the second interradial plates resting on their upper oblique sides. Third radials short, pentagonal, supporting on each of their upper oblique sides a supraradial plate, on which rests a second supraradial plate supporting brachial plates; those of the anterior ray, above the third radial, being simple brachial plates. First interradial plate hexagonal, supporting two other smaller hexagonal plates, and these two other elongate plates which lie between the groups of arms. First anal plate heptagonal, succeeded by a second and third series of three each, which are mainly hexagonal; two or more ranges of small plates surrounding the aperture, which is situated about midway between the bases of the arms and the summit. Apicial plate subcentral, tuberculiform.

ARMS from the anterior ray in a single pair, from each of the antero-lateral rays two pairs, and from the postero-lateral rays three arms, or sixteen arms altogether. Surface granulose, with sometimes faint indications of low ridges at the junction of the radial plates.

Column round, somewhat slender, consisting of alternating longer and shorter joints.

In the summit, the apicial tubercle and position of the anal opening, this species is analogous with several of the preceding; while the great development of the basal plates gives a very different aspect to the base, and separates this widely from all the other forms.

Fig. 8 *a* Anal side of specimen.

Fig 8 *b*. Anterior side, showing one pair of arms.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus trinodus (n. s.).

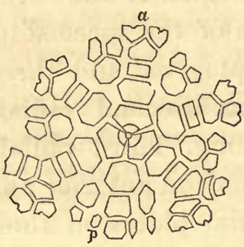
Body depressed turbinate below, convex above, spreading at the arms : base truncate, the outer margins of the three basal plates projecting beyond the bases of the succeeding radials. First radial plates five, two heptagonal and three hexagonal, nearly twice as wide as long. Second radials small, quadrangular, twice as wide as long. Third radials pentagonal, twice as wide as long, and, on the anterior and antero-lateral rays, supporting the brachial plates on their upper oblique sides; while in the postero-lateral rays there is an intermediate supraradial plate on one of the divisions, and two on the other (there being an irregularity on one side). First interradial plate octagonal, supporting two somewhat irregular hexagonal plates, and a second series of two which lie above the base of the arms. First anal plate heptagonal, supporting in the second range a central hexagonal plate, which, with the two succeeding similar ones, forms a prominent round elevation reaching to the small plates surrounding the anal opening. In the second anal range there is one lateral heptagonal or hexagonal plate on each side; in the third range, two on each side; and in the fourth range, two on each side of the central plate : base of anal opening on a plane with the upper margin of the arm-bases.

Summit composed of numerous convex plates, symmetrically arranged from the arm-bases to the subcentral plate : apicial plate tuberculiform. Standing above and near the anal aperture there is likewise on each side an elongated tubercle, which rises from the upper side of each of the postero-lateral arms, the three being nearly equidistant from the aperture.

Arms two from the lateral and antero-lateral rays ; two pairs from the right, and one pair and a single one, or three arms, from the left postero-lateral ray. Surface finely granulose.

This species resembles the *A. symmetricus* in general form, though proportionally broader and less convex on the summit : the base also is much larger, and the number of arms quite different. In the prominent anal ridge, and the tubercles bordering the anal opening, it resembles *A. tricornis ;* from which it differs essentially in the smoother surface of plates, number of arms, and other characters.

Fig. 83.



The accompanying diagram illustrates the form and proportion, as well as the number of plates to the bases of the arms.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus cornigerus (n. s.).

Plate IX. Fig. 12 *a*, *b*, *c*.

Body urnshaped. Basal plates large, concave below, spreading out in a broad thickened margin much beyond the base of the radial plates, and overhanging the column. First radial plates hexagonal, twice as wide as long. Second radial plates quadrangular, and in the same proportions as the first. Third radial plates somewhat pentagonal or irregular, very short. First anal plate hexagonal, supporting on its upper truncated edge another hexagonal plate, and on the sloping upper edges two other smaller plates; the third series not distinctly traceable· Anal aperture lateral, near the summit, and surrounded by a series of small plates. Brachial plates two, three or four, resting upon each of the third radials.

The arms on each side of the anal area in two pairs at their origin, or four from each ray; those on the anterior ray three, and the intermediate ones in twos, making altogether fifteen arms at the base. Above each set of arms originates a long divergent spine, which gradually tapers to an acute point. A similar spine arises vertically from the centre of the summit, which is surrounded at base by a double series of small plates lying between it and the lateral spines. Surface granulose.

This species resembles in some respects the *Actinocrinus* (*Dorycrinus*) *mississippiensis* of Rœmer; but it is a smaller species, having smooth or granulose plates, with arms varying in number in the different rays, while that one is represented as having four in each. In the species under consideration, the proportional diameter of the base is much greater than in Dr. Rœmer's species; and they have likewise different geological positions.

There is no reason for separating these forms from Actinocrinus, so far as I can observe; as we have in different species every degree of development in the plates of the summit, from round to acute tubercles, and thence to spines of varying and extreme dimensions, till these appendages themselves become in turn tuberculous or spiniferous*.

Fig. 12 *a*. View of anal side of specimen.
Fig. 12 *b*. Anterior side of same.
Fig. 12 *c*. Basal view, showing the form and extent of base and distribution of arms. A single spine only is entire, and the others are traced in outline.

Geological formation and locality. In the Burlington limestone: Burlington, Iowa.

Actinocrinus pentagonus (n.s.).

Plate X. Fig. 6 *a*, *b*.

General form pentahedral below, with the arm-bases conspicuously extended: base truncate or slightly concave, composed of three plates; two equal hexagonal, and one smaller pentagonal plate. First radial plates five, three

* See Plate XV of this volume.

heptagonal and two hexagonal. Second radials octagonal, the upper and lower sides horizontal and parallel. Third radials pentagonal, supporting on their upper sloping sides the arm-plates. First interradials hexagonal, supporting two plates in the second range which are hexagonal or heptagonal, and lie between the bases of the arms. Arms unknown, apparently simple at base from each ray, and composed of a double series of plates. Crown composed of numerous plates arranged in somewhat regular series from the upper side of the arm-bases : proboscis subcentral. The plates of the body below the arms are marked by a strong angular ridge running from each side, and meeting a similar one from the adjacent plate ; the ridges meeting in a prominent node in the centre. Surface of plates granuliferous.

The specimen figured is remarkable for the absence of the first anal plate; the first range of plates above the base consisting of only five, leaving the interradial spaces essentially equal, as shown in the diagram. In another individual the first anal plate is well developed, having the same size as the plates of the first radial series.

Fig. 6 *a*. Anterior side of specimen. Fig. 6 *b*. Posterior side of the same.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

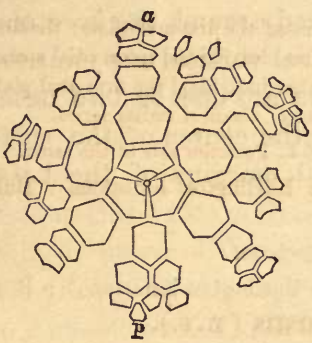
Actinocrinus verrucosus (n. s.).

PLATE X. FIG. 7 *a, b*.

BODY urnshaped, with an extremely convex summit, terminated by a proboscis : base deeply concave ; the outer margins of the basal plates much extended in a broad thickened rim, which is deeply notched at the junction of the plates. First radial plates a little wider than long; two heptagonal and three hexagonal. Second radials hexagonal, nearly twice as wide as long. Third radials pentagonal, or sometimes with the upper lateral angles truncate, and supporting simple brachial plates which sustain the arm-plates proper. Arms two from each ray at their origin, probably subdividing above. First interradial plates hexagonal, supporting two smaller hexagonal plates in the second series, and three or four small ones in the third series; which fill the interbrachial spaces. First anal plate hexagonal, supporting two other heptagonal plates, and above these a small central one, and above this an arch of four small plates; these support a range of five or six small interbrachial plates. Crown composed of numerous plates of unequal size, all the larger ones prominently tuberculiform. Plates below the arms with obtuse ridges extending to the margins and meeting those from the adjacent plate, converging altogether in a central angular node or transverse ridge. Entire surface granuliferous. Extent of arms and proboscis unknown.

Fig. 7 *a*. Anterior side of specimen. Fig. 7 *b*. Posterior view of the same.

FIG. 84.



The accompanying diagram illustrates the structure of this species, which corresponds with the more simple forms of the genus.

Geological formation and locality. In the Burlington limestone: Burlington, Iowa.

Actinocrinus multiradiatus.

PLATE X. FIG. 9.

Actinocrinus multiradiatus: SHUMARD, Trans. Acad. Scien. St. Louis, 1857, p. 7.

BODY urnshaped: base truncate; summit convex, with a subcentral proboscis. Basal plates large; the margins extended in a thickened expanded rim, which is deeply notched at the line of division between the plates; a groove continuing along the suture, and extended to the centre of the next succeeding plate, margined by sharp angular ridges.

First radial plate about as long as wide ; two heptagonal and three hexagonal. Second radials short, pentagonal. Third radials turning outwards from the summit of the second nearly at right angles, seven- or eight-sided, supporting two brachial plates which give origin to a pair of arms from each ray. Interradials three; the lower one hexagonal, the two upper ones hexagonal or heptagonal. First anal plate hexagonal, as large as the first radial. Second anals smaller, heptagonal; a third, fourth and fifth series to the base of the proboscis.

Plates of the body ornamented by strong radiating ridges which extend to the margin, and meet corresponding ones on the adjacent plates ; those of the first and second radials terminating in a central node, or transverse nodulose ridge. The ridges of the basal plates proceed around the base and along the margins of each, and a central vertical one joins the curving ridge within : on each side are one or two other abruptly curving ridges, formed by the course of the ridge from the upper to the upper lateral margins of the basal plates. Entire surface granulose.

Fig. 9. Anterior view of specimen.

Geological formation and locality. In the Burlington limestone* : Burlington, Iowa.

Actinocrinus multibrachiatus (n. s.).

PLATE X. Fig. 10.

Body subturbinate ; summit depressed-conical, and furnished with a strong central proboscis : distance from base

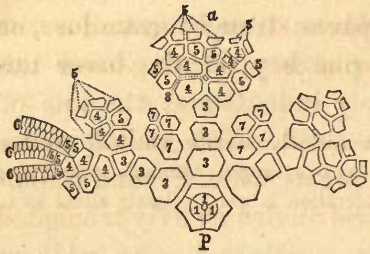
* If I am right in the identification of this species, I cannot agree with Dr. Shumard that it occurs in the "Archimedes limestone". The bluffs at Quincy (Illinois), whence he cites his specimens, are of the Burlington limestone; and the *Spirifer striatus*, large variety, is unknown to me in this locality, the nearest representative being *S. grimesi*, which is related to *S. sowerbyi*, and regarded by some geologists as identical with that species. The *Actinocrinus* (*Dorycrinus*) *mississippiensis* can scarcely occur in the bluffs at Quincy; but there is an allied species in the same rock, *A. cornigerus*. The brachiopod and crinoid cited occur in a higher position, the Keokuk limestone.

of proboscis to origin of arms about two-thirds as great as from origin of arms to base of calyx; base concave for the reception of the column. Basal plates projecting over the column in a thin rim, and deeply indented at the line of junction : plates above the rim short. First radial plates hexagonal, about two-thirds as long as wide. Second radials hexagonal, having the upper lateral angles shortly truncated by the second interradial plates, nearly twice as wide as long. Third radials pentagonal, supporting on each upper oblique side a pentagonal supraradial plate, and each one of these two other plates, the outer ones being truncate above and supporting a single brachial plate; while the inner ones are wedgeform above, and support on one side a brachial plate and on the other a third supraradial plate, giving four brachial plates to each first supraradial; the outer ones supporting a second brachial plate, thus giving four arms or eight arms from each ray. First interradial plate hexagonal, supporting two smaller hexagonal plates, which on their principal upper sides support the first supraradial plates. A single third interradial plate rests above and between the second interradials, supporting on its upper sides the outer brachial plates of adjacent rays.

Arms composed of a double series of short broad plates to the number of forty in the space of one inch, very obtusely wedgeform at the inner margins. Plates of the calyx all marked by strong radiating angular ridges, which meet in an angular node on the centre, or form a transverse ridge. Plates of the summit subangularly tuberculous : proboscis composed of numerous short transverse plates, with sharp projecting edges. Column near the body composed of alternating thicker and thinner joints, and, at a greater distance from the body, of three different sets of joints which are deeply striated upon the articulating surfaces.

Fig. 19. View of anterior side of specimen, showing the body with part of the column and proboscis, with a portion of the arms of the opposite side.

FIG. 85.



The accompanying diagram (fig. 85) consists of the anterior and right antero-lateral rays of this species, illustrating the structure of the ray in its supraradial and brachial plates and the mode of origin of the arms; each terminal plate, as represented, being the base of an arm as shown.

The same diagram also illustrates the structure of the anterior and left antero-lateral ray as far as the bases of the arms, while the right antero-lateral ray shows the plates of the arms above the brachial plates.

Geological formation and locality. In the Burlington limestone: Burlington, Iowa.

Actinocrinus sculptus (n. s.).

PLATE X. FIG. 11 *a*, *b*.

CALYX broadly turbinate: base truncate, and slightly depressed in the centre. Basal plates moderately large, the two larger twice as wide as long. First radial plates about as wide as long; the anterior plates the longest, and the two postero-lateral ones distinctly smaller. Second radials much smaller, hexagonal. Third radials hexagonal, thickened on the upper edge, and supporting an irregular brachial plate upon which the arm-plates are subdivided, giving origin to three arms from each ray, the central one of which may perhaps be again subdivided, making fifteen or perhaps twenty arms altogether. First interradial plate as large as the second radial, supporting two smaller interradials, and these a third series of three or four which lie in a range with the first arm-plate. First anal plate nearly as large as the first radial; and the second range, consisting of two plates of the same size as the second radials: third anal range, three plates; fourth, five; and the fifth series six or seven plates, lying in a direct horizontal range between the bases of the arms.

SURFACE of plates marked by abrupt narrow ridges in single or double series radiating from the centre to the sides of the plate; the intermediate spaces strongly granulose, or fine tuberculous. Column and arms beyond the bases unknown.

This species is referable to a group of Actinocrinides, among which *A. costatus*, *A. polydactylus*, *A. icosidactylus*, and others, may be arranged. Although approaching some European forms, the species under consideration is not so closely allied as to require the distinctions to be pointed out.

Fig. 11 *a*. View of specimen, looking upon the postero-lateral ray, the anal side being upon the right.

Fig. 11 *b*. Anterior side of specimen.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus ornatus (n. s.).

PLATE X. FIG. 12.

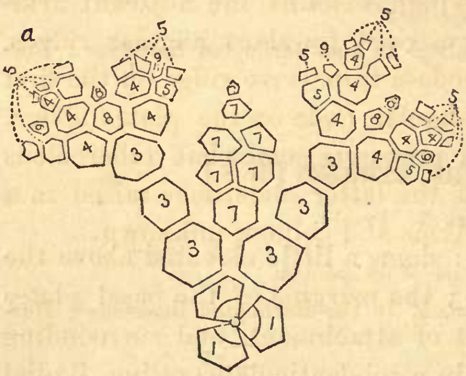
BODY broadly turbinate : dome a little elevated above the arm-bases : base truncate; the margins of the basal plates extended below the point of attachment, and surrounding the summit of the column in a subdenticulate outline. Radial plates wider than long. Second radials hexagonal. Third radials equal to or larger than the second radials, octagonal, supporting on each upper oblique side a subhexagonal supraradial plate; and each of these, two other plates, the outer ones of which are brachial plates, being truncate and supporting a single second brachial plate; while the inner ones are obtusely wedgeform above, supporting on one side a brachial plate and on the other a third supraradial; giving four brachial plates and as many arms from each first supraradial, or eight arms from each ray, the supraradial plates being separated by two intersupraradial plates. First interradial plate a little larger than the second radials; a second and third range of two each, hexagonal or pentagonal, the third series supporting one or two small plates between the arms. Anal plates somewhat smaller and shorter than the radials, making that side of the calyx shorter than the other.

SUMMIT composed of a great number of small plates, rising to a low dome, in the centre of which is a small aperture. Broad shallow grooves pass downward from this dome, and become deep defined channels between the sets of arms from each ray.

This is one of the most beautifully ornamented species of this genus, so far as known among the American species of ACTINOCRINUS.

Fig. 12. View of the anterior side, the specimen being slightly compressed.

FIG. 86.



The accompanying diagram is an illustration of the anterior and right antero-lateral ray, showing the form and proportional size of the plates, the mode of bifurcation in the supraradial plates, and the origin of the arms. The structure of the supraradial and brachial series is precisely like that of *A. multibrachiatus;* but the plates are larger, the interradial plates are more numerous, and there is an intersupraradial series as well as axillary plates which do not exist in that species.

The series of plates referred to are numbered in the diagram as follows: 1, Basal plates; 3, Radial plates; 4, Supraradials; 5, Brachial plates; 6, Arm-plates; 7, Interradials; 8, Intersupraradials; 9, Axillary plates.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus proboscidialis (n. s.).

PLATE X. FIG. 13.

BODY below the arms turbinate, above terete conical, gradually contracting into an elongate proboscis : base excavated for the reception of the column. Basal plates short, thick, projecting over the columns in a thickened rim, and deeply grooved along the sutures. First radial plates much wider than long. Second radials quadrangular, nearly twice as wide as long. Third radials somewhat irregularly hexagonal or pentagonal, and supporting on each of the upper sloping sides a supraradial plate, which gives origin to two simple brachial plates, whence the arms proceed, four from each ray. First interradial plate heptagonal, smaller than the first radial plate, and supporting two small hexagonal or irregular plates ; and above these is a fourth, resting on the inner oblique edges of the two below, and lying between the bases of the arms. First anal plate as large as the first radial : second anals as large as the first interradials; these support the third anal, which sustains the adjacent arm-plates. Surface of plates marked by short angular ridges, which terminate in a binodose transverse ridge on the first radials, and in a strong angular node on the plates above. Plates of the summit and proboscis somewhat tuberculous or subspiniferous ; some of the latter sometimes raised in a narrow transverse ridge. Arms and column unknown.

Fig. 13. Anterior side of the specimen.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus cœlatus (n. s.).

PLATE X. FIG. 14 *a, b*.

BODY short, subfusiform : base broadly truncate or slightly concave ; summit teretely conical, and produced into a long strong proboscis. Basal plates short, strong ; lower margins much thickened ; sutures broadly grooved. First radial plates broader than long, two heptagonal and three hexagonal ; the right postero-lateral one as long as wide. Second radials once and a half as wide as long, supporting on each upper oblique side a hexagonal or heptagonal or rarely pentagonal supra-radial plate : each of these sustain, on their upper oblique sides, two other plates ; the outer one (a brachial) sustains on its truncated upper side a second brachial plate, succeeded by a third, from which proceed the arm-plates. The inner one is bevelled above, and supports on its outer sloping side a brachial plate, and on its inner side a pentagonal third supraradial, which supports two brachial plates ; thus giving four arms from each supraradial, or eight from each ray : these all being equal, make forty arms altogether. The arms of each ray are separated at the base by a long narrow plate, and those of the division of the ray by a similar plate, or by the extended edges of the brachial plates, sometimes appearing as a double plate. First interradial plates much smaller than the first radial, supporting two smaller hexagonal or subhexagonal plates ; and above these a third range of two still smaller plates, which support the outer division of the adjacent rays. First anal plate hexagonal, and of the same size as the right postero-lateral first radial, supporting two second anals, one heptagonal and the other hexagonal : third range of two similar smaller plates, with a small quadrangular plate inserted centrally between the four. A similar central one in the fourth range supports the second supraradial plates of the outer divisions of two adjacent rays.

Surface of plates ornamented by rounded somewhat tuberculous ridges which radiate in one or two to each side of the plates, sometimes bifurcating, and frequently interrupted and becoming nodulose. Surfaces between the second radials and interradials, and between the supraradials at the base of the arms, deeply excavated.

Summit above the axil of each set of arms composed of numerous minute plates ; the space above with larger and smaller plates, which are raised in tubercles and sometimes short spires or angular ridges, and, near the margins of the plates, smaller pustules. Plates of proboscis proper, coarsely granuliferous.

In this species the character of the surface is very distinct from that of any of the preceding species; and though bearing a general resemblance to *A. proboscidialis*, f. 13, it is remarkably distinct not only in this, but in the number of arms. In the number and arrangement of plates of body and base of arms, this species corresponds with *A. multibrachiatus* ; but the form of body, the proboscis and surface markings, are very distinctive.

Fig. 14 *a*. Left postero-lateral side, partially showing the anal side (the specimen slightly distorted).

Fig. 14 *b*. Antero-lateral view of same specimen.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus turbinatus (n. s.).

PLATE XI. FIG. 1.

BODY symmetrically uniform : calyx with sides straight or very slightly concave, in a line from the basal to the brachial plates; the dome curving regularly upwards to the base of a strong proboscis : base abruptly concave, for the reception of the column. Basal plates thick, short, forming a distinct rim projecting over the column. First radial plates proportionally very large, about once and a half as wide as long. Second radials very small, quadrangular. Third radials small, pentagonal, supporting on each of the upper oblique faces a series of two supraradials, which again divide on the second plate above, giving origin to four brachial plates in the anterior and antero-lateral rays; while in the postero-lateral rays there is a third supraradial plate intervening on the anal side, giving origin to an additional arm from each of those rays. This gives five arms to each postero-lateral ray, and four arms to each

$$\text{of the other rays} = \frac{4}{5}\overset{4}{\overline{\quad}}\frac{4}{5} = 22 \text{ arms.}$$

First interradial plate ten-sided, resting on adjacent radials below, and flanked on either side by the second and third radials and first supraradials, and above by the second range of interradials, one or two in number, which support a small single hexagonal interradial in the third series. First anal plate larger than the first radials, as wide as long, supporting three anal plates in the second range, the central one of which is hexagonal and the two outer ones heptagonal : third anal series three, with two small irregular plates above, and beyond this sometimes a narrow elongate plate lying between the arm-bases.

ARMS composed of a double series of short slightly interlocking plates, which, when perfect, are marked by three or four distinct nodes with the intermediate spaces granuliferous, with tentacles from the centre of the inner edge.

SURFACE beautifully granuliferous.

This neat and pretty species has a symmetrical urnshaped calyx, with the arms all similar, equidistant from each other, and closely arranged. The only irregularity in the arms is the additional one from each postero-lateral ray.

Fig. 1. Posterior side of specimen, showing arrangement of radial and anal plates.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus turbinatus, var. elegans.

PLATE XI. FIG. 5.

This specimen has the same general form as the preceding, symmetrical calyx and hemispheric summit : the radial plates and arms are of the same form and number; the first interradial plate differs in being nine-sided, and supporting upon its upper edge a single small pentagonal plate, and above this another small hexagonal plate, instead of the two and one as in the other. The second series of anal plates are proportionally larger than in the preceding form; and the third series consists of three irregular plates, and two narrow ones above between the bases of the arms. The arms are arranged in a precisely similar manner, being a little stronger at their bases : the basal plates are squarely truncate below, and indented at the sutures; while those of the other are rounded, and not thus indented.

FIG. 87.

The accompanying diagram illustrates the number and arrangement of the plates of the body and bases of the arms.

These differences, though affecting the structure of the body in a degree. do not appear to me of specific importance, unless other specimens should show a constancy in these characters.

Fig. 5. View of the anterior side.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus longirostris (n. s.).

Plate XI. Fig. 2, 2 *a*, *b* = (4 *c*, 4 *d*).

Body symmetrically urnform, with convex sides : summit regularly convex to the base of a strong elongated proboscis. Basal plates turgid, moderately concave at the base for the reception of the column, and marked by broad shallow grooves along the suture lines. First radial plates tumid, large, wider than long; two very distinctly heptagonal, and three hexagonal. Second radials small, quadrangular (one sometimes irregularly pentagonal). Third radials hexagonal, with the lateral margins short, the upper oblique edges supporting each two supraradial plates, the highest of which is pentagonal, and upon the upper oblique faces supports the brachial or subbrachial plates from which proceed the arm-plates of two arms, making four arms from each ray except the anterior ray. The last radial plate supports on each side two brachial plates in succession, giving one pair of arms to this ray; making two from the anterior, and four from each of the other rays;

$$\text{making the number} = \begin{matrix} & 2 & \\ & \overline{} & \\ 4 & & 4 \\ \overline{4} & & \overline{4} \end{matrix} = 18 \text{ arms.}$$

First interradial plate large, hexagonal, supporting on its upper sides two second interradials, and sustained laterally by the second and third radials. Third interradials supporting an elongate plate which lies between the bases of the arms. First anal plate a little larger than the first radials, supporting three in the second range; the central one hexagonal, and the other two heptagonal. Third range consisting of four small plates; above which are two or three small irregular plates lying between the bases of the arms.

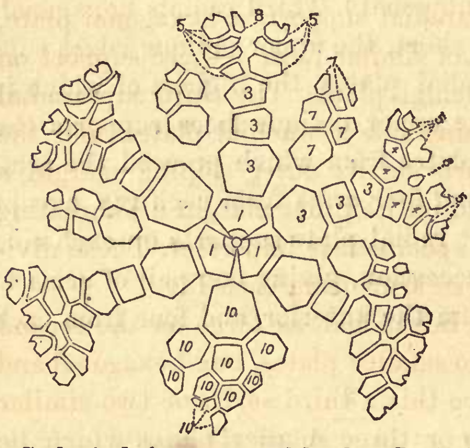
Arms consisting of a double series of short plates, slightly interlocking by their obtusely wedgeform faces, and furnished with long jointed tentacula. Proboscis extremely elongated [that of the specimen figured measuring more than three inches, and still imperfect at the extremity]. Column round, consisting of thick joints with rounded margins and intermediate thinner joints.

This species, though bearing some resemblance to *A. turbinatus*, var. *elegans*, is nevertheless distinctly marked by the convexity of its sides, stronger calyx, larger and differently arranged plates, less number of arms, and longer proboscis.

Fig. 2. A specimen somewhat crushed, but preserving the arms, a large part of the proboscis, and a portion of the column.

Fig. 2 *a*, *b* (4 *c*, 4 *d*, by error on some plates). Posterior and postero-lateral views of another specimen without arms, column or proboscis.

Fig. 88.



The accompanying diagram illustrates the structure of this species, which is one of the most simple and uniform of those possessing the supraradial plates; the anterior ray being like the more simple forms of the genus, with no supraradial plates, and only two or three brachials intervening between the third radial and the arm-plates.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus umbrosus (n. s.).

Plate XI. Fig. 3 *a*, *b*.

Body urnshaped, with the summit depressed-convex, the margins spreading from below towards the base of the arms nearly rectangularly to the direction of the axis; base distinctly hexagonal : plates of the body turgid, and obtusely subangular in the middle. Basal plates thick, strong, truncate below and projecting in a thickened rim over the column, broadly and deeply notched at the suture lines, the groove reaching to the summit of the plates : suture lines marked in the base of the plates by a narrow elevation on each side, giving a slight prominence in the bottom of the notch. First radials as long as wide ; joining to the base and among themselves, as well as with those above, by very short angular processes from the margins. Second radials hexagonal, as wide as long. Third radials heptagonal (those of the postero-lateral rays hexagonal), and supporting on each of the superior oblique sides a series of four or five supraradials in direct line, diverging from each other so as to leave room for a series of superinterradials, as one, two, and two ; the third series supporting brachial plates. The outer oblique margin of each first supraradial supports a hexagonal plate, and this in turn a second of similar form : these support on their upper edges the brachial plates. The third supraradial supports on its outer sloping side a brachial plate ; and the fourth supraradial supports on its outer sloping margin a simple brachial plate, and on its inner margin a bifurcating plate, beyond which the specimen is imperfect. These divisions give eleven or twelve arms from each ray.

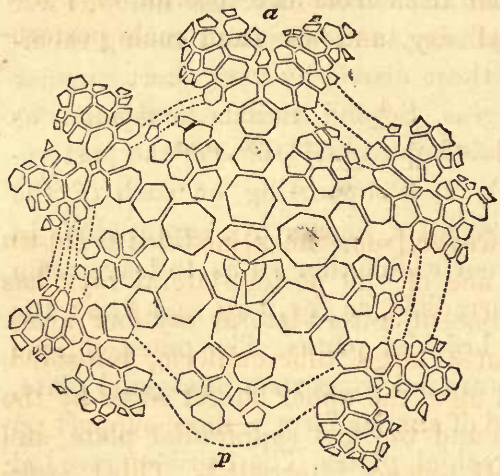
First interradial plate hexagonal, as large as the second radial, and supporting two smaller plates, one hexagonal and one pentagonal; and above this a third series of two similar plates, succeeded by two or three smaller plates which lie in a plane with the first supraradials : above these are two ranges of two each, nearly as large as the second and third interradials, which sustain the brachial plates of the intermediate arms as already described. Anal plates in series of one, two, four, and two, the latter in a plane with the first supraradials; to which succeed two series of two each, as between the other rays, to the brachial plates.

Summit composed of numerous small plates and a sub-central proboscis. Surface granulose.

This species is remarkably distinct from any described, in the character of base and walls of calyx, and still more in the spreading crown and laterally projecting supraradial plates.

Fig. 3 *a*. Anterior side of specimen. Fig. 3 *b*. Anal side.

Fig. 89.



The accompanying diagram illustrates the form and arrangement of the plates of the body and rays to the fourth subdivision. This may be regarded as a type of those species with broad spreading summits and numerous arms. The number of secondary plates in the rays and the number of arms are fully equal to those of the large species of the *Megistocrinus* of Owen, and the arrangement is the same as in that fossil.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus æqualis (n. s.).

Plate XI. Fig. 4 *a*, *b*.

Calyx somewhat urnshaped, abruptly spreading from the summit of the radials : dome depressed conical, terminating in a strong central proboscis : arms situated about midway between the base of calyx and the base of proboscis : base symmetrically hexagonal, the centre abruptly concave for the reception of the column ; the lower margins truncate, with a broad groove at the suture lines. First radial plates wider than long, subangularly tuberculiform. Second radial plates quadrangular, very small. Third radials pentagonal, the upper sloping sides supporting each a series of two or three supraradial plates; the upper ones pentagonal, and supporting on each side two or three brachial plates. This structure is modified on the two divisions of the supraradial plates of each antero-lateral ray, and more extremely modified in the postero-lateral rays, where there is an additional plate introduced on each side above the divisions of the supraradial plates, giving the requisite number of arms to that ray. This gives four arms from the anterior ray, five from each antero-lateral ray, and six from each postero-lateral ray;

$$\text{giving} = \begin{array}{ccc} & \overline{4} & \\ 5 & & 5 \\ \overline{6} & & \overline{6} \end{array} = 26 \text{ arms.}$$

This arrangement is, however, [sometimes] modified as shown in the diagram, where one of the postero-lateral rays has seven arms, and the adjacent antero-lateral ray four arms.

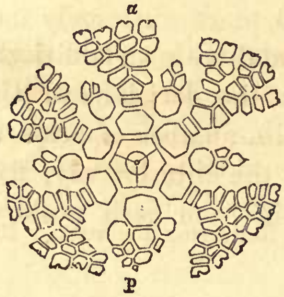
First interradial plates large, tuberculiform, ten-sided, supported laterally and upon the upper lateral edges by the first and second radials and the first supraradial plate, and succeeded by two small second interradials. Third range consisting of a single interradial, supporting subdivisions of the supraradial plates of two adjacent rays. First anal plate larger than the first radials. Second anal plates three, tuberculiform, the central one largest: above these is a small intercalated plate, and an arch of three which support the supraradial plates of the postero-lateral rays. Arms and proboscis unknown beyond their base. Dome composed of numerous small tuberculiform plates. Surface beautifully granulose striate.

The basal and first interradial plates, and the first and second anal plates, are conspicuously tuberculiform; the plates of the other ranges being much smaller: the three radial plates occupy scarcely more than one-third the length from the base to the arms.

This species differs in the number of arms, as well as in form, from any other species described in this place.

Fig. 4 *a*. Anal side of specimen. Fig. 4 *b*. Anterior side of same.

FIG. 90.



The accompanying diagram is a strict illustration of the plates composing the body of the specimen figured, showing the form and proportions of the plates as far as the brachial plates upon which the arm-plates commence.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus discoideus (n. s.).

BODY extremely short, spreading, discoid : base distinctly hexagonal : dome depressed-convex, with a subcentral proboscis. Basal plates short, projecting in a somewhat rounded rim. First radial plates prominent, much wider than long, transversely tubercular. Second radial plates very short, quadrangular, and sometimes nearly obsolete. Third radials small, pentagonal, supporting on each oblique upper side a range of two or three diverging supraradials which are succeeded by brachial plates in first and second series, from each of which arise a series of arm-plates; giving four arms from the anterior and each antero-lateral ray, while each postero-lateral ray is modified so as to support five arms,

$$\text{making altogether } \begin{array}{ccc} & 4 & \\ 4 & & 4 \\ 5 & & 5 \end{array} = 22 \text{ arms.}$$

Interradial plates large, ten- or twelve-sided; sides below flanked by the second and third radials, and above by the first and second supraradials : no second interradials. First anal plate and second range of three plates large, prominent; third range of three plates holding the position of subbrachial plates, and supporting the arm-joints. Dome composed of numerous subangularly tuberculous plates, and the proboscis of similar plates.

SURFACE granulose or granulose-striate, with a plain slightly elevated band along the margins of the larger plates.

This species resembles in some degree the *A. æqualis;* but it is more depressed, with a smaller number of arms and a single series of interradial plates. The discoid form is characteristic.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Actinocrinus ventricosus (n. s.).

PLATE XI. FIG. 6 *a, b.*

CALYX subturbinate, ventricose above, the anal side much shorter : dome very convex, with a depression in the centre for the aperture, the sides deeply channelled for the divisions of the arm-plates ; base concave for the attachment of the column. Basal plates short ; lower margins angular. Anterior and antero-lateral first radial plates much wider than long; postero-lateral radials as wide as long. Second radial plates hexagonal (the right postero-lateral one heptagonal). Third radials heptagonal, and supporting on each of their upper oblique sides a heptagonal supraradial, which in turn supports two others, the outer of which are brachial plates ; and the adjacent inner ones each support two plates, the inner of which are brachial plates, and the outer ones of the two being pentagonal and supporting brachial plates; making eight arms from each ray, all the rays being apparently alike (with one exception where one ray has seven and another nine arms).

First interradial plate hexagonal, the size of the second radial ; to this succeed two series of two each, nearly equal in size, and a fourth series of two much smaller plates which support the outer second supraradial plates of two adjacent rays. The supraradial plates likewise enclose an area of two small plates in succession, or sometimes one succeeded by two much smaller, which support the inner divisions of the supraradial series.

First anal plate smaller than the first radials : second range consisting of two hexagonal plates ; third series, three smaller hexagonal plates, succeeded by two plates, and again by a range of two which support the first and second supra-radial plates adjoining the anal area.

DOME more convex on the anterior side, composed of minute plates having broad grooves running to the interradial spaces. Plates of the calyx joining at their edges by rounded processes, of which there are one, two, or three from each side, leaving oval poriform spaces between, which penetrate to the inner face of the plate, if not quite to the cavity of the body.

Fig. 6 *a*. View of anal side of specimen. Fig. 6 *b*. Anterior side of same.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

BRACHIOPODA OF THE BURLINGTON LIMESTONE.

Orthis michelina, var. **burlingtonensis.**

PLATE XII. FIG. 4 *a*, *b*.

SHELL circular or subcircular : valves nearly equally convex; hinge-line short. Ventral valve depressed-convex in the middle, flattened below and often gibbous on the umbo, having the beak a little extended beyond the opposite valve; area high. Dorsal valve regularly convex, sometimes scarcely flattened through the centre : beak a little elevated above the area-margin.

SURFACE marked by fine bifurcating striæ, which have numerous tubular openings : a few strong imbricating lines of growth near the margins. Entire surface punctate or papillose.

This is one of the species usually referred to *O. michelina;* but it differs in many respects from others which are so included. Compared with a European specimen of that name in my collection, it has a more extended beak and higher area in the ventral valve, while it corresponds in surface markings.

Fig. 4 *a*. Ventral valve of a specimen of medium size.

Fig. 4 *b*. Enlargement of striæ, showing the tubular openings upon the surface.

Geological formation and localities. In the Burlington limestone : Burlington, Iowa ; Quincy, Illinois ; Hannibal, Missouri.

Orthis swallovi (n. s.).

PLATE XII. FIG. 5 *a*, *b*.

SHELL somewhat semiglobose : hinge-line less than the greatest width of the shell; cardinal extremities rounded. Ventral valve depressed-convex near the beak, flattened at the sides, with a broad depression beginning in the middle and becoming more strongly marked towards the base : area large, extending to the extremities of the hinge-line; foramen broad. Dorsal valve very convex, gibbous or somewhat ventricose in the middle and on the umbo, broadly curving in front and sloping more abruptly at the sides.

SURFACE marked by fine closely arranged striæ, some of which become enlarged and present numerous tubular openings upon the surface; concentrically marked by numerous unequally distant, sharp, imbricating lines of growth. Entire substance of the shell punctate.

This is one of the largest and finest species of ORTHIS in the Carboniferous limestones, which I dedicate with pleasure to Prof. SWALLOW, in whose collections from the Missouri Survey I have seen much finer specimens than any yet furnished from Iowa localities.

This species resembles the *Orthis resupinata* of Europe; but on comparison with several specimens of that name in my collection, it shows a more extended hinge-line and larger area : the ventral valve is less convex than in a specimen of *O. resupinata* from Yorkshire, England, which has the dorsal valve equally ventricose with ours; while an Irish specimen of the same name shows no depression in the middle of the ventral valve. A third specimen under the same name differs from either of these.

Fig. 5 *a*. Ventral valve of a mature individual of this species.

Fig. 5 *b*. Dorsal valve of another specimen.

Geological formation and localities. In the Burlington limestone : Burlington, Iowa ; Quincy, Illinois, and numerous localities in Missouri in the same formation.

Chonetes logani.

PLATE XII. FIG. 1 *a* – *e*, and 2.

Chonetes logani : NORWOOD & PRATTEN, Journal of the Academy of Natural Sciences of Philadelphia, 1854, Vol. iii, p. 30.

SHELL small, semielliptical : hinge-line scarcely equalling the width of the shell below. Ventral valve convex, gibbous in the middle and on the umbo; the cardinal margin furnished with five or six oblique spines on each side of the beak. Dorsal valve slightly concave, the concavity much less than the convexity of the opposite valve.

SURFACE marked by fine rounded dichotomizing striæ, of which from one hundred to one hundred and twenty or more may be counted on each valve, dependent upon the size of the shell. Vascular impressions in the dorsal valve large, doubly ovate, and separated by a longitudinal ridge which reaches from the beak half way to the base.

This species bears some resemblance to *C. variolata;* but it is proportionally longer, while the hinge-line is less extended, and there is no appearance of a sinus in the middle of the ventral valve. It approaches in form very nearly to *C. shumardiana;* but is more coarsely striated, and does not possess the fine granulations so characterestic of that species.

Fig. 1 *a*. Ventral valve of a small specimen.
Fig. 1 *b*. Profile of the same.
Fig. 1 *c*. Dorsal valve of another individual.
Fig. 1 *d*. Enlargement of a ventral valve, showing the character and number of the striæ.
Fig. 1 *e*. A farther enlargement of the surface, showing the radiating and fine concentric striæ.
Fig. 2. Interior of a small dorsal valve, showing the vascular impressions.

Geological formation and localities. In the Burlington limestone : Burlington, Iowa; Quincy, Illinois.

Productus flemingi, var. burlingtonensis.

PLATE XII. FIG. 3 *a* – *g*.

Productus flemingi : SOWERBY, Min. Conchology, 1812, Vol. i, pa. 155, pl. 68, f. 2.
P. flemingi : DE KONINCK, Monograph of the Genus Productus, etc. pa. 95, pl. x, f. 2.
For synonymy and references, see DE KONINCK as above.

SHELL of medium size or larger, longer than wide, sometimes length and breadth equal : hinge-line less than the width of the shell below; cardinal extremities auriculate. Ventral valve extremely ventricose, recurved, bringing the beak opposite or below the centre of the valve, and nearer the base than the width of the hinge-line; marked by a central longitudinal sinus, which is more or less strongly defined, and reaches from near the beak to the base. Dorsal valve moderately concave, and sometimes nearly flat in the upper part and abruptly curved or geniculate in the middle, the lower portion being rectangular to the upper; sometimes a slight elevation along the centre of the lower part.

Surface of the ventral valve marked by regular rounded radiating ribs, which bifurcate a few times, the bifurcations occurring almost wholly above the centre of the shell; transversely marked by fine concentric striæ, and some strong wrinkles upon the upper part of the valve, and a few inconspicuous undulations upon the middle of the shell. Scattered, round, tubular spines occur on the middle and lower part of the shell at the coalescing of the ribs, and rarely a row near the base, with smaller ones sometimes at the base of the ears and towards the hinge-line.

Interior of the dorsal valve showing a bifurcate cardinal process, each branch of which appears to be slightly bilobed at the extremity, proceeding from a thickened interior cardinal margin, and connected with a short median ridge; the reniform vascular areas widely separated.

In deference to numerous authorities, I refer this species to *P. flemingi*, indicating at the same time its character as a distinct variety at least; and I have little doubt that it will prove, when fully known, a distinct species. On the middle of the ventral valve there are from 13 to 17 ribs in the space of ten millimetres, or 17 – 21 in the space of half an inch, while there are respectively 10 – 15 and 14 –18 in the same space on the margins. The vascular areas are proportionally much more widely separated than represented in De Koninck's figure of *P. flemingi*.

Fig. 3 *a*. Cast of a dorsal valve where the shell is almost entirely exfoliated, leaving a mould of the exterior.

Fig. 3 *b*. Profile of the same, which shows only a part of the anterior extension of the shell.

Fig. 3 *c*. Ventral valve of the same species.

Fig. 3 *d*. Profile of the same.

Fig. 3 *e*. Cardinal view of the same.

Fig. 3 *f*. Interior of the dorsal valve, showing the cardinal process and hinge-line, the shell below being exfoliated.

Fig. 3 *g*. Enlargement of the fine concentric striæ.

Geological formation and localities. In the Burlington limestone, occurring in great numbers at Burlington (Iowa), Quincy (Illinois), and other places.

Athyris incrassatus (n. s.).

Plate XII. Fig. 6.

Shell thick, suborbicular, a little wider than long. Ventral valve with a prominent extended beak, gibbous on the umbo and upper part of the shell, curving regularly towards the lateral margins, with a broad sinus in front, which is only conspicuous below the middle of the shell, and becomes elevated into a sublinguiform process in front.

Surface marked by concentric striæ, and on the lower part of the shell by imbricating lines of growth, which become closely crowded and the shell much thickened at the margin of the valves.

Fig. 6. The ventral valve of this species.

Geological formation and localities. In the Burlington limestone: Burlington, Iowa; Quincy, Illinois; Hannibal, Missouri, etc.

Spirifer forbesi.

Plate XIII. Fig. 1.

Spirifer forbesi: Norwood & Pratten, Journal Academy Nat. Sciences, Philadelphia, 1854, N. S. Vol. iii, p. 73.

Shell of medium size, extremely transverse: hinge-line extended into acute submucronate points. Ventral valve moderately gibbous in the middle: sinus very shallow, occupied by from three to five plications and defined on each side by a stronger plication, which is often more or less distinctly dichotomised towards the base; plications simple, rounded, about twenty-two on each side of the mesial fold and sinus: cardinal area narrow.

I have identified this species from several specimens of the ventral valve, which, from having been worn before imbedding in the rock, have the finer surface markings removed. The description given by Messrs. Norwood and Pratten of the dorsal [ventral] valve corresponds so precisely with the ventral valve of *S. biplicatus*, that a doubt may be suggested as to the specific difference of that species. All the specimens of *S. biplicatus* which I have seen are much smaller than *S. forbesi;* the specimen of which, figured on Plate xiii, is about two and a quarter inches in width and an inch in length.

The *S. biplicatus* occurs in the yellow sandstone and in the oolitic limestone of the age of the Chemung group, while the *S. forbesi* occurs in the Burlington limestone. It is perhaps possible that the small dorsal valve figured by Messrs. Pratten and Norwood may have been derived from a lower horizon than the larger ventral valve.

Fig. 1. A ventral valve from which the surface markings have been worn.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Spirifer imbrex (n. s.).

Plate XIII. Fig. 2.

Compare *Spirifer forbesi* ubi supra.

Shell semielliptical, width about twice as great as the length ; cardinal extremities somewhat rounded, or, in the young state, abruptly pointed : hinge-line equalling the greatest width of the shell. Dorsal valve moderately convex, flattened at the margins and having the mesial elevation not distinctly defined, spreading at the base, covered by plications similar to those on other parts of the valve, of which there are eight or nine proceeding from the dichotomizing of two at the apex : plications on the sides of the valve abruptly rounded or subangular, dichotomizing near the beak and sometimes midway on the valve, becoming about twenty-four on each side at the margin of the shell.

Surface concentrically marked by strong lamellose striæ, which are abruptly arched upon the plications ; and towards the margin of the shell, by a few strong imbricating lines of growth.

This species resembles the *S. forbesii ;* but there are a greater number of plications on the mesial fold, and those of the lateral portion of the shell are dichotomized, while the outline is more rounded below and wider towards the extremities, which are not so much produced as in that species.

Fig. 2. Dorsal valve of a specimen of this species.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Spirifer incertus (n. s.).

Plate XIII. Fig. 3.

Shell semielliptical, more than twice as wide as long : cardinal extremities salient; valves nearly equally convex. Ventral valve gibbous in the middle and compressed at the extremities. Dorsal valve somewhat less convex than the opposite : area moderately wide, linear and extending to the cardinal extremities, common to the two valves, the dorsal being about half as wide as the ventral area ; foramen large.

Surface marked by fine, abruptly elevated, round or subangular plications, which cover equally the mesial sinus and elevation; those of the latter originating at the apex in a single one, which frequently dichotomizes before reaching the base. Plications all dichotomizing once or twice below the beak, and reaching the number of thirty or more at the margin of the shell; concentrically marked by fine sharp elevated imbricating lamellæ.

Both this species and the preceding (Plate xiii, fig. 2) bear considerable resemblance to *Spirifer attenuatus* of Sowerby; but the proportionate length and breadth differ in some degree, while there are other differences in the striæ, the area, etc. In the absence of authentic specimens for comparison, I must presume them to be distinct.

Fig. 3. Cardinal view of the specimen, showing the linear area.

Geological formation and locality. In the Burlington limestone : Burlington, Iowa.

Spirifer plenus (n. s.).

PLATE XIII. FIG. 4 *a – d*.

SHELL large, subglobose, transversely suboval, ventricose: valves nearly equal; hinge-line scarcely equal to the greatest width of the shell, obtusely angular or a little rounded at the extremities. Dorsal valve very prominent in the middle; mesial fold obtusely elevated and smoothly rounded. Ventral valve most convex on each side of the sinus below the beak, sloping somewhat abruptly towards the lateral margins: sinus broad, rounded and deep, extending from the beak to the front, where it is prolonged as a broad linguiform extension. On each side of this projection, the margin of the valve is broadly sinuate: beak arched, and projecting beyond the opposite; area high and distinctly arcuate; foramen large, triangular, width and height equal, often partially or entirely enclosed by a pseudo-deltidium.

SURFACE marked by about twenty simple rounded depressed plications on each side of the mesial fold and sinus, crossed by concentric lines of growth. Under a lens, the whole surface is seen to be beautifully marked with an extremely fine textile ornament, produced by minute irregularly disposed rounded depressed points and lamellose striæ.

Interior of the ventral valve marked by strong projecting dental lamellæ, extending in parallel direction from the base of the foramen nearly to the front of the valve.

This species may be readily distinguished by its high arcuate area, simple flattened plications, and deep broadly rounded sinus. The interior of the ventral valve also differs from any of the associated species, resembling in this respect *S. sowerbyi*.

Fig. 4 *a*. Ventral view of a specimen of this species.
Fig. 4 *b*. Dorsal view and area of same.
Fig. 4 *c*. Front view of same.
Fig. 4 *d*. Profile view (the beak of the ventral valve is represented too little arcuate).

Geological formation and localities. In the Burlington limestone: Burlington, and nine miles below Iowa city, Iowa; Quincy, Illinois, etc.

Spirifer grimesi (n. s.).

PLATE XIV. FIG. 1 – 5.

SHELL very large, gibbous, varying from longitudinally to transversely subelliptical : hinge-line usually less than the greatest breadth of the shell, obtusely angular or a little rounded at the extremities. Dorsal valve very convex, gibbous, rising in the middle into a broad subangular undefined mesial fold, which becomes much expanded towards the base. Ventral valve convex : mesial sinus rather broad, subangular below, not distinctly defined at the margins ; area of moderate height, short ; foramen broad triangular ; beak strongly incurved.

SURFACE ornamented by numerous depressed rounded irregularly bifurcating plications, about twenty to twenty-five of which occupy the mesial fold and sinus : plications marked by closely arranged extremely fine longitudinal striæ, and equally fine concentric striæ, with some stronger imbricating lines of growth.

Interior of ventral valve showing a broad suboval muscular area, limited by the dental lamellæ which diverge from the base of the foramen, and again converge in a low ridge, approaching each other in the middle or towards the front of the valve.

Nearly all the specimens which I have seen of this fine spirifer are more or less distorted, and give for the most part an imperfect idea of its form. It occurs generally in the condition of separated valves, which have apparently a longer cardinal line than is shown in the only entire individuals seen. It is, however, clearly distinct from *S. striatus* and *S. sowerbyi*, to which it has been referred. From the former it may be distinguished by its less transverse form, short hinge, broader and more shallow and subangular mesial sinus, as well as by the peculiar mode of bifurcation of the plications, by which they are separated into pairs, and never increase by implantation.

In its general external features it resembles *S. sowerbyi*; but it has not the strong parallel dental laminæ, which, in that species, extend from the base of the foramen nearly the entire length of the shell, while the form of the area and other characters are equally distinctive. It is not improbable that the imperfect ventral valves of *S.*

plenus, like that figured on Plate xiii, fig. 4 *e*, which occur in the same association, may have been regarded as the ventral valves of this species, and thus induced the reference to *S. sowerbyi*.

Fig. 1 *a*. Dorsal view and area of an entire specimen.

Fig. 1 *b*. Profile view of the same.

Fig. 2. View of ventral valve of a specimen as it ordinarily appears in the limestone.

Fig. 3. Interior of a fragment of the ventral valve, showing the muscular and vascular impressions, with the low curving dental lamellæ.

Fig. 4. Cast of the ventral valve, showing the form of the muscular impression and direction of the dental lamellæ.

Fig. 5. Another similar specimen, showing a smaller muscular impression.

The hinge-line in both these casts is proportionally more extended than in the specimen fig. 1 *a*, *b* ; but the external features are similar.

In two other specimens, where the remaining shell is similar to these, the hinge-line has a straight extension of more than four inches, with muscular impressions similar to those figured, except that they are proportionally shorter and smaller in all respects.

Geological formation and localities. In the Burlington limestone : Burlington and other places in Iowa ; Quincy, Jersey landing, and elsewhere in Illinois.

Euomphalus latus (n. s.).

PLATE XII. FIG. 7 *a*, *b*.

SHELL discoid : volutions about four or five, very gradually enlarging from the apex ; spire very little elevated ; upper surface of the volutions obliquely flattened ; outer margin distinctly angulate and subcarinate ; inner margin abruptly elevated, and somewhat carinate at the suture line : base broadly umbilicate.

All the specimens examined are so much worn or distorted, that I have not been able to determine the true form of the aperture.

This species is distinguished from others in the same association, by the strongly angular form of the upper side of the volutions, and the subcarinate suture margin.

Fig. 7 *a*. Upper side of a worn specimen, showing the angular outer margin (the inner volutions imperfect).

Fig. 7 *b*. Lower side of another specimen, showing the broad shallow umbilicus.

Geological formation and localities. In the Burlington limestone : Burlington, Iowa ; Quincy, Illinois.

CRINOIDEÆ OF THE KEOKUK LIMESTONE.

The fossils of this family in the Keokuk limestone, although of the same genera as those of the Burlington limestone, nevertheless present in general aspect a striking contrast with those of that formation. The species of Platycrinus are far less abundant in proportion to the other forms; while Actinocrinus is presented in numerous strong, rude and extravagant forms, attaining apparently its maximum of development as far as regards size, strength, and excess of ornament and appendage : at the same time, while the number of species is less than in the Burlington limestone, certain forms of the Actinocrinus of that formation are fully represented in the Keokuk by analogous forms. The genera Cyathocrinus and Poteriocrinus are more fully developed than in the Burlington limestone. The other genera already noticed are, with few exceptions, represented in the Keokuk limestone by distinct and characteristic species.

Pentremites wortheni (n. s.).

Plate XV. Fig. 1.

Body elongate subfusiform; length of base and distance from base of radials to base of pseudo-ambulacral area, and length of the latter, about equal to each other : base triangular. Basal plates very gradually spreading; upper margins concave for the reception of the radials. Radial plates long, narrow, almost linear; branches lanceolate. Interradial plates very small, acutely lanceolate, reaching very nearly to the summit. Pseudo-ambulacral areas narrow, linear, extending downwards about half the length of the radial plate, and one-third the entire length of the body : each of these areas contains about thirty-five pore pieces on each side.

Surface finely striated longitudinally and transversely.

The specimen figured is crushed, so that the character of the summit cannot be be determined : the base also is apparently imperfect, and is a little shorter than the distance to base of pseudo-ambulacral areas.

Fig. 1. View of a specimen, showing on the left side parts of two pseudo-ambulacral areas. [The number of pieces in the pseudo-ambulacral areas is about half as great as represented in the figure.]

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; Nauvoo, Illinois.

Pentremites bipyramidalis (n. s.).

Plate XV. Fig. 2.

General form bipyramidal, the greatest diameter being a little below the middle at the base of the pseudo-ambulacral areas, distinctly pentagonal : base truncate, narrow, subangularly concave on each side. Basal plates short, little more than one-fifth the entire length of the body, slightly concave on their upper edges. Radial plates sublinear, gradually widening from the base to the base of the pseudo-ambulacral areas, and becoming very gradually narrower above, prominently angular along the middle of the lower part : branches slender ; the two adjacent ones, with the interradial plate, presenting an elongate lanceolate form. Interradial plates short-lanceolate, reaching to the summit, which is truncate. Pseudo-ambulacral areas narrow, almost linear, somewhat deeply seated particularly above the middle ; each marked by a double row of about forty-eight squamiferous pore-pieces. Summit narrow ; mouth central, somewhat semicircular ; ovarian aperture obscure ; anal aperture large, elongate. Surface doubly striated.

Fig. 2. View of the antero-lateral side. [The summit and base of the figure are too wide, and the number of pseudambulacral pieces represented is little more than one-half the true number.]

Geological formation and locality. The horizon of the Keokuk limestone, State of Missouri.

Actinocrinus pernodosus (n. s.).

PLATE XV. FIG. 3 *a, b;* and PLATE XVI. FIG. 7 ?

BODY urnshaped, regularly spreading to the base of the arms : dome strongly arched, with a subcentral proboscis; base deeply excavate for the reception of the column. Basal plates extended at the margins in a strong rim over the column, spreading a little from the inside, and curving inwards from the outside : a broad and deep indentation extends half the length of the plates, and marks the suture line. First radial plates very large and strong, joining the basal plates by prominent subangular processes. Second radials hexagonal, very strong. Third radials short, pentagonal, supporting on each upper oblique side a pentagonal supraradial plate, each of which supports a brachial plate on its outer upper side and a second and third supraradial on its inner upper side, the last of which is pentagonal, giving origin to two brachial plates and two arms ; giving six arms to one of the antero-lateral rays : the others unknown.

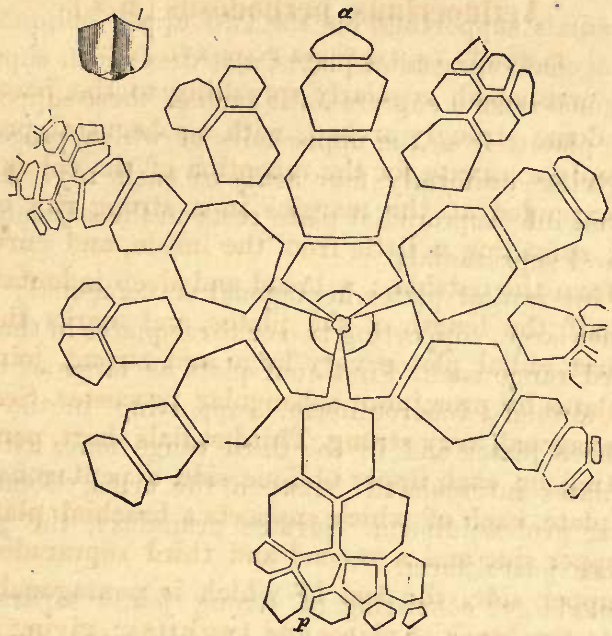
First interradial plate hexagonal. Second interradials two, smaller and of the same form, supporting three smaller plates. First anal plate smaller than the first radial : second anal plates hexagonal, supporting a range of four smaller plates; and these, a second range of four plates. The first and second ranges of each series of plates above the base are very strongly tuberculiform; the radial plates being somewhat transverse, with sometimes a depression upon the upper side, the other plates having the form of strong tubercles. Arm-bases prominent. Dome composed of numerous tuberculiform plates : plates at the base of the proboscis subangularly nodulose.

This species may be distinguished by its extremely nodose or tuberculiform character of plates of the body.

Fig. 3 *a*. Base of the specimen, the posterior side being uppermost. The right postero-lateral ray has the arm-bases broken off close to the body, which gives a somewhat unequal appearance to the two sides.

Fig. 3 *b*. Anterior view of same, showing the summit of the third radial plate.

Fig. 91.



The above diagram illustrates the structure, from the specimen figured on Plate xv, fig. 3. The left antero-lateral ray is the only one where the plates are preserved to the bases of the arms. Fig. 1 represents the upper articulating surfaces of the third radial plates, showing the broad area for the reception of the succeeding plates.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Actinocrinus nashvillæ.

Plate XV. Fig. 4; and Plate XVI. Fig. 4 *a*, *b*.

Actinocrinus nashvillæ : Troost, Monograph of Crinoideæ, MS.; Catalogue of Crinoideæ, Proceedings of Am. Association for the Advancement of Science, 1849, p. 60.

Body urnshaped, rounded at base and excavated for the reception of the column, contracted above, and somewhat rapidly expanding at the brachial margin : dome moderately elevated, with a strong central proboscis. Basal plates more than twice as wide as long, spreading in a broad thickened rim, indented at the line of suture. First radial plates large, wider than long, tuberculose transversely, and prominent above the other plates. Second radials wider than long. Third radials supporting, on the two upper oblique sides, two hexagonal supraradial plates, and these each supporting a pentagonal second supraradial : each of these supports two brachial plates, from the upper sides of which proceed the arms, giving uniformly four arms to each ray. A small heptagonal intersupraradial plate rests on the adjacent edges of the first supraradials.

First interradial plates heptagonal or octagonal; the anterior ones large, supporting two or three plates in the second and third range each. First anal plate as large as the first radials, strongly tuberculiform, supporting in the second range three plates and in the third range four, with some small plates intercalated between the arms. Dome large, becoming proboscidiform. Surface granulose, the granules sometimes pustuliform.

Column large, consisting of strong joints separated by thinner ones, and, farther from the body, by two, three, four, or more thinner ones.

This species is peculiar in character. The body, composed of large strong plates, is surmounted by the projecting bases of the arms, from which the latter rise vertically, being inserted upon the top and within the margin of the brachial plates. The proboscis is remarkably large and strong : it is somewhat crushed in the specimen fig. 4, pl. 15, the base only remaining; while in fig. 4, pl. 16, the lower part is well preserved to the height of six or seven plates above the axils.

Plate xv, fig. 4. View of the postero-lateral side of a large specimen.

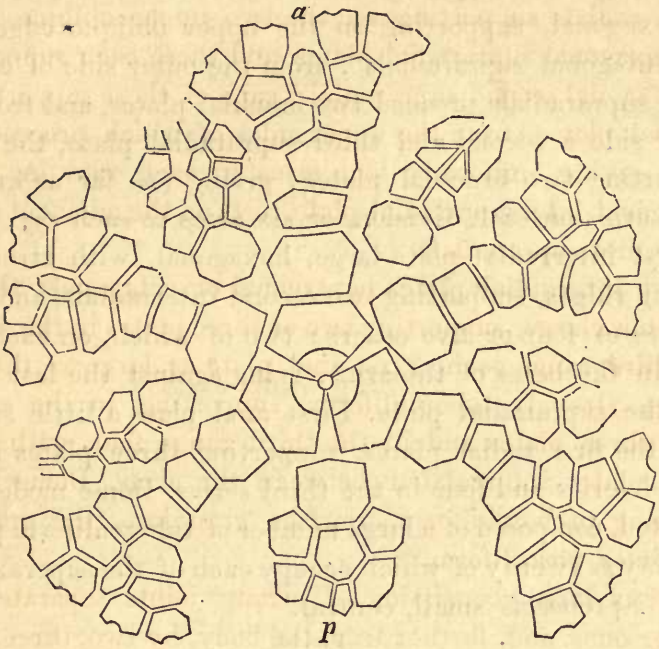
Plate xvi, fig. 4 *a*. Anterior side of a well-preserved specimen. [The figure is too broad below, and the brachial margin is not sufficiently prominent.]

" fig. 4 *b*. A similar view of another specimen, representing more perfectly the form of the base.

The following diagram (fig. 92) illustrates the form and proportions of the plates of this species, from the specimen fig. 4, pl. 15. There is some irregularity in one of the interradial series, as shown in the figure, which has produced a slight distortion in the anterior ray. There is a single intersupraradial plate which is truncated above, and upon which rests a small plate with its upper extremity thickened and elevated above the brachial plates. The articulating surface for the arm-plates scarcely occupies more than one-third the width of the brachial plates at their summits.

In the smaller specimen figured on Plate xvi, fig. 4 *a*, there is a second narrow plate between the brachial plates of each division of the ray, and the third series of

Fig. 92.



interradials sustains two narrow plates which lie between the brachial plates of the adjacent rays.

Geological formation and localities. In the Keokuk limestone : Warsaw, Illinois ; White's Creek springs, Tennessee.

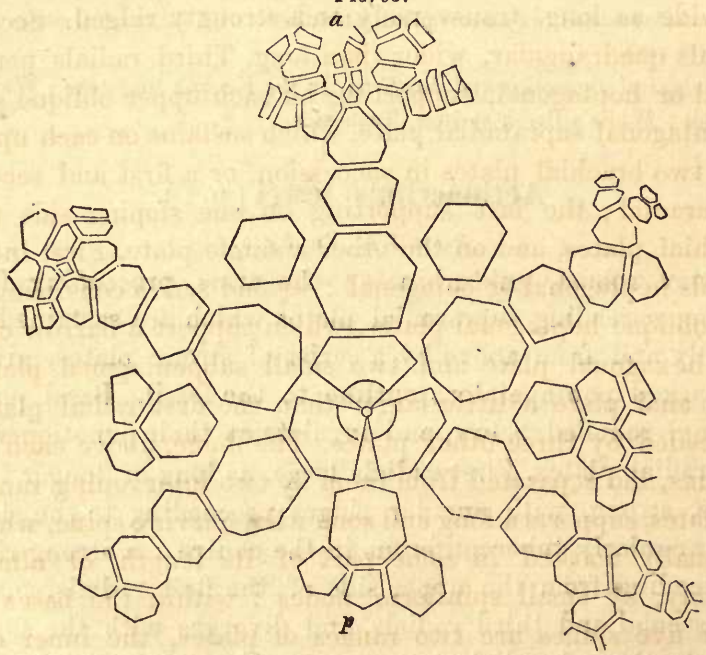
Actinocrinus lowei (n. s.).

Plate XV. Fig. 5 *a*, *b*.

Body robust, subturbinate; the arms proceeding from strong spreading supraradial plates which are sustained laterally and from above by a series of strong plates, giving a marked pentapetalous outline to the fossil. Basal plates strong, rounded below, and angulate at their junction with the radial plates. First radials large, as long or longer than wide, strong, with angular ridges proceeding to the sides, and angularly tuberculiferous in the centre : a strong ridge proceeding from the upper side of the first radials, marks the second and third radials, and diverges with the supraradials. Second radial plates hexagonal, except adjoining the anal side, wider than long. Third radials somewhat irregularly hexagonal, supporting on the upper oblique edges two subpentagonal supraradials : from the outer side of each of these supraradials proceed two brachial plates, and from the inner side a second and third supraradial plate, the latter supporting two brachial plates; giving (as far as known) three arms on each division, or six arms to each ray.

First interradial plate large, hexagonal, with strong radiating ridges, supporting two second interradials, and these a series of four or five others; two of which, on each side, sustain the bases of the arms, lying against the last radial and the supraradial plate. First anal plate a little smaller than the first radial plates, supporting three plates in the second series and four in the third series. Dome moderately elevated, composed of a large number of tuberculiform plates, as many as twenty of which occupy each of the superaxillary areas : proboscis small, central.

FIG. 93.



The above diagram shows the form and proportions of the plates of the body and the bases of the arms, as far as can be traced in the specimen Plate xv, fig. 5.

The peculiar form of this species, and its strongly ridged and spreading arm-bases, are distinguishing features. It has sometimes been referred to *A. humboldti* of TROOST, but a comparison with the original of that species shows the two to be quite distinct. *A. humboldti* is remarkable for its large basal plates and large first radials, the height of the body to the top of the second radial plate being greater than the entire height of the body of the present species.

Fig. 5 *a*. Anal side of specimen.

Fig. 5 *b*. View of right antero-lateral side, the arm-base of which is smaller than the others. The cavity near the summit is only from the breaking away of some of the plates, and is not an organic feature.

Geological formation and locality. In Keokuk limestone near Warsaw, Illinois.

Actinocrinus gouldi (n. s.).

PLATE XV. FIG. 6 *a*, *b*.

BODY urnshaped, convex above, and marked by a long central slightly curved spine and five superior lateral spines: base large, deeply excavated. Basal plates spreading and almost recurved at their lower margins, deeply and broadly grooved at the suture lines. First radial plates nearly twice as wide as long, transversely and strongly ridged. Second radials quadrangular, wider than long. Third radials pentagonal or heptagonal, supporting on each upper oblique side a pentagonal supraradial plate, which sustains on each upper side two brachial plates in succession, or a first and second supraradial; the last supporting on one sloping side two brachial plates, and on the other a single plate. First interradials heptagonal or octagonal : second series consisting of two oblique heptagonal plates, which support a narrow central hexagonal plate and two small subpentagonal plates. First anal plate a little larger than the first radial plates, succeeded by three other plates. The dome, above each set of arms, and separated from them by two intervening ranges of plates, supports a long and somewhat curving spine, which is usually marked in some part of its length, or almost entirely, by small spiniform nodes : within the bases of these five spines are two ranges of plates, the inner one surrounding and supporting a strong central spine, which is more or less strongly marked by spiniferous nodes, and slightly curved over the anal side. Surface beautifully striate, and sometimes granulose-striate.

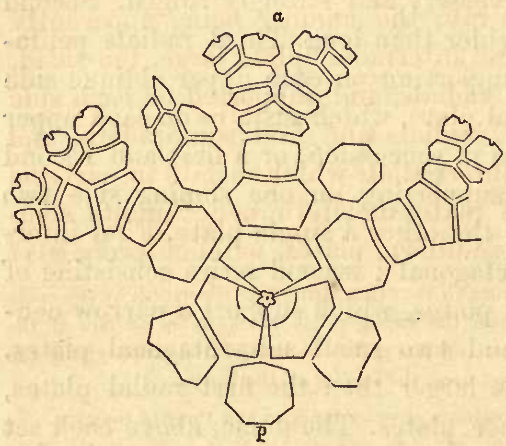
This species differs from the *Actinocrinus* (*Dorycrinus*) *mississippiensis* of Rœmer, both in the character of the base and the form of the plates and their surface markings, as well as in the spines, which in that one have a different form, and are represented as quite smooth; while such character rarely or never occurs, except from wearing, in the species before us.

I have before me two very distinct species, from the same rock, bearing spines. One of these, though much smaller, resembles, in the character of its base and general outline of form, the species of Dr. Rœmer, and is furnished with smooth tapering spines like that one. The other species has the spines running in a direction almost rectangular to the axis of the body, and much shorter and more abruptly tapering than either of those mentioned.

Fig. 6 *a*. The anterior side of specimen, showing the base of arms and anterior spine, with portions of two others on the left side. The left antero-lateral spine is essentially entire, the representation being to make room for the separate spine on that side. The postero-lateral spine is, by error, represented as smooth in some of the figures.

Fig. 6 *b*. The central spine of a larger individual, showing the slightly curved form and spiniferous character above, while it is nearly smooth towards the base : the latter feature is not always characteristic.

Fig. 94.



The accompanying diagram illustrates the structure of the anterior and antero-lateral rays, showing two supraradials in the former and one in the latter, with the brachial plates. The opposite side of the specimen is too much crushed to determine satisfactorily the structure.

Geological formation and locality. In the Keokuk limestone near Warsaw, Illinois.

Actinocrinus ramulosus (n. s.).

PLATE XV. FIG. 7.

BODY depressed-urnform : base moderately depressed in the centre for the attachment of the column. Basal plates short, expanded below and spreading in a broad rim beyond the column, slightly grooved at the sutures. First radial plates much wider than long, with a transverse angular ridge in the centre. Second radials short, quadrangular, nearly twice as wide as long, each with a central node or tubercle. Third radials pentangular, with a bifurcating ridge on each plate, which diverges to the upper sloping margins, from each of which proceed in succession a quadrangular and a pentagonal supraradial; from the latter of which proceed two series of three or four brachial plates each, to the base of the arms. The surface of all these plates, from the third radial, is marked by a strong longitudinal ridge, which bifurcates on the pentangular supraradial; thus giving origin to four arms from each ray, the number being apparently uniform throughout. First interradial plate large, ten-sided, resting on the two first radials, and supported on each side by the second and third radials and first supraradials, and supporting two second interradials which sustain in part the supraradial plates. Anal plates undetermined. Summit composed of numerous tuberculiform plates, without proboscis?

This species is distinguished from all the other forms here described, by the mode of bifurcation of the radial plates, the strong ridges marking the surface of the third radial, and the plates above continuing to the base of the arms; giving the appearance of bifurcating branches upon the surface of the body.

Fig 7. View of a distorted specimen, showing the base and three of the rays.

Geological formation and locality. In the Keokuk limestone : Nauvoo, Illinois.

Actinocrinus biturbinatus (n. s.).

PLATE XVI. FIG. 5 and 6 *a*, *b*, *c*.

BODY depressed turbinate below, conical above : base small, moderately concave. Basal plates short, rounded below. First radial plates short, twice as wide as long. Second radials small, quadrangular. Third radials pentagonal, supporting on their upper oblique sides two supraradials, with modifications corresponding to each ray. The anterior ray supports two arms, without supraradials proper : each anterolateral ray has four arms with two supraradials on each side, and each postero-lateral ray has three arms. First interradial plate large, eight-, nine- or ten-sided, supporting in the second range two smaller plates, and these sustaining the supraradials of the antero-lateral arms. First anal plate longer than the first radials : second series consisting of two plates ; third series of three plates, with a small central plate intercalated between the second and third series. A range of three single plates in succession succeeds the third anal plate, separating more widely the arms on that side. Dome composed of numerous subtuberculiferous plates, and terminating above in a subcentral oblique próboscis.

ARMS slender, composed of double rows of very short joints which are furnished with large jointed tentacula. Column round or obtusely pentangular, composed of alternating thicker or thinner joints. Surface finely granulose.

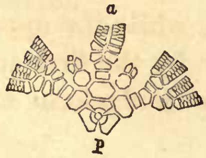
Fig. 5. Anterior side of an individual with base somewhat longer than usual, preserving the arms and a portion of the column.

Fig. 6 *a*. Anal side of a specimen without arms, with base of proboscis which is turned obliquely towards the anal side.

Fig. 6 *b*. Anterior side of same.

Fig. 6 *c*. Basal view of same.

FIG. 95.



[The error in representing the arms in the figure of the plate is corrected in the accompanying diagram, which illustrates the relations of the arms to the rays.]

Geological position and locality. In the Keokuk limestone : Nauvoo, Illinois.

Actinocrinus pernodosus, var.?

PLATE XVI. FIG. 7.

This fossil bears so close a resemblance to *A. pernodosus*, Plate xv, fig. 3, that I can find no means of specific distinction : the basal plates are thinner at their margins, and the nodose plates more angular in their prominences, while the third radial plates are not bent outward as in the larger individual. The details of the structure and arrangement of the plates of the body, and the bases of the arms, are essentially alike in the two specimens, and this one is probably only the young of that species.

Fig. 7. The anterior side of the specimen.

Geological position and locality. In the Keokuk limestone at Warsaw, Illinois.

Agaricocrinus tuberosus.

PLATE XVI. FIG. 2 *a*, *b*, *c*.

Agaricocrinus tuberosus : TROOST, in MS. and published Catalogue of Crinoideæ.
Amphoracrinus americanus? RŒMER, Bronn's Lethea Geognostica, Vol. ii, p. 250; Tab. iv, f. 15 *a*, *b*.

BODY robust, subconical or hemispheric, with strong arms: base more or less deeply concave, the concavity involving the entire radial series of plates. Basal plates very small, rarely projecting beyond the circumference of the column. First radial plates wider than long, the postero-lateral ones largest. Second radials quadrangular, wider than long. Third radials larger than either of the others, pentagonal, and supporting on each upper sloping side a wide brachial plate, which is succeeded by a second and sometimes a third similar plate, all projecting at nearly right angles to the axis of the fossil; the outer limit of the basal concavity being at the third radial plate, and usually near the summit of the same. Interradial plate single, twelve-sided, extremely elongate, resting on the first radials, and its lower lateral edges sustained by the second and third radials, while the upper lateral edges are bordered by the first or by the first and second brachial plates : its upper narrow wedgeform extremity sustains in part two plates, which rest mainly on the outer edges of the brachial plates, and, curving upwards, rise to the level of the top of the arm-bases.

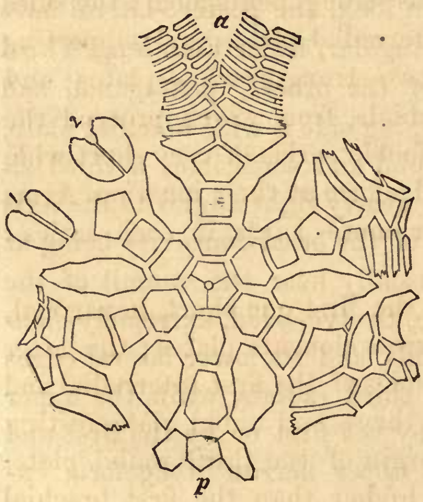
First anal plate much elongated, sustaining on its upper truncated edge a large plate, and on its lateral oblique sides partially supporting two large plates which rest mainly on the adjacent radial plates, and extend upwards adjoining the first and second brachial plates, and reach nearly to the top of the arm-bases. The anal plates above these are somewhat obscure, but apparently consist of about four series; the central portion protruding in a rounded ridge, with a broad depression on either side : aperture opening upwards.

On the third plate above the last radial, the arm-plates subdivide, giving origin to a pair of strong arms, each pair of which are separated at base by the thickness of two brachial plates, and sometimes an axillary plate.

The arms consist of a double series of short but very wide plates, which are abruptly wedgeform at their junction with each other.

DOME composed of numerous strong tuberculiform plates, a series of more prominent ones extending from the arms

FIG. 96.



The accompanying diagram illustrates the form and proportions of the plates of this species, as seen in the specimen figured on Plate xvi, fig. 2.

Figs. 1 and 2 (of diagram) are transverse sections of the arms ; fig. 1 representing a section near the base where the outer edge of the plate is compressed by the side of the adjacent arm of the same ray, while fig. 2 represents a section of the arm at a higher point.

towards the summit, the anterior range terminating as usual in the *Actinocrinus* in two such plates ; the summit crowned by a larger tuberculiform plate. Entire surface granulate or granulose striate towards the margins of the plates.

Fig. 2 *a*. The anal side of a specimen from which the arms have been separated.

Fig. 2 *b*. The base of the same specimen, the basal plates not being visible beyond the circumference of the column. All the other plates, to the base of the arms, are shown in this figure.

Fig. 2 *c*. The dome, showing the aperture which opens upwards, the central tuberculiform plate, and the ranges of larger plates from each arm; there being two in the range of the anterior arm, at the base of the central plate.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; Nauvoo and Warsaw, Illinois ; White's Creek springs, Tennessee. The latter locality is that cited by Dr. Troost, and the specimens from that place show no specific difference from those of the more northern localities.

Agaricocrinus wortheni (n. s.).

Plate XVI. Fig. 1.

Body robust, somewhat hemispheric : base concave, the concavity extending to the base or middle of the third radial plate. Basal plates nearly hidden by the column. First radial plates wider than long, hexagonal. Second radials hexagonal, the upper angles being truncated by the second interradial plates. Third radials strong, pentagonal; the sides resting against the second interradial plates, and supporting on their upper sloping faces two strong brachial plates; and these, two other shorter brachials, from which proceed the strong arms, consisting of a double series of very short wide plates which are abruptly wedgeform at their junction. Arms long, consisting of ninety or more joints in each series : tentacula unknown.

Interradial plates three : the first one short, hexagonal, supporting two extremely narrow elongate plates ; the latter resting on the sloping upper sides of the first interradial and the truncated upper angle of the second radial plate, resting against the lower lateral margin of the third radial plate, and reaching as high as or higher than the first brachial plates, which, in the curvature, bring the summits of these plates nearly as high as the upper side of the arm-bases. First anal plate as long as the first radial plates, succeeded by three longer plates. The area above broad and flattened, with the aperture opening laterally. Summit marked by two tuberculiform plates in the axils of the arms, and two others in a line between these and the summit, with smaller plates intervening.

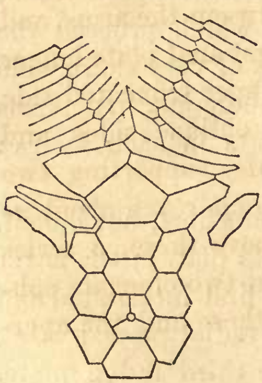
Column consisting of alternating thicker and thinner joints, which are striato-granulate on the exterior margin.

This species has a close resemblance in general form to the *A. tuberosus*, but differs essentially in the details of its structure, and somewhat in form of the body. The second radial plates are hexagonal, while in the other they are quadrangular : the third radial is proportionally a larger and stronger plate, while the first interradials are much shorter than in *A. tuberosus*, and support two narrow second interradials which reach to the second radial plate.

A comparison of the diagrams giving the forms and proportions of the plates of the two species will show these differences to be important. The anal side is not protuberant as in the other species, but presents a nearly flat area, with the aperture opening laterally and farther from the summit. The dome is composed of a greater number of plates, but with fewer large tuberculiform ones.

A comparison with specimens in the collection of the late Dr. Troost shows that the characters already illustrated are those of the genuine *A. tuberosus*. The original of f. 1, pl. xvi, was received as a specimen of *A. tuberosus ;* but some differences being observed, a comparison was instituted with other specimens from Keokuk, and these differences found to be constant in several, while there is no evidence of a gradation of the one form into the other. I must therefore regard them as distinct species.

Fig. 97.



The accompanying diagram represents the form and proportions of the basal and first radial plates, with the plates of one ray entire, including the brachial and arm-plates to about the tenth range. The adjacent interradial plates on the two sides show a marked difference when compared with those of *A. tuberosus*.

Fig. 1. View of a very fine specimen preserving a portion of the column, and the arms to the extent of three and a half inches, with about eighty and in one about ninety joints on each side. The entire number was probably more than one hundred joints.

This splendid specimen, from the Cabinet of Mr. H. A. Worthen, is the only one known, so far as I am aware, which preserves the arms.

Geological position and localities. In the Keokuk limestone : Keokuk, Iowa, and Warsaw, Illinois.

Agaricocrinus whitfieldi (n. s.).

Body depressed-hemispheric above ; the base deeply concave for the reception of the column, the concavity reaching to the brachial plates. Basal plates not extending beyond the circumference of the column. First radials short, much wider than long. Second radials of the anterior and antero-lateral rays regularly quadrangular ; of those of the postero-lateral rays, one is oblique and unequally quadrangular, and the other has its upper acute angle truncated by one of the interradial plates. Of the five third radial plates, two are hexagonal and three pentagonal. First brachial plates very large, and succeeded by two central somewhat wedgeform subaxillary plates, and a broad lateral one on each side ; and upon these plates the arms originate in two double series of plates. First interradial plate elongate, somewhat irregularly octagonal, reaching as high as the third radial or to the brachial plates, and supporting on its upper sides one or two narrow elongate plates which extend between the arms, and reach to the summit of the arm-bases. First anal plate longer than the first radials, supporting on its upper truncated side an elongate hexagonal plate ; its upper oblique sides, and the oblique sides of the adjacent radials, supporting two elongate irregularly octagonal plates, which reach about as high as the centre of the arm-bases : above these, a series of five plates, one central hexagonal, and two elongate subhexagonal on each side, while between these and the aperture are three series of smaller plates.

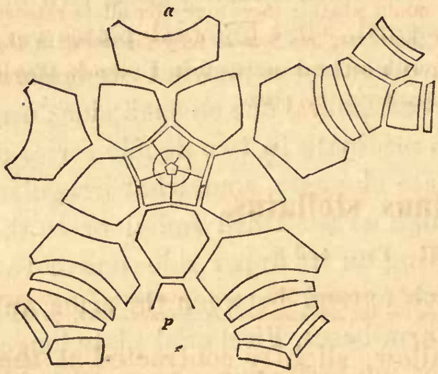
Dome composed of numerous small plates, a larger depressed tuberculiform plate within the axil of each pair of arms, and four somewhat larger ones around the central plate ; two of them corresponding to the anterior ray, and two others to the antero-lateral rays, while at the summit are no large plates corresponding to the postero-lateral rays. Arms beyond their bases, and column, unknown. Surface beautifully radiating granulose-striate.

This species differs from *A. tuberosus* in its generally more depressed form, and in the smooth plates of the dome beyond the superaxillary plates, which are not conspicuous. There is no protrusive ridge on the anal side, and the plates are of different form. The first brachial plates are larger, and their lower sides participate in the concavity of the base.

Geological position and locality. In Keokuk limestone : Green county, Illinois.

GENUS CYATHOCRINUS (MILLER).

FIG. 98.



GENERIC FORMULA.

Basal plates, 5.
Subradials, 5.
Radials, 1 large and 2 small × 5.
Anals, 2 or 3.

THE base is composed of five plates equal in size and shape, forming altogether a regular pentagon with concave sides, depressed in the middle for the attachment of the column, with a central round or pentapetalous opening. Subradial plates regularly alternating with the basal plates ; four of them hexagonal, the angles at the base sometimes scarcely salient : the fifth plate is heptagonal, being truncated above by an anal plate, and sometimes separated on its upper sloping side from the adjacent radial by a small intercalated plate.

The five first radials are usually large and strong plates, separated on one side by the anal plate, and broadly concave on the upper side for the reception of the second radial plate. Second and third radial plates smaller, the upper one a pentagonal bifurcating plate. The arms are variously branched or bifurcating.

I have placed under this genus the following species, which appear to me to have the habit and essential structure of the genus. The small intercalated plate below, and to the right of the first large anal plate, is an approach to the structure of POTERIOCRINUS as shown in the diagram given by DE KONINCK and LE HON. It is easy to see how the small quadrangular anal plate, as shown in the figures 7 and 8 on Plate xviii, in becoming enlarged, and separating the radial on that side from the anal plate, may itself sustain on its upper truncated angle a second plate; thus separating the rays by two anal plates, as in *Poteriocrinus missouriensis* of SHUMARD (Plate xvii, fig. 7 *a*, of this volume). The gradation, therefore, from CYATHOCRINUS proper, as shown in *C. bullatus*, *C. tumidus* and *C. protuberans* (Plate xviii), to POTERIOCRINUS, through such forms as *C. spurius* and *C. intermedius* of the same plate, is very gradual, and suggests a doubt whether there may after all be reasons for the generic distinction. This point, however, has been so fully discussed in the memoir of DE KONINCK and LE HON, with better materials than I possess, that it is quite unnecessary to introduce the question in this place.

Cyathocrinus stellatus.

PLATE XVI. FIG. 3 and 8.

Cyathocrinus stellatus : TROOST, Monogr. of Crinoideæ, MS.; and Catalogue, Proceedings of the American Association for the Advancement of Science, 1849, p. 61.

BODY broad cupform, shallow, slightly contracted at the upper margins. Basal plates small, acute above. Subradials hexagonal; four of them rounded on the upper oblique sides, the centres produced into angular or subspiniferous nodes which often project below the plane of the base, giving a stellate outline as seen from below. Radial plates short, tumid; upper sides straight, the articulating faces sloping outwards. First anal plate quadrangular. First arm-plates broad and very short. Surface finely granulose-striate.

A comparison of specimens with the authentic original of Prof. TROOST shows no important differences of character. The specimen figured is vertically compressed, and the figure of a better preserved specimen has been omitted by mistake.

Fig. 8. View of the exterior of the base.

Fig. 3. Interior of the cup.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Cyathocrinus bullatus (n. s.)

PLATE XVIII. FIG. 1 *a*.

BODY somewhat irregularly hemispheric : base small, pentagonal. Subradial plates very tumid, hemispherical, extending much below the plane of the base in broad subspheroidal prominences. First radial plates short : two of them very tumid ; the others shorter, wider, and scarcely tumid. Second and third radials very short and wide. Arms dividing on the last radial : arm-plates almost entirely circular, with a deep narrow groove on the inner side. Column apparently subpentangular. Surface finely granulose, with distinct prominent small granulæ.

Fig. 1 *a*. View of the base and a part of two arms. [The subradial plates are not represented as sufficiently prominent or globulose.]

Geological position and locality. In the Keokuk limestone : Green county, Illinois.

Cyathocrinus tumidus (n. s.).

PLATE XVIII. FIG. 1 *b*, *c*.

CALYX basin-form, shallow, the plates thick and tumid. Basal plates small ; their area nearly occupied by the column, and presenting a small pentapetalous opening in the centre. Subradial plates with the bases nearly straight, pentagonal, except the one on the anal side which is hexagonal ; each plate prominently convex or tumid. Radial plates somewhat unequal, very thick and broad, convex in the middle ; articulating faces nearly in a plane with the axis. First anal plate quadrangular, small.

SURFACE finely granulose or granulose-striate towards the margins of the plates.

The base is more prominent than the surrounding subradial plates; in which character it differs from *C. bullatus*, the subradials being less protuberant, and the radials larger and more equal in size.

This species resembles the *C. pentaspherіcus* of TROOST; but the cup is proportionally broader and more shallow, the base of the column is smaller, with a pentapetalous perforation, while in TROOST'S specimen the foramen is round. The radial plates of the species under consideration are much wider and proportionally shorter, while the articulating faces are much more extended.

Cyathocrinus tennesseeœ of TROOST also resembles this species; but it is a much smaller form, with smaller and less tumid radial plates.

Fig. 1 *b*. Anal side of specimen. Fig. 1 *c*. Basal view of same.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Cyathocrinus spurius (n. s.).

PLATE XVIII. FIG. 7 & 8.

Compare *Poteriocrinus meekianus*, SHUMARD, Geological Report of Missouri, pa. 188, pl. A, f. 7 *a*, *b*.

CALYX broad basin-shaped, gibbous, the upper margin irregular : base comparatively small. Basal plates elongate, pentagonal. Subradial plates hexagonal, except the one on the anal side, which is heptagonal and very convex. First radial plates wide, the antero-lateral ones longer than the others : second and third radials very short and wide. First anal plate quadrangular, with the lower righthand angle truncated by a small quadrangular plate lying between the two adjacent subradials, the postero-lateral and the anal plate. Arms unknown. Surface granulose.

This species resembles the preceding in its general form and the thickened character of the plates; but the subradials are less protuberant, the radial plates are of different proportions, and the articulating faces for the second radials are more oblique to the axis; while the intercalation of a small quadrangular plate on the anal side presents a marked difference in the character of the specimen, and allies the present species with the Genus POTERIOCRINUS.

Fig. 7. View of the anal side of specimen. Fig. 8. Basal view of the same.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Cyathocrinus protuberans (n.s.).

PLATE XVIII. FIG. 9.

CALYX depressed subturbinate, and somewhat obtusely pentagonal. Basal plates extending beyond the circumference of the column about half its diameter : centre perforated by a moderately large pentapetalous foramen. Subradial plates longer than wide, subangularly tuberculiferous in the centre, and distinctly impressed in the spaces between. Radial plates broad, thick, and tumid in the middle; the anterior and antero-lateral ones being larger than the others. Second radials short and wide. Third radials twice as long as the second : the arm-plates diverging from the upper sloping sides; the divisions sending off branches on each side alternately from the thickened margins of every fourth plate, beginning at the seventh or eighth plate from the base. Anal plate small, quadrangular. Column round, composed of alternating longer and shorter joints. Surface granulose or granulose-striate.

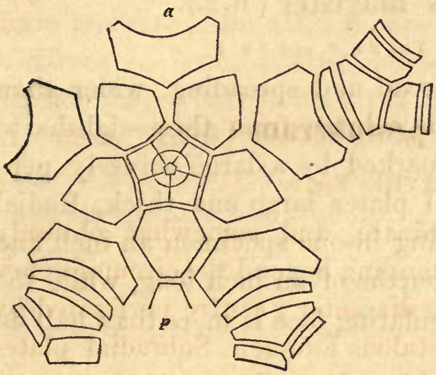
(In some of the impressions, the subradial plates are not represented as sufficiently prominent.)

In one of the arms, which is partially preserved, the branches on one side are seen; and on the opposite side of the same arm, the branches originate from the second plate above.

This species resembles the two preceding, *C. tumidus* and *C. spurius;* but the obtusely angular character of the nodes or tubercles on the subradial plates allies it also with *C. stellatus*, where these nodes are spiniform. The space between the nodes, including the margins of the adjacent subradial plates, the base of the radials, and the apex of the basal plates, is distinctly concave and impressed. In these respects, and in the character of the upper radial plates, this species is very distinct.

Fig. 9. View of the left antero-lateral side of specimen.

FIG. 99.



The accompanying diagram represents the form and proportions of the plates of the body of this species, including the first plates of the arms on three of the rays.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Cyathocrinus intermedius (n. s.).

PLATE XVIII. FIG. 10.

CUP narrow subturbinate. Basal plates wider than long, slightly spreading from the top of the column. Subradials longer than wide, very gradually widening from the base to the upper margins. First radial plates nearly twice as wide as long : second and third radials unknown. Arm-plates nearly as long as wide : arms bifurcating several times.

COLUMN large, gradually tapering below the base, consisting of alternating thicker and thinner joints, which are deeply striated upon their articulating surfaces.

This species has the aspect of POTERIOCRINUS, except in the character of the anal plates. In the arrangement shown in this one and two other species of apparently true CYATHOCRINUS, there is an intercalated quadrangular plate lying between the right subradial and the succeeding radial, and between the first anal plate and the subradial plate below : this plate is so small, that it allows the lateral edges of the radial and first anal proper to meet; and in this respect differs from the typical POTERIOCRINITES, as shown in the diagram, illustrative of the generic formula, by DE KONINCK and LE HON. For this reason, I retain the species under CYATHOCRINUS.

Fig. 10. The anal side of specimen, which is much crushed and the plates separated.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Cyathocrinus magister (n. s.).

PLATE XVIII. FIG. 2 *a*, *b*, and 3 *a*, *b*.

CALYX large; the base broad and spreading, wider than high, projecting beyond the column from three-eighths to half an inch, the centre marked by a large obtusely pentagonal opening : subradial plates large and thick. Radial plates large and strong, being in one specimen an inch and a quarter wide and three-fourths of an inch long, while the thickness on the upper articulating face is more than half an inch.

COLUMN very large, obtusely pentangular with the sides concave, composed of alternating thicker and thinner joints, the thicker ones sometimes nodose at the angles.

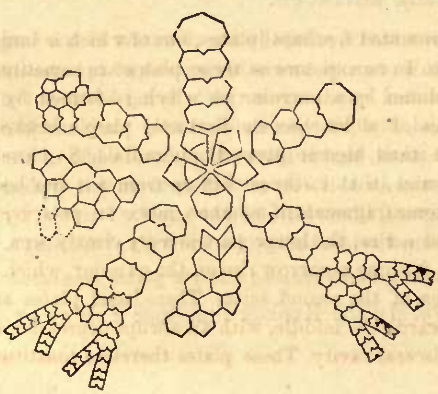
The specimens described are the basal plates with a fragment of the column attached, and a separate fragment of a similar column. Another specimen, not figured, preserves the plates of the body and a piece of the column. Some other large fragments, and roots of large size, apparently belong to this species.

Fig. 2 *a*. The basal plates and fragments of column attached.
Fig. 2 *b*. Base of the same specimen.
Fig. 3 *a*. Fragment of separate column of apparently the same species.
Fig. 3 *b*. Transverse section of the column, showing a large obtusely pentagonal foramen.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; and in the same rock opposite Madison in Illinois.

GENUS FORBESIOCRINUS (DE KONINCK & LE HON).

FIG. 100.



"GENERIC FORMULA.

Basal pieces, 5.
Radial pieces, 4 × 5.
Interradial pieces, 12 or 13 × 4.
Anals unknown.
Interaxillaries, 3 known.
Number of arms, 50 to 60.

"BASAL pieces five : four of them precisely of the same form and size; the fifth, on the anal side, a little larger and different in form, alternating with the first radial pieces. Radial pieces four to each ray, including the axillary piece. All these, except the last, alike, and united to the interradial pieces, which number twelve to thirteen on each regular side. On the anal side, the upper extremity of the basal piece is united to two small anal pieces, and consequently has two articulating faces more than the four other basal pieces, none of which join directly to the interradials. The fourth radial or auxiliary piece gives origin to two rays, each of which is composed of four articulations. Between these rays, which bifurcate once or twice more, are ordinarily three interaxillary pieces. The presence of these pieces seems to authorise us to believe that the calyx of the species of this genus is extended beyond the origin of the arms, the last ramifications of which may be as many as sixty. Arms composed of very thick articulations, having a little median appendage at the lower side, which corresponds to a small notch on the upper side of the plates upon which they rest. Last articulations of the column very fine, thin and regular."

There are in the collection before me some half dozen species, which, though apparently referable to this genus of DE KONINCK and LE HON, present in their fundamental structure certain differences from the generic formula given by these authors. They exhibit, moreover, among themselves some diversity in the development of the basal portions ; and we may suppose that the structure of this part has been misapprehended.

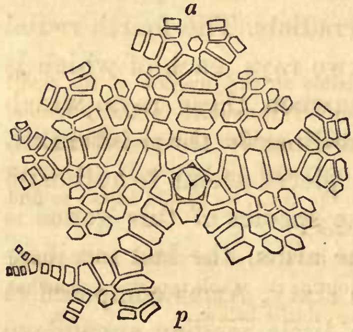
In the diagram cited above are represented five basal plates, one of which is larger and different from the others in form. In our specimens these plates are sometimes conspicuously separated from the column by a narrow rim which is formed by a lower series of plates, the five angles of which become distinctly visible between the bases of these five plates, which thus become properly subradials. So closely united are the plates of this lowest series, that in the perfect specimens it has been difficult to trace the subdivisions. In some fragments of columns, however, preserving the first plates, and one of the second series, the lower part is very clearly seen to consist of three plates closely united, forming a narrow rim on the exterior, which is elevated in five angles at the junction of the second series. These basal plates are much thicker and very prominent towards the middle, with an abrupt depression in the centre, forming the base of the visceral cavity. These plates therefore constitute a part of the structure of the body, and may be more or less developed, as we have had occasion to observe in different species.

FIG. 101.

Illustration of basal plates.

I would therefore propose a modification of the generic description, so as to include the basal plates, properly so called, which, from our present knowledge, appear to be three*. The generic formula, as thus modified, would be as follows :

FIG. 102.



Basal plates, 3;
Subradial plates, 5; four of equal size, one on the anal side larger and hexagonal.
Radial plates, 3 or 4 × 5;
Interradial plates, 4 to 20 or more;
Anal plates, 10 to 24 or more;
Interaxillary plates, 1 to 10 or more;
Arms, 40 to 60?

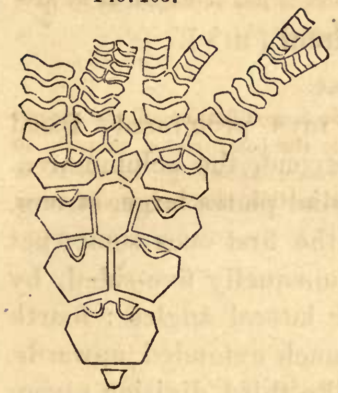
Under this generic formula the following species may be arranged, as well as some others known to me at the present time.

In the generic description of DE KONINCK and LE HON, and in the figures of their species, there is indicated a peculiarity in the mode of articulation of the arm-plates, consisting apparently of an indentation in the upper margin of the plate for the reception of a projection or process from the lower side of the succeeding one. This character, though not always conspicuous, is sometimes a feature of more importance and complexity than is usually observed in the plates of crinoids. The indentation on the upper margin does not extend throughout the thickness of the plate, but only to a very moderate depth, and is filled by a superficial plate which is separately articulated and sometimes anchylosed to the outer margin of the plate above, and lying over the suture below, somewhat like the patella of the knee-joint. This patelloid plate is sometimes large.

The following illustration is of a portion of a ray of the *Forbesiocrinus agassizi*, exhibiting the relation of these patelloid plates.

* In respect to these lower plates, as well as in the general form of the radial plates, this genus has an analogy with ICHTHYOCRINUS; which, with an external basal series of five plates, has sometimes in the base of the body a range of three plates which appear never to be developed externally. In the FORBESIOCRINUS, the series corresponding to these plates of ICHTHYOCRINUS has become so far developed as to form a ring at the base of the calyx.

Fig. 103.



The illustration shows the third or last radial (the species being remarkable for possessing three radial plates only) of one of the rays, with the secondaries and interaxillary plates, and also the bases of the arms to the third bifurcation.

In many instances there is no suture-line visible at the junction of the small patelloid plate with the next above; while in others, the suture is clearly visible, proving it a part of the structure. Had it been otherwise, this thin projecting plate, so far overlapping the plate below, would have prevented all motion in a direction outwards; and since this structure extended into the arms, we should expect to find there the means of free movement among the plates.

All the species of Forbesiocrinus appear to have been furnished with round columns, composed near the body of thin equal joints; the whole tapering somewhat rapidly, and becoming much attenuated and long-jointed below.

Forbesiocrinus meeki (n. s.).

Plate XVII. Fig. 3.

Body somewhat discoid, with strong marked rays. Basal plates not developed beyond the circumference of the column. Subradial plates minute. Radial plates large and strong, more than twice as wide as long, scarcely indented at their upper margins, the articulating faces deeply striated; the secondary plates, or those of the first division above the radials, showing a shallow depression for the patelloid plate. Interradial plates five or more : interaxillary plates two or more ; anal plates unknown.

Column round, composed of thin equal joints, and tapering rapidly from its summit downwards.

Fig. 3. View of the base, showing the column, the subradial and radial plates, with those of the first division of the rays, which in four of the rays are three below the second bifurcation.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Forbesiocrinus wortheni (n. s.).

Plate XVII. Fig. 5.

Body large, somewhat discoid : rays prominent. Basal plates small, slightly projecting beyond the column-area. Subradial plates of medium size. Radial plates large, strong, more than twice as wide as long; the first ones somewhat heptagonal; the second and third unequally five-sided, by the truncation of one of the upper lateral angles : fourth radials pentagonal, with the apex much extended upwards. Secondary plates three; those of the third division seven, with the patelloid or intercalated plate conspicuous in the divisions of the ray (although omitted in the figure). Interradial plates thirty or more. Anal plates about twenty determinable (the full number unknown). Interaxillary plates eight, ten or more : interaxillaries of the third division three, four or more. Surface finely granulose.

This large and fine species differs conspicuously from any of the other forms in its great number of interradial and interaxillary plates, as well as in the form and proportion of the plates of the rays and their subdivisions.

Fig. 5. Basal view of the specimen, as it lies expanded on the surface of the stone.

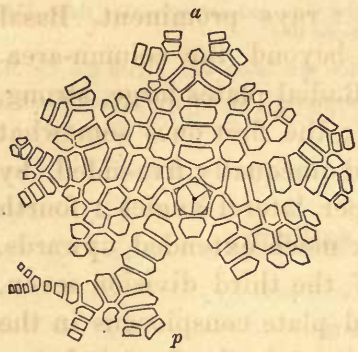
Geological formation and locality. In the Keokuk limestone : Keokuk, Iowa.

Forbesiocrinus whitfieldi (n. s.).

Body subdiscoid : rays depressed. Basal plates minute, presenting five low angular elevations above the narrow basal ring, with three suture-lines. Subradial plates large ; four of them pentagonal and one hexagonal. Radial plates twice as wide as long ; the lower ones pentagonal, the second and third hexagonal, and the fourth pentagonal. The secondary or supraradial plates two on each subdivision, where the second bifurcation occurs : plates of the third division three. Interradial plates ten ; interaxillary plate one : anal plates unknown. Plates scarcely indented on their upper margins.

This species differs conspicuously from the preceding, both in the subradial plates and in the proportions of the radial plates, as well as in the number of plates in the secondary series.

FIG. 104.



The accompanying diagram illustrates the form and relations of the plates of the body, and of two of the rays beyond the second subdivision.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Forbesiocrinus giddingei (n. s.).

PLATE XVII. FIG. 2 & 4.

BODY subturbinate : rays prominent. Basal plates scarcely projecting beyond the circumference of the column. Subradial plates large, that of the anal side much longer than the others; those adjacent to the anterior ray truncated above by the interradial plates. Radial plates more than twice as wide as long, distinctly indented on their upper margin (and the patelloid plate sometimes preserved); the first ones somewhat heptagonal; the second and the third unequally hexagonal, and the fourth pentagonal : plates of the second division, three; of the third division, four or five. Interradial plates eight or ten. Anal plates numerous, undetermined : interaxillary plate, one. Arms simple beyond the third subdivision, giving to each ray eight arms, or forty altogether (so far as determinable). Column round, composed of thin joints, and rapidly tapering from its summit, Surface finely granulose.

This species differs from the preceding, both in form and proportionate size of the plates, as well as in the number of plates in each division of the ray. It is a much more delicate species than either of the others.

Fig. 2. View of the anal and postero-lateral side of specimen.

Fig. 4. Diagram of plates enlarged, showing their form and arrangement; those of the anal area being determinable only on one side.

Geological formation and locality. This specimen was given me by Mr. GIDDINGE, of Boonville, Missouri, and supposed to be from the Keokuk limestone.

Platycrinus saffordi.

PLATE XVIII. FIG. 5 & 6.

Platycrinus saffordi : TROOST in MS.

CALYX large, urnshaped or subturbinate : base moderately depressed for the insertion of the column. Basal plates large, from three-fifths to five-eighths as long as the radial plates. Radial plates about as long as wide; the articulating surface narrow, occupying little more than one-third the width of the plate at the summit, and margined by a moderately thickened angular border. Surface of basal plates ornamented by lines of radiating nodes, which extend from the base to the upper margins of the plates. Radial plates marked by a prominent line of nodes from the two outer basal angles diagonally to the base of the brachial articulating scar, and, between these and outside of them, by concentric lines of nodes parallel to the margins of the plates.

The specimen figured is much smaller than the authentic specimens of Dr. TROOST, on which the species was founded. The proportions of the plates and of the cup, as well as the exterior markings, correspond so closely as to leave no doubt of the identity of the specimens when compared with several in Dr. TROOST'S collection. We may presume, moreover, from the occurrence of this species and of *Actinocrinus nashvillæ*, *Agaricocrinus tuberosus* and *Cyathocrinus stellatus* in the same association in Iowa and Illinois, that the Keokuk limestone is the horizon from which these species are obtained in Tennessee.

Fig. 5. Lateral view, showing the base and three radial plates.

Fig. 6. Basal view of an imperfect specimen.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

BRACHIOPODA OF THE KEOKUK LIMESTONE.

THE following species are among the most prominent and characteristic of the Keokuk limestone, in those localities which I have examined. Numerous other species occur in the same rock, some of which are doubtless as widely distributed, and as characteristic of the formation, as any here given. In making the selection, I have endeavored to give representative species of the same genera as those of the preceding and following formations, for the purpose of furnishing the means of instituting a comparison between the most nearly allied species of the different rocks. The range of my illustration, however, has been mainly limited to certain parts of Iowa and the adjacent portions of Illinois; not feeling at liberty to introduce here other species which I know from the same horizon in Missouri, but which nevertheless offer quite as great a distinction as those here illustrated.

Productus wortheni (n. s.).

PLATE XIX. FIG. 1 *a, b*.

SHELL varying from small to medium size, as wide or wider than long : hinge-line equalling the width of the shell, auriculate. Ventral valve extremely arcuate, very ventricose, flattened in the middle : margin spreading abruptly and again abruptly inflected, leaving a prominent rim or cingulum, which is less conspicuous in front. Dorsal valve concave in the middle near the beak, elevated towards the margins, and flattened at the cardinal extremities; the middle and lower part of the valve nearly flat, or moderately concave.

SURFACE marked by even, rounded, prominent striæ, which bifurcate two or three times on the upper half of the valve, and rarely below the middle : radiating striæ crossed on the upper half of the shell by concentric folds or wrinkles, which become more conspicuous on the margins. Entire surface marked by fine concentric striæ : radiating striæ sometimes interrupted or pustulose on the upper part of the shell, and, on the marginal band, distinctly showing the bases of small round spines.

This shell resembles the *P. marginicinctus* of Dr. PROUT, but differs in form, being more ventricose, wider towards the beaks, and less depressed down the centre; the radiating folds or striæ are finer, more even and continuous, and there are no spine-bases on the middle of the shell. There are likewise other less conspicuous differences in the two species.

Fig. 1 *a*. Profile view of a specimen. Fig. 1 *b*. Ventral valve of the same.

Geological formation and locality. In the Keokuk limestone : Nauvoo, Illinois.

Productus mesialis (n. s.).

PLATE XIX. FIG. 2 *a*, *b*, *c*.

SHELL varying in form from length and breadth equal, to width much greater than length : hinge-line equalling the width of the shell, subauriculate. Ventral valve extremely ventricose, abruptly curving or geniculate above the middle of the valve, marked by a broad longitudinal sinus which reaches nearly to the beak of the shell, and becomes more conspicuous at and below the geniculation. Dorsal valve concave in a small space just below the beak, and nearly flat to the geniculation of the valve, where it is bent almost rectangularly upwards; having a longitudinal mesial elevation on the lower half of the valve.

SURFACE marked by elevated, rather sharply rounded costæ, which bifurcate two or three times on the upper half of the shell, and sometimes below the geniculation; becoming gradually less prominent on the lower half of the shell. On the upper part of the shell, the surface is marked by strong concentric wrinkles, which become more prominent towards the cardinal margins, and are frequently nodulose at the crossing of the radiating costæ. Just below, and parallel to the cardinal margin, the surface is marked by the bases of four or five round spines on each side of the beak. In perfect specimens, the entire surface is covered by fine concentric striæ.

This species is a common form in the Keokuk limestone; differing sufficiently from any of those in the same rock, and in the other limestones, to be readily recognized. The *P. flemingi*, var. *burlingtonensis*, resembles this in some degree; but is proportionally longer, less abruptly geniculate, and less distinctly marked by the mesial sinus. That species also bears spines on the middle and front of the shell, and has no range of spines on the hinge-line; while the species under consideration is conspicuously marked in this manner.

Fig. 2 *a*. The interior of a dorsal valve, from which the ventral valve has been exfoliated.
Fig. 2 *b*. Profile view of the ventral valve.
Fig. 2 *c*. Ventral valve of a large individual, which is somewhat broader than the prevailing forms.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; and Nauvoo, Illinois.

Productus semireticulatus.

PLATE XIX. FIG. 4 *a*.

Anomites semireticulatus : MARTIN, 1809.
For synonymy and authorities, see DE KONINCK, Recherches sur les animaux fossiles, 83.

DORSAL valve wider than long; the cardinal extremities auriculate, extended beyond the width of the shell below. Visceral portion of the shell nearly flat, a little elevated in the centre, with margin abruptly deflected both at the sides and in front.

SURFACE marked by strong radiating costæ, which, on the flat portion of the valve, are crossed by almost equally strong concentric wrinkles : costæ often nodulose at the junction of the concentric wrinkles.

This valve appears to be identical with *P. semireticulatus* in its broader and stronger varieties, as figured by DE KONINCK (Recherches sur les animaux fossiles). The species, however, according to reliable authorities, assumes so many phases, that we might include various other forms under the same designation; and it is difficult, in a small collection of individuals, to determine the limits of its variation.

Fig. 4 *a*. Interior of dorsal valve, from which most of the shell has been exfoliated, leaving an impression of the external markings.

Geological formation and locality. In the Keokuk limestone : Keokuk, Iowa.

Productus setigerus (n. s.).

PLATE XVIII. FIG. 3.

SHELL longitudinally semielliptical, as wide or wider on the hinge-line than the shell below. Ventral valve gibbous, with the beak much elevated above the hinge-line, and strongly incurved. Dorsal valve very moderately concave, abruptly inflected near the margin, turning upwards nearly at right angles to the plane of the surface of the valve : cardinal extremities auriculate.

SURFACE marked by even rounded radiating costæ, which bifurcate several times above the middle of the shell, and less frequently below; concentrically crossed by fine equal undulating striæ. The radiating costæ become, at intervals, tuberculous, and support fine elongated tubular spines, which are irregularly distributed over the entire surface of the dorsal valve; and others more closely arranged, somewhat in rows, on the auriculate cardinal extremities. The cardinal margin of the ventral valve presents a closely arranged row of tubular setiform spines, and several similar rows below this on the auriculate portions of the valve; giving a compact fascicle of these appendages, which originally have been nearly two inches in length, extending upwards with a slight divergence, and gently curving inwards towards the beak.

This species, in its slightly concave dorsal valve, numerous setiform spines over the entire surface, with fascicles of the same on the cardinal extremities, presents characters by which it may be readily distinguished from any of those which have fallen under my observation. The ventral valve is but partially known.

Fig. 3. Dorsal side of specimen, showing the beak and umbo of the opposite valve, with the long setiform spines from the cardinal margin.

Geological formation and locality. In the Keokuk limestone : Keokuk, Iowa.

Productus setigerus? var. keokuk.

PLATE XIX. FIG. 4 *b, c*.

SHELL somewhat ovoid, ventricose below, and tapering towards the beak : hinge-line equaling or less than the width of the shell below. Ventral valve flattened or broadly depressed along the centre, with the umbo very prominent and beak strongly incurved.

SURFACE marked by numerous well-defined rounded costæ, which are about equal to the spaces between them. Costæ bifurcating on the upper part of the shell, and frequently coalescing below; marked at frequent intervals by the bases of small tubular spines, which are crowded in great numbers along the cardinal margins and the auriculate portions of the valve.

The specimen figured is somewhat distorted by pressure. Another specimen before me, of similar character, is larger, with the umbo much elevated, and having a width of two and a half inches at the base. In general form it resembles *P. semireticulatus*, and the specimens have been referred to that species : they differ, however, in the more rapid diminution towards the beak, and the finer costæ, as well as the numerous fine pustulose markings indicating the bases of minute spines. In these respects, there is a well-marked difference from authentic specimens of *P. semireticulatus*

Having no means of verifying satisfactorily the ventral valve of *P. setigerus*, I refer this, with doubt, as a variety of that species; the specimen figured (Plate xix, fig. 3) showing the spine-bases more elevated, and more nearly rectangular to the surface than in these under consideration.

Fig. 4 *b*. Cardinal view of a ventral valve.

Fig. 4 *c*. Another view of the same specimen, looking apon the centre of the valve.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa; and Warsaw, Illinois.

Productus vittatus (n. s.).

SHELL subhemispherical or broadly semiovoid. Dorsal valve moderately and uniformly concave. Ventral valve regularly convex; greatest elevation a little above the centre, flattened or slightly depressed longitudinally along the middle : umbo elevated, and beak abruptly and closely incurved over the hinge-line.

SURFACE marked by numerous concentric elevated bands, which are pustulose or striato-punctate : entire surface, where exfoliated, finely striato-punctate.

This species is, I believe, usually referred to *P. punctatus;* but the specimens which I have examined have a proportionally longer hinge-line, and the surface is less strongly marked, while the concentric bands are often equally or more conspicuous.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; Warsaw and Nauvoo, Illinois.

Orthis keokuk (n.s.).

PLATE XIX. FIG. 5 *a, b.*

Orthis umbraculum ? OWEN, Report on Wisconsin, Iowa and Minnesota, Pl. v, f. 11.

SHELL resupinate, somewhat broadly semielliptical in outline, depressed hemispheric : cardinal extremities rounded. Ventral valve flat or slightly concave : area low, extending to the hinge extremities; foramen forming an equilateral triangle, closed by a pseudo-deltidium. Dorsal valve broadly convex, the greatest elevation being a little above the middle, and often equal to one-third the width of the shell.

SURFACE marked by even rounded radiating striæ, which increase by bifurcation and interstitial addition, and are crossed by fine concentric striæ.

This species has been referred to *O. umbraculum;* but a comparison with the figures of that species given by DE KONINCK shows the cardinal area to be nearly twice as large as in our specimens; the form is proportionally broader, the spaces between the striæ much greater than the striæ (while in our shell they are less), and the fine concentric markings, as shown in the enlarged figure, are very different from those in the species under consideration.

The figure of *O. umbraculum* given in DUNKER & VON MEYER's Palæontographica, Plate xxxviii, fig. 2, differs from that of DE KONINCK, and from our own, in the greater extension of the hinge-line; while the enlargement of striæ differs equally from the Belgian and American specimens.

There is a closer resemblance between the present species and the figures of *O. undiferus* (Palæontographica, Plate xliv, fig. 1 *a, b, c*) *:* the latter, however, more nearly resembles, in its outline and general expression, the *Orthis swallovi* of the Burlington limestone.

Fig. 5 *a*. View of ventral valve, which is broken transversely across a little below the beak. The ridge extending from the beak is accidental, from pressure on the opposite side.

Fig. 5 *b*. Ventral valve of a specimen which is partially concealed at the margins.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa; Warsaw, Nauvoo, etc. Illinois.

Spirifer tenuimarginata (n. s.).

PLATE XX. FIG. 1 *a*, *b*, *c*.

SHELL semielliptical, length more than three-fourths as great as the width, moderately gibbous in the middle; extremities rounded; margins impressed. Dorsal valve with a rounded or subangular mesial fold, little elevated above, and becoming rapidly wider and high towards the front. Ventral valve with a shallow scarcely defined sinus; beak elevated and incurved : area moderately wide, not extending to the cardinal extremities.

SURFACE marked by numerous fine dichotomizing plications, which divide once or twice above the middle of the shell, and continue simple, for the most part, to the base; about twenty on each side, and ten or eleven upon the mesial fold and sinus; concentrically marked by fine undulating striæ.

This species bears some resemblance to *S. inequicostata* of OWEN (Report of Wisconsin, Iowa and Minnesota, pa. 586, pl. v, f. 6); but the plications are more numerous than those described of that shell, and are distinctly dichotomizing.

Fig. 1 *a*. View of the ventral valve.
Fig. 1 *b*. Dorsal view.
Fig. 1 *c*. Profile view of the same shell.

Geological formation and locality. In the Keokuk limestone : Warsaw, Illinois.

Spirifer rostellatus (n. s.).

PLATE XX. FIG. 2 *a*, *b*, *c*.

SHELL longitudinally broad oval, with sides symmetrically curving : hinge-line much shorter than the width of the shell. Ventral valve longer than wide, the beak greatly elevated above the opposite valve, incurved : a narrow mesial sinus is well defined near the beak, becoming broad and undefined below, and marked by about seven to twelve dichotomizing plications; area high, short, with angular margins. Dorsal valve wider than long, with a broad somewhat undefined mesial fold, which is scarcely conspicuous above the middle.

SURFACE marked by regular rounded plications, eighteen or twenty of which are on each side of the mesial fold and sinus : some of these dichotomize near the beak, and, more rarely, below, while those of the sinus and fold dichotomize near the base. Fine concentric striæ give a granulose appearance to the surface, when not worn.

This species resembles *S. recurvatus* of DE KONINCK (Description des Animaux fossiles, pa. 261, pl. 16, f. 5); but our shell is less gibbous, with a less strongly defined sinus.

Fig. 2 *a*. Dorsal valve of this species.
Fig. 2 *b*. Ventral valve.
Fig. 2 *c*. Profile view.

Geological formation and locality. In the Keokuk limestone : Skunk river, Iowa.

Spirifer keokuk (n. s.).

PLATE XX. FIG. 3 *a* – *d*, and 2 *d*.

SHELL transversely oval, gibbous : valves nearly equal ; hinge-line equalling or a little less than the width below, obtusely angular or somewhat rounded at the extremities. Dorsal valve convex, very gibbous in the umbonial region : beak prominent and distinctly incurved ; mesial fold more or less elevated below the middle. Ventral valve convex : beak very prominent, gibbous and strongly incurved ; in old shells, closely pressed against that of the other valve : sinus faint and narrow near the beak, deeper and rounded in front, terminating in a triangular projection, fitting into a corresponding depression in the front of the opposite valve : area arcuate ; foramen triangular, open. Plications from eighteen to twenty-eight, three or four occupying the sinus and four the mesial fold : those on the sides are nearly always simple, while some of those in the sinus bifurcate, and those on the fold are formed by the bifurcation of two simple ones at the apex, and are sometimes smaller than the others.

SURFACE marked by extremely fine regular radiating striæ, which cover the plications, and are crossed by equally fine concentric striæ and coarser lines of growth.

This species has generally been referred to *S. striatus*, var. *attenuatus* ; but presents well-marked differences, being much more ventricose and gibbous at the beaks, the sinus and mesial fold smaller, and not more than half as many plications. I have observed no intermediate forms or gradations between the present species and the large one usually considered as identical with *S. striatus*.

Fig. 3 *a*. Dorsal view, showing the area and foramen of the opposite valve.

Fig. 3 *b*. Ventral view of a larger individual.

Fig. 3 *c*. Profile of a very gibbous specimen, where the beak of the dorsal valve is closed beneath that of the opposite valve.

Fig. 3 *d*. Profile view of the specimen fig. 3 *a*.

Fig. 2 *d*. Enlargement of surface, showing the radiating striæ.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; Nauvoo, Warsaw, etc. Illinois.

Spirifer neglectus (n. s.).

PLATE XX. FIG. 5.

SHELL transversely oval, gibbous; hinge-line less than the greatest width, rounded at the extremities. Dorsal valve convex; mesial fold small at the beak, increasing rapidly towards the front, where it is very prominent, not plicated; beak a little elevated above the hinge, incurved. Ventral valve a little the more convex, elevated in the umbonial region : mesial sinus broad and deep, with one broad faint plication in the middle, and indications of another on each side : umbo very gibbous ; beak strongly arched ; area high arcuate, its lateral margins rounding gradually on each side ; foramen large, triangular, a little higher than wide.

SURFACE marked by about six broad depressed and rounded simple plications on each side of the mesial fold and sinus ; concentrically crossed by fine undulating striæ and a few stronger wrinkles of growth.

The specimens of this shell are usually crushed and distorted; but it may be recognized by the rounded extremities, strongly elevated and non-plicate mesial fold, and broad obscure plications. In general appearance it resembles *S. pinguis* (SOWERBY), as figured by DE KONINCK (An. foss. pl. 14, f. 4); but it is broader in proportion to its length, with fewer plications, a more prominent dorsal beak, and the area less distinctly defined.

Fig. 5. Dorsal view of a specimen distorted by pressure so that the valves are separated, showing the entire area of the ventral valve, the dorsal valve being forced beneath the other along the cardinal line.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; Warsaw, Illinois.

Spirifer suborbicularis (n. s.).

SHELL suborbicular, length and width nearly equal or somewhat wider than long : hinge-line much shorter than the width of the shell; cardinal extremities regularly curved. Dorsal valve convex, gibbous above the middle, with the mesial fold becoming defined below the beak, and somewhat prominent at the base. Ventral valve convex, gibbous above the middle, with elevated umbo and beak abruptly incurved over a narrow area, which in length is about equal to half the width of the shell : foramen with the dental lamellæ projecting, and partially closed by a pseudo-deltidium.

SURFACE marked by broad flattened scarcely defined plications, of which there are seven or eight on each side of the mesial fold and sinus, with two or three more faintly defined on these parts of the shell, and some appearance of a smaller plication in the centre of the sinus.

This species has usually been referred to *S. pinguis*; but it differs in being more orbicular, and having a proportionally more extended hinge-line, as well as the extremely flattened plications, by which it may be distinguished from all the other species which have fallen under my observation from the carboniferous rocks.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; Warsaw, Illinois.

Spirifer pseudolineatus (n. s.).

PLATE XX. FIG. 4.

SHELL transversely elliptical, length about three-fourths as great as the width, the sides symmetrically rounded : valves about equally gibbous. Dorsal valve with the beak a little elevated above the hinge-line and incurved, marked by a rounded undefined mesial fold which is often scarcely visible above the middle of the shell, and moderately conspicuous on the lower half : lateral portions of the valve regularly curving to the margin. Ventral valve more gibbous above the middle ; mesial sinus shallow, rounded, becoming more defined below, and rarely extending to the beak, which is prominent, attenuated, and incurved over the area : area of moderate height, much shorter than the width of the shell, vertically striated, well defined at its junction with the exterior shell, which curves inwards, occupying a portion of the space.

SURFACE marked by more or less regular concentric lamellose folds or wrinkles and radiating striæ, extended into long bristleform spines from the edges of the folds, which are strongly punctate when the shell is partially exfoliated ; and when still farther exfoliated, the entire surface is strongly striated.

This species bears some resemblance to *S. lineatus* (MARTIN); but the specimens which have come under my observation are generally broader and less rotund, with a more defined mesial sinus and fold, while the concentric folds and radiating striæ are less strongly defined than are represented in the figures of SOWERBY and DE KONINCK. It is clearly a representative of the European species, though perhaps less closely similar than another species in the Chester limestone which is figured on Plate xxvii of this volume. The species which appears to be identical with *S. lineatus* of Europe, is one having a wide geographical range in the coal measures of the United States.

Fig. 4. Dorsal view of a specimen of medium size.

Geological formation and localities. In the Keokuk limestone : Keokuk Iowa ; Warsaw, Illinois.

Spirifer subcuspidatus (n. s.).

PLATE XX. FIG. 5 *a*, *b*.

SHELL triangularly subpyramidal; width about one-third greater than the length, extended into subacute angles. Dorsal valve semielliptical, moderately convex on each side of the mesial fold, abruptly incurved towards the margin : mesial fold narrow and well defined near the beak, rapidly increasing in width and rising towards the front of the shell. Ventral valve subtriangular, the margin on each side of the mesial sinus broadly sinuate : mesial sinus narrow and well defined quite to the beak, rapidly expanding below, and produced into a broad rounded linguiform extension : beak much elevated, slightly arcuate but not incurved : area high, equal to about one-third the greatest width of the shell, and reaching to the cardinal extremities; foramen extending to the beak, its height nearly once and a half its width at the base.

SURFACE marked by eighteen to twenty or more strong simple rounded and little elevated plications, which are marked by some strong concentric wrinkles of growth and longitudinally striato-punctate, varying in their character, dependent on the degree of exfoliation or state of preservation of the surface.

This species has usually been referred to *S. cuspidatus* (SOWERBY); but it is much more extended on the hinge-line in proportion to its height of area, and the area is less extended than in SOWERBY'S figures, while the number of plications given by that author are less than in our shell. There are several species of this type, commencing in the Chemung group and extending through the Carboniferous limestones, but I have not yet seen a species that can be identified with the *S. cuspidatus*.

Fig. 6 *a*. Dorsal valve and area of a specimen of ordinary size.

Fig. 6 *b*. Ventral valve of the same.

Geological formation and localities. In the Keokuk limestone : Keokuk, Iowa ; Nauvoo and Warsaw, Illinois.

Spirifer propinquus (n. s.).

VENTRAL valve triangularly pyramidal : beak much elevated, not arched; sinus well defined, deep, abruptly curving in the bottom; area plane, the height equalling one-third the width of the shell : width of foramen, at base, about three-fifths the height; exterior sloping abruptly from the beak towards the base.

SURFACE marked by twenty-four or more simple plications on each side of the sinus. Structure minutely striato-punctate, varying with degree of exfoliation.

This shell has the general form of *S. subcuspidatus;* but the sinus is deeper, the area entirely flat, and the number of plications more numerous. I have not yet observed intermediate forms which will justify the union of this and the preceding species, though they are nearly allied.

Geological formation and locality. This species occurs with the preceding in the same localities.

Spirifer —— (n. s.).

There is in my collection, from the same geological horizon, another species resembling the preceding, but more gibbous, the valves being longitudinally more curving and the area concave. It is associated with a species bearing much resemblance to *Spirifer attenuatus ;* but which is probably a distinct species, with narrower area and more numerous plications.

Spirifer striatus? var.

There is in the Keokuk limestone a species resembling the *S. striatus;* but the area is less linear and does not extend to the extremities, which are rounded : the sinus is very broad, not defined at its margins, and, together with the mesial fold and lateral plications of the shell, covered by somewhat unequal bifurcating plications, which are themselves covered by fine radiating striæ.

Spirifer logani (n. s.).

PLATE XX. FIG. 7; and PLATE XXI. FIG. 1 *a, b,* and FIG. 2.

SHELL large, transverse, semielliptical; length and width nearly as three to four, gibbous. Dorsal valve gibbous in the middle, depressed towards the cardinal extremities, and broadly curving to the base : mesial fold very prominent, extremely elevated and subangular in front, not defined at the margins. Ventral valve very gibbous at the sides, marked by a broad deep undefined mesial sinus, which, in the middle of the shell, occupies fully one-third of the width, sloping abruptly to the cardinal extremities, and extremely produced and elevated in front in a subtriangular extension : umbo moderately gibbous : beak neatly defined and incurved over the foramen : area moderately wide, concave, the sides nearly parallel, sharply defined on the outer margin, vertically and longitudinally striate; foramen forming a nearly equilateral triangle, the base being a little longer than the sides.

Surface of shell, including the mesial fold and sinus, covered by small rounded bifurcating plications, some of which, on the sides of the mesial sinus, are finer than the others : minute structure undetermined, but apparently striato-punctate.

This species is, in the Keokuk limestone, the representative of the *S. grimesi* of the Burlington limestone. It differs from that in being usually more extended on the hinge-line and less produced in front, while the mesial sinus and elevation are more distinctly defined; the plications are likewise somewhat stronger, and of different character. The area of the muscular and vascular impressions of the ventral valve are proportionally shorter and broader.

This is one of several species which have usually been referred to *Spirifer striatus* of Martin; and it is without doubt a closely allied species, but differs in the prominence of the baso-lateral margins, in the depth of the mesial sinus and prominence of the mesial fold, while the foramen appears to be proportionally larger, and the plications stronger and fewer than in shells of *Spirifer striatus* of the same size.

Plate xxi, fig. 1 *a*. Dorsal view of a large individual, natural size.
Plate xxi, fig. 1 *b*. Ventral view of the same specimen.
Plate xxi, fig. 2. Cardinal view of a separate ventral valve.
Plate xx, fig. 7. Profile view of the specimen fig. 1 *a*, *b*, of pl. xxi.

Geological formation and locality. In the Keokuk limestone; near Nauvoo, Illinois.

FOSSILS OF THE WARSAW LIMESTONE.

The Warsaw limestone, though a well-marked and distinct group of strata, nevertheless, as already stated, rarely attains any considerable thickness. In many localities, and over wide areas, it appears to have been deposited in shallow water : it is often oolitic in character, and contains numerous species of Gasteropoda, with many small forms of Brachiopoda, and a great abundance of Bryozoa.

I have endeavored to present a few of the most characteristic forms of each of these families of fossils, limiting the number of illustrations below those given for the preceding rocks, chiefly in accordance with our present views of the importance of the formation, and corresponding somewhat to the number of species known to belong to this rock within an area equal to that from which the fossils of the Burlington and Keokuk limestones have been obtained. Some of them have, however, been derived from more distant points; but as those from Indiana serve to indicate the same horizon, which has been recognized by Mr. Worthen as corresponding to that above Alton, and of Warsaw (Illinois), and which is likewise proved in the southern part of Iowa, it has seemed desirable to illustrate the association of species from strata which are yet but partially investigated.

CORALS AND BRYOZOA.

THE Corals of this formation are of the cyathophylloid character, among which the one figured is the most characteristic. The Bryozoa are chiefly of the Fenestellidæ; among which, the spiral forms, or the *Archimedes* of LESUEUR, are very conspicuous. The species here illustrated, in its entire structure and characteristics, is the most common form, and will serve to give a correct idea of this group of species, which, so far as we know, begin their existence in the Keokuk limestone, and continue at least as far as the Kaskaskia limestone, and perhaps to the limestones of the Coal measures.

Zaphrentis spinulifera (n. s.).

PLATE XXII. FIG. 1 *a*, *b*.

CORAL in the form of an elongated reversed cone, curved. Calyx slightly oblique, circular or subcircular, the cavity deep; septal fosset strongly marked, situated on the inner side of the curvature. Radiating lamellæ strongly defined, somewhat irregularly curved, numbering at the margin from forty-two to fifty, and uniting in fascicles of two, three, four or more before reaching the centre: outer wall of the calyx thin at the upper margins, becoming very thick and strong below. Externally somewhat rugose, and often swelling abruptly at intervals; the stages of growth marked by somewhat regular rows of nodes or short spines.

This species differs from the *Z. spinulosa* of EDWARDS and HAIME, which it simulates principally in the short external spines. The *Z. dalii* of the same authors, cited as from Warsaw (Illinois), is probably an associated species, and equally common with the one here described, though not so clearly distinct from a Keokuk species.

Fig. 1 *a*. Lateral view of a specimen of medium size.
Fig. 1 *b*. View of the calyx showing the rays.

Geological formation and locality. In the Warsaw limestone: Warsaw, Illinois.

GENUS FENESTELLA (MILLER).

Subgenus Archimedes (LESUEUR).

THE Bryozoans designated as above by LESUEUR do not differ in their essential structure from FENESTELLA : their mode of growth, however, is quite distinct; the flabelliform expansion acquiring a solid central axis, around which it revolves in an ascending spiral form, spreading equally on every side*.

Archimedes wortheni.

PLATE XXII. FIG. 3; 4 *a*, *b*; 5 *a*, *b*.

Fenestella (Archimedes) wortheni : HALL, Proceedings of the American Association for the Advancement of Science, 1856, p. 176.

AXIS strong, robust, having a little more than three volutions in an inch (or from three to four in the same space) : axis and base of expansion rugose, the latter extremely thickened and often supported by oblique braces of solid calcareous matter. Frond broadly spreading, ascending, externally marked by oval fenestrules and strong closely arranged connecting processes. Branches, on the inner or celluliferous side, rounded, with a faint sharp meandering ridge down the middle, which is sometimes thickened, with usually a single row of cells on each side : cells round, opening vertically, with the margins frequently thickened; three in the space of each fenestrule. A third row of cells sometimes just below the bifurcation, and also on the connecting processes.

This species is remarkable for its thick strong axis, and for the finely fenestrate frond, which presents some variations in its characters according to age and other circumstances.

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* See "Observations on the Genus ARCHIMEDES or FENESTELLA, with descriptions of species, etc.": Proceedings of the American Association for the Advancement of Science, 1856, p. 176.

Fig 3. A portion of the axis of a specimen of this species, showing the usual characteristics, together with several of the small props or braces extending from one volution to the other.

Fig. 4 *a*. A fragment of the axis preserving several volutions of the frond, as seen from the inner side.

Fig. 4 *b*. A portion of the inner celluliferous surface enlarged, showing arrangement of cellules.

Fig. 5 *a*. Exterior of the same specimen, showing the fenestrules.

Fig. 5 *b*. Enlargement of surface of fig. 5 *a*, showing form of fenestrule.

Geological formation and locality. In the Warsaw limestone : Warsaw, Illinois.

Archimedes reversa (n. s.).

PLATE XXII. FIG. 2.

AXIS strong, expanding or thickening towards the middle, and gradually tapering above : volutions of the spiral sinistral, about four in the space of an inch; frond unknown.

This species has the general form and robust aspect of the preceding; but the fusiform character and reversed direction of the spiral frond indicate a probable specific difference, though the latter character not unfrequently exists in the species that are usually dextral.

In two specimens of the species from the Kaskaskia limestone, where the axis has been apparently broken, the growth has been resumed in a dichotomizing form; one branch being dextral and the other sinistral in its spire.

Farther observation is necessary to determine the question of identity or difference between this form and the *A. wortheni* in the same rock.

Fig. 2. The axis preserving the bases of the frond, showing gradual expansion towards the middle and diminution above.

Geological formation and locality. In the Warsaw limestone : Warsaw, Illinois.

GENUS PTYLOPORA (SCOULER in MS.);

M'COY, Synopsis Carb. fossils, 1844.

"GENERIC CHARACTER. Flabelliform or infundibuliform, attached by roots from which a strong midrib arises, giving origin on each side to thin equidistant interstices connected by regular dissepiments : external face of the interstices carinate, and bearing two rows of pores."

Ptylopora prouti (n. s.).

PLATE XXII. FIG. 6 *a*, *b*, *c*, and FIG. 7.

MIDRIB strong, rounded on the celluliferous side, subangular on the poriferous side, and marked by a double row of cellules, often giving a carinate appearance to the central part, which is margined by two narrow grooves containing the oval cellules. Branches, on the noncelluliferous side, rounded and striated; on the celluliferous side, carinate in the middle, and the cellules placed in a depression on each side, with the narrow outer margin slightly elevated.

Fig. 6 *a*. Celluliferous side of a specimen, natural size.
Fig. 6 *b*. The same enlarged.
Fig. 6 *c*. A portion still farther enlarged.
Fig. 7. Exterior of the same species.

Geological formation and locality. In the Warsaw limestone : Warsaw, Illinois

Among the Bryozoa in this rock, I have noticed, in addition to those described above, several other genera, among which are CLATHROPORA [= COSCINUM?], STICTOPORA and CALLOPORA, which are likewise Silurian genera. Among the latter, I have designated the following :

Callopora punctata (n. s.).

FROND branching, dendroid, round or oval in section; internal structure radiatingly fibrous. Surface transversely ridged or nodose : cells round or somewhat pentapetalous, small, uniformly distributed over the surface; intermediate spaces minutely celluliferous : the surface punctate; three, four, or more rows of punctæ between the cells.

Geological position and localities. In the Warsaw limestone : Keokuk, Iowa; Warsaw, Illinois.

CRINOIDEÆ AND OTHER ECHINODERMATA OF THE WARSAW LIMESTONE.

At the present time, I am acquainted with four species of Platycrinus, one of Actinocrinus, one of Cyathocrinus, one of Scaphiocrinus, two of Dichocrinus, one of Forbesiocrinus, and one of Pentremites, besides a species of Archæocidaris, all undescribed and characteristic of this formation. It was originally my intention to illustrate and describe these species in this report; but the subject has expanded before me to such a degree that it has been necessary to curtail the matter in hand, to avoid a too great extension of the volume.

The following species are characteristic of the horizon of the Warsaw limestone.

Dichocrinus simplex.

Plate XXII. Fig. 12 *a*, *b*.

Dichocrinus simplex : Shumard, Transactions Academy of Sciences of St. Louis, 1857.

"Calyx beadshaped or cylindrico-elliptical, length and breadth about equal; plates rather thin and smooth(?). Base semiglobose, about two-thirds the entire height of the calyx: the pieces of which it is composed are much thicker below than above. The facet for articulating with the last joint of the column is small, circular, and lies in a deep cavity which is a little wider than the facet. Radial pieces higher than wide, evenly convex and widest inferiorly: four of them quadrangular, their inferior edges rounded; one of them pentagonal and wider: all the radial pieces differ from each other in width. The anal piece resting on the base is all that is known: it presents nearly the same form and dimensions as the pentagonal radial piece. The column, arms, and vault are unknown.

"Dimensions: Height of calyx, 4½ lines; diameter of the same, 4 lines; width of anal piece at base, $2\frac{1}{2}$ lines; ditto at the top, $1\frac{1}{2}$ lines."

This species occurs in the collections of the late Dr. TROOST, under the name of *Doliolocrinites ovalis;* but the name is neither in the published catalogue or in the MS. of the monograph. The specimen is from Sparta (Tennessee), a locality which has furnished other species of Warsaw limestone fossils.

Fig. 12 *a*. Basal view of specimen. Fig. 12 *b*. Lateral view of the same.

Geological formation and locality. In the Warsaw limestone : Spergen hill, Indiana.

Pentremites conoideus.

PLATE XXII. FIG. 8, 9 & 10.

Pentremites conoideus : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

GENERAL form conoidal or pyramidal, with the angles rounded : base subtruncate ; apex a little flattened. Basal plates slightly convex : radial plates extremely elongated, and deeply divided for the reception of the pseudoambulacral areas; interradial plates deeply inserted between the radial plates, long lanceolate, and very acutely pointed above. Pseudo-ambulacral spaces very elongate, narrow, extending nearly to the base, with sides subparallel, convex along the median line, which is sharply depressed. Poral plates varying with age from twenty-five to fifty : ovarian apertures circular : anal aperture ovate, and much larger than the others.

SURFACE marked by fine closely arranged striæ, which, on the radial plates, are parallel to the margins till near the summit, where they are stronger and diverge from the suture : striæ on the interradial plates diverging from the centre. Length, from one-fourth to three-fourths of an inch.

In the young the base is more extended, and the poral pieces much fewer than in older specimens.

Fig. 8. A full-grown individual, which is more elongated than usual.
Fig. 9. A specimen of the ordinary form and size.
Fig. 10. The base, showing form of basal plates and bases of the pseudoambulacral areas.

Geological formation and localities. In the horizon of the Warsaw limestone : Spergen hill and Bloomington, Indiana.

Pentremites koninckana.

PLATE XXII. FIG. 11 *a*, *b*, *c*.

Pentremites koninckana : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

BODY small, globose or subpyriform, upper part rounded ; base subpyramidal, angular. Basal plates small, the lateral edges short and covered by the column, allowing the base of three of the radial plates to come within the limits of the column-area; the two other plates resting upon the long sides of the larger basal plates. Radial plates short, convex in the middle and sloping to the sides, widening a little from the base upwards, and dividing only half way down for the reception of the pseudo-ambulacral areas. Interradial plates minute, linear or tapering very gradually upwards to a point, and having two extremely short oblique sides below. Pseudo-ambulacral areas broad, nearly plane, and extending only about half way from the summit to the base, rather deeply impressed at their rounded lower ends. Poral plates varying from six to thirteen. Oral aperture small, pentagonal : anal aperture large, oval ; ovarian openings small, nearly round.

SURFACE very finely and beautifully striated : striæ on the sides of the radial plates nearly vertical, but on the lower part deflected obliquely across so as to meet at an obtuse angle on the centre below the ambulacral areas.

COLUMN, at its junction with the body, round, relatively very large. Length, one-twelfth to one-fourth of an inch.

This species resembles *P. caryophyllatus* of DE KONINCK (Crinoides du Terrain carbonifère de la Belgique), but differs in the shorter base and peculiarity of the basal plates, as well as in the interradial plates, which in our species are extremely small and almost linear, the one on the anal side extending into that aperture. A single individual shows a nearly entire obliteration of one of the pseudo-ambulacral spaces.

Fig. 11 *a*. A specimen, natural size.
Fig. 11 *b*. The same enlarged.
Fig. 11 *c*. Summit of the same enlarged.

Geological formation and localities. In limestone of the age of the Warsaw limestone : Spergen hill and Bloomington, Indiana ; and Alton, Ill.

BRACHIOPODA OF THE WARSAW LIMESTONE.

In the exposures of this rock along the Mississippi river, in Iowa and the adjacent parts of Illinois, comparatively few species of Brachiopoda are usually observed. In the more southern localities, however, these forms become more numerous ; and in the continuation of this rock in Indiana, there are a considerable number of species known ; most of them, however, of small size, and associated with numerous species of Lamellibranchiata and Gasteropoda. I have selected from all those known to me from the different localities, such as appear to be most characteristic of the formation.

Retzia verneuilana.

Plate XXIII. Fig. 1 *a, b, c, d.*

Retzia verneuilana : Hall, Transactions of the Albany Institute, Vol. 4, 1856.

Shell longitudinally ovate : valves almost equally convex. Ventral valve most prominent near the beak, which is elevated and incurved so as to bring the circular foramen nearly on a line with the margins of the valves : foramen round. Dorsal valve smaller, auriculated on the cardinal angles : beak small, scarcely rising above the straight cardinal margin ; area small, triangular, not entirely confined to the larger valve, bounded by a distinct angular margin.

Surface longitudinally striate, marked by about fifty rounded, beautifully punctate, simple striæ.

Length, ·10 to ·32, width ·08 to ·27 of an inch, usually. Some specimens have a length of three-fourths of an inch.

Fig. 1 *a, b*. Ventral and dorsal views of a small individual.

Fig. 1 *c*. An enlarged figure, showing the foramen and auriculate extensions of the dorsal valve.

Fig. 1 *d*. Enlarged figure of the same.

Geological formation and localities. In limestone of the age of the Warsaw limestone : Spergen hill and Bloomington, Iowa.

Rhynchonella mutata.

PLATE XXIII. FIG. 2 *a*, *b*.

Rhynchonella mutata : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL subtrigonal, more or less gibbous; front broadly rounded or nearly straight, abruptly tapering to the apex, the two sides meeting at an angle of nearly 90°. Dorsal valve much more convex than the opposite one, which is often depressed; shell most convex near the anterior margin; beak obtusely angular, and closely incurved. Beak of ventral valve nearly straight, or but slightly incurved : sinus not deeply impressed on the margin of the shell; foramen triangular.

SURFACE marked by from twelve to sixteen strong subangular plications, about four or five of which are depressed in the sinus of the dorsal valve : concentric striæ rarely visible.

Length, ·15 to ·30, width ·14 to ·32 of an inch.

Fig. 2 *a*, *b*. Dorsal and ventral views of a specimen of ordinary size.

Geological formation and locality. In the Warsaw limestone near Alton, Illinois.

Rhynchonella subcuneata.

PLATE XXIII. FIG. 3 *a*, *b*, *c*.

Rhynchonella subcuneata : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL triangular, subcuneate ; front rounded, meeting the lateral slopes at an obtuse angle ; sides sloping to the beak, and meeting at an angle of 60° or 65° : valves nearly equally convex. Ventral valve most convex towards the beak which is very acute, scarcely incurved, and perforated by a triangular foramen : sinus obscure : beak of dorsal valve acute, closely incurved below the triangular foramen.

SURFACE marked by about twelve to fourteen (and rarely sixteen) strong simple angular plications, which are somewhat obsolete near the beak. Plications crossed by fine concentric striæ, and, in old shells, at irregular distances, by stronger imbricating folds or wrinkles parallel to the lines of growth. Sides of both valves, beneath the beak, free from plications, and forming a very distinct elongate oval space.

Length, ·16 to ·41, width ·15 to ·39 of an inch.

Fig. 3 *a, b*. Ventral and dorsal views of a specimen.
Fig. 3 *c*. Profile of the same.

Geological formation and localities. In limestone of the age of the Warsaw limestone : Bloomington and Spergen hill, Indiana.

Terebratula trinuclea.

PLATE XXIII. FIG. 4 *a*, *b*, *c*, and 5.

Terebratula trinuclea : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL subpentagonal or ovate, robust, trilobate, lobes nearly equal : valves nearly equal ; the ventral one gibbous towards the beak ; sinus beginning above the middle of the valve, gradually becoming wider and deeper towards the base ; in some specimens, distinctly bounded by an obtusely angular ridge. Dorsal valve varying from subcircular to transversely oval and longitudinally ovate, most convex between the centre and the beak, and distinctly trilobate ; lobes extending about half way to the beak, the middle lobe often marked by a distinct linear depression : beak of ventral valve strong, rounded and incurved, truncated vertically by a distinct rounded foramen.

SURFACE marked by fine concentric lines, which undulate with the lobes, and are extremely sinuous near the margin of the shell.

Old shells are often marked by strong imbricating lamellæ at unequal distances.

Length, ·20 to ·51, width ·19 to ·46 of an inch.

This species bears a very close resemblance to *Athyris* (?) *triloba* of M'COY (Synopsis of the Carboniferous limestone fossils of Ireland, pa. 149, pl. xx, f. 21), particularly the old shells, which are broader and more strongly marked than the others.

Fig. 4 *a*, *b*. Dorsal and ventral views of a specimen of the ordinary form.

Fig. 4 *c*. Profile of the same.

Fig. 5. Dorsal view of a broader form, showing a wide mesial lobe, with a narrow impression down the centre.

Geological position and localities. In limestone of the age of the Warsaw limestone : Bloomington and Spergen hill, Indiana.

Spirifer subcardiiformis (n. s.).

PLATE XXIII. FIG. 6 *a*, *b*.

SHELL somewhat depressed globose, gibbous towards the beaks and depressed towards the basal and lateral margins : valves subequal. Dorsal valve a little the less convex : beak rising above the hinge-line, with a comparatively large triangular area beneath : mesial fold little elevated, marked in the middle and at base by four strong plications which originate at the beak as a single one ; about seven simple, strong, rounded and little elevated plications on each side. Ventral valve with the beak a little elevated above the opposite, incurved : mesial sinus faintly defined and marked by three strong plications, one of which lies in the centre and one on each side, with seven or eight on the lateral portions of the shell : area short and high, little extended on each side of the large foramen, which forms nearly an equilateral triangle.

The surface marking appears to have been minutely striato-punctate, but it is not well preserved in the only specimen examined.

The only European Carboniferous species that resembles this, is the *S. rotundatus;* from which this species is distinguished by its short high area, its larger foramen, its more equal beaks, and less number of plications.

Fig. 6 *a*. Ventral valve, the specimen a little distorted from pressure.

Fig. 6 *b*. Dorsal view of the same, showing the area and foramen of the opposite valve.

Geological formation and locality. In the Warsaw limestone, above Alton, Illinois.

Spirifer lateralis (n. s.).

PLATE XXIII. FIG. 7 *a*, *b*, *c*.

SHELL extremely transverse, the greatest width being nearly three times the length, gibbous in the middle, gradually attenuate towards the extremities. Dorsal valve regularly convex, and nearly semicylindrical on the lateral portions : mesial fold abruptly and strongly elevated, acutely angular and much incurved towards the beak, becoming rounded below. Ventral valve less convex on the sides than the opposite valve, a little more gibbous on the umbo, with the beak moderately incurved : mesial sinus scarcely visible at the umbo, becoming broad, shallow and scarcely defined below : area concave, narrow, extending to the extremities of the shell, and having the outer margin acutely angular.

SURFACE marked by rounded closely arranged and little elevated plications, about twenty-five of which may be counted on each side, while about ten or twelve occupy the mesial fold and sinus respectively ; of the latter, the six or eight central ones arise from the dichotomizing of two or three which originate at the beak. A large number of the plications run out upon the hinge-line : minute structure striato-punctate.

In the cast, the vascular impression occupies nearly half the width of the shell : muscular impressions of the dorsal valve strongly marked ; margins denticulate.

This species is so remarkably unlike any other which has fallen under my observation, that it may be readily distinguished.

Fig. 7 *a*. Dorsal view, showing the area and foramen of the ventral valve.

Fig. 7 *b*. Ventral valve of the same specimen, showing the broad undefined mesial depression.

Fig. 7 *c*. Front view, showing the outline and elevation of the mesial fold.

Geological formation and locality. In the Warsaw limestone : Clifton, Illinois.

Spirifer tenuicostatus (n. s.).

Plate XXIII. Fig. 8 *a*, *b*, *c*.

Shell semielliptical, nearly twice as wide as long : valves nearly equally convex. Dorsal valve more or less gibbous in the middle; the mesial elevation not defined, and scarcely distinct from the general convexity of the shell above the centre, becoming prominent on the lower half of the shell : cardinal margin marked by a narrow linear area. Ventral valve with the beak moderately elevated above the opposite, and slightly incurved : mesial sinus often well defined at its margins on the upper half of the shell, and becoming broader and undefined on the lower half : area of moderate height, concave ; foramen large.

Surface, including the mesial sinus and elevation, marked by fine equal striæ, some of which bifurcate on the upper half of the shell; those occupying the mesial fold and sinus being from ten to fourteen, resulting from the dichotomizing of two or three at the apex : about twenty-four to twenty-eight plications on either side of the mesial fold and sinus. Plications crossed by fine elevated closely arranged concentric striæ, with stronger distant imbricating laminæ of growth.

This species varies in its degree of gibbosity, but is usually distinguished by its moderate convexity and the fine equal plications, which are scarcely interrupted by the bifurcations, and the closely arranged concentric striæ by which it differs from any other species observed. It appears to be common to the Warsaw and Keokuk limestones, unless there be some error in the marking of specimens. Some specimens from Keokuk are undistinguishable from the Warsaw specimens, and it is not improbable that all are from beds of the age of the Keokuk limestone.

Fig. 8 *a*. Dorsal view, showing the beak and part of the area and foramen of the opposite valve.

Fig. 8 *b*. Ventral valve, in which the lines of growth and concentric striæ are well preserved.

Fig. 8 *c*. Profile view of the same.

Geological formation and localities. In the Keokuk and Warsaw limestones : Keokuk, Iowa ; Warsaw, and Dallas, Illinois.

Spirifer subequalis (n. s.).

PLATE XXIII. FIG. 9 *a, b, c*.

SHELL semielliptical, about twice as wide as long : valves almost entirely equal, the beak of the ventral valve being very slightly elevated above the opposite. Dorsal valve depressed convex ; the mesial fold obtusely angular, scarcely defined at its margins : a narrow cardinal area, which is conspicuous in well preserved specimens. Ventral valve somewhat gibbous on the umbo : beak slightly incurved : mesial sinus not observable on the upper half of the shell, and becoming a broad depression with undefined margins below : area of moderate width, extending to the cardinal extremities ; foramen large, the width at base greater than the length of the side.

Entire surface, including sinus and fold, marked by simple rounded plications, which bifurcate near the beak, and of which there are about eighteen on each side, and about eight on the mesial fold and ten in the sinus ; concentrically marked by undulating laminæ of growth and finer striæ.

Fig. 9 *a*. View of the ventral valve.

Fig. 9 *b*. Dorsal view, showing the beak of the opposite valve rising a little above the other.

Fig. 9 *c*. Cardinal view, showing the area and foramen.

Geological formation and locality. In the Warsaw limestone : Warsaw, Illinois.

Cypricardella nucleata.

PLATE XXIII. FIG. 10 *a, b, c, d*.

Cypricardella nucleata : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL inequilateral, subquadrangular, gibbous ; anterior end short, rounded ; posterior end broader, abruptly compressed, vertically truncated at the extremity : beak nearer the anterior end, small. Posterior umbonial slope extremely gibbous (a broad undefined ridge), reaching to the base of the truncation.

SURFACE marked by fine regular concentric lines parallel to the border of the shell.

Length, ·11 to ·13, width ·08 to ·10 of an inch.

Fig. 10 *a*, *b*. Dorsal view, and view of the right valve.
Fig. 10 *c*. The same enlarged.
Fig. 10 *d*. Enlargement of the concentric striæ.

Geological position and locality. In limestone of the age of the Warsaw limestone : Spergen hill, Indiana.

Cypricardella subelliptica.

PLATE XXIII. FIG. 11 & 12.

Cypricardella subelliptica : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL subelliptical, obliquely truncated at the posterior end. Beaks minute at the apex, rising little above the hinge : umbones subgibbous, with an undefined elevation extending obliquely towards the posterior basal margin ; anterior end narrower than the posterior, rounded at the extremity. Cardinal margin forming an angle with the beak of 25° : base forming a regular elliptical curve.

SURFACE marked by regular fine concentric elevated lines, which are equal to the spaces between.

Length, ·19 to ·32, width ·14 to ·24 of an inch.

Fig. 11. View of the right valve.
Fig. 12. Interior of the same, showing the character of the hinge-line.

Geological position and locality. In limestone of the age of the Warsaw limestone : Spergen hill, Indiana.

Pleurotomaria wortheni.

PLATE XXIII. FIG. 13 *a*, *b*, *c*, *d*.

Pleurotomaria wortheni : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL depressed subglobose : spire but little elevated, oblique from the great expansion of the last volution. Volutions about three, somewhat flattened above, rapidly expanding so that the last volution makes nearly the whole bulk of the shell, obtusely angulate on the periphery : upper margin of the volutions marked by a row of strong nodes, which extend about one-third across.

SURFACE marked above by striæ parallel to the lines of growth, which, on the last volution, disappear in passing over the angulate periphery : base of last volution marked by strong revolving lines on the space between the outer margin and the umbilical area. Base deeply excavated about the umbilical region, but the umbilicus is unknown. Aperture subquadrate ; upper edge of the outer lip projecting far over the lower.

Diameter ·60, height ·48 of an inch.

Fig. 13 *a*. View of the summit, natural size.
Fig. 13 *b*. Profile view, showing the elevation of the spire.
Fig. 13 *c*. View of the base.
Fig. 13 *d*. Enlargement of the striæ and carinations which characterize the surface.

Geological formation and localities. In limestone of the age of the Warsaw limestone : Spergen hill and Bloomington, Indiana.

Capulus acutirostris.

PLATE XXIII. FIG. 14 *a*, *b*.

Capulus acutirostris : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL obliquely conical, more abruptly contracted above, and continued in more slender proportions to the apex, which is incurved, making about a single volution without contact with the body of the shell : aperture subcircular ; margin sinuate.

SURFACE subplicate, with narrow subangular folds and wider depressed spaces : lines of growth strong, abrupt upon the angles, and arching forwards on the spaces between.

This little shell is a very common and characteristic species of this rock; and though sometimes attaining a greater size than the figure, rarely varies from the characters here assigned.

Fig. 14 *a*, *b*. Views of the upper and lower sides of the shell.

Geological position and localities. In the Warsaw limestone : Warsaw, Illinois ; Spergen hill and Bloomington, Indiana.

Bellerophon sublævis.

PLATE XXIII. FIG. 15 *a, b, c.*

Bellerophon sublævis : HALL, Transactions of the Albany Institute, Vol. iv, 1856.

SHELL subglobose, inflated on the last volution. Aperture transverse, arcuate, expanded; the lip thickened, and much extended at the junction with the volution : umbilicus none; dorsum carinated by a narrow slightly elevated carina.

SURFACE ornamented by fine regular striæ, which bend abruptly and deeply backwards on the carina, denoting the depth of the emargination of the lip : striæ sometimes irregular from interrupted growth.

Length, from ·062 to ·875 of an inch.

Fig. 15 *a*. View of the aperture.
Fig. 15 *b*. Lateral view of the shell.
Fig. 15 *c*. Dorsal view of the same.

Geological position and localities. In the Warsaw limestone, above Alton, Illinois ; Spergen hill and Bloomington, Indiana.

Dentalium primarium (n. s.).

PLATE XXIII. FIG. 16.

SHELL elongate; the lower half nearly straight and very slightly tapering, gradually curving above and more rapidly diminishing.

SURFACE marked by fine annulating striæ, which at intervals become more strongly marked.

The specimen examined is somewhat exfoliated, and the original surface marking is not fully preserved. The species is among the earliest of this genus, several others occurring in the Carboniferous rocks.

Fig. 16. Lateral view of the specimen, natural size.

Geological formation and locality. In the Warsaw limestone : Hancock county, Illinois.

FOSSILS OF THE ST. LOUIS LIMESTONE.

This rock, though developed over a large area in the State of Iowa, has thus far proved comparatively unproductive of fossils. It was originally designated by Dr. Owen the "*Brecciated limestone*"; and the rock, in this condition, contains few fossils. Farther to the southward the brecciated character is partially or entirely lost, and the rock becomes a regular-bedded and important formation, as I have already shown in the geological report.

It has been necessary, therefore, in order to illustrate its palæozoic characters, to go beyond the limits of the State; and consequently the illustrations are restricted to a few species, some of which occur within the State, while others are from the nearest authentic localities of this rock upon the Mississippi river.

Lithostrotion mamillare.

Plate XXIV. Fig. 5 *a*, *b*.

Stylina : Lesueur, 1832.

Astrea mamillaris : Castelnau, Terrains Sil. de l'Amérique du Nord, Pl. 24, f. 5, 1843.

Axinura canadensis : Ib. Id. Pl. 24, f. 4.

Acrocyathus floriforme : D'Orbigny, Prodrome de Paléontologie, T. i, p. 160, 1850.

Lithostrotion basaltiforme : Owen, Report of Wisconsin, Iowa and Minnesota, Tab. iv, f. 5 and 6, 1852.

Lithostrotion mamillare : Edwards and Haime, Monograph des Polypiers fossils, pa. 433, pl. 13, f. 1, 1 *a* and 1 *b*.

Coral massive, or more rarely in subdendriform tufts. Calyces circular or polygonal, varying according to the degree of proximity of the individuals, very unequal, profound: the centre is monticuliform, and the summit terminated by a salient columella, which is sometimes compressed and subcristiform. A very small septal fosset on each side, in the direction of the longer horizontal axis of the columella, a little deeper on one side than on the other. Number of rays variable, according to the size of the calyx, from 18 to 46; the ray-chambers slightly concave in the upper part, a little convex in the middle, and again concave below.

In many weathered specimens the exterior cellular portion is worn away, leaving the interior cylindrical portion entirely separated by a vertical line.

This fossil is one of the most widely distributed corals of the Carboniferous limestones, and appears to hold the same geological position from Central Iowa to Alabama, everywhere marking the horizon of the St. Louis limestone. Being an abundant and conspicuous fossil, it becomes one of the best guides for the determination of any member of the Carboniferous limestone series below the Coal formation.

The illustrations given are but feeble representations of the beautiful and magnificent masses of this coral which occur in Southern Iowa and the neighboring State of Missouri.

Fig. 5 *a*. View of the calyces of a small group, showing the varying dimensions.

Fig. 5 *b*. Vertical section of a portion of the mass, showing the columnar structure where the cells are closely compressed, the elevated columella, etc.

Geological position and localities. In the St. Louis limestone : Mount-Pleasant, and numerous localities in the valley of the Desmoines, Iowa ; St. Francisville, and other places in Missouri ; Warsaw, Johnson's landing, Milan, Alton, Prairie du Rocher, and other places in Illinois ; Elliottsville, Indiana ; and numerous localities in Kentucky, Tennessee and Alabama.

Lithostrotion proliferum (n. s.).

Plate XXIV. Fig. 6 *a*, *b*, *c*.

Coral dendroid, simple or in tufts, cylindrical or obconic, proliferous. Calyx often profound, monticuliform, the columella often extremely salient; exterior portion having the celluliferous structure well developed. Rays strong, varying from twenty to thirty or more in each calyx.

The continuity of the exterior growth is often abruptly interrupted by the mode of increase; the germs growing from the cup on one, two or more sides, while the central or original germ is often much contracted to give room for the bases of the lateral ones, which thus go on increasing till large groups are formed.

The mode of growth of this coral is so different from that of the *L. basaltiforme*, that I cannot suppose it to be a variety of that species, which indeed does often occur in separate cylindrical individuals or in groups of several together; but in no instance have I observed the mode of growth shown in fig. 2 *a*.

The central columella is not well shown in the figure, the section not reaching the centre. In weathered specimens this feature is often very well shown, both in its longitudinal extension and its narrow pointed elevation in the bottom of the calyx.

Fig. 6 *a*. A small group, showing the central cup, with the branches arising from proliferous budding.

Fig. 6 *b*. A longitudinal section, which is a little on one side of the centre.

Fig. 6 *c*. Transverse section enlarged.

Geological position and localities. In the St. Louis limestone : Johnson's landing and Milan, Illinois.

CRINOIDEÆ OF THE ST. LOUIS LIMESTONE.

I HAVE selected, from among the collections of Mr. WORTHEN, a few species from St. Louis for the illustration of this formation, which, although occurring at numerous localities and over wide areas in Iowa, has thus far afforded no fossils of this family.

These species of the Crinoideæ of the St. Louis limestone I originally arranged on the plates with those of the Keokuk limestone, principally upon the authority of information furnished by Mr. WORTHEN, which seemed to show that the lower beds at St. Louis were on a parallel with the Keokuk beds, and contained some of the same species of fossils; and the possession by Mr. WORTHEN of a (*Melonites*) *Palechinus*, similar to the remarkable and characteristic one of St. Louis, seemed to afford presumptive evidence of the identity of the two limestones. Further examination, however, has not shown any identical species; and with my present information, I must regard all the beds reached in the excavations at St. Louis as pertaining to this division of the Carboniferous limestone, as proposed by Professor SWALLOW.

Poteriocrinus missouriensis.

PLATE XVII. FIG. 7 *a*, *b*.

Poteriocrinus longidactylus: SHUMARD, Geological Report of Missouri, 1855, pa. 188, Pl. B, f. 5 *a*, *b*, *c* (Non Austin Crinoid. pl. 11, f. 3).
P. missouriensis: SHUMARD, Trans. Acad. Scien. St. Louis, 1857 (p. 12 of extract).

BODY narrow turbinate, gradually tapering to the column below. Basal plates five, pentagonal, length and breadth about equal: subradial plates as wide as long, three regularly hexagonal, two adjoining the anal side irregularly heptagonal. First radial plates wider than long, alternating with the subradial plates, and the one on the right of the anal plates resting on the truncated upper face of a subradial plate, two of its sides supporting two anal plates : the articulating surfaces occupy the entire width of the plate. Second radials quadrangular, wider than long, the succeeding plates gradually becoming wedgeform above. Arms long; (in two specimens examined) bifurcating on the thirteenth plate above the second radial, and again at a higher point. Proboscis elongate, composed of transverse hexagonal plates. Suture lines between the plates of every second range marked by rows of minute pores.

Column long cylindrical, enlarging near the base of the calyx, with a pentapetalous canal.

This species is described by Dr. Shumard as having a column two feet in length.

Fig. 7 *a*. A specimen showing the anal side, with a few joints of the column and the lower part of the arms, and a part of the proboscis.

Fig. 7 *b*. Enlargement of the plates of the proboscis, showing the pores between the alternate ranges.

Geological position and locality. In the St. Louis limestone, near St. Louis, Missouri.

Scaphiocrinus dactyliformis (n. s.).

Plate XVII. Fig. 6.

Body broadly subturbinate, wider at the summit than the length. Basal plates small, pentagonal, longer than wide; subradial plates hexagonal, except on the anal side, about as long as wide. First radial plates pentagonal, much wider than long. Second radial plates pentagonal, a little longer than wide : arms originating in pairs on the upper sloping sides of the second radial, composed of strong thick plates with alternating longer and shorter sides, and bifurcating on the fourth plate from the base in some of the arms.

Column composed of alternating thicker and thinner joints near the base of the body, becoming more unequal below, every fourth or fifth plate being larger than the others.

This species is distinguished by its strong convex or semicylindrical arms and a broader stronger calyx than those previously described. The tentacula have not been observed.

Fig. 6. The anterior and antero-lateral rays of the column with a part of the adjacent rays.

Fig. 105.

The accompanying diagram illustrates more fully the arrangement of the plates of the base, the subradial and radial plates.

Geological formation and locality. In the St. Louis limestone : St. Louis, Missouri.

Forbesiocrinus shumardianus (n. s.).

Plate XVII. Fig. 1.

Body broadly turbinate with the rays strongly prominent: basal plates forming a narrow rim around the summit of the column; subradial plates comparatively large, two of them hexagonal and three heptagonal, being truncated at their summit by the interradial plates. Radial plates large, about twice as wide as long, the first ones pentagonal, the second and third hexagonal, and the fourth pentagonal; secondary plates three between the first and second bifurcation, with the same number between the second and third bifurcation, becoming somewhat abruptly smaller at this point: subdivisions of the arms giving ten or twelve to each ray; interradial plates twelve or more; anal plates undetermined; interaxillary plates four or more.

Column round, composed of short joints near the summit, gradually becoming larger below.

This species differs conspicuously from either of the others described, in its broad turbinate form which is abruptly rounded below; the rays are proportionally stronger and more abruptly elevated, while the divisions above the first bifurcation are much more abruptly tapering than in any described species.

Fig. 1. View of the anterior side of specimen, showing the truncated subradial plates.

Geological formation and locality. In the St. Louis limestone : St. Louis, Missouri.

Synbathocrinus swallovi (n. s.).

Plate XVII. Fig. 8 & 9.

Body elongate : base small, somewhat truncate below, and depressed for the reception of the column; sutures of the three divisions barely visible. First radial plates quadrangular, wider than long, except on the anal side, where two of them are slightly truncated on their upper angles; forming, with the base, a shallow spreading basin. Second radial plates quadrangular, wider than long, narrower above, subangular in the middle of the upper half of the plate. Arms simple, elongated, scarcely tapering : plates quadrangular, wider than long, the lower ones obtusely angular in the middle, those of the upper and middle part becoming regularly convex.

Column composed of alternating longer and shorter plates, with a shorter plate at every third, fourth or fifth articulation : joints of the column deeply serrated on the articulating faces.

This species differs from the *S. wortheni* of the Burlington limestone in being less elongated, having a broader and shorter base, the depth of the calyx from the base to the top of the first radials being not more than two-thirds as great as in the former species; while the arm-joints are proportionally shorter.

Fig. 8. A specimen somewhat distorted from pressure, with arm-joints less distinctly angular than in the other specimen.

Fig. 9. A specimen preserving a portion of the column, and having the summit broken away [The plates of the arms are improperly represented in the figure as opposite to each other, while they alternate; the two rays on the right hand vary nearly a quarter of the length of the plate, and on the left ray the sutures are opposite the centre of the plates of the adjacent ray.]

Geological position and locality. In the St. Louis limestone, near St. Louis, Missouri.

Platycrinus saræ* (n. s.).

PLATE XVII. FIG. 4.

BODY broadly turbinate, gibbous in the middle. Basal plates convex exteriorly, and curving upwards from the centre; upper margins concave; length about three-fourths as great as the radial plate: column-area large. Radial plates as wide as long, indented on their upper margin with a deep articulating scar for the reception of the brachial and arm-plates; summit of the plates, on each side, reaching as high as the third plate of the brachial series. Subbrachial plate small, triangular, situated in the bottom of the articulating scar, and supporting on each upper sloping side a first and second brachial plate, upon the last of which the plates bifurcate, those of the outer side continuing simple, while the inner adjacent ones bifurcate on the second plate above; giving six arms from each ray. Arms composed near their base of a single series of wedgeform plates, which gradually become a double series of alternating plates: tentacula composed of joints which are about three or four times as long as wide.

COLUMN obtusely pentangular, composed of alternating longer and shorter joints.

SURFACE marked by ridges extending from the base to the upper angles of the basal plates; and from the centre and outer basal angles of the radial plates, similar ridges converge towards the base of the arms: entire surface granulose.

This surface character is but obscurely represented in the specimen figured.

Fig. 4. View of a specimen having the body, arms and tentacula nearly entire, with a small portion of the column.

Geological position and locality. In the St. Louis limestone, near St. Louis, Missouri.

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* In honorem Dominæ WORTHEN.

BRACHIOPODA OF THE ST. LOUIS LIMESTONE.

Productus ovatus (n. s.).

PLATE XXIV. FIG. 1.

VENTRAL valve ovoid, rounded below and gradually diminishing, from the broader part of the shell, with a curved outline to the beak, prominently convex in the middle, with the beak incurved : extent of the cardinal extremities unknown.

SURFACE marked by fine, scarcely elevated, rounded costæ; the cardinal extremities, sides and front of the shell ornamented by numerous slender elongated tubular spines.

This species differs from any described one with which I am acquainted. In some of its characters it resembles the *P. altonensis* ; but the costæ are stronger, the shell is less arcuate, and narrower towards the beak.

Fig. 1. Ventral valve of a specimen of this species.

Geological position and localities. In the St. Louis limestone : Ottumwa and Keosauqua, Iowa ; and St. Louis, Missouri.

Productus marginicinctus.

PLATE XXIV. FIG. 3 *a*, *b*, *c*.

Productus marginicinctus : PROUT, Transactions of the Academy of Sciences of St. Louis, Vol. 1, pa. 43, pl. 2, f. 1-16.

SHELL of medium size, subquadrate, usually wider than long. Dorsal valve subquadrate, convex at the beak and depressed on each side, flattened in the middle and towards the base. Ventral valve highly arched with the summit of the arch nearer the beak, broad and gibbous below, narrowing towards the beak, with the sides nearly straight above the middle of the shell : beak closely incurved, and projecting slightly beyond the hinge-line.

SURFACE marked by round salient costæ, which are dichotomous at intervals; the point of bifurcation marked by an elongated tubercle, from which originates a spine. This character is more conspicuous on the middle and front of the shell. On the upper part of the shell, the costæ are crossed by prominent concentric wrinkles, which are more conspicuous on the auriculate cardinal extremities, where they are marked by minute round tubercles or spine-bases: these give a somewhat nodose character to the costæ over the upper portion of the shell. Fine concentric striæ mark the entire surface.

The differences in character between this species and *P. wortheni* have already been pointed out; and the two shells, though approaching each other in general form, are conspicuously distinct.

I am indebted to Dr. PROUT, of St. Louis, for the means of illustrating this species. For a more full description and illustration of the same, see the paper cited at the head of this description.

Fig. 3 *a*. Ventral valve of a specimen of this species. [The figure represents the shell too broad, and the sides too much curved.]

Fig. 3 *b*. Profile view of the same, showing the arcuate form and prominence of the marginal cincture.

Fig. 3 *c*. Dorsal valve of another individual.

Geological position and localities. In the St. Louis limestone: St. Louis, Missouri; Milan, Illinois.

Productus tenuicostus (n. s.).

PLATE XXIV. FIG. 2 *a, b, c, d*.

SHELL somewhat ovoid, usually much longer than wide, extremely arcuate above, the summit of the arch nearer the beak. Dorsal valve convex near the beak and depressed on each side, flattened in the middle and suddenly bent upwards in front. Ventral valve extremely arcuate, rounded and gibbous above, flattened or scarcely depressed and sometimes a little elevated in the middle, spreading and auricalate at the cardinal margins, extremely produced in front, expanded and somewhat longitudinally plicate.

SURFACE marked by numerous slender filiform costæ, which bifurcate on the upper part of the shell, becoming very regular on the central portions, and again bifurcating irregularly and extremely below the middle and towards the base. A few rounded prominent spines occur on the central portion of the ventral valve, at the coalescing or bifurcation of the costæ. The upper part of the shell is marked by concentric wrinkles, which become more conspicuous on the auriculate cardinal extremities, and are there marked by a few tubercles which are probably the bases of spines.

This species possesses some characters in common with *P. altonensis* of Norwood and Pratten; but the spreading and subplicated character of the front of the shell, as well as the absence of the reticulated appearance mentioned by these authors, prove it to be quite distinct. In general form and aspect it resembles the *P. flemingi*, var. *burlingtonensis*; but is more finely costate, the spines are smaller, and the mesial depression not existing or inconstant.

It also resembles the figures of *P. flexistriæ* of M'Coy; but is more finely costate, and bears spines on the anterior portion of the shell, which are not shown in the figures of M'Coy or De Koninck.

Fig. 2 *a*. Ventral valve of this species. [The anterior longitudinal folds or undulations are not well shown in the figure.]

Fig. 2 *b*. Profile view, showing the extremely arcuate character of the shell.

Fig. 2 *c*. View of the cardinal and upper portion of a ventral valve.

Fig. 2 *d*. Dorsal valve of this species.

Geological position and locality. In the St. Louis limestone, associated with *Lithostrotion mamillare* and *Productus marginicinctus*: Milan, Ill.

Spirifer keokuk, var.

Plate XXIV. Fig. 4 *a, b, d*.

Shell transversely semielliptical; hinge-line longer or shorter than the width of the shell below: valves nearly equally convex. Dorsal valve with the mesial sinus abruptly elevated, simple above, and becoming divided into four distinct plications below. Ventral valve with the sinus simple at its origin, and becoming marked by a strong flattened plication in the bottom, with a smaller elevated one on each side: beak closely incurved, linear; foramen broad.

Surface, on each side of the mesial fold and sinus, marked by from seven to ten simple plications; the two adjacent to the mesial sinus and elevation originating from a single one near the apex. Entire surface cancellated by extremely fine concentric striæ and somewhat stronger radiating striæ, which are more conspicuous than the others, and, towards the margin, by stronger imbricating lamellose lines of growth.

This species bears so close a resemblance to *S. keokuk*, that I cannot find characters for a specific distinction. The plications are usually less numerous in a shell of the same size; but it is somewhat variable in form, and particularly in the extension of the cardinal extremities and the gibbosity of the shell.

Fig. 4 *a*. A ventral valve, showing the extended cardinal extremities.

Fig. 4 *b*. Cardinal view of the same.

Fig. 4 *d*. Dorsal view of a more gibbous specimen, with the cardinal extremities rounded.

Geological position and locality. In the Brecciated or St. Louis limestone at the mouth of Lizard creek, Webster county, Iowa.

FOSSILS OF THE KASKASKIA LIMESTONE.

As previously stated in the Geological Report, this limestone is not known within the State of Iowa; thinning out in its northern prolongation before reaching so far in that direction. In order therefore to illustrate the entire series of Carboniferous limestones, I have found it necessary to go beyond the limits of the State for the materials.

The Crinoideæ, as well as some of the Brachiopoda, have been furnished by Mr. Worthen from his extensive cabinet. Having examined the rock in some of its best developed localities, I am prepared to recognize it as very distinct in its palæozoic features from either of the preceding limestones, not having thus far found any species which are common to this rock and either of those already described.

CRINOIDEÆ AND OTHER ECHINODERMATA OF THE KASKASKIA LIMESTONE.

THE Crinoideæ most characteristic of this rock are the ZEACRINUS of TROOST, and the SCAPHIOCRINUS, already described under the Burlington limestone ; genera having a very similar fundamental structure, but differing essentially in general form and habit. Several species of PLATYCRINUS and CYATHOCRINUS are likewise known in this rock; but so far as my observation has extended, they do not constitute an equal proportion of the whole, when compared with the Crinoideæ of the other rocks of the Carboniferous period. Far from having made a selection for contrasting with those of the preceding formations, I have taken the most common and prevailing forms; and it is extremely interesting to compare, in the successive epochs of the Carboniferous period, so well marked in physical characters over so wide an area of the Mississippi plateau, the development and expression of this family of fossils.

It is likewise in this rock that the Genus PENTREMITES becomes so conspicuous; and from this formation were obtained the typical species of the genus, described by SAY. Although at the present time there are perhaps an equal number of species known in the Burlington limestone, they are mostly different in form, and far from being as numerous individually as those of the Kaskaskia limestone.

GENUS SCAPHIOCRINUS.

(For generic description, see pp. 549 and 550 of this report.)

Scaphiocrinus decabrachiatus (n. s.).

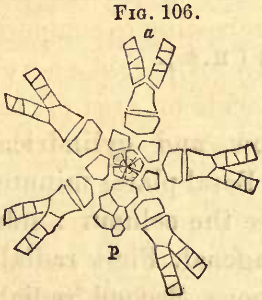
PLATE XXV. FIG. 1.

BODY and arms subcylindrical, tapering to the base. Basal plates small, forming together a very shallow basin : subradial plates about as wide as long. First radial plates a little wider than long. Second radials nearly once and a half as long as wide, distinctly concave at the sides; the upper sloping faces supporting a pair of arms which are composed of subcuneate plates in alternate series, the lower ones of which are conspicuous and concave on their longer sides. Arms simple from their origin, and tentaculate from the upper angles of the longer sides of the plates.

This species, in its simple arms, resembles the *S. simplex* of the Burlington limestone; but the body is proportionally much longer, the basal plates larger and more prominent, the anal plates conspicuously different in form and arrangement, and the plates of the arms longer.

Fig. 1. The anal side of specimen; the right antero-lateral ray somewhat broken and distorted.

FIG. 106.



The accompanying diagram illustrates the form and proportions of the plates of the body and bases of the arms.

Geological position and locality. In the Kaskaskia limestone : Kaskaskia, Illinois.

Scaphiocrinus internodius (n. s.).

PLATE XXV. FIG. 2.

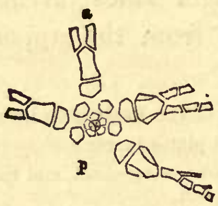
CALYX symmetrically turbinate to the top of the first radials. Basal plates proportionally large, as long or longer than wide : subradials, except on the anal side, symmetrically hexagonal, as wide as long. First radial plates pentagonal, wider than long, and slightly spreading above. Second radials twice as long as wide, thickened, rounded exteriorly and concave at the sides, the margins spreading to the sutures. Arms composed of elongated joints, which, near the base, are more than twice as long as wide, rounded externally, and concave at the sides.

Column round or obtusely pentagonal, composed near the body of thickened equal joints.

This species differs from any other of the genus, in the elongate second radials and the long arm-joints, which are simple, as far as observed.

Fig. 2. The anterior side of a specimen preserving the lower joints of the arms.

Fig. 107.



The accompanying diagram illustrates the form and proportions of the plates of the body and the elongate lower plates of the arms and tentacula, which are distinguishing features of this species. The lateral extensions of the second radial plates, beyond the curved line, represent the thin articulating margins, which are usually not visible in the specimens examined.

Geological position and locality. In the Kaskaskia limestone : Chester, Illinois.

Scaphiocrinus scoparius (n. s.).

Plate XXV. Fig. 3 *a*, *b*.

Body small, regularly turbinate below, and cylindrical above to the first bifurcation of the arms. Basal plates minute, forming a small pentangular disc above the column : subradial plates very small, regularly hexagonal. First radials pentagonal, wider than long, straight above. Second radials pentagonal, wedgeform above, a little longer than wide, sides parallel, and slightly converging above ; each second radial giving origin to a pair of arms, the lower joints of which are twice or thrice as long as the succeeding ones. Arms bifurcating on the sixth or seventh plate from the base, composed of plates which are alternately thicker and thinner on their opposite sides; those above the bifurcation minute, quadrangular.

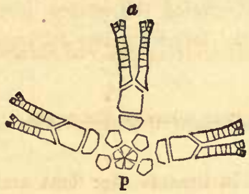
COLUMN round, composed near the body of alternating thicker and thinner joints.

This species may be distinguished by its small size, the parallel sides of the third radial plates, and the elongate first arm-joints.

Fig. 3 *a*. View of anterior side of specimen.

Fig. 3 *b*. The same enlarged, showing more distinctly the form and arrangement of the plates.

FIG. 108.



The accompanying diagram illustrates the structure of this species, which, in the form and proportions of the plates of the body and arms contrasts conspicuously with the preceding species.

Geological position and locality. In the Kaskaskia limestone : Chester, Illinois.

Zeacrinus intermedius (n. s.).

PLATE XXV. FIG. 4.

BODY broad, abruptly spreading to the base of the first radials. Basal plates minute, hidden by the column. Subradial plates longer than wide, hexagonal, except the anal and right postero-lateral plates, which are heptagonal. First radial plates pentagonal, short, nearly twice as wide as long. Second radial plates short, pentagonal; each one, on the upper sloping sides, supporting two diverging arms composed of short plates, which, with the exception of the lower ones, are more than twice as wide as long. Arms bifurcating on the third, fourth, fifth or sixth plate above the base, and the outer divisions of each ray again bifurcating on the sixth plate above the first division. Anal plates six determinable.

COLUMN small, pentagonal, consisting of alternating longer and shorter joints, or of several shorter ones between the longer ones : the larger joints are thickened at their angles, and bear slender rounded branching rootlets.

This species is more depressed and shorter in the body and rays than any other of this genus known to me. It presents the characters of *Zeacrinus* in its small basal plates, long subradials and short second radial plates; while the base is scarcely depressed and the arms have more the expression of *Scaphiocrinus* in their branching, while the plates are of the form corresponding to *Zeacrinus*. The form is one showing the intimate relations of the two genera, and may with almost equal propriety be referred to either. The extremities of the two types may be seen by comparing the generic illustration on page 550 with the following one on page 684.

FIG. 109.

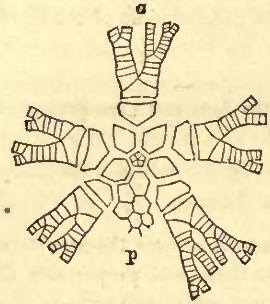


Fig. 4. The anterior side of the specimen, which has the arms of this ray broken off above the first bifurcation.

Geological position and locality. In the Kaskaskia limestone : Chester, Illinois.

Zeacrinus maniformis.

PLATE XXV. FIG. 8.

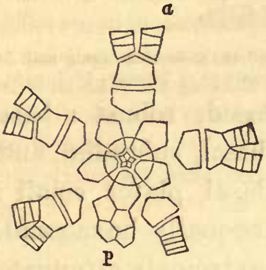
Poteriocrinus maniformis : YANDELL and SHUMARD, Contributions to he Geology of Kentucky, 1847, pa. 24, pl. 1, f. 2.
Cyathocrinus maniformis : Y. and S., Catalogue, etc.
Cyathocrinus gracilis : TROOST, Catalogue, 1849.

BODY subcylindrical, concave at the base, rounded and gibbous above, the concavity involving the lower half of the subradial plates, depressed subconical above when the arms are closed. Basal plates hidden by the column : subradial plates longer than wide, the lower half abruptly bent inwards to form the exterior cavity (the upper half of the plates only showing in the figure). First radial plates wider than long, pentagonal. Second radials shorter than the first, obtusely wedgeform above, and supporting on the sloping sides a pair of arms, which are composed of a series of short quadrangular plates, alternately longer and shorter on the same side of the arm, the longer faces supporting the tentacula. Arms simple throughout their entire length.

COLUMN, near the base of the body, composed of alternating thicker and thinner joints.

Fig. 8. View of the antero-lateral and postero-lateral rays of the left side, the latter having the second radial truncate, and sustaining but a single arm. This feature is probably accidental.

FIG. 110.



The accompanying diagram illustrates the form and relations of the plates as far as observed. The circular line in this and the following figures indicates the limits of the external concavity of the base.

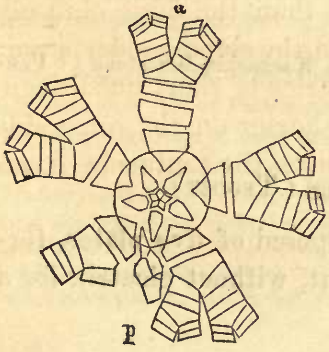
Geological position and locality. In the Kaskaskia limestone : Chester, Illinois.

Zeacrinus wortheni (n. s.).

BODY semiglobose, concave at the base, the concavity involving the subradial and lower part of the first radial plates. Basal plates minute : subradial plates elongate, hexagonal. First radial plates pentagonal, wedgeform and pointed below. Second radial plates pentagonal, wedgeform above, and supporting a pair of arms, which are composed of short quadrangular plates, bifurcating on the fourth plate above the base; the anterior ray having two quadrangular plates inserted between the first and last radial, and the arms bifurcating on the third and fourth plates above the base, some of them bifurcating a second and a third time.

This species is much larger than the *Z. maniformis,* and the area of the exterior basal concavity and bifurcation of the arms are characteristic features.

FIG. 111.



The accompanying diagram, already used in the generic description and remarks, p. 545, is from a specimen of this species.

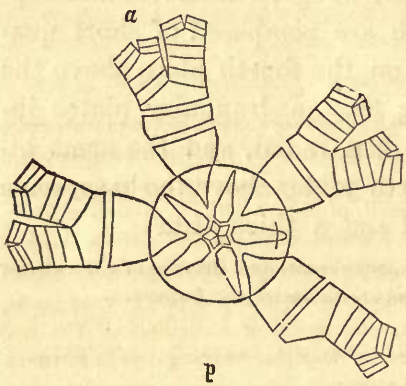
Geological position and locality. In the Kaskaskia limestone : Chester, Illinois.

Zeacrinus magnoliæformis.

Zeacrinus magnoliæformis : TROOST in MS. of Monograph of the Crinoideæ, etc.; and in Catalogue, Proceedings of American Association for Advancement of Science, 1849, p. 61.

BODY and arms cylindrical when closed, robust : base concave, the cavity deep, involving the basal, subradial, and lower half of the first radial plates. Basal plates small : subradial plates extremely elongated, unequally hexagonal. First radial plates about as wide as long, extremely attenuate below, and terminating in an acute point. Second radials very short, more than twice as wide as long, obtusely wedgeform above, and supporting a pair of arms which bifurcate on the third or fourth plate above, and again dichotomise once or twice in the course of their length. The anterior ray has a single intercalated quadrangular plate, giving three radial plates to that ray.

FIG. 112.



The accompanying diagram is from the original specimen of Dr. TROOST, the anal plates and one ray being concealed in the stone.

Geological position and locality. In the Kaskaskia limestone ("Pentremital limestone") : Tennessee.

GENUS AGASSIZOCRINUS (TROOST).

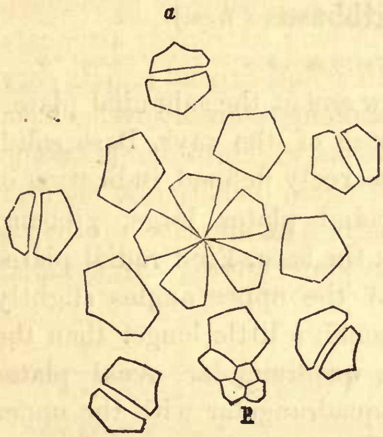
"GENERIC CHARACTER. Pelvis composed of five plates, terminating at the base in a solid point, without cicatrix for a column.

"Costals five, subhexagonal;
"Scapulars five, pentagonal;
"Arms five, pentagonal."

The above description of this genus is from the MS. of Dr. Troost.

The genus has been recognized by Drs. D. D. Owen and Shumard in the Report on Wisconsin, Iowa and Minnesota, p. 597; and by Dr. Shumard in the Geological Report of Missouri. It may be characterized according to the nomenclature here used, as follows :

Fig. 113.



GENERIC FORMULA.

Basal plates, 5.
Subradial plates, 5.
Radials $2 \times 5 = 10$, being 2 from each ray*.
Anal plates, 4 or more?

Agassizocrinus dactyliformis (Troost).

The basal plates are often prominent, forming together a mamilliform protuberance which projects beyond the subradial plates. The cicatrix for the attachment of a column is usually null, or very obscure. The subradial plates are large and prominent, sometimes gibbous. The radial plates are small, pentagonal; the first one wedgeform below, and the second wedgeform above. The arms are composed of a single series of short quadrangular plates, which are scarcely longer on one side than on the other : they are alternately tentaculate, the tentacula being composed of short strong joints, which, in section, are like the arm-joints, semicircular or semielliptical. The anal side is conspicuously marked by the presence of four plates arranged as in Poteriocrinus (this number may vary to less or more).

The structure of the body of the typical species, and others of this genus, does not differ from that of *Poteriocrinus*, *Zeacrinus* or *Scaphiocrinus*. The conspicuous features are the form of body, protuberance of basal plates, and usual absence of a cicatrix for the attachment of a column. The basal plates are extremely thickened, forming together a solid mass with occasionally a scarcely visible foramen extending from the base of the visceral cavity, which sometimes reaches a little below the bot-

* The second radial plates are described as the arms [arm-plates] by Dr. Troost, of which there are five, each in fact giving origin to two arms.

tom of the subradial plates, to the lower extremity. The solid basal portion sometimes presents a central longitudinal space filled with different material, with radiating and dichotomizing branches of the same substance, which appears to have been originally vessels reaching nearly to the exterior margin of the plates. The base of the visceral cavity often occupies a small space at the top of the basal plates. The arms are in like manner arranged as in the genera cited; and it is a closely allied form, which will probably be traced through other species to more intimate relations.

It is probable that the species of this type were fixed in their young state, and became free as they grew older.

Agassizocrinus gibbosus (n. s.).

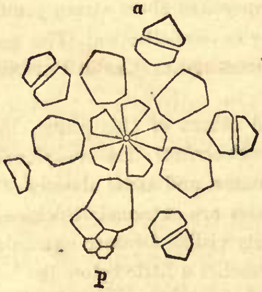
Plate XXV. Fig. 6 & 6 *b*.

Body ovoid, protuberant below and at the subradial plates, somewhat contracted at the base of the rays. Base solid, preserving suture-lines and a scarcely defined indication of the column-attachment : subradial plates large, gibbous, about once and a half as long as the base. First radial plates small, pentagonal, with one of the upper angles slightly truncate. Second radials pentagonal, a little longer than the first radials. Arm-plates short, quadrangular. Anal plates four; the lower one large, subquadrangular with the upper lefthand angle truncated; the three upper ones small.

This species differs from the *A. dactyliformis* of Troost in the generally smaller form, smaller and protuberant base and gibbous subradials, while it is more distinctly contracted at the base of the radials.

Fig. 6. View of the anal side of the specimen. Fig. 6 *b*. Basal view of the same.

Fig. 114.



The accompanying diagram illustrates the structure of this species, the form and proportions of the plates, etc.

Geological position and locality. In the Kaskaskia limestone : Chester, Illinois.

Agassizocrinus constrictus (n. s.).

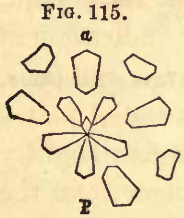
PLATE XXV. FIG. 10.

BODY elongate-turbinate : base long and narrow, constricted at the junction of the subradial plates, and swelling above. Basal plates extremely elongate, narrow; a small intercalated plate at the base, on the anterior side : subradials contracted at the base and gradually spreading above, more than once and a half as long as wide, hexagonal. First radials small, wider than long. Second radials and arms unknown.

This species differs so conspicuously from any other known species of the genus, that it can be readily identified.

Fig. 10. The anterior side of the specimen, natural size.

FIG. 115.



The diagram illustrates the form of the basal, subradial and radial plates. The small intercalated plate at the base is probably accidental.

Agassizocrinus conicus : OWEN & SHUMARD, Geological Report of Wisconsin, Iowa and Minnesota, pa. 597, pl. 5, f. 6.

Geological position and locality. In the Kaskaskia limestone : Chester, Illinois.

The solid turbinate basal pieces of this species are very common in the Kaskaskia limestone at Chester and elsewhere, and are readily distinguished from either of the species described above.

Cyathocrinus? pentalobus (n. s.).

PLATE XXV. FIG. 5 *a, b*.

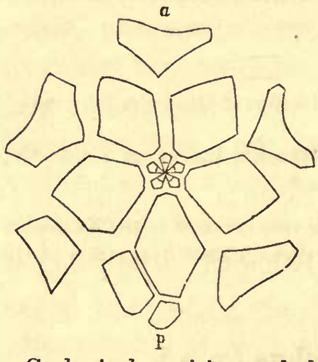
BODY depressed, broadly and deeply concave at the base, the concavity extending to the middle of the subradial plates : outline pentagonal, with the angles extremely produced. Basal plates minute, hidden by the column, which fills the exterior cavity of the base : subradial plates large, hexagonal (except on the anal side), about half the length of the plate curving downwards into the basal cavity, the upper part projected laterally into prominent obtusely angular protuberances which are gradually narrowed towards the summit of the plate. First radial plates pentagonal (except one on the anal side which is quadrangular), protuberant in the centre. Second radial plates small (imperfect in the specimen described). Anal plates two; the one truncating the subradial plate, small, a large unequally pentagonal plate lying obliquely between the truncated subradial plate and the adjacent radial, and reaching as high as the top of the latter, its lower shorter side resting against the adjacent subradial on the right.

This species is remarkable for the broadly rounded basal depression and the prominent angular extension of the subradial plates, giving to this part a stellate or five-lobed form; while the first radials alternate in five more rounded protuberances, lying above, and in a line with the depressions between those below.

Fig. 5 *a*. Basal view of the specimen.

Fig. 5 *b*. View of the anal side of the same, showing the protuberant form of the plates.

FIG. 116.



The accompanying diagram illustrates the form and proportions of the plates of this species as far as the first radial plates. Most of the impressions of the engraved plates erroneously represent the subradial plates as extending to the centre: this error is corrected in the diagram.

Geological position and locality. In the Kaskaskia limestone: Pope county, Illinois.

The body of this species is very similar to that described by Mr. S. S. LYON, in the Geological Report of Kentucky, as *Graphiocrinus 14-brachialis* (the anterior ray having two arms and the others each three); and I observe now for the first time that he expresses a doubt whether the basal pieces, of the formula of DE KONINCK and LE HON, are the true basal pieces. The specimen under consideration has certainly five plates within the larger protuberant ones, and the form of the anal plates has induced me to refer the species to the Genus CYATHOCRINUS. It differs from *C. stellatus* of TROOST in the deeper basal depression and the more obtusely protuberant subradial plates, and it may prove more nearly allied to *Zeacrinus* than to *Cyathocrinus.* It is possible that the present species will prove identical with the one described by Mr. LYON.

Dichocrinus protuberans (n. s.).

PLATE XXV. FIG. 7.

BODY depressed, twice as wide as high : base flat, with a small central depression; the two plates forming a pentagonal disc, with a triangular indentation at the junction on one side for the base of a long narrow anal plate. Radial plates short, much wider than long, projecting below and laterally beyond the plane of the basal plates in round tuberculiform protuberances.

(Structure above the radial plates undetermined.)

This species, though so unlike the ordinary forms of *Dichocrinus* which have been illustrated, I can refer to no other genus, since the division of the base is into two parts.

Fig. 7. View of the base, which shows the two basal plates, three of the protuberant radials, and the narrow anal plate.

Geological formation and locality. In the Kaskaskia limestone : Chester, Illinois.

GENUS ACROCRINUS (YANDELL).

GENERIC DESCRIPTION. "Body goblet-shaped, constituted of about sixteen series of plates [which are] generally hexagonal, and increasing in size from the base to the summit; each series including from twenty to twenty-five pieces, the last supporting five large arm-bearing plates, which give origin to twenty rays composed of a double row of tentaculated joints. Pelvis undivided? large, circular, saucer-shaped. Column round, consisting of thin serrated joints, gradually expanding towards the base of the cup."

The specimen under consideration does not enable us to add much to the generic description given, except that the ring-like pelvis presents a well-marked suture on one side, so that the divisions have probably been two or three.

Acrocrinus urnæformis (n. s.).

PLATE XXV. FIG. 9 *a, b.*

BODY small, with base divided on one side, very symmetrically urnshaped, gradually swelling out from the rimlike base with the sides very gently curving, preserving on the most extended portions about ten ranges of plates which are irregularly pentagonal or hexagonal.

Arms and column unknown.

This species has the same geological associations as the *A. shumardi* described by Dr. YANDELL.

Geological formation and locality. In the Kaskaskia limestone : Pope county, Illinois.

Pentremites cervinus (n. s.).

PLATE XXV. FIG. 11 *a, b.*

BODY angularly subovoid; the base, below the pseudo-ambulacral areas, three-fourths as long as the part above, obtuse, the basal plates forming a little prominence not sloping in the same plane as the succeeding ones : section across the body, at base of pseudambulacral areas, pentangular, with the sides slightly concave ; sides sloping somewhat abruptly from the greatest diameter to the summit. Basal plates forming a shallow pentagonal cup with the angles highly elevated, and each plate sometimes a little protuberant just without the column-area. Radial plates broad below and abruptly diverging to the base of the pseudambulacral areas, the width at base and summit very nearly equal. Interradial plates long lanceolate, reaching to within the width of three or four poral pieces of the ovarian openings.

Pseudambulacral areas limited by the elevated margins of the forked radial plates, slightly convex near the exterior margin, and thence sloping gently to the median line, very gradually expanding in width to the summit, marked by about fifty (more or less in specimens of different age) pore-pieces, which, in well-preserved specimens, are distinctly striated in the longitudinal direction of the pores.

Mouth central, pentagonal : ovarian apertures five, ovate, somewhat closely arranged.

SURFACE finely striate in a direction parallel to the margins of the plates.

This species resembles the *P. sulcatus* of RŒMER, but has the base more prominent, and is more rapidly contracted above the widest part of the body. The pseudambulacral areas are not so sharply and prominently margined by the edges of the adjacent plates, the interradial plates do not extend as high, and the ovarian apertures are comparatively smaller and closer together, and are oval or ovate, while those of *P. sulcatus* are somewhat quadrangular. There are also other differences of a less prominent character.

Fig. 11 *a*. Lateral view of a specimen.

Fig. 11 *b*. View of the summit of the same, showing the ovarian apertures, etc.

Geological formation and localities. In the Kaskaskia limestone : Chester, Illinois ; and near Huntsville, Alabama.

Pentremites cherokeeus.

PLATE XXV. FIG. 12 *a*, *b*.

Pentremites cherokeeus : TROOST, MS. of Monograph; Catalogue, 1849, Proc. Am. Assoc. for the Advancement of Science, p. 60.

Pentremites sulcatus : RŒMER, Mon. of Blastoideæ, 1852, pa. 354, tab. vi, f. 10 *a*, *b*, *c*.

BODY large, subglobose, subtruncate below; base slightly projecting. Basal plates together forming a pentagonal moderately convex disc. Radial plates broad, projecting sometimes almost rectangularly to the base of the pseudambulacral areas, deeply forked for the reception of the poral plates, and rising abruptly in a thin sharp margin above and becoming more prominent at the apex. Interradial plates small, lanceolate, usually as high as the truncate summit, and often extending above it in acute points. Pseudambulacral areas elongate, gradually widening above, concave, the two sides flattened and regularly sloping to the median line, somewhat deeply inserted in the forks of the radial plate : from forty to fifty poral pieces on each side, marked down the centre of each range by a suture-line and minute pores. Mouth central, pentagonal : ovarian apertures somewhat quadrangular.

In several specimens, some of the plates originally closing those apertures are still remaining*.

This species is distinguished by its stellate outline, the angularly concave form of the pseudambulacral areas, the elevated acute margins of the radial plates, the truncate summit, prominent interradial plates, and quadrangular ovarian apertures.

Fig. 12 *a*. Lateral view of a small specimen.

Fig. 12 *b*. Summit of the same. (The ovarian apertures are represented with the sides too much curved.)

Geological formation and localities. In the Kaskaskia limestone : Chester and Prairie du Long, Illinois ; near Huntsville, Alabama. Dr. TROOST cites this species from Cherokee county, Tennessee.

Pentremites godoni.

PLATE XXV. FIG. 13 *a*, *b*.

Kentucky asteroid fossil : PARKINSON, 1808, Organic Remains, edition of 1833, pa. 235, pl. 13, f. 36 & 37.
Encrina godoni : DE FRANCE, 1818, Dict. Sci. Nat, T. 14,
Encrinites florealis : SCHLOTHEIM, 1820, Petrefak. I, 339.
Pentremites florealis : SAY, 1822, SOWERBY, Zool. Journal, Vol. ii, pa, 311, tab. ii, f. 2.
Pentremites florealis : TROOST, Trans. Geol. Soc, Pa. Vol, i, pa. 229, pl. 10.
Pentremites florealis : RŒMER, 1852, Monog. Blast. pa. 353, pl. 14, f. 1, 2, 3, 4; and pl. v, f. 8.
Pentremites godoni : SHUMARD, Descript. New Species Blastoideæ, Trans. Acad. St.Louis, Vol. i, no. 2.

BODY ovoid, short, subtruncate below, obtusely pentangular, stelliform in outline. Basal plates forming a small pentagonal moderately convex disc, with the spreading upper joint of the column usually attached, and presenting a small papilliform elevation. Radial plates extending almost rectangularly to the base of the pseudambulacral areas, abruptly bent and obtusely angular in the middle of the base : sides nearly parallel, deeply forked for the reception of the pseudambulacral areas. Interradial plates long lanceolate, not reaching to the summit. Pseudambulacral areas long lanceolate, reaching nearly to the base of the calyx, very gradually widening above, convex, each side curving to a median suture which is more elevated than the sides. Poral plates narrow, crowded,

* See observations on the structure of the summit in the Genus PENTREMITES in a paper entitled "Descriptions of New Species of Blastoideæ", by Dr. B. F. SHUMARD, in Trans. Acad. Scien. St.Louis. Vol. i, no. 2.

from forty to fifty on each side, nearly rectangular to the area, and slightly curving upwards on the median line. Mouth pentangular : ovarian apertures broad oval ; summit convex.

This species resembles in many respects the *P. pyriformis ;* but is more truncate at the base, and the initial joint of the column is spreading above, and forms a more conspicuous feature. The specimens before me do not offer gradations from one species to the other, as suggested by Dr. Rœmer.

Fig. 13 *a*. Lateral view of a specimen. Fig. 13 *b*. Basal view of the same.

Geological formation and localities. In the Kaskaskia limestone : Chester, Illinois ; Huntsville, Alabama, etc.

Pentremites pyriformis.

Plate XXV. Fig. 16.

Pentremites pyriformis : Say, 1822, Jour. Acad. Sci. Philadelphia, Vol. iv, p. 294.
— — Troost, Trans. Geol. Soc. Pennsylvania, Vol. i, pa. 228, pl. 10.
— — Sowerby, Zoological Journal, Vol. ii, p. 315.
— — Rœmer, Monog. Blastoideæ, pa. 354, pl. 5, f. 9 *a*, *b*, *c*.

Body pyriform, the greatest diameter in the middle, and tapering to both extremities; the summit more obtuse and rounded, obtusely pentangular below the pseudambulacral areas, with the sides flat : base narrow, with the upper joint of the column usually remaining attached. Basal plates forming a pentagonal shallow vase. Radial plates spreading and ascending, angular along the middle at the base, deeply furcate, slightly concave along the lateral sutures. Interradial plates narrow lanceolate, reaching nearly to the summit. Pseudambulacral areas lanceolate, gradually enlarging from the base, concave towards the median line, or sometimes flat : the number of pore-pieces varies from thirty to fifty on each side of the median line. Mouth pentagonal : ovarian apertures closely arranged, often somewhat transversely oval.

This species has been so fully described, that it is unnecessary to enter into detail in this place. The specimens before me seem clearly distinct from *P. florealis,* while there is much difficulty in separating them from *P. tennesseeæ* of Troost, which latter is perhaps identical with *P. koninckana* of Hall. Should this suggestion be verified, the latter name will give place to that of Dr. Troost.

Fig. 16. A specimen of small or medium size, with a portion of the column attached.

Geological formation and localities. In the Kaskaskia limestone : Chester, Illinois ; near Huntsville, Alabama, etc.

Pentremites symmetricus (n. s.).

PLATE XXV. FIG. 14.

Compare *Pentremites pyriformis*, etc.

BODY narrow ovate, with a pointed and obtusely angular base; greatest diameter about one-third the distance upwards from the base, very gradually tapering above, with summit rounded or subtruncate. Basal plates small, forming a small pentapetalous cup, with one or two joints of the column usually attached. Radial plates narrow below, expanding to the base of the pseudambulacral areas and thence continuing with the sides parallel, prominently angular in the middle below the furcation. Interradial plates very long lanceolate, not reaching the summit within the space of four or five poral plates. Pseudambulacral areas long lanceolate, reaching two-thirds the entire length of the body, convex; the poral plates of each side turning slightly upwards along the median line, and divided along the centre of each side by distinct sutures. About forty plates on each side, in a specimen of medium size. Mouth small, pentagonal: ovarian apertures round-ovate, closely arranged, that on the anal side distinctly larger.

SURFACE finely and beautifully striated parallel to the margins of the plates.

This species differs from the *P. pyriformis* in the less prominence of the angles at the base of the pseudambulacral areas, while the median angle of the radial plate is more conspicuous: the proportions of length below and above the greatest diameter are very distinct in the two species. The pseudambulacral areas are more convex; and in a specimen of *P. pyriformis* of the same size as the one figured, there are no more than thirty-five poral plates on each side of the area; and in none of the specimens of that species examined, have I been able to distinguish the longitudinal suture which divides each side of the area into two equal parts.

The specimen fig. 14 was originally given to illustrate a variety of form in the *P. pyriformis*; but the constancy of the characters presented in a large number of specimens seems to sanction its separation as a distinct species.

Fig. 14. View of a specimen of medium size.

Geological formation and locality. In the Kaskaskia limestone, Kentucky.

Pentremites obesus.

PLATE XXV. FIG. 15.

Pentremites obesus : LYON, Report on Geology of Kentucky, 1857, pa. 469, pl. 2, f. 1 *a–d*.

BODY angularly ovoid, its greatest diameter below the centre, width about three-fourths of the height. Basal plates longer than wide, forming altogether a pentapetalous cup. Radial plates narrowed below, obtusely angular along the middle to the base of the ambulacral areas, where they are extremely prominent; the bifurcation extending for three-fifths the length of the plate. Interradial plates long lanceolate. Pseudambulacral areas long and narrow, extending two-thirds the entire length of the body, concave in the middle, having the appearance of a rounded groove along the median line, convex near the outer margin, and each side divided by a longitudinal suture; along which line the plates are frequently separated, showing the area to be distinctly composed of four ranges of plates. The number of plates in the length of the area varies from ninety to more than one hundred (43 in the young to 150 in full-grown specimens, LYON). The mouth is acutely pentangular; the ovarian apertures broad ovate or rounded.

This species has been very elaborately described and illustrated by Mr. LYON in the report cited above.

Fig. 15. Lateral view of a specimen, natural size. The species frequently attains a larger size.

Geological formation and localities. In the Kaskaskia limestone : Southern Illinois, and Kentucky.

Pentremites globosus.

PLATE XXV. FIG. 17,

Pentremites globosus : TROOST, MS. of Monograph.

BODY globose, small : base rounded or subangular, short, greatest diameter about the centre. Interradial plates not reaching the summit. Pseudambulacral areas comparatively large, somewhat concave, each division a little rounded on its outer margin. Poral pieces from eighteen to twenty-three on each side : ovarian opening nearly round.

The specimens under this name in Dr. TROOST'S collection resemble so nearly the young of *P. sulcatus*, that I hesitate as to the propriety of retaining the name; and it will require farther comparison to determine fully the relations and differences of these two species. The specimen figured preserves all the characters of the *P. globosus* of TROOST.

Fig. 17. A specimen preserving a part of the column and some fragments of the arms or tentacula.

Geological formation and locality. In the Kaskaskia limestone : Hardin county, Illinois.

GENUS AGELACRINUS (VANUXEM).

Agelacrinus kaskaskiensis (n. s.).

PLATE XXV. FIG. 18.

BODY discoid, with an apparently entire apex, from which the rays proceed. Rays six, radiating and curving towards the margin so as to come nearly in contact on the periphery, composed of subcuneiform plates which are crenulate or poriferous at their interlocking edges : intermediate spaces occupied by plates of hexagonal or irregular forms, nearly flat. Surface finely granulate.

The condition of the specimen is such as not to admit of a full description. The rays or ambulacral areas present in some parts apparently a plain double series of cuneiform plates; and in other parts there appear to be intermediate smaller plates, which are extended into tentaculiform processes.

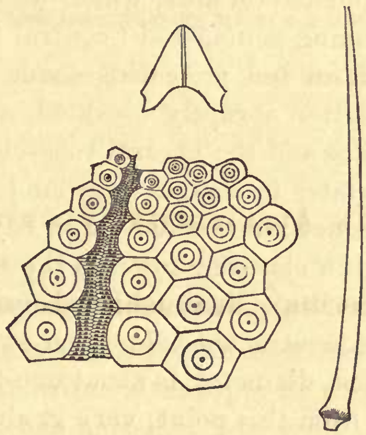
Fig. 18. View of the specimen, natural size.

Geological formation and locality. In the Kaskaskia limestone : Kaskaskia, Illinois.

GENUS ARCHÆOCIDARIS (M'COY);

(Echinocrinus, AGASSIZ; Palæocidaris, DESOR.)

FIG. 117.



BODY spheroidal; interambulacral spaces composed of three or more rows of plates, those on each side next the ambulacra pentagonal, those of the intermediate ranges hexagonal; each plate having a central mamillary perforated tubercle, which is surrounded by an elevated ring: to each of these tubercles is attached a large movable spine, which is generally muricate or sometimes spinuliferous, and rarely striate or granulose striate. Surface of the plates marked by radiating ridges, nodes or tubercles. Ambulacral spaces consisting of two ranges of alternating poriferous plates.

From each of the limestones described in the preceding pages, I have selected a single species of ARCHÆOCIDARIS, and grouped them together on Plate xxvi. These are numbered in the order of succession of the rocks, and offer at a single glance characteristic features by which each one may be distinguished.

With the exception of the *Palechinus* (*Melonites*) *multipora* of OWEN and NORWOOD, I am not aware that any fossils of this family have been described from the Carboniferous limestones below the Coal measures. Dr. SHUMARD, in the catalogue of fossils accompanying the Missouri Report, has enumerated three new species, and has identified one as *A. nerii?* I have not the means of knowing whether the species here described are identical with those he enumerates as new species, or otherwise*.

Archæocidaris agassizi (n. s.).

PLATE XXVI. FIG. 1 *a* – *d*.

BODY unknown; plates small, hexagonal, except those adjacent to the ambulacral area, which are a little rounded on that side, becoming pentagonal: central tubercle slender, elongated, tubuliform and projecting above the surrounding annulation, the latter abruptly elevated, and leaving, between its inner face and the central tubercle, a deep cavity. Surface of the plate, immediately around the annulation, elevated in a distinct low annular ridge, beyond which it is depressed and again elevated towards the margin, which is ornamented by a series of low elongated nodes. Spines elongated, compressed, contracted below, and swelling out above so that the greatest diameter is about one-third the length above the base; from this point, very gradually tapering to the summit. Surface of the lower contracted portion, smooth; muricate above, with small spiniform tubercles, which, on the lower part, are arranged in somewhat distant curving annulating rows, becoming more curved above, or in oblique ascending rows, giving a quincunx order. Point of attachment somewhat elongate, the thickened annulation strongly striate.

This beautiful species differs from any other American or European species known to me, in its strong compressed spines and comparatively small plates, while in the details of its characteristic markings there is an equal distinction from those here described.

Fig. 1 *a*. A fragment preserving several plates of the body, with a small group of the spines, natural size.

Fig. 1 *b*. A single plate enlarged.

Fig. 1 *c*. Profile view of the same.

Fig. 1 *d*. A single spine enlarged to twice the natural size.

Geological formation and locality. In the Burlington limestone: Burlington, Iowa.

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* Dr. SHUMARD has recently described three species: *Archæocidaris aculeatus*, *A. biangulatus* and *A. megastylis*, from the Coal measures of Missouri, Kansas and Texas.

Archæocidaris keokuk (n. s.).

PLATE XXVI. FIG. 2 *a*, *b*.

BODY unknown; plates hexagonal, with a prominent elevated nodulose rim: central tubercle papilliform, the space between it and the surrounding annulation slightly depressed. Surface outside the annulation marked by a somewhat flattened elevation, and between this and the nodulose rim distinctly concave. Spines round, of moderate length, muricate with elongate ridges and spiniform tubercles; spines expanding near the base into a subangular annulation; concavity in base of spine large.

Fig. 2 *a*. A single plate with the spine, as it occurs on the surface of the stone. The figure is very slightly enlarged.

Fig. 2 *b*. Profile view of a single plate enlarged.

Geological formation and locality. In the Keokuk limestone: Warsaw, Illinois.

Archæocidaris shumardana (n. s.).

PLATE XXVI. FIG. 3 *a*, *b*, *c*, *d*.

BODY unknown; plates hexagonal, except adjacent to the ambulacral field: central tubercle subtubuliform or papilliform, with usually a deep space between it and the annulation, which is abrupt toward its upper margin and gradually swelling out below, and expanding in a slightly convex rim, between which and the elevated nodulose margin the surface is somewhat abruptly concave; margin elevated, the nodes somewhat rounded. Spines short, small, smooth or finely striated longitudinally near the base, muricate, with elongated ascending nodes; the articulating extremity abruptly contracted below and above the annulation.

This species differs from the *A. keokuk* in the smaller and proportionally narrower plates and smaller spines, as well as in the articulating processes of the plates and spines.

Fig. 3 *a*. A fragment, natural size, showing several plates and a small group of the spines. The figure is a part of a much larger mass of plates and spines.

Fig. 3 *b*. A single plate enlarged.

Fig. 3 *c*. Profile view of the same.

Fig. 3 *d*. A single spine twice enlarged. The accompanying figures are a section of the spine, and enlargements of the surface markings on the middle and lower parts.

Geological formation and locality. In the Warsaw limestone : Warsaw, Illinois.

Archæocidaris wortheni (n. s.).

Plate XXVI. Fig. 4 *a* – *g*.

Body spheroidal, the central upper portion composed of numerous small imbricating plates. Interambulacral spaces composed of four ranges of plates, the two inner ones hexagonal, the others pentagonal, with a convex side adjoining the ambulacral areas. Central tubercle papilliform, moderately elevated above the annulation, the space between it and the annulation slightly concave : annulation thickened and spreading below into a slightly elevated disc, between which and the denticulate margin the surface is nearly flat. Plates of the ambulacral areas in a double alternating series, wide and short, pentagonal, interlocking at their obtusely wedgeform margins ; each plate with two oval pores. Spines slender, elongate, slightly curving, smooth or finely granulate ; articulating extremity expanding from above into a crenulate annulation, and abruptly contracting below.

This species, in the form of its smooth spines, is remarkably distinct from the others described; the plates are in form and proportions similar to the Warsaw species, but larger and less concave, as well as less strongly nodose on the margins.

The specimens under examination show the body nearly entire, and almost completely flattened. From other fragments it would appear that the body, in its natural condition, was very depressed spheroidal, with the sides broadly rounded and base a little concave.

Fig. 4 *a*. Upper side of a crushed specimen. The small imbricating plates of the summit are not well shown in the figure.

Fig. 4 *b*. Base of specimen, showing the displaced and crushed plates, with several broken spines.

Fig. 4 *c*. A single plate enlarged, showing the mamillary tubercle, the annulation and surrounding disc, etc.

Fig. 4 *d*. Profile of the same.

Fig. 4 *e*. Enlargement of one of the ambulacral areas and the adjacent plates in outline, showing the oval pores, etc.

Fig. 4 *f*. A single spine, natural size; length a little more than two and a quarter inches, imperfect at the extremity.

Fig. 4 *g*. Enlargement of a portion of a spine near the base, showing the crenulations on the edge of the annulation.

Geological formation and locatity. In the St. Louis limestone : Near St. Louis, Missouri.

Archæocidaris norwoodi (n. s.).

PLATE XXVI. FIG. 5 *a* – *e*.

BODY unknown; plates transverse hexagonal and pentagonal; the central tubercle papilliform or subtubuliform with sides thickened, elevated above the annulation; surrounding area slightly depressed : margin of the annulation thickened, rounded and constricted below, spreading on the surface of the plate into a small well-defined flattened disc; the space between which and the nodulose margin is slightly depressed, and sometimes showing obscure radiating ridges. Spines slender, elongated, slightly curving, longitudinally striate below and muricate above with fine sharply elevated denticles, and at intervals marked by short round diverging spinules : intermediate surface cancellate or granulose.

This species has usually been regarded as the *Archæocidaris nerii*, but differs from that species in the less transverse plates and the less acute lateral angles, as well as in the radiating ridges surrounding the central disc, and the tubercles on the outside of these : the spines of the two species are likewise quite distinctive.

Fig. 5 *a*. A fragment, showing several imperfect spines and a plate of the body.

Fig. 5 *b*. A plate enlarged, from the range adjacent to the ambulacral area.

Fig. 5 *c*. Profile view of the same.

Fig. 5 *d*. A spine nearly twice enlarged, showing the striate lower part, and the muricate and spinulose character of the middle and upper part.

Fig. 5 *e*. A farther enlargement of the lower part of the spine, showing the longitudinal striæ, which are strongly marked on the annulation above the articulating surface.

Geological formation and locality. In the Kaskaskia limestone : Chester, Illinois.

BRACHIOPODA OF THE KASKASKIA LIMESTONE.

Among the Brachiopoda of the Kaskaskia limestone, I have selected a few of the most common and characteristic species, for the purpose of carrying forward the means of comparison in this class of fossils with those of the preceding formations. The number of species here given might easily be doubled, without exhausting the forms that seem to be everywhere characteristic of the rock.

So far as I have observed, the species of the Genus Productus are more rare, and of Spirifer perhaps more abundant; while those of Athyris occur in greater number and in much more numerous individuals, than in any of the lower rocks of the Carboniferous period.

Athyris sublamellosa (n. s.).

Plate XXVII. Fig. 1 *a*, *b*, *c*.

Shell suborbicular, oval or ovate, more or less gibbous. Dorsal valve regularly convex, gibbous in the middle ; beak entering the foramen of the opposite valve : no mesial elevation. Ventral valve convex in the middle above, depressed below, often flattened in front, but without distinct sinus ; beak extended beyond the opposite, scarcely incurved, transversely or somewhat obliquely truncated by a round foramen.

Surface marked by concentric lamellose imbricating striæ, which, when perfect, are extended in thin fimbriate expansions.

This species belongs to the group which includes *Athyris roissyi*, *A. planosulcatus* and *A. lamellosa ;* differing from the former in the absence of a sinus, and from the latter in the lesser convexity of the ventral valve, as well as other features. It is possible that older specimens of this species may show a mesial sinus in front.

Fig. 1 *a*, *b*. Dorsal and ventral views of a specimen of the ordinary size.
Fig. 1 *c*. Profile view of the same.

Geological formation and localities. In the Kaskaskia limestone : Chester, Illinois; and Crittenden county, Kentucky.

Athyris subquadrata (n. s.).

PLATE XXVII. FIG. 2 *a*, *b*, *c*, *d*.

SHELL ovoid, subquadrate, more or less gibbous according to age; greatest width a little below the middle, curving thence abruptly to the base, and more gradually to the beak. Dorsal valve the more convex, with a broad mesial fold, which becomes more strongly developed below the middle of the shell : beak abruptly incurved beneath the opposite. Ventral valve the less convex; sinus broad and deep below the middle, and scarcely conspicuous on the upper third of the shell, produced in front : beak incurved, and vertically truncated by a round foramen.

SURFACE marked by fine concentric striæ of growth, and towards the margins by strong imbricating lamellæ, which thicken the edges. Certain states of preservation of the surface show fine radiating striæ, while the perfect condition presents a finely punctate appearance.

The individuals of this species vary in their characters to a considerable degree; the old shells showing a broad deep sinus which elevates the front of the shell often in an extreme degree, while in some of the younger individuals there is but a moderate sinus below, and a slight angular depression reaching to the beak.

This species is more abruptly and deeply sinuate than *Terebratula* (*Athyris?*) *subtilita*, which it resembles in some respects, though always proportionally broader and shorter. Space does not permit an illustration of the variations presented in different stages of growth.

Fig. 2 *a*. View of the dorsal valve, and beak of the ventral valve, of a specimen of medium size.
Fig. 2 *b*. Ventral view of the same.
Fig. 2 *c*. Profile view of the same.
Fig. 2 *d*. Ventral view of a smaller and more orbicular form, where the shell is exfoliated, showing the vascular impressions.

Geological formation and localities. In the Kaskaskia limestone : Chester, Illinois; and Crittenden county, Kentucky.

Retzia vera (n. s.).

PLATE XXVII. FIG. 3 *a*.

SHELL ovate in outline, broadly rounded at the base, somewhat compressed in the lower part, regularly and equally swelling above, somewhat gibbous on the umbones : valves equally convex; hinge-line straight, auriculate at the extremities. Dorsal valve regularly convex : umbo prominent. Ventral valve somewhat arcuate, a little flattened on the middle in old shells; sides tapering to the beak, which is strongly arched, and truncated at the extremity by a round foramen : cardinal extremities slightly produced to meet those of the opposite, leaving a narrow area between the two valves.

SURFACE marked by from forty to fifty simple rounded radiating costæ, which are fine and scarcely perceptible to the naked eye, but become much coarser as they extend. A small extent on either side below the beak, particularly on the ventral valve, is free from plications. Radiating costæ marked by fine closely arranged concentric striæ, which are only visible under a lens : minute structure punctate.

This shell resembles the *Retzia* (*Terebratula*) *marcyi* of SHUMARD (MARCY'S Report of an Exploration of the Red River of Louisiana, pa. 204, pl. 1, f. 4 *a, b*), but differs in its larger size and greater number of striæ; and judging from the association with *T. subtilita*, the *R. marcyi* is of the age of the Coal measures.

The species under consideration differs from *R. verneuilana* of the Warsaw limestone in its larger size and coarser costæ, and in having its greatest width below the middle of the shell, and the beak more strongly arcuate.

Fig. 3 *a*. Ventral view of a specimen, each valve of which is marked by fifty costæ : a much smaller specimen has forty.

Geological formation and locality. In the Kaskaskia limestone : Chester, Illinois.

Retzia vera, var. costata.

PLATE XXVII. FIG. 3 *a, b*.

The specimen figured is much larger than the preceding, having the same general form, or being a little more flattened upon the back. The surface is marked by thirty-eight simple rounded costæ : entire surface beautifully punctate.

This differs from the specimen fig. 3 *a*, not only in size, but also in the fewer costæ and more distinctly punctate surface, with the lines of growth scarcely visible. For the preseut, I propose to recognize this as a distinct variety.

Fig. 3 *b*. View of the dorsal valve, showing the beak and broken foramen of the opposite valve.

Fig. 3 *c*. Ventral valve of the same specimen.

Geological formation and locality. In the Kaskaskia limestone : Chester, Illinois.

Spirifer setigerus (n. s.).

PLATE XXVII. FIG. 4 *a*, *b*.

SHELL depressed orbicular, gibbous on the umbones : cardinal line shorter than the width of the shell below. Dorsal valve broadly elliptical, elevated in the middle by an undefined mesial sinus, prominent on the lower half of the shell, becoming obsolete before reaching the beak ; beak incurved, with a broad foramen below and distinctly defined area, which is sharply limited by the exterior shell. Ventral valve a little more convex on the umbones than the dorsal valve : mesial sinus reaching to the beak in a narrow depression, which becomes deeply marked below the middle of the shell ; umbo prominent, rounded, with the beak curving over the foramen ; area high, short, contracted by the encroachment of the exterior shell which curves inwards along the margins, vertically striated : foramen large, wider at base than the length of the side.

SURFACE marked by fine concentric and radiating striæ ; the concentric striæ becoming at intervals lamellose, and the margin extended into numerous setiform spines, the bases of which usually remain upon the surface of well preserved specimens.

This species is more rotund than that of the Keokuk limestone; the area is much shorter, and the mesial fold and sinus more strongly defined. From *Spirifer lineatus*, it differs in its less rotundity and the more strongly defined mesial fold and sinus.

Fig. 4 *a*. View of the dorsal valve, showing the beak of the opposite valve.

Fig. 4 *b*. Ventral valve of the same specimen.

Geological position and localities. In the Kaskaskia limestone : Kaskaskia and Chester, Illinois.

Spirifer spinosus.

Plate XXVII. Fig. 5 *a*, *b*, *c*.

Spirifer spinosus : Norwood & Pratten, Transactions of the Academy of Nat. Sciences, Philadelphia, 1856, pa. 71, pl. ix, f. 1 *a*, *b*, *c*, *d*.

Shell less than the medium size, semioval : cardinal extremities equalling or greater than the width of the shell below, gibbous in the middle. Dorsal valve a little shorter than the opposite; mesial fold prominent, and defined on each side by a deeper furrow. Ventral valve slightly more convex than the opposite; mesial sinus strongly defined; beak slightly arched; cardinal area moderately high, a little less than the width of the shell : foramen moderate.

Surface marked by four or five angular plications on each side of the mesial fold and sinus, which are marked by concentric imbricating lamellæ of growth : entire surface finely punctate, with numerous small tubular spines irregularly distributed.

In its punctate surface this shell resembles *S. kentuckensis* of Shumard, but differs in being more robust, in the coarser punctæ or granulations, and in the presence of the tubular spines.

Fig. 5 *a*, *b*. Dorsal and ventral views of this species.

Fig. 5 *c*. Enlargement of the surface, showing the punctate character of the shell and the bases of the small spines.

Geological formation and localities. In the Kaskaskia limestone : Kaskaskia and Chester, Illinois ; Crittenden county, Kentucky.

Spirifer increbescens (n. s.).

Plate XXVII. Fig. 6 *a* – *i*.

Shell transversely semioval, gibbous : hinge-line equalling the greatest width of the shell, and terminating in more or less salient submucronate extensions which are frequently unequal on the two sides of the shell. Dorsal valve gibbous in the central and umbonial parts, and becoming depressed and somewhat flattened at the cardinal extremities; mesial fold simple at the apex, bifurcating just below the beak and again on the umbo, making four plications, which are rounded and moderately elevated. Ventral valve very regularly convex, arching from the beak to base; extremities compressed; beak arching and incurved; sinus simple at the beak, and marked by three plications which are strongly developed on the lower half of the shell; area narrow, well defined, and extending to the hinge extremities : foramen large, triangular, the upper part hidden by the incurving beak, and sometimes partially closed above by the thickening of the dental lamellæ.

Surface marked by from sixteen to eighteen rounded plications on each side; those adjacent to the mesial lobe and sinus bifurcating, and one division on each side often depressed so as to give the appearance of fine plications in the sinus; the others simple : a few strong undulating and imbricating lines of growth, with fine striæ between; and the entire surface, in well-preserved specimens, marked by fine radiating striæ, with a reticulate ornamentation visible only under a lens.

This species has sometimes been referred to *Spirifer incrassatus*, Eichwald; but it differs essentially from the figures and descriptions of that species, in being always angular instead of rounded at the cardinal extremities. The mesial fold in our shell is smaller, and marked by plications smaller and less distinct than those on each side; while in *S. incrassatus*, these are represented as larger than those on other parts of the shell. There are from fourteen to sixteen plications on each side in full-grown shells of the present species, while the number on the same parts of *S. incrassatus* is given by Murchison and de Verneuil as twelve. These authors, though mentioning the concentric striæ, do not speak of the fine radiating striæ, which, in our shell, are more conspicuous than the others.

Fig. 6 *a*. Dorsal view of an individual of medium size, with the cardinal extremities somewhat mucronate.

Fig. 6 *b*. Ventral view of the same.

Fig. 6 *c*. Profile of the same.

Fig. 6 *d*, *e* & *f*. Dorsal, ventral and profile views of an older shell, which is more gibbous, and has the cardinal extremities less extended.

Fig. 6 *g*. Interior of an imperfect ventral valve, showing the foramen and muscular impressions.

Fig. 6 *h*. Interior of the ventral valve of an older specimen, which is more gibbous and the beak more arched.

Fig. 6 *i*. Enlargement of the surface, showing the fine radiating and concentric striæ.

Geological formation and localities. In the Kaskaskia limestone; Kaskaskia, Chester, and other places in Illinois.

Spirifer increbescens, var. transversalis.

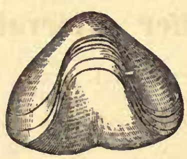
Shell somewhat semicircular, twice as wide as long, gibbous in the middle, attenuate at the extremities, which are prolonged into mucronate points. Dorsal valve marked by a prominent mesial fold of four rounded plications, which proceed from the bifurcation of a single one at the beak. Ventral valve with a well-defined sinus, which is marked by three plications of which the central one is the strongest; beak small, and neatly incurved over the apex of the broad foramen; area of medium height, slightly concave and strongly striated vertically, extending to the cardinal extremities : foramen wider at base than the length of the side.

Surface marked by distant imbricating lines of growth and finer concentric striæ, which are crossed by equally fine radiating striæ.

This shell agrees with the preceding in all its essential characteristics, except in being narrower and more extended on the hinge-line. This form is always smaller; and I can only regard it as an intermediate stage of growth, in which it differs no more from the larger forms than does *Spirifer mucronatus* in its various stages of growth. It has sometimes been referred to *S. strangwaysi* of Murchison and de Verneuil, but differs from that species in having the plications on the mesial fold and sinus smaller instead of larger than those on the sides of the shell, and the lateral plications never bifurcate near the border as in that species.

The figures 6 *a*, *b* of Pl. xxvii may be considered as representatives of this type, which is often narrower and proportionally more extended. It is always associated with the larger forms, or occurs in the same beds.

Fig. 118.



Athyris subquadrata. Front view, showing the elevation of the mesial fold and the deep sinus in front. This feature varies with age, from a very moderate or scarcely perceptible elevation and sinus, to the extreme character here shown.

FOSSILS OF THE COAL MEASURES.

In the selection of a few species of fossils characteristic of the Coal measures, I have made no attempt to indicate those of the upper or lower measures, or to carry the discrimination still farther, as I am aware it may most advantageously be done in the determination of the fossils of the successive beds of the series. Such a course would require far more space than I have at my disposal at the present time. The greater proportion of Lamellibranchiata and Gasteropoda given among the Coal-measure fossils is in fact the natural expression of the fauna as it has fallen under my observation.

In the Coal measures, and their associated limestones, we find the fossils having a wider geographical distribution than we know in any of the preceding periods. Several species, which are common and characteristic forms in Western Pennsylvania and Ohio, are known in Indiana, Illinois, Iowa and Missouri; and they have been found at intervals from the most northerly part of the continent explored, throughout the entire extent of the Rocky mountains to New-Mexico.

Spirifer cameratus.

Plate XXVIII. Fig. 2 *a*, *b*.

Spirifer cameratus : Morton, Silliman's American Journal of Science, 1836, Vol. xxix, pa. 150, pl. 2, f. 3.

Spirifer meusebachanus : Rœmer, Kreid. von Texas, 1852, pa. 88, pl. 11, f. 7.

Spirifer triplicatus : Hall, Stansbury's Report on the Exploration and Survey of the Valley of the Great Salt Lake of Utah, 1852, pa. 410, pl. 2, f. 5 (by error pl. 4).

Spirifer fasciger? Keyserling : Owen, Report on Wisconsin, Iowa and Minnesota, 1852, pl. 5, f. 4.

Spirifer cameratus, Morton : Hall, in Explorations and Surveys for a R.R. Route from the Mississippi river to the Pacific ocean, 1856, Vol. iii, pa. 102, pl. 2, f. 9, 12 & 13.

Shell transverse, semielliptical, semicircular or subtrigonal in outline, often subalate. Dorsal valve with a rounded or subangular mesial fold which expands rapidly towards the margin of the shell, defined at the sides, simple at its origin, bifurcating just below the apex, and each division dichotomizing once or twice before reaching the base of the shell. Ventral valve a little more convex than the opposite; mesial sinus varying from shallow and curvilinear to deep and subangular, simple at its origin, the bordering plications bifurcating just below the beak, and one division on each side going to form the bottom of the sinus; the plications continue to dichotomise mainly on the sides of the sinus, until there are three, four or five plications on each side of the centre : beak somewhat abruptly arched over the foramen, which is somewhat wider than high; area with the sides nearly parallel, extending to the cardinal extremities, concave in the middle and flat on each side, strongly striated vertically.

SURFACE of the shell marked by rounded or subangular plications, which are disposed in fasciculi : plications crossed by fine concentric striæ.

The form of this shell varies, in a considerable degree, in specimens from different localities. It is in general somewhat inflated, and ranges from trigonal to semicircular, depending on the prominence of the lower margin of the shell. The umbo is often very gibbous, and the beak abruptly incurved; but in this character there are some variations. The mesial sinus is subangular above, and becomes broader and gently curved towards the base, rarely subangular throughout. The plications are disposed in fascicles, and, in some specimens, nearly uniformly of three plications in each : others are irregular. The mesial elevation is often marked by two fascicles of three plications each, even when the remaining plications are irregularly disposed.

A comparison of specimens from different localities shows that the one described by me in Captain STANSBURY'S Report, under the name of *Spirifer triplicatus*, is identical with specimens from New-Mexico, which correspond with the figures given by RŒMER of *S. meusebachanus*. Specimens from a limestone in the Coal measures of Greentown (Ohio) are more extended laterally, and more nearly semicircular than the southwestern specimens, and likewise present some slight differences in the strength and disposition of the plications; but they are clearly identical species.

A farther comparison of the original specimens of the species in Dr. HILDRETH'S collection, and numerous others from Illinois and Iowa, shows no constant difference in the forms, though the degree of variation is sometimes excessive. It is not improbable that the *S. fasciger* of KEYSERLING may be identical with the American species.

Fig. 2 *a*. Dorsal view of a specimen above the medium size, having the extremities imperfect.

Fig. 2 *b*. Ventral view of the same.

Geological formation and localities. In the Coal-measure limestones and rocks of the same age in Ohio, Illinois, Iowa, Missouri, Nebraska; Santa Fé and Pimos village, New-Mexico; and other places in the range of the Rocky mountains.

This species has perhaps a wider geographical distribution than any of the genus known upon this continent: over much of the area, it is associated with *Spirifer lineatus*, *Terebratula* (*Athyris?*) *subtilita*, and *Productus rogersi*; while *Terebratula millepunctata* = *T. bovidens?* has possibly a distribution of equal extent. From our present knowledge, it would appear that this species is known in both the Upper and Lower Coal measures*.

Spirifer opimus (n. s.).

PLATE XXVIII. FIG. 1 *a*, *b*.

SHELL rotund, gibbous, length and width nearly equal; hinge-line equalling or sometimes a little greater or less than the width of the shell below: valves nearly equally gibbous in their greatest convexity. Dorsal valve regularly convex, with a strong well-defined mesial fold which is simple at the apex, dividing a little below, and each division again dichotomizing, the two middle divisions stronger than the lateral ones, and separated by a well-defined groove; in some of the smaller shells, the lateral plications of the mesial fold are feebly or not at all developed: beak elevated a little above the hinge-line, and incurving over a narrow defined area. Ventral valve most gibbous above the middle, and abruptly rounding towards the sides and front; mesial sinus well defined, simple above, and becoming marked by three small plications in the middle and lower part; beak much elevated and strongly incurved, covering the upper part of the large foramen; area high in the middle, slightly

* The *Spirifer striatus* is cited as having a wide geographical distribution on this continent, as well as in Europe; but I have not been so fortunate as to see specimens from any distant localities.

concave, continued to the extremities of the hinge-line, vertically striated : foramen large, forming an equilateral triangle.

SURFACE marked by from eight to ten simple abruptly elevated plications which are equal to the spaces between, concentrically marked by strong imbricating lamellose lines of growth, and, on well-preserved specimens, by finer radiating and concentric striæ.

Fig. 1 *a*, *b*. Profile and dorsal views of a large individual.

Geological formation and localities. In the Coal measures of Ohio, Maryland, Iowa, etc.

Productus costatus, var.

PLATE XXVIII. FIG. 3 *a*, *b*, and 4 *a*, *b*, *c*.

Producta costata : J. D. C. SOWERBY, 1827, Min. Conchology, Vol. vi, pa. 115, pl. 560, f.1.
For synonomy and references, see DE KONINCK, Mon. of *Productus* and *Chonetes*, p. 92.

SHELL somewhat hemispheric, transverse, about as long as wide. Ventral valve strongly arcuate, ventricose in the middle on each side, with a broad shallow depression down the centre which does not extend to the beak, constricted at the cardinal extremities below the vault, and extended in short sometimes recurved auricles ; beak incurving a little beyond the hinge-line ; sides rounded, compressed, the front usually somewhat sinuate. Dorsal valve regularly concave in the middle, flattened or broadly grooved towards the hinge extremities.

SURFACE of ventral valve marked by numerous rounded costæ, many of which frequently dichotomise on the upper part of the shell, and often coalesce and again subdivide below : cardinal margin marked by two or three spines on each side (two often quite conspicuous on each of the ears), and a row of spines upon the fold just within the constriction bounding the ears, extending from near the beak in a curving line towards the base of the shell. Entire surface of the valve marked at irregular intervals by the bases of spines, which are sometimes numerous : upper half of the shell covered by strong concentric wrinkles. Surface of dorsal valve marked by strong rounded costæ and equally strong concentric wrinkles, giving, as in the opposite valve, a subnodose appearance. Entire surface of both valves, in well-preserved specimens, marked by fine concentric striæ.

This shell is doubtless the same as that identified by M. DE KONINCK with the *P. costatus* of Europe; but if the figures of SOWERBY and DE VERNEUIL are to be relied upon as characteristic, our shell should be regarded as distinct. In deference to the authority of M. DE KONINCK, however, I have referred the specimens under examination to that species, merely indicating them as a well-marked variety, which I believe future examinations will prove a distinct species.

Fig. 3 *a*. Ventral valve of a specimen preserving a greater number of spine-bases than usual.

Fig. 3 *b*. Profile view of the same.

Fig. 4 *a*. Ventral valve of a strongly costate specimen with few spines, and a well-marked mesial sinus.

Fig. 4 *b*. Dorsal view of the same [the radiating costæ and concentric wrinkles are not properly shown in this figure].

Fig. 4 *c*. Profile view, showing the curving row of spines which extend from near the beak.

Geological formation and localities. In the Coal measures of Ohio, Illinois, Missouri and Iowa.

Orthis robusta (n. s.).

PLATE XXVIII. FIG. 5 *a, b, c, d*.

SHELL resupinate, semielliptical in outline, plano-convex. Dorsal valve extremely convex, gibbous in the middle and towards the umbo, broadly and evenly curving towards the front. Ventral valve nearly flat at the sides, slightly concave in the middle, with the beak and umbo elevated and somewhat distorted; beak not incurved : area moderately high, plane, extending to the cardinal extremities, which are as wide as the greatest width of the shell below : foramen narrow, closed nearly to the base, where there is a narrow transverse semioval space which is nearly filled by a cardinal process from the opposite valve, having a central groove which is partially visible when the valves are a little separated.

SURFACE marked by sharp radiating striæ, with broader spaces between, which are crossed by fine undulating striæ, and, towards the margins, by strong imbricating lines of growth which give a thickened condition to that part of the shell.

This species resembles, in many of its characters, the *O. umbraculum*, but differs from all the figures and descriptions which have come under my observation: it may be compared with *O. undiferus* of SCHNUR (DUNKER and VON MEYER'S Palæontographica, pa. 217, pl. 45, f. 1).

Fig. 5 *a*. View of the ventral valve, with the greater part of the shell exfoliated.
Fig. 5 *b*. View of the dorsal valve, from which the striæ are nearly obliterated.
Fig. 5 *c*. Profile view of the same.
Fig. 5 *d*. Enlargement of the surface, showing the concentric striæ. [Incorrect shading has represented the depressed portions as elevations.]

Geological formation and locality. Lower Coal measures : St. Clair county, Illinois.

Terebratula subtilita.

Terebratula subtilita : HALL in Stansbury's Report of an Exploration of the Valley of the Great Salt Lake of Utah, 1852.

This species has a very wide geographical distribution; being known in Eastern Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, Nebraska, the Pecos villages in New-Mexico, and in several other places along the range of the Rocky mountains. After a careful examination of many specimens, I find the punctate structure very feebly represented under an ordinary magnifier. The exfoliation, however, often takes place in parallel laminæ, and the surfaces present a striato-punctate appearance.

It is possible that this may prove to belong to the Genus ATHYRIS, some species of which it resembles in form and surface striæ.

LAMELLIBRANCHIATA OF THE COAL MEASURES.

GENUS ASTARTELLA (n. g.).

SHELL bivalve, thick, smooth or concentrically furrowed: lunule impressed; ligament external; hinge-teeth two in each valve, the anterior tooth of the right valve large and strong, with a longitudinal pit in the summit. Related to ASTARTE.

The hinge and teeth of but a single species have been observed, but the characters seem to be sufficiently distinct to constitute a separate genus.

Astartella vera (n. s.).

PLATE XXIX. FIG. 1 *a*, *b*, *c*.

SHELL somewhat rhomboid-ovate, gibbous on the umbones: beaks subanterior, elevated, approximate; anterior end slightly concave below the beak and rounded below, posterior end obliquely subtruncate. An oblique undefined ridge extends from the beak to the posterior basal margin, having the space between it and the ligamental area flattened: lunule cordiform, strongly impressed; ligamental area deeply marked, and extending to the posterior extremity. Anterior and posterior muscular impressions distinct; hinge strong. Teeth of right valve separated by a deep pit; the anterior tooth with a longitudinal pit in the summit, and a callosity on the inner margin at its base.

SURFACE marked by strong concentric furrows, which are separated by sharp angular ridges; the intermediate spaces finely striated.

Fig. 1 *a*. View of the exterior of the right valve.

Fig. 1 *b*. Interior of the same, showing the teeth, etc.

Fig. 1 *c*. Cardinal view of another specimen, showing the impressed lunule and ligamental area.

Geological formation and localities. Coal measures; Illinois and Indiana,

Dolabra? alpina (n. s.).

PLATE XXIX. FIG. 2.

SHELL subrhomboidal; length a little greater than the height; anterior extremity rounded; posterior extremity obliquely truncate; umbo gibbous; the beak elevated, nearly central; an obtuse ridge extending from the beak to the posterior basal margin, and the space between this and the margin somewhat concave.

SURFACE marked by fine concentric striæ, and, near the margin, by stronger imbricating lines of growth.

This shell has the external form of some of the characteristic species of the Genus DOLABRA of M'COY; but I have not been able to ascertain the structure of the hinge.

Fig. 2. View of the left valve, natural size.

Geological formation and locality. In the Lower Coal measures of the Desmoines valley, Alpine dam, Iowa.

Edmondia? radiata (n. s.).

PLATE XXIX. FIG. 3.

SHELL oval-ovoid; length much greater than the height; beak near the anterior extremity, slightly sinuate on the anterior basal margin; posterior extremity broadly rounded; anterior extremity rounded below, and concave just beneath the beak.

SURFACE marked by concentric and radiating striæ, the latter somewhat more conspicuous when the shell is partially exfoliated.

This species is described from a single well-marked right valve.

Fig. 3. View of the right valve, from which the shell is partially exfoliated.

Geological formation. Coal measures.

Nucula ventricosa (n. s.).

PLATE XXIX. FIG. 4 & 5 *a*, *b*.

SHELL ovoid, gibbous or subventricose on the middle and upper part of the shell; outline regularly curving to the base and posterior extremity: beaks near the anterior extremity incurved and inclining forwards, with a cordiform depression beneath them.

SURFACE marked by fine concentric striæ and some stronger lines of growth. Hinge-line marked, on the posterior side of the beak, by thirteen or fourteen small prominent teeth, which increase in strength as they recede from the beak; anterior side with several small teeth, and two others much stronger with a deep pit between : muscular impressions strongly marked; shell thickened just within the margin.

Fig. 4. View of the interior of a left valve.
Fig. 5 *a*. Exterior of the left valve of another individual.
Fig. 5 *b*. Cardinal view of the same.

Geological formation. In the Coal measures.

Leda bellastriata.

PLATE XXIX. FIG. 6 *a, b, c, d.*

Leda bellastriata : STEVENS, Am. Journal of Science, Vol. xxv, p. 261.

SHELL about twice as long as wide, broadly subovoid anteriorly, contracted and attenuated posteriorly, gibbous on the umbones : beaks anterior to the centre of the shell, much elevated, sharp, incurved, appressed at their extremities, and pointing posteriorly : hinge-line curved, armed with about eleven or twelve teeth on the anterior side of the beak, with about an equal number on the posterior side. Externally the cardinal line on the posterior side is sharply elevated, with a space between it and the umbonial slope, which is flat or slightly concave; the escutcheon faintly defined, long and narrow.

SURFACE marked by fine abruptly elevated concentric striæ, which become obsolete in passing over the posterior slope, and strong on the flattened area adjacent to the cardinal line.

This shell differs from *Leda* (*Nucula*) *arata* (HALL in STANSBURY'S Report), in having the beaks more abruptly elevated, the escutcheon less strongly marked, and the concentric striæ much finer.

Fig. 6 *a*. View of the right valve of a small individual, which is imperfect at the posterior extremity.
Fig. 6 *b*. Cardinal view of the same.
Fig. 6 *c*. Interior of the right valve of a larger individual, in which the teeth are broken off on the posterior side.
Fig. 6 *d*. Enlargement of the concentric striæ.

Geological formation and locality. Lower Coal measures : Illinois.

GASTEROPODA OF THE COAL MEASURES.

Among the fossils of the Coal measures as developed in the valley of the Mississippi and to the eastern limits of Ohio, we find a greatly increased number of Lamellibranchiata and Gasteropoda. The latter, in the Genera PLEUROTOMARIA, MACROCHEILUS, BELLEROPHON, and other forms, are every where common, and in some of the strata not unfrequently abundant. Associated with these are likewise numerous forms of the Cephalopoda of the Genera NAUTILUS, GONIATITES, and ORTHOCERAS; but it has been impossible, for want of space, to illustrate these genera in the present volume.

Macrocheilus fusiformis (n. s.).

PLATE XXIX. FIG. 7.

SHELL elongate, subfusiform. Spire gradually tapering from the last volution which is more ventricose, consisting of seven or more volutions, which are very moderately convex except the last. Suture-line faint in the shell, deeply canaliculate in the cast : aperture not fully known, nearly equalling half the length of the spire.

This shell corresponds in general form and characteristics with *M. missourensis* of SWALLOW; but the angular character of the volutions in the cast is not observed.

Fig. 7. View of a specimen (of the natural size), from which the shell is partially exfoliated, and several of the volutions at the apex broken off.

Geological formation and locality. Coal measures : Alpine dam, Desmoines valley, Iowa.

Macrocheilus ventricosus (n. s.).

PLATE XXIX. FIG. 8.

SHELL ovoid-acute : last volution very ventricose, and more than twice the length of the spire above, which rapidly tapers to an acute apex. Volutions moderately convex, about eight or more altogether; columellar lip thickened.

Surface very finely striated in the direction of the lines of growth.

Fig. 8. View of specimen (natural size), showing the entire spire and a portion of the columellar lip.

Geological formation and locality. In the Lower Coal measures : Desmoines valley, Iowa.

Macrocheilus newberryi.

Plate XXIX. Fig. 9.

Loxonema newberryi & L. carinata : Stevens in Silliman's American Journal of Science, Vol. 25, New series, 1858, p. 259.

Shell subfusiform, symmetrically conical above the last volution. Volutions about eight, the last one moderately ventricose and longer than the spire above. Suture-line slightly concave, and marked by a narrow fillet : aperture elongate, not much inflated; columellar lip thickened below, with a defined spiral groove above the callosity, which is distinct within the aperture, and becomes obsolete on the exterior shell.

Surface markings obscure.

The shell is replaced by iron pyrites, and the surface markings are indistinct. Possibly the narrow spiral band marking the sutures is simply due to the solution and removal of a portion of the shell on each side of the suture-line.

On comparing the original specimens of the two species described by Dr. Stevens, with the one here figured and described, I am not able to find the means of specific distinction.

Fig. 9. View of the anterior side of the shell, natural size.

Geological formation and locality. In the Coal measures of Illinois. (From Dr. R. P. Stevens.)

Macrocheilus paludinæformis (n. s.).

Plate XXIX. Fig. 10.

Shell thin, ovoid-acute; the last volution ventricose, a little longer than the spire above : spire somewhat rapidly tapering. Volutions about eight, the upper ones very moderately convex. Suture-line plain, very slightly impressed : aperture undetermined.

Surface very finely striate in direction of the lines of growth.

This species bears some resemblance to *M. ventricosus*, but is comparatively less ventricose, and the last volution is proportionally less in length than in that species.

The Genus Plectostylus of Conrad was founded upon a cast which very much resembles the cast of this species; and should it prove identical, the name *Macrocheilus hildrethi* will supersede the present one.

Fig. 10. View of the anterior side of the specimen.

Geological formation and locality. In the Lower Coal measures : Desmoines valley, Iowa.

Macrocheilus primogenius.

Plate XXIX. Fig. 11 *a*, *b*.

Stylifer primogenia : Conrad, Transactions of the Geological Society of Pennsylvania, 1835, Vol. i, pa. 267, pl. 12, f. 2.

Fusus? inhabilis : Morton in Silliman's Am. Journal of Science, Vol. xxix, 1836, pa. 160 (appendix), pl. 3, f. 19 [also pl. 2, f. 14].

Plectostylus, new genus : Conrad, 1842.

Macrocheilus inhabilis : Norwood & Pratten, Journal of the Academy of Nat. Sciences, Philadelphia, 1855, pa. 76, pl. 9, f. 9 *a*, *b*.

Compare *Macrocheilus ponderosus*, Swallow, Transactions of the Academy of Sciences, St. Louis, Vol. i, no. 2, p. 7.

Shell ovoid, thick, ventricose. Spire short, tapering abruptly. Volutions rounded, five or more, the last one very ventricose, and more than twice as long as the spire above. Suture well defined, and sometimes a slight depression just without the suture-line : aperture more than half the length of the shell, oblong-ovate ; columella with a strong fold or callosity ; outer lip thin and sharp.

Surface marked by striæ parallel to the lines of growth, which are sometimes more conspicuous on the upper part of the volution.

I can have little doubt but this is the shell originally described by Mr. Conrad in 1835, and in the succeeding year by Dr. Morton, from casts in the collection of Dr. Hildreth. It has been recognized by Messrs. Norwood & Pratten as identical with that described by Dr. Morton, and the *M. ponderosus* of Swallow seems to be nearly related to the shell under consideration.

Fig. 11 *a*. View of the aperture and columella.

Fig. 11 *b*. Anterior side of the same shell.

Geological position and localities. In the Coal measures of Ohio, Indiana, Illinois and Iowa.

Pleurotomaria tabulata.

PLATE XXIX. FIG. 12 *a*, *b*.

Turbo tabulatus : CONRAD, Transactions of the Geological Society of Pennsylvania, 1835, Vol. i, pa. 267, pl. 12, f. 1.

Pleurotomaria tabulata : CONRAD, Journal of the Academy of Nat. Sciences, Philadelphia, 1842, Vol. viii, p. 272.

Compare *Pleurotomaria virgulata*, DE KONINCK, Description des Animaux fossiles, 1844, pa. 375, pl. 32, f. 4, and pl. 35, f. 1.

SHELL turreted, conical. Volutions about eight or nine, angular, somewhat rapidly ascending; the last one ventricose, carinate on the outer margin, with a prominent crenulate or nodiferous band, above and below which the volutions are sometimes a little concave. Suture well defined : aperture transverse, somewhat ovate; columella thickened; umbilicus none.

SURFACE marked by conspicuous striæ which are parallel to the lines of growth, bending abruptly backwards on the angulated periphery of the volution : these are crossed by revolving striæ which sometimes become slightly nodulose near the sutures of the upper volutions, while on the lower side of the last volution they are more conspicuous, and are cancellated by the vertical striæ, becoming nodulose at the junction.

This species has been referred to *P. virgulata* of DE KONINCK; but our shell is larger and more robust, and the revolving striæ are much less prominent on the upper volutions. The species has a wide distribution, being known from Pennsylvania to the Mississippi river.

Fig, 12 *a*. View of the anterior side of a large individual.
Fig. 12 *b*. View of the aperture, which is imperfect. The specimen figured has the striæ much obliterated, and these surface characters are not represented as they exist in other specimens.

Geological formation and localities. In the Coal measures of Pennsylvania, Indiana and Illinois.

Pleurotomaria sphærulata.

PLATE XXIX. FIG. 13.

Pleurotomaria sphœrulata : CONRAD, Journal of the Academy of Natural Sciences, Vol. viii, pa. 272, pl. 16, f. 12.

Pleurotomaria coronula : HALL in Stansbury's Report, pa. 413, pl. 4, f. 6 *a, b, c, d* [by error pl. 2, f. 6 *a, b, c, d*].

SHELL subglobose, semiglobose, or depressed conical, with the angles more or less rounded. Spire more or less elevated, often subtruncate above : volutions about five or six, the last one angular on the periphery; aperture quadrangular, subrhomboidal; umbilicus none; suture-line marked by an elevated band, which is studded with rounded or subangular nodes.

SURFACE marked by fine striæ parallel to the lines of growth, which bend abruptly backwards on the periphery, curving forwards on the base, and bending backwards towards the centre to a spiral band, which follows the direction of the columella.

This shell is sometimes very variable (from pressure or other causes) in the elevation of the spire and angularity of the last volution. The specimen figured is one having the spire unusually elevated.

Fig. 13 *a*. Anterior view of specimen. Fig. 13 *b*. View of the aperture.

Geological position and localities. In the Coal formation of Indiana, Illinois, Iowa, Missouri, and Kansas.

Euomphalus rugosus (n. s.).

PLATE XXIX. FIG. 14 *a, b, c*.

Compare *Inachus catilloides* : CONRAD, Journal Academy Natural Sciences, Philadelphia, Vol. viii, pa. 273, pl. 15, f. 3.

SHELL discoidal, nearly flat and slightly oblique on the dorsum, both sides concave from the outer margin to the centre; margins of the outer volution unevenly carinate or nodose carinate : all the volutions exposed in the broad shallow umbilicus. Spire slightly depressed, showing about four volutions.

UPPER surface marked by strong elevated striæ, which, from the inner side of the volution, curve very gently backwards, and then slightly advance towards the periphery, where they become more conspicuous, rising over the carinæ somewhat in irregular fascicles, and giving a seminodulose charactar to this part of the shell : striæ vertical on the periphery, stronger on the carinated margin below, and again less conspicuous in the umbilicus than on the upper side of the shell. Cast smooth.

This species may be identical with the one cited above; but the description of " back obtusely carinated in the middle", does not apply to the shell under examination.

Fig. 14 *a*. View of the lower side and umbilicus.

Fig. 14 *b*. Dorsal view, showing the aperture.

Fig. 14 *c*. View of the upper side, showing the depressed spire.

Geological position and locality. In the Coal measures of Illinois.

Bellerophon nodocarinatus (n. s.).

PLATE XXIX. FIG. 15 *a*, *b*, *c*.

SHELL subglobose, expanded at the sides, without umbilicus. Back and sides of the shell, near the aperture, marked by longitudinal or revolving ridges or carinæ, about seven or eight on each side of the centre ; the two central ones of which, in their extension forward, become more prominent, and form a kind of double carina which becomes nodose towards the aperture : a broadly concave depression on each side of the carina where the shell is thinner, becoming convex and extremely thickened towards the margins.

The aperture is imperfect in the specimen examined. The species bears a general resemblance to *B. urii* of Europe; but the carinæ are much fewer and coarser, while the double nodose central carination is a very distinctive feature.

Fig. 15 *a*. View of the imperfect aperture and back of the shell.

Fig. 15 *b*. Lateral view of the same.

Fig. 15 *c*. Dorsal view, showing the double dorsal carina, which becomes nodose towards the aperture.

Geological formation and locality. In the Coal measures of Illinois and Iowa.

Dentalium obsoletum (n. s.).

PLATE XXIX. FIG. 16, 17 & 17 *a*.

SHELL thick, terete, slender, very gradually tapering, slightly arcuate : section at the smaller extremity circular, slightly compressed below (perhaps from accident).

SURFACE marked by longitudinal slightly undulating striæ, which become somewhat obsolete on the lower half of the shell, and more distinctly crossed by transverse striæ of growth.

This shell is marked near the apex by regular longitudinal striæ, which are uniform and conspicuous on the middle and lower parts, and on the outer side of the curve are partially or entirely obsolete, while at the same time the concentric striæ become more conspicuous. The fragments figured show the shell to have been extremely elongated.

This species, in its longitudinal striæ, bears some resemblance to *D. ornatum* of DE KONINCK, but is more slender and less arcuate, while the striæ are coarser.

Fig. 16. A fragment near the base of the shell.
Fig. 17. A more slender fragment from the upper part of the shell.
Fig. 17 *a*. Enlargement of the longitudinal striæ.

Geological formation. In the Coal measures.

INDEX TO PART II.

PLATES.

PLATE I.

		Page
Fig. 1.	MEGISTOCRINUS LATUS.	480

1 *a*. Summit of specimen.

1 *b*. Basal view of the same.

Fig. 2.	SYNBATHOCRINUS MATUTINUS.	483

2. View of an imperfect specimen.

Fig. 3.	TAXOCRINUS INTERSCAPULARIS.	482
Fig. 4.	PENTREMITES SUBTRUNCATUS.	485
Fig. 5.	CLADOPORA DICHOTOMA.	478
Fig. 6.	STRIATOPORA RUGOSA.	479
Fig. 7.	ACERVULARIA PROFUNDA.	477

7 *a*. Part of a large hemispheric mass, showing several young cells, some of which are nearly circular : natural size.

7 *b*. Transverse section of a cell, enlarged, from a polished surface. The inner wall is not defined, and many of the rays are continuous to the centre of the cup.

7 *c*. A portion of a cell, enlarged, showing the denticulated rays.

Fig. 8.	ACERVULARIA DAVIDSONI.	476

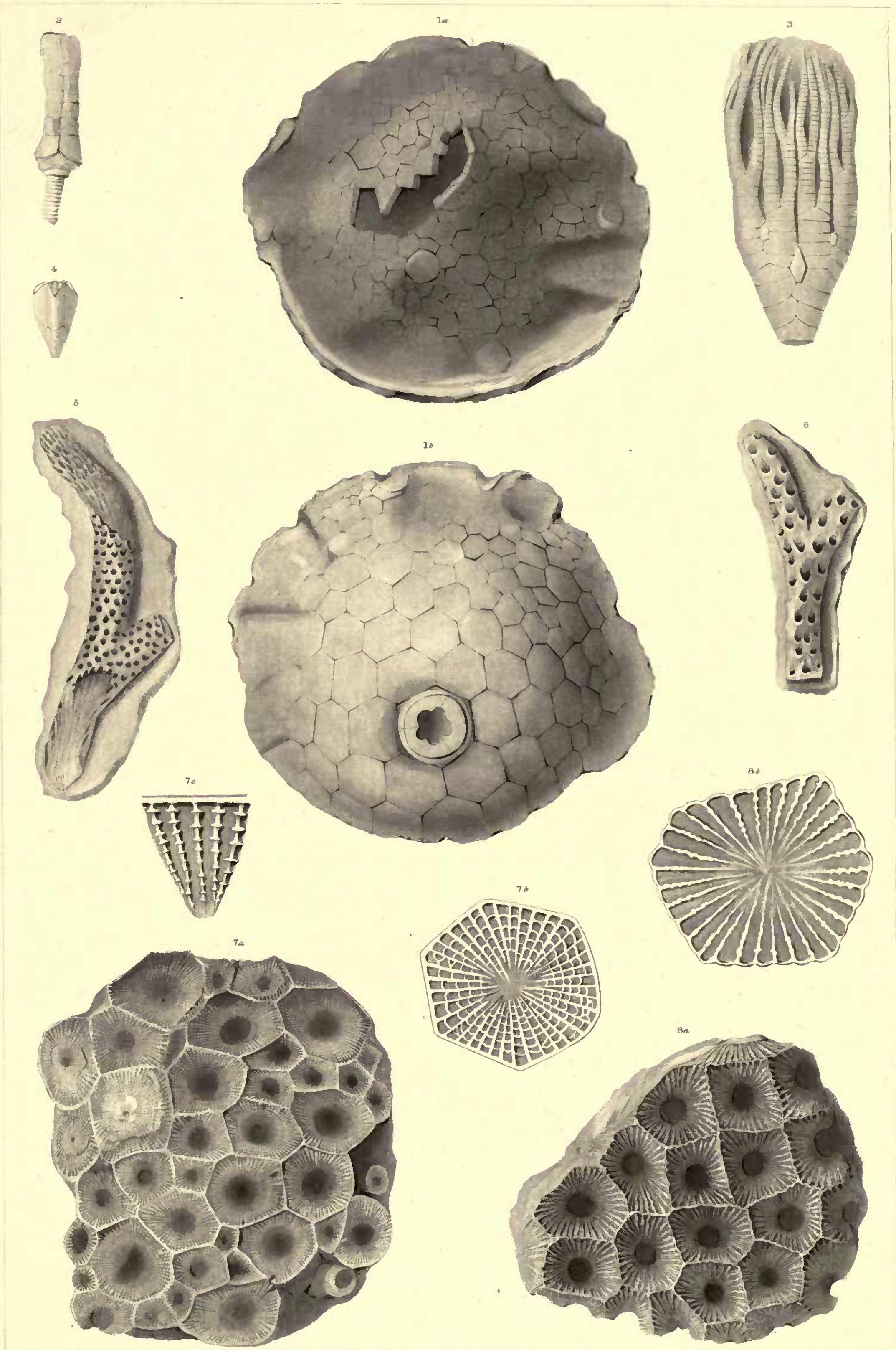
8 *a*. A weathered fragment of this species.

8 *b*. An enlargement of one of the cells.

HAMILTON GROUP.

(Devonian.)

CRINOIDEÆ, ETC.



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HAMILTON GROUP (Devonian) BRACHIOPODA

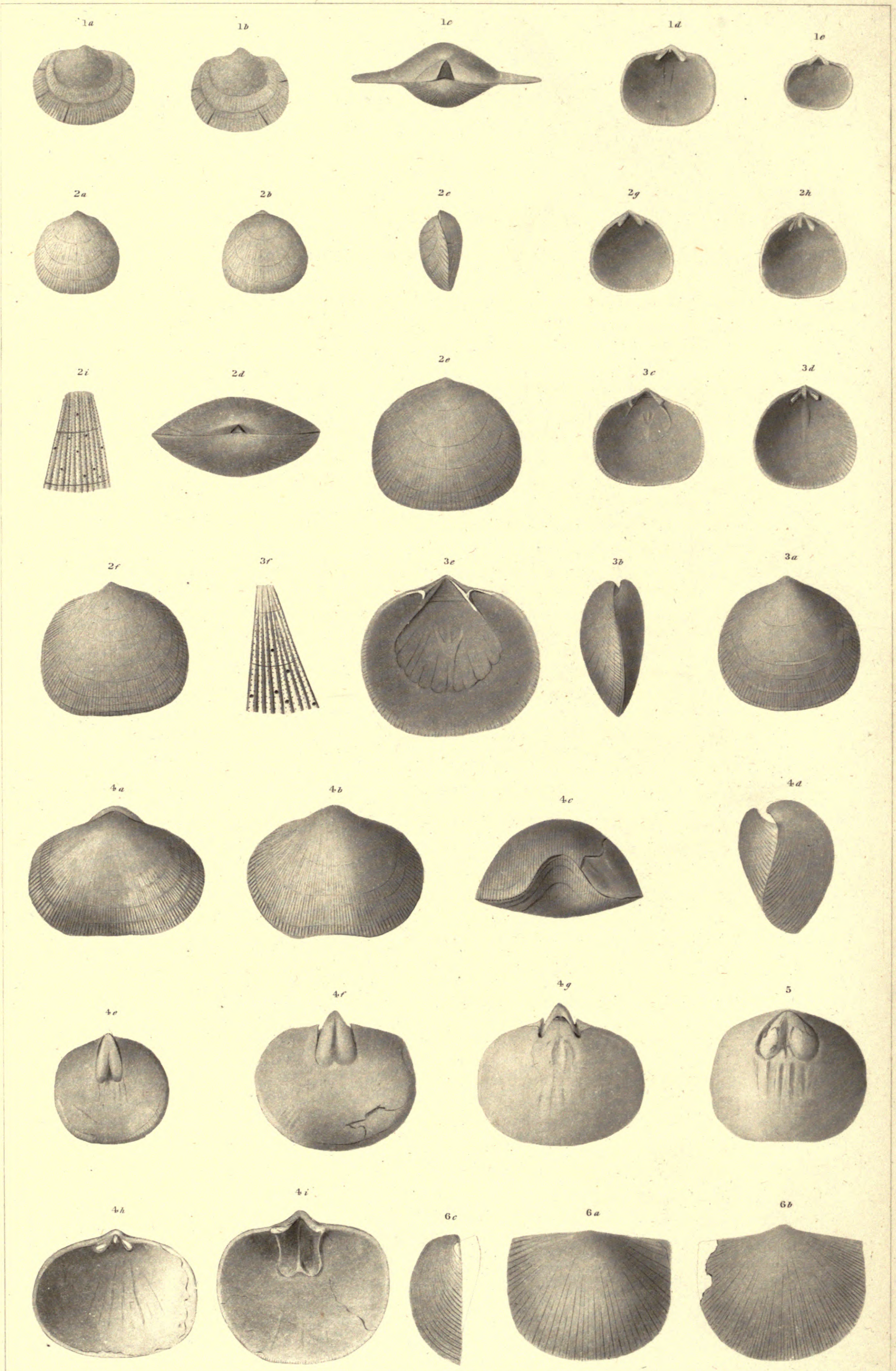

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PLATE II.

		Page
Fig. 1.	ORTHIS SUBORBICULARIS.	486

1 *a*, *b*. Dorsal and ventral views of an entire individual.

1 *c*. Cardinal view of the same enlarged.

1 *d*. Interior of a dorsal valve, showing the brachial and cardinal processes.

1 *e*. Interior of a ventral valve of a small individual, showing the cardinal teeth.

Fig. 2 & 3. ORTHIS VANUXEMI. 487

2 *a*, *b*, *c*. Ventral, dorsal and profile views of a specimen of the usual form of the species in its more northwestern localities.

2 *d*. Cardinal view, enlarged, to show area and foramen.

2 *e*, *f*. Dorsal and ventral views of a specimen from the same geological position in Missouri.

2 *g*, *h*. Interior of ventral and dorsal valves.

2 *i*. Enlargement of striæ.

3 *a*, *b*. Ventral and profile views of a specimen of medium size, from the shales of the Hamilton group in New-York.

3 *c*, *d*. Interior of ventral and dorsal valves from New-York specimens; the ventral valve showing some slight differences in form and divergence of the teeth from 2 *g*.

3 *e*. Interior of a large ventral valve from the Hamilton group of New-York, showing the vascular and muscular impressions: the teeth are broken.

3 *f*. Enlargement of the striæ, showing the punctate surface and more distinct tubular openings.

Fig. 4. ORTHIS IOWENSIS. 488

4 *a*, *b*. Ventral and dorsal views of a specimen of this species.

4 *c*. Front view of the same.

4 *d*. Profile view of specimen.

4 *e*, *f*. Cast of the ventral valve of a young and of a full-grown individual.

4 *g*. Cast of the dorsal valve of 4 *f*.

4 *h*. Interior of dorsal valve, showing the brachial and cardinal processes.

4 *i*. Interior of ventral valve, showing the teeth and the form of the muscular impressions, with indistinct radiating lines below, indicating the course of the vascular impressions.

Fig. 5. ORTHIS IOWENSIS, *var.* FURNARIUS. 489

5. Cast of the dorsal valve.

Fig. 6. ORTHIS INEQUALIS. 490

6 *a*. Dorsal valve.

6 *b*. Ventral valve.

6 *c*. Profile view.

PLATE III.

Page

Fig. 1 & 2. STROPHODONTA ARCUATA. 492

1 *a*, *b*, *c*. Dorsal, ventral and profile view of a specimen : natural size.
2 *a*. Interior of ventral valve, showing the muscular and vascular impressions, the central cardinal process, and the indentations of the area made by the cardinal process of the opposite valve.
2 *b*. A portion of the same enlarged, showing the parts described.
2 *e*, *f*. Enlargement of the striæ from two specimens, showing in 2 *f* the prevailing character, while some specimens present the features of 2 *e*.

Fig. 3. STROPHODONTA LEPIDA. 493

3 *a*. Exterior view of a ventral valve of large size.
3 *b*. Interior of the ventral valve, showing the muscular and vascular impressions.
3 *c*. Interior of a dorsal valve, showing the crenulated hinge line and muscular impressions.

Fig. 4. STROPHODONTA REVERSA. 494

4 *a*. Dorsal view of a specimen having the margin somewhat irregularly plicated, which is apparently due to accident during the life of the animal.
4 *b*. Ventral view of the same.
4 *c*. Profile view.
4 *d*. Interior of ventral valve, showing the indented margin of area, bilobed cardinal process, the muscular and vascular impressions.

Fig. 5. STROPHODONTA DEMISSA. 495

5 *a*, *b*. Ventral and dorsal views of a specimen of ordinary form and size, from Iowa.
5 *c*. A specimen where the cardinal extremities are more salient.
5 *d*. Profile, showing the convexity of the specimen.
5 *e*. Interior of the ventral valve of a specimen from New-York, showing the bilobed cardinal process in the centre of the area, and the muscular and vascular impressions.
5 *f*. Enlargement of the area surface, showing the deeply striate character.
5 *g*. Interior of the dorsal valve of a specimen from New-York, showing the muscular impressions and the double cardinal process.
5 *h*. The same enlarged, showing the crenulate dental lamella on each side of the base of the cardinal process.
5 *i*. Enlargement of a portion of the area and cardinal process of the dorsal valve, looking from the outside. In this individual there are no prominent crenulated lamellæ, as in fig. 5 *h*.
5 *k*. A similar view of another individual, showing, at the base of the cardinal process, the indentations made by the two lobes of the process from the ventral valve, and the lateral crenulated lamellæ.

Fig. 6. STROPHODONTA FRAGILIS. 496

6 *a*. View of the ventral valve.
6 *b* Interior of ventral valve, showing the foliate vascular impressions, entire area, etc.
6 *c*. Enlargement of the striæ.

Fig. 7. PRODUCTUS DISSIMILIS. 497

7 *a*, *b*. Dorsal and ventral views of the shell.
7 *c*. Profile of the same.
7 *d*. Enlargement of the striæ from the surface of the ventral valve.
7 *e*. Enlargement of concentric striæ from the surface of the dorsal valve.

Fig. 8. PRODUCTUS PYXIDATUS. 498

8 *a*. Ventral valve, showing a few spiniferous tubercles on the upper part of the valve, while the ridges which usually characterize the lower part in such specimens are not perceptible. This specimen is proportionally narrower than the prevailing forms.
8 *b*. Ventral valve of the ordinary form, without spiniferous nodes or ridges.
8 *c*. Dorsal valve of another individual, with some undefined radiating ridges upon the surface.
8 *d*. Profile view of a specimen.
8 *e*. Interior of a dorsal valve, showing the cardinal process, muscular impressions, etc.

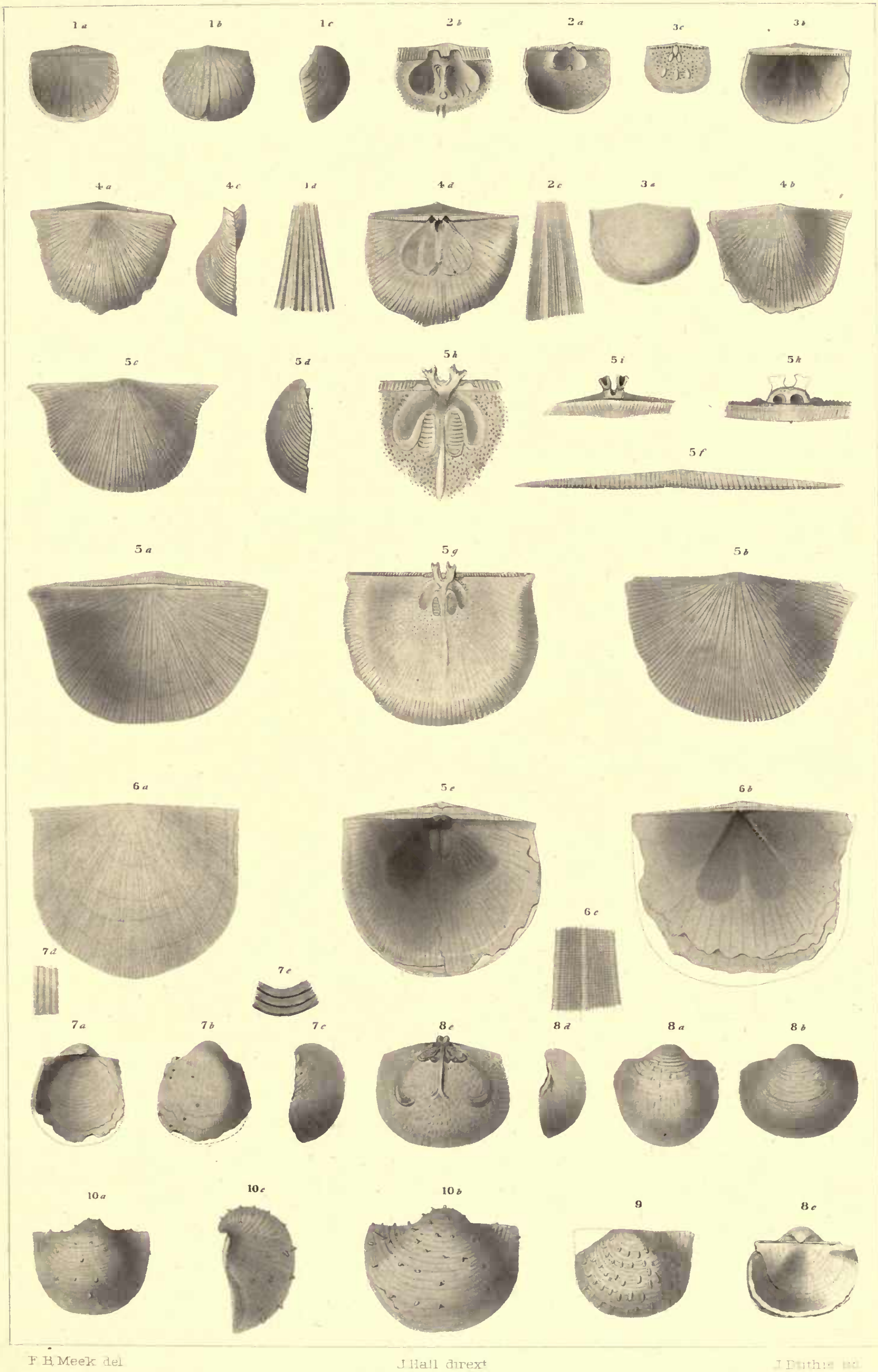
Fig. 9. PRODUCTUS SHUMARDIANUS. 499

9. Interior of a dorsal valve, showing the marks of the spiniferous ridges upon the inner surface.

Fig. 10. PRODUCTUS SUBALATUS. 500

10 *a*. Ventral valve of a specimen of medium size, with few spines, and preserving the usual characteristics of the species.
10 *b*. Ventral valve of a larger specimen, showing the irregular distribution of the spines.
10 *c*. Profile view of fig. 10 *b*.

HAMILTON GROUP (Devonian) BRACHIOPODA



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HAMILTON GROUP (Devonian) BRACHIOPODA

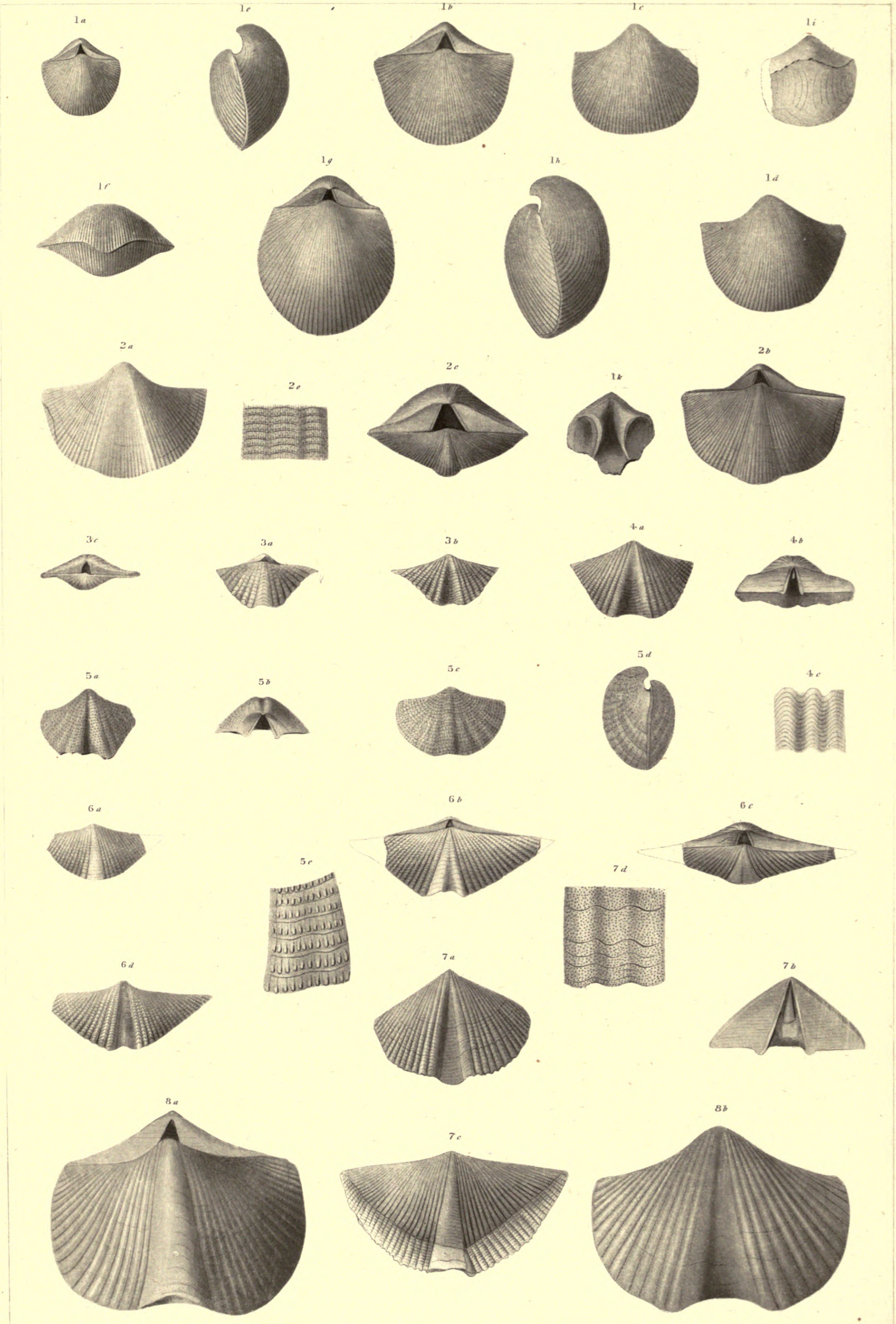

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PLATE IV.

Page

Fig. 1. SPIRIFER HUNGERFORDI. 501

1 *a*, *b*. Dorsal views of two individuals, showing the form of shell, portion of area, etc.
1 *c*, *d*. Ventral views of two individuals.
1 *e*. Profile view of 1 *b*.
1 *f*. Front view, the ventral valve being above.
1 *g*, *h*. Dorsal and profile views of an old shell.
1 *i*. Ventral view where the shell has been ground off to show the internal spires.
1 *k*. Interior of the ventral valve, showing the foramen and dental lamellæ which extend downwards to the middle of the shell.

Fig. 2. SPIRIFER WHITNEYI. 502

2 *a*, *b*. Ventral and dorsal views of a specimen of medium size.
2 *c*. Cardinal view of the same.
2 *e*. Enlargement, showing the fine striate and granulose surface.

Fig. 3. SPIRIFER SUBMUCRONATUS, *read* SUBATTENUATUS. 504

3 *a*, *b*. Dorsal and ventral valves of a specimen having one hinge extremity produced more than the other.
3 *c*. Cardinal view of the same specimen.

Fig. 4. SPIRIFER INUTILIS. 505

4 *a*. View of the ventral valve.
4 *b*. Cardinal view, showing the area and foramen.
4 *c*. Enlargement of the surface of fig. 4 *a*.

Fig. 5. SPIRIFER FIMBRIATUS. 505

5 *a*. Fragment of a ventral valve in which the sinus is subangular.
5 *b*. Cardinal view of the same, showing the broad foramen which occupies a large part of the area.
5 *c*. Dorsal valve of a small individual preserving the spiniferous bases.
5 *d*. Profile view of a small specimen from the Hamilton group of New-York.
5 *e*. Enlargement of the surface as it usually appears when the bases of the spines are preserved.

Fig. 6. SPIRIFER BIMESIALIS. 507

6 *b*. Dorsal valve of an apparently full-grown specimen.
6 *c*. Cardinal view, showing the area, foramen and part of the dorsal valve.
6 *d*. Ventral valve of another specimen, showing the small plication in the centre of the mesial sinus.

Fig. 7. SPIRIFER ASPERA. 508

7 *a*. Ventral valve of a specimen less than the full size.
7 *b*. Cardinal view of the same, showing the area and foramen which is partially filled with the pseudodeltidium.
7 *c*. Dorsal valve of a large individual which shows about twenty plications on each side of the mesial fold.
7 *d*. Enlargement of the surface, showing the granulose character with a few distinct imbricating lines.

Fig, 8. SPIRIFER PARRYANUS. 509

8 *a*. Dorsal view, showing the beak of the ventral valve, the area in part with the foramen, etc.
8 *b*. Ventral valve of the same specimen.

PLATE V.

Page

Fig. 1. SPIRIFER PENNATUS. 510

1 *a*. Dorsal valve of a young specimen of this species.

1 *b*. Cardinal view of a larger individual.

1 *c*, *d*. Dorsal and ventral views of a large individual, in which one side is much more extended than the other.

1 *e*. Cardinal view of the same, showing the extension of the area to the right where the shell is broken off. The shell has probably extended an inch beyond the present termination.

1 *f*, *g*. Cardinal and dorsal views of a more gibbous specimen, where the extremities are much less extended.

1 *h*. Profile view of the preceding specimen.

1 *i*. Enlargement of the surface, showing the radiating and concentric striæ, which presents only one of several characters of surface of the specimens, in various degrees of perfection or conditions of preservation.

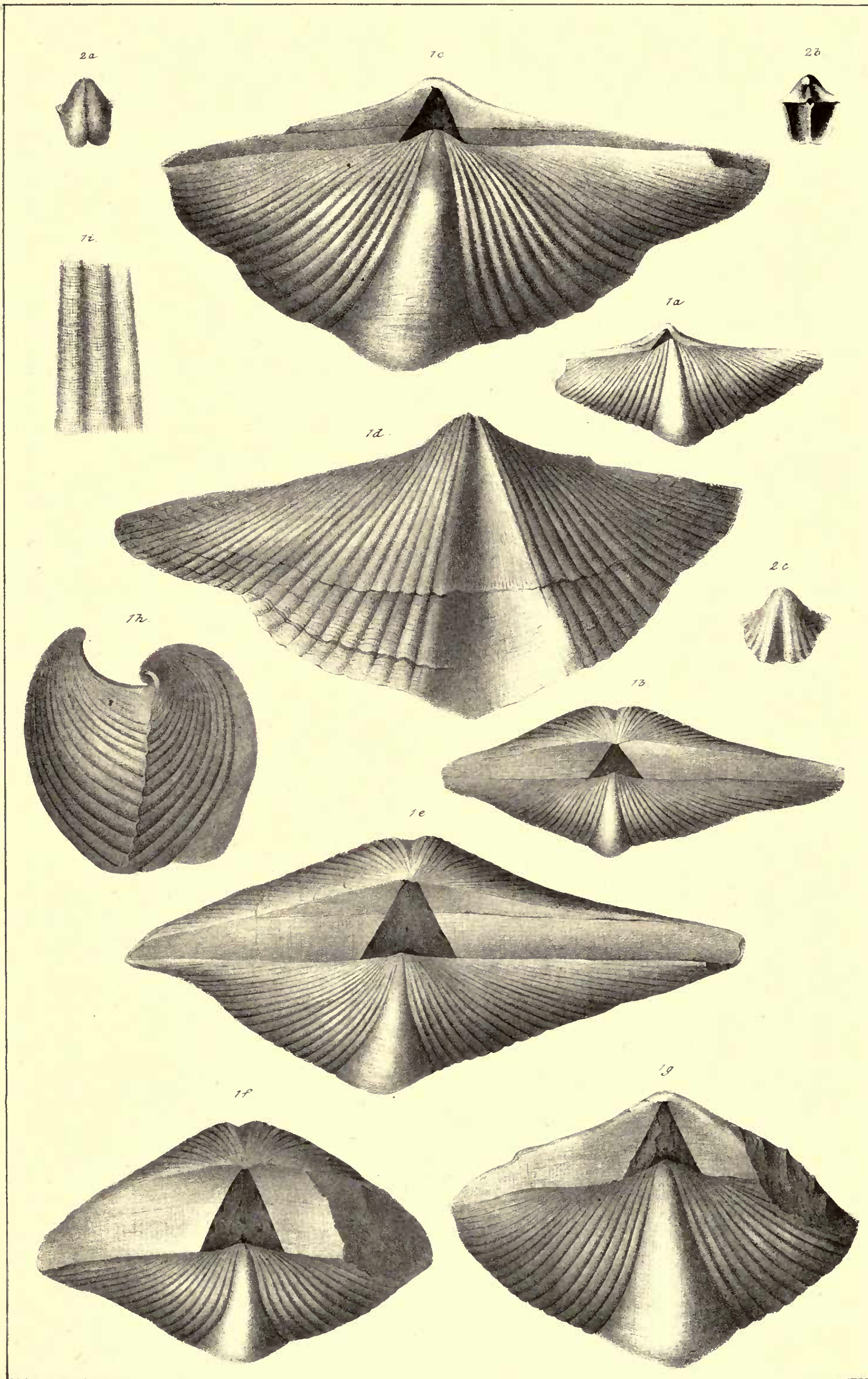
Fig. 2. CYRTIA UMBONATA. 512

2 *a*. Ventral valve of a worn specimen, with surface free from plications, and having a narrow sinus.

2 *b*. Interior of ventral valve, showing the central septum and the closed foramen, with the tubular opening between the dental lamellæ and pseudo-deltidium, which, at its upper extremity, opens just beneath the beak.

2 *c*. A larger and more perfect individual, showing the broad subangular sinus, the surface plications and auriculate cardinal extremities.

HAMILTON GROUP. (Devonian.) BRACHIOPODA.



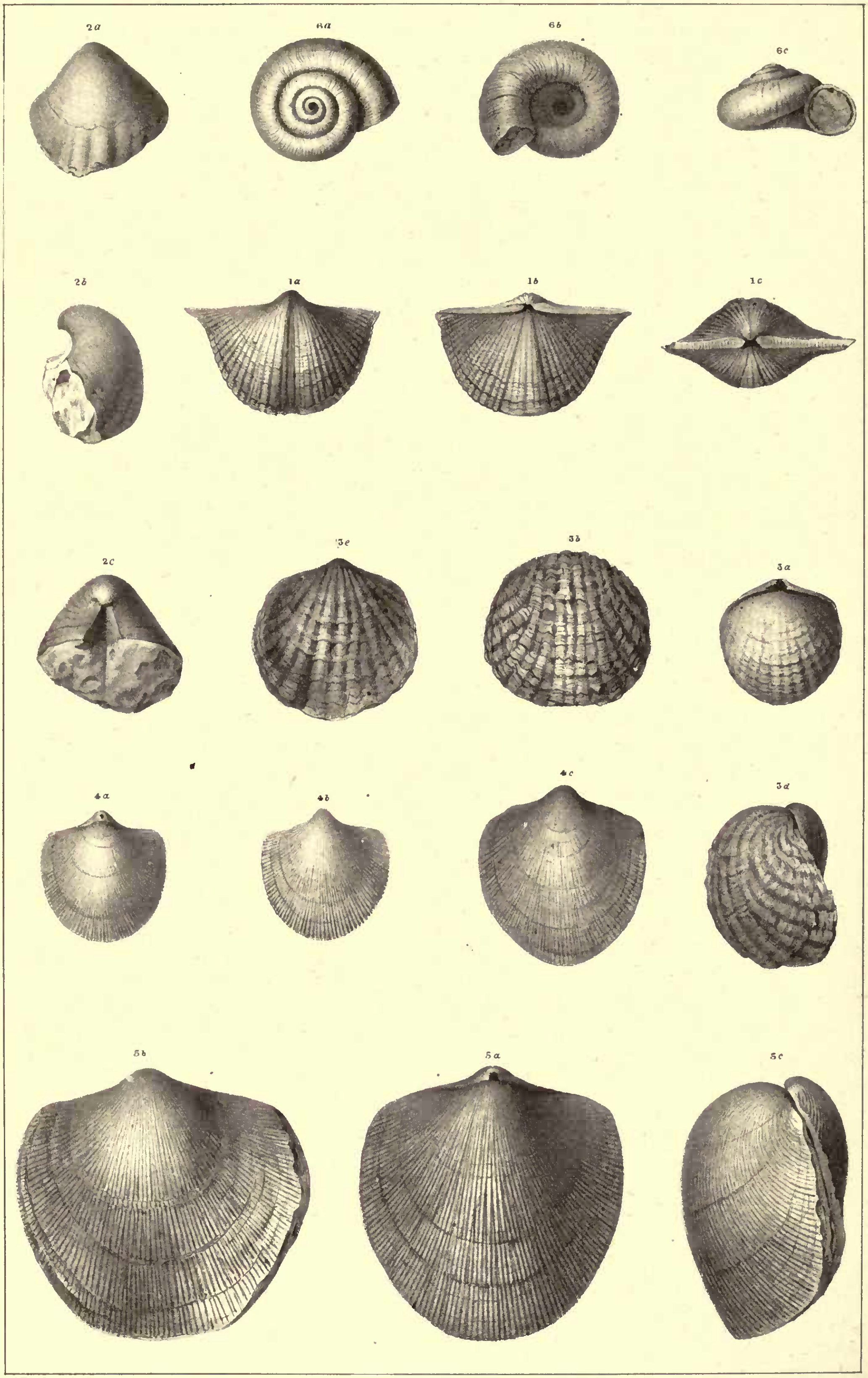


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PLATE VI.

		Page
Fig. 1.	SPIRIFER MARIONENSIS.	511
	1 *a, b*. Ventral and dorsal views of a specimen of medium size.	
	1 *c*. Cardinal view of the same, showing the narrow linear area.	
Fig. 2.	PENTAMERES OCCIDENTALIS.	514
	2 *a*. Ventral view of an imperfect specimen.	
	2 *b*. Profile of the same.	
	2 *c*. Interior, showing the hinge, the triangular cavity, etc.	
Fig. 3.	ATRYPA ASPERA, *var*. OCCIDENTALIS.	515
	3 *a*. Dorsal valve of a specimen below the medium size.	
	3 *b*. Dorsal valve of a very ventricose specimen.	
	3 *e* (= 3 *c*). Ventral valve of the same.	
	3 *d*. Profile of the same specimen, showing the extreme convexity of the ventral valve, and small elevation of the other valve near the beak.	
Fig. 4 & 5.	ATRYPA RETICULARIS.	515
	4 *a, b*. Dorsal and ventral views of a small specimen.	
	4 *c*. Ventral view of a larger individual.	
	5 *a, b, c*. Dorsal, ventral and profile views of a very large individual.	
Fig. 6.	EUOMPHALUS CYCLOSTOMUS.	516
	6 *a*. View of the summit of a specimen of the ordinary size.	
	6 *b*. View of the base of the same.	
	6 *c*. Profile view, showing the elevation of the spire.	

PLATE VII.

		Page
Fig. 1.	CHONETES FISCHERI.	517

1 *a*. A specimen in sandstone, which preserves no radiating striæ.

1 *b*. A specimen in limestone, which partially preserves the radiating striæ.

1 *c*. Enlargement of the surface, showing the radiating striæ and diagonal lines.

Fig. 2. PRODUCTUS SHUMARDIANUS. 499

2. View of the ventral valve.

Fig. 3. PRODUCTUS CONCENTRICUS. 517

3. View of the interior of the dorsal valve of this species.

Fig. 4. PRODUCTUS ARCUATUS. 518

4 *a*. View of the ventral valve.

4 *b*. Profile view of the same.

Fig. 5. SPIRIFER BIPLICATUS. 519

5 *a*. Dorsal valve from the Oolitic beds below the Burlington limestone.

5 *b*. Cast of a dorsal valve from the Yellow sandstone.

Fig. 6. SPIRIFER EXTENUATUS. 520

6. Dorsal valve of this species.

Fig. 7. SPIRIFER CAPAX. 520

7 *a*. Dorsal valve of a large individual.

7 *b*. Ventral valve of the same.

7 *c*. Profile view.

7 *d*. Cardinal view, showing height of area and foramen.

Fig. 8. SPIRIFER SUBROTUNDATUS. 521

8 *a*. Cast of the dorsal valve of this species.

8 *b*. Cast of the ventral valve, showing the narrow elongate muscular impressions below the beak.

Fig. 9. AVICULA CIRCULUS. 522

9. The right valve of this species.

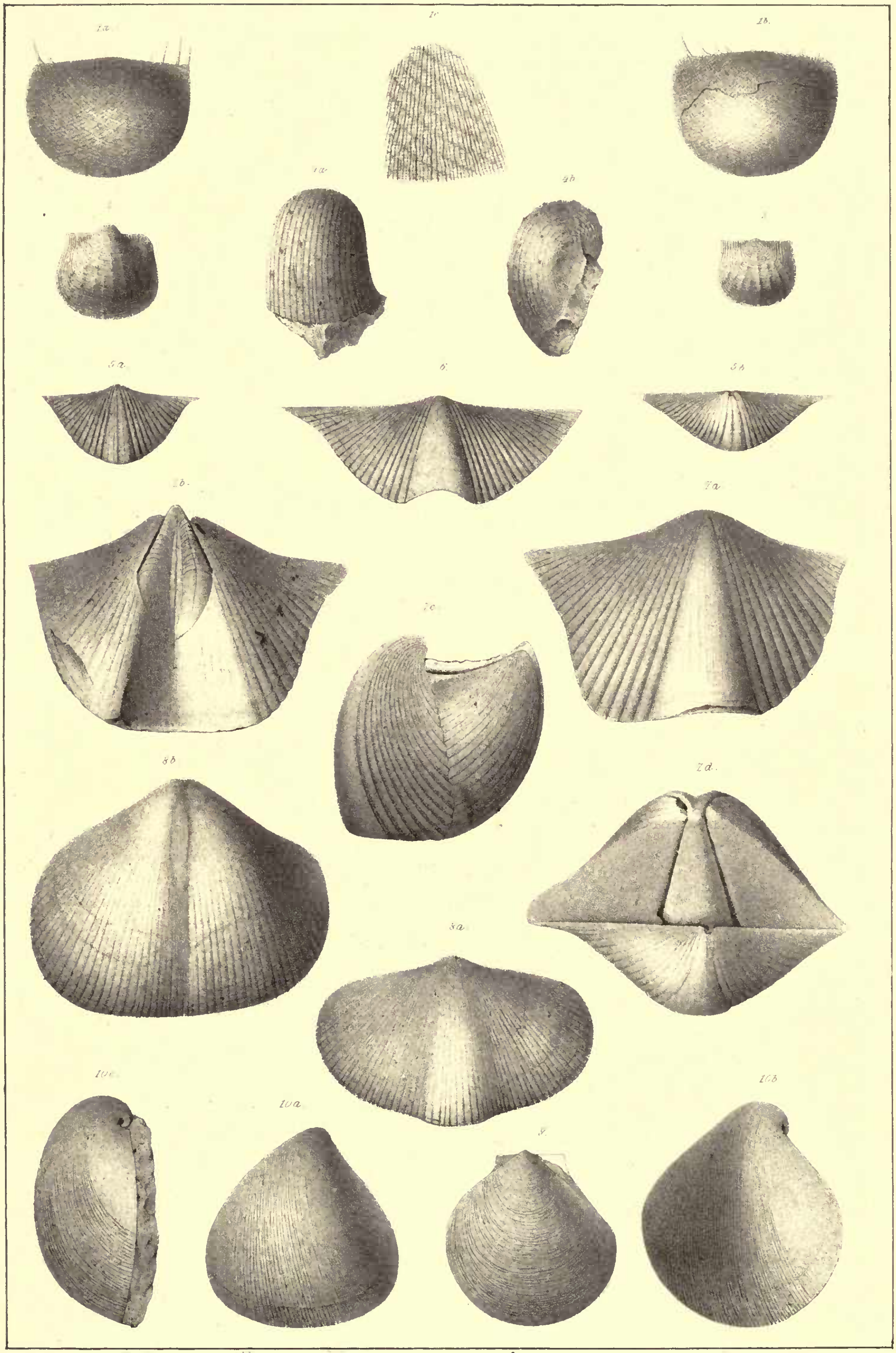
Fig. 10. CARDIOMORPHA OVATA. 522

10 *a*. The right valve of a specimen, which shows an obtuse ridge from the beak towards the base.

10 *b*. A similar valve, where the surface is more uniformly convex, and without a ridge.

10 *c*. Profile of the same specimen.

CHEMUNG GROUP. (Devonian.) BRACHIOPODA, ETC.



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BURLINGTON LIMESTONE. (Carboniferous) CRINOIDEÆ.

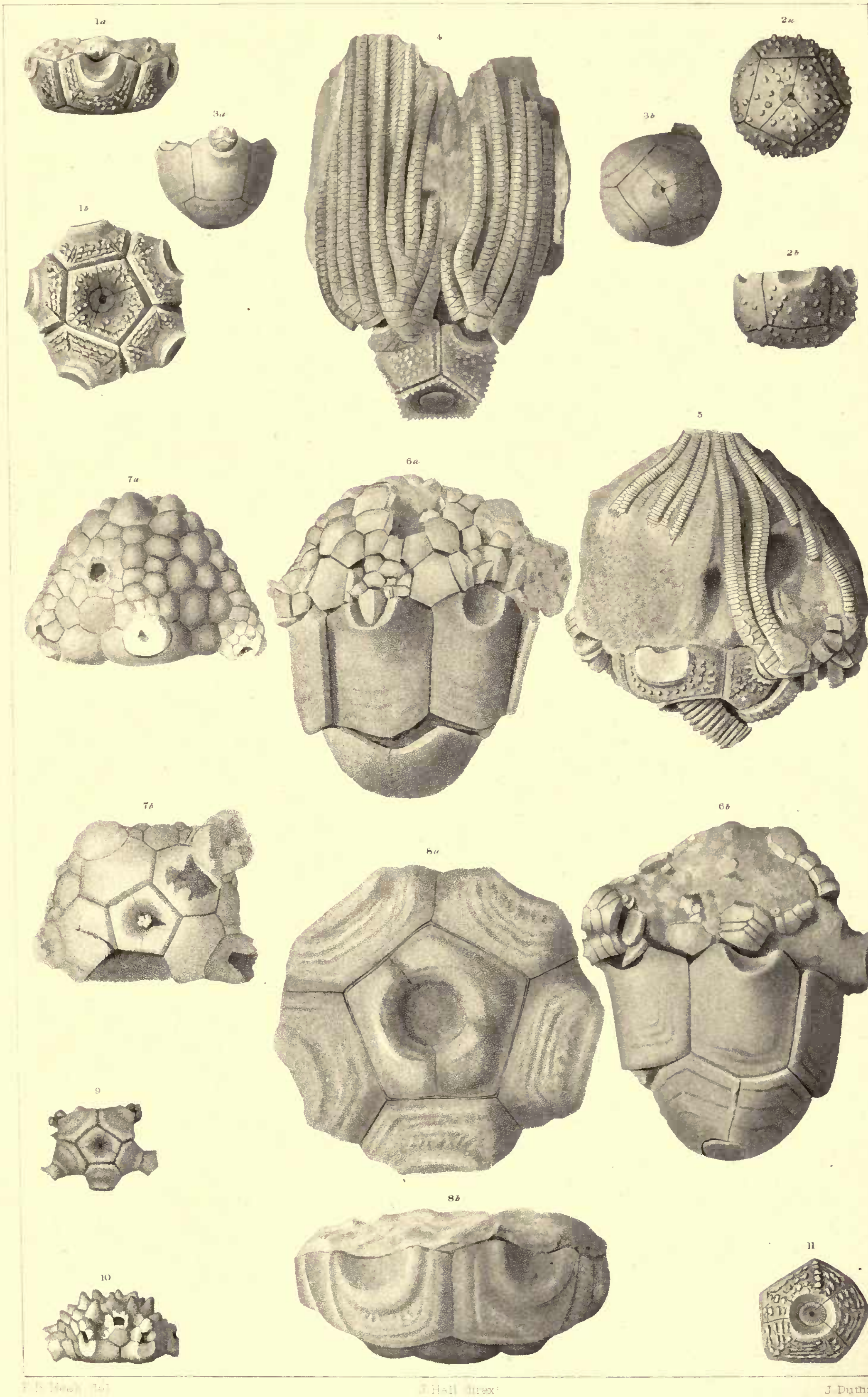

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PLATE VIII.

Page

Fig. 1. PLATYCRINUS CAVUS. 527

1 *a*. The calyx in profile.
1 *b*. View of the base, natural size.

Fig. 2. PLATYCRINUS POCILLIFORMIS. 528

2 *a*. View of the base.
2 *b*. Profile, showing elevation, form of first radial plates, and cicatrix for the attachment of the second radial.

Fig. 3. PLATYCRINUS PILEIFORMIS. 529

3 *a*. View showing the elevation of the basal plates, the first radial plates, with the base of one pair of arms attached.
3 *b*. Basal view of the same specimen : the two lower radial plates of the figure, and the radial on the left side, are represented as too protuberant.

Fig. 4. PLATYCRINUS WORTHENI. 530

4. A specimen preserving the base, with two of the radial plates, and the arms of two series nearly entire.

Fig. 5. PLATYCRINUS SHUMARDIANUS. 532

5. Lateral view, showing the cup with fragment of column, the edges of the concave base, the radial plates and arms which are somewhat broken and distorted.

Fig. 6. PLATYCRINUS PLANUS ? 533

6 *a*. Lateral view, showing form of cup on one side, radial plates with points of attachment to arm-plates, interradials, and plates of the summit.
6 *b*. View of the opposite side, showing similar features in the lower plates, with some remains of the arms above.

Fig. 7. PLATYCRINUS TUBEROSUS. 534

7 *a*. Anal and postero-lateral view, showing the incurved upper margins of the radial plates, the bases of the arms, and the plates of the summit with the anal opening.
7 *b*. View of the base of the specimen, showing the basal, radial, and first arm-plates, with the interradial plates.

Fig. 8. PLATYCRINUS DISCOIDEUS. 535

8 *a*. Basal view of the specimen.
8 *b*. Profile view, showing the elevation of the side of the cup.

Fig. 9 & 10. PLATYCRINUS SUBSPINOSUS. 536

9. View of a small specimen, showing the base and first arm-joints.
10. Profile view, showing the surface of attachment for the second arm-plates, the anal aperture, and the spiniform extension of the plates.

Fig. 11. PLATYCRINUS SCULPTUS. 536

11. Basal view, showing the depressed area for attachment of column, form of plates and surface ornaments. [The nodes are often more confluent than shown in the figure.]

PLATE IX.

		Page
Fig. 1 & 2.	ZEACRINUS ELEGANS.	547

1. Anterior side of specimen.
2. Posterior side, showing the anal plates.

Fig. 3.	ZEACRINUS RAMOSUS.	548

3. Antero-lateral side of specimen, showing the radial plates and the anterior ray on the left side of figure, with arms and tentacula. On that side two of the subradial plates are partially broken off, so that the figure does not give the form of these plates entirely.

Fig. 4.	CYATHOCRINUS MALVACEUS.	554

4 *a*. The anal side of the specimen.
4 *b* View of the base, showing the depressed centre and minute basal plates.

Fig. 5.	CYATHOCRINUS DIVARICATUS.	554

5. An individual preserving a portion of the column and several of the arms to the second bifurcation. The upper angles of the basal plates should be shown in the figure.

Fig. 6.	POTERIOCRINUS CALYCULUS.	553

6 *a*. Anal side of calyx.
6 *b*. The anterior side.
6 *c*. Basal view of another specimen, where the basal plates are wanting.

Fig. 7.	CYATHOCRINUS ROTUNDATUS.	555

7 *a*. Anal side of specimen (on some of the plates imperfectly represented).
7 *b*. Base of the same (the lines of division between the basal plates are not clearly shown in some of the impressions).

Fig. 8.	RHODOCRINUS WORTHENI.	556

8 *a*. View of anal side.
8 *b*. Basal view of same specimen.
8 *c*. Enlargement, showing more distinctly the form and arrangement of the plates.

Fig. 9.	SYNBATHOCRINUS WORTHENI.	560

9. View of the specimen, natural size.

Fig. 10.	SCAPHIOCRINUS SIMPLEX.	551

10. Anal side of specimen described.

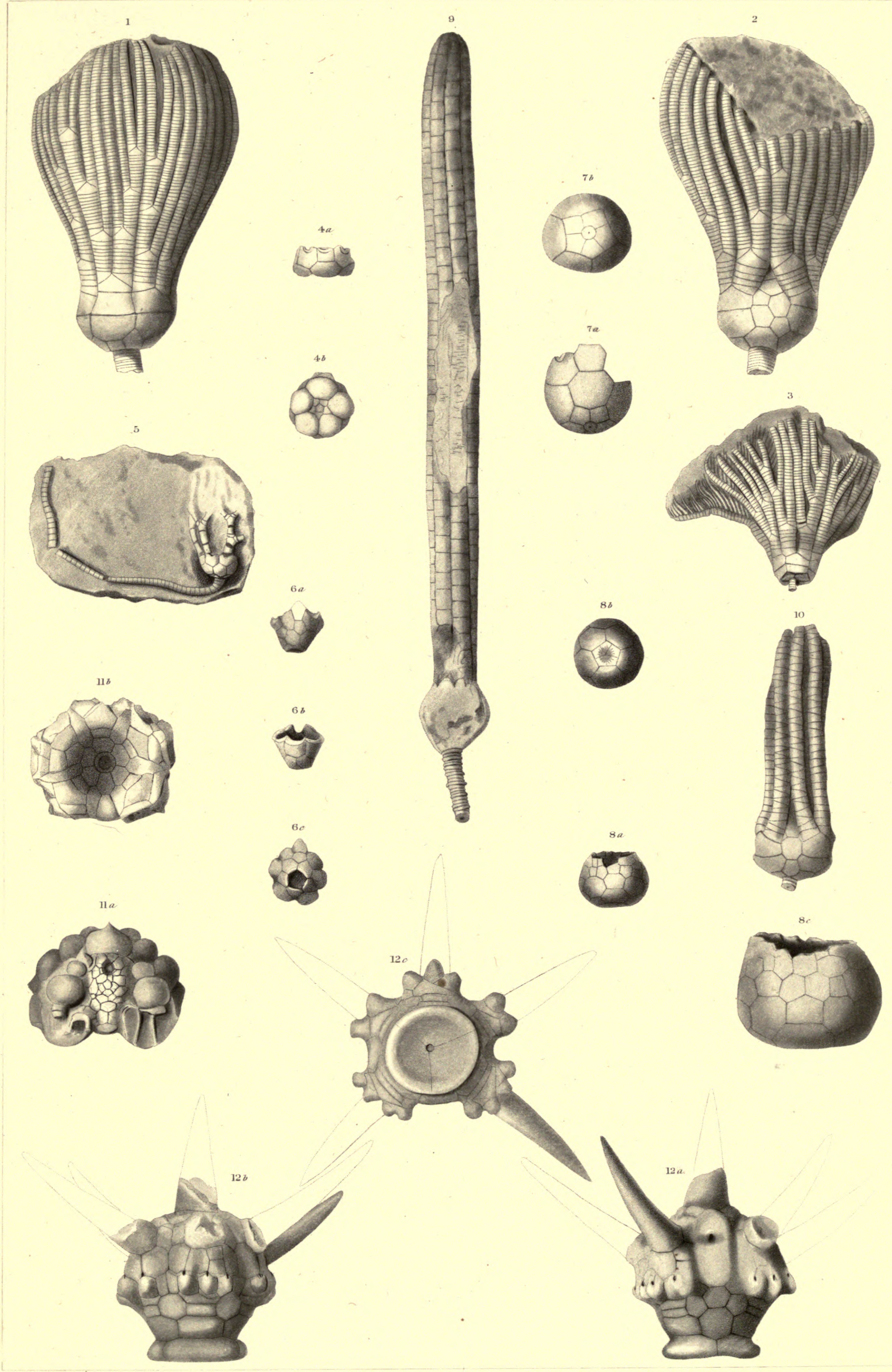
Fig. 11.	AGARICOCRINUS BULLATUS.	562

11 *a*. View of the anal side, seen a little from above.
11 *b*. Base of same specimen.

Fig. 12.	ACTINOCRINUS CORNIGERUS.	576

12 *a*. View of anal side of specimen.
12 *b*. Anterior side of same.
12 *c*. Basal view, showing the form and extent of base and distribution of arms. A single spine only is entire, and the others are traced in outline.

BURLINGTON LIMESTONE. (Carboniferous.) CRINOIDEÆ.



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BURLINGTON LIMESTONE. (Carboniferous) CRINOIDEÆ.

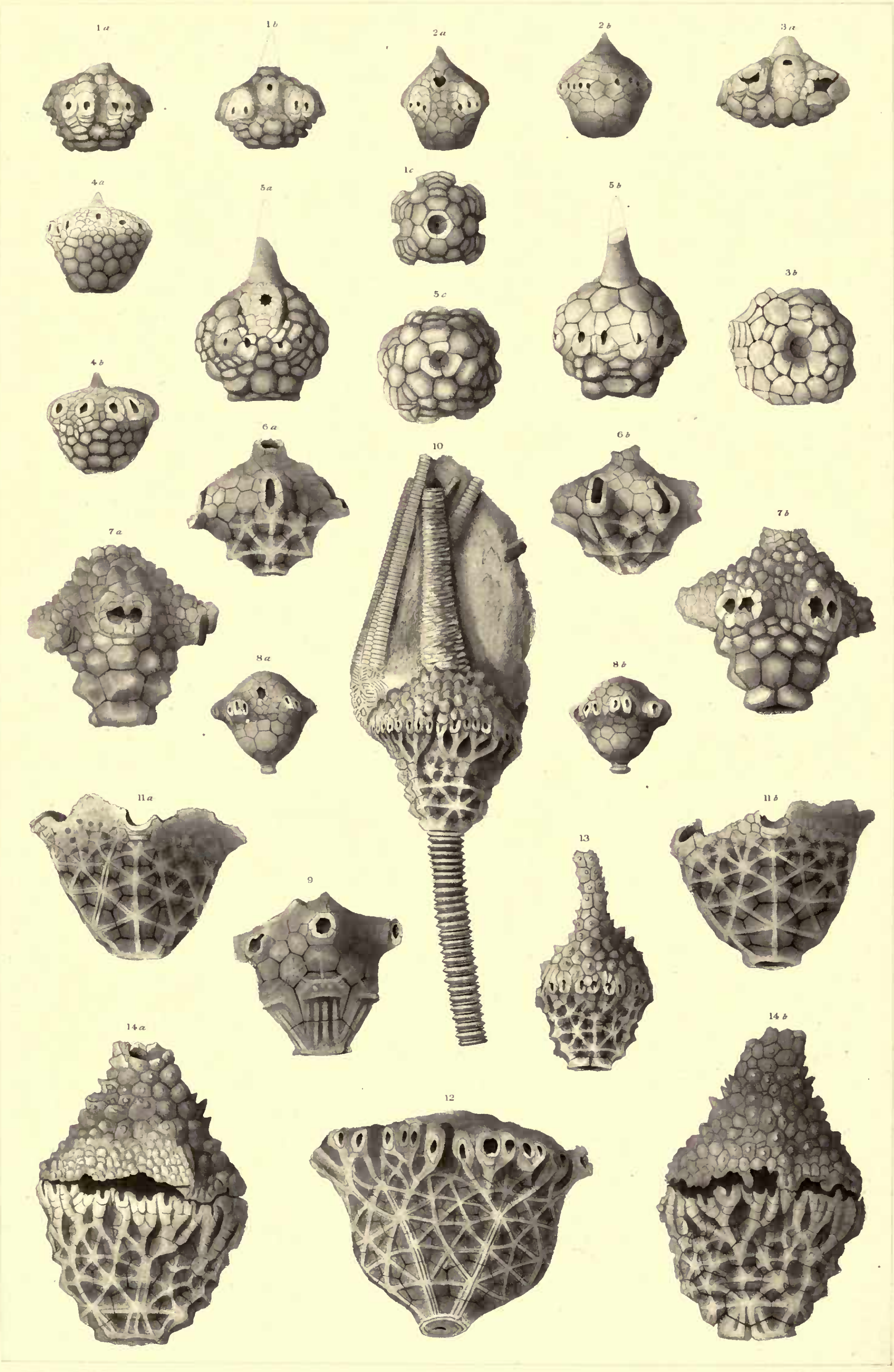

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PLATE X.

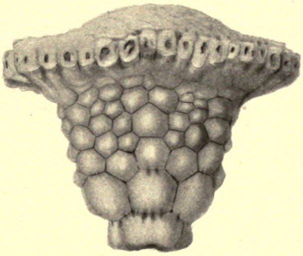
PLATE XI.

BURLINGTON LIMESTONE

(Carboniferous.)

CRINOIDEÆ.

3a



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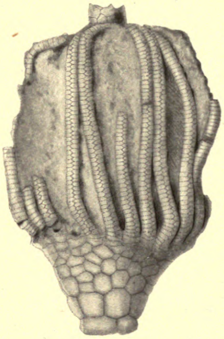

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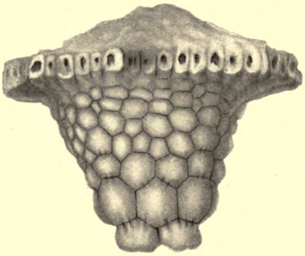

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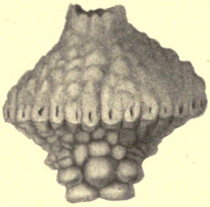

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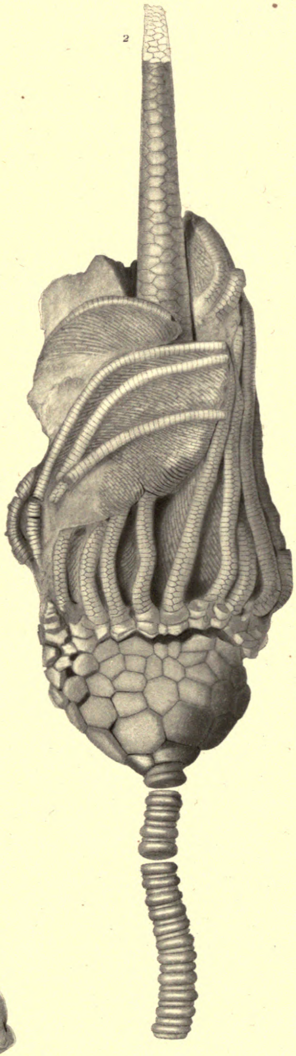

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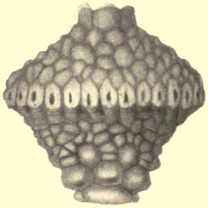

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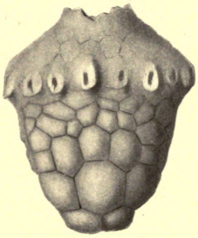

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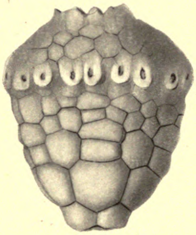

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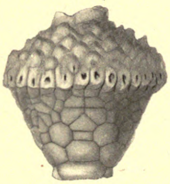

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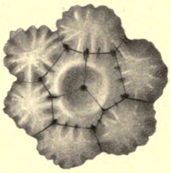

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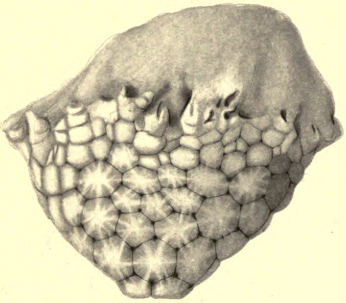

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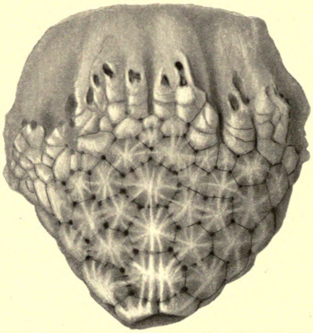

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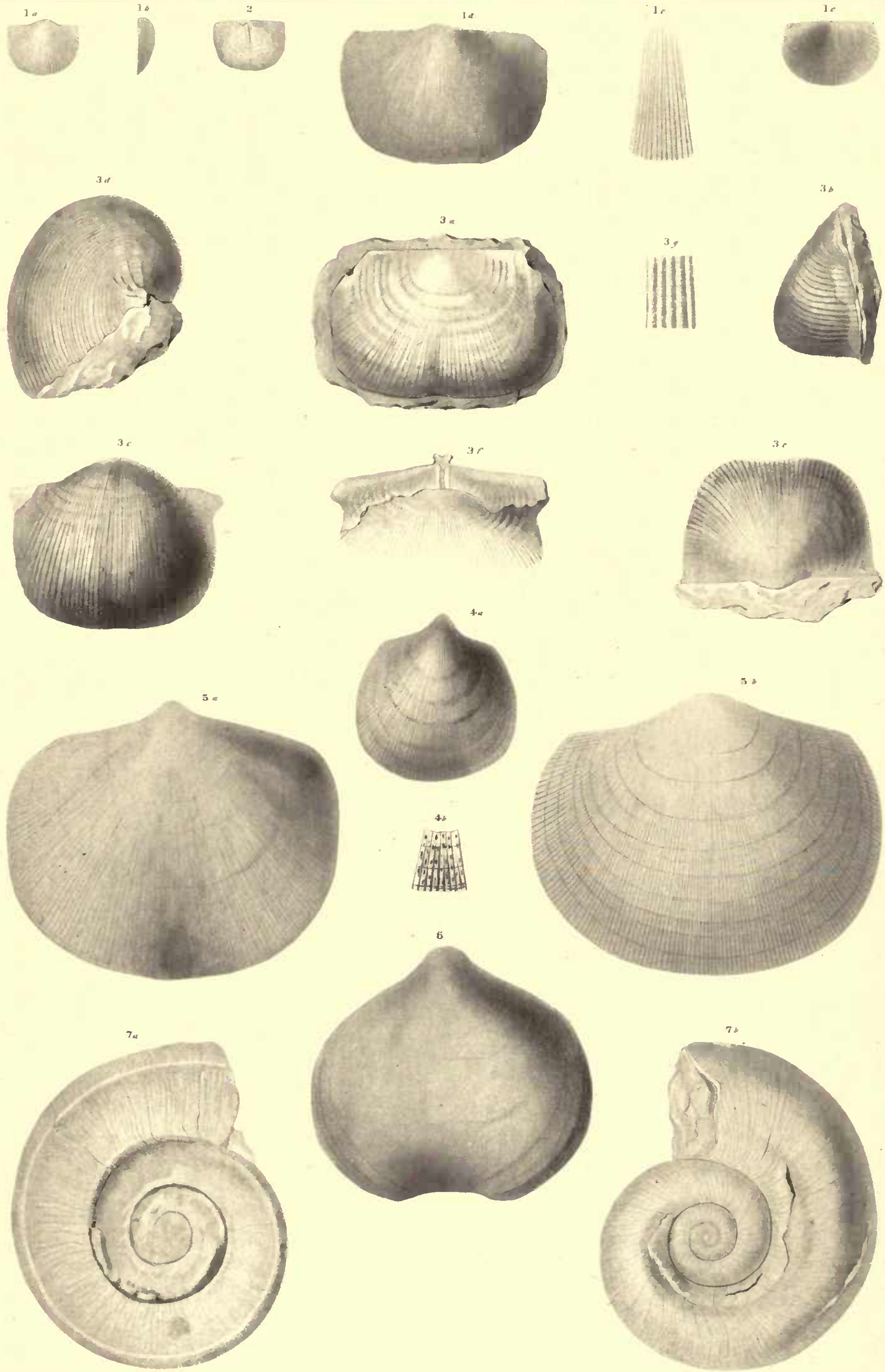

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PLATE XII.

		Page
Fig. 1 & 2.	CHONETES LOGANI.	598

1 *a*. Ventral valve of a small specimen.

1 *b*. Profile of the same.

1 *c*. Dorsal valve of another individual.

1 *d*. Enlargement of a ventral valve, showing the character and number of the striæ.

1 *e*. A further enlargement of the surface, showing the radiating and fine concentric striæ.

2. Interior of a small dorsal valve, showing the vascular impressions.

Fig. 3. PRODUCTUS FLEMINGI, *var.* BURLINGTONENSIS. 598

3 *a*. Cast of a dorsal valve where the shell is almost entirely exfoliated, leaving a mould of the exterior.

3 *b*. Profile of the same, which shows only a part of the anterior extension of the shell.

3 *c*. Ventral valve of the same species.

3 *d*. Profile of the same.

3 *e*. Cardinal view of the same.

3 *f*. Interior of the dorsal valve, showing the cardinal process and hinge-line, the shell below being exfoliated.

3 *g*. Enlargement of the fine concentric striæ.

Fig. 4. ORTHIS MICHELINA, *var.* BURLINGTONENSIS. 596

4 *a*. Ventral valve of a specimen of medium size.

4 *b*. Enlargement of striæ, showing the tubular openings upon the surface.

Fig. 5. ORTHIS SWALLOVI. 597

5 *a*. Ventral valve of a mature individual of this species.

5 *b*. Dorsal valve of another specimen.

Fig. 6. ATHYRIS INCRASSATUS. 600

6. The ventral valve of this species.

Fig. 7. EUOMPHALUS LATUS. 605

7 *a*. Upper side of a worn specimen, showing the angular outer margin (the inner volutions imperfect).

7 *b*. Lower side of another specimen, showing the broad shallow umbilicus.

PLATE XIII.

		Page
Fig. 1.	SPIRIFER FORBESI.	600

1. A ventral valve from which the surface markings have been worn.

Fig. 2.	SPIRIFER IMBREX.	601

2. Dorsal valve of a specimen of this species.

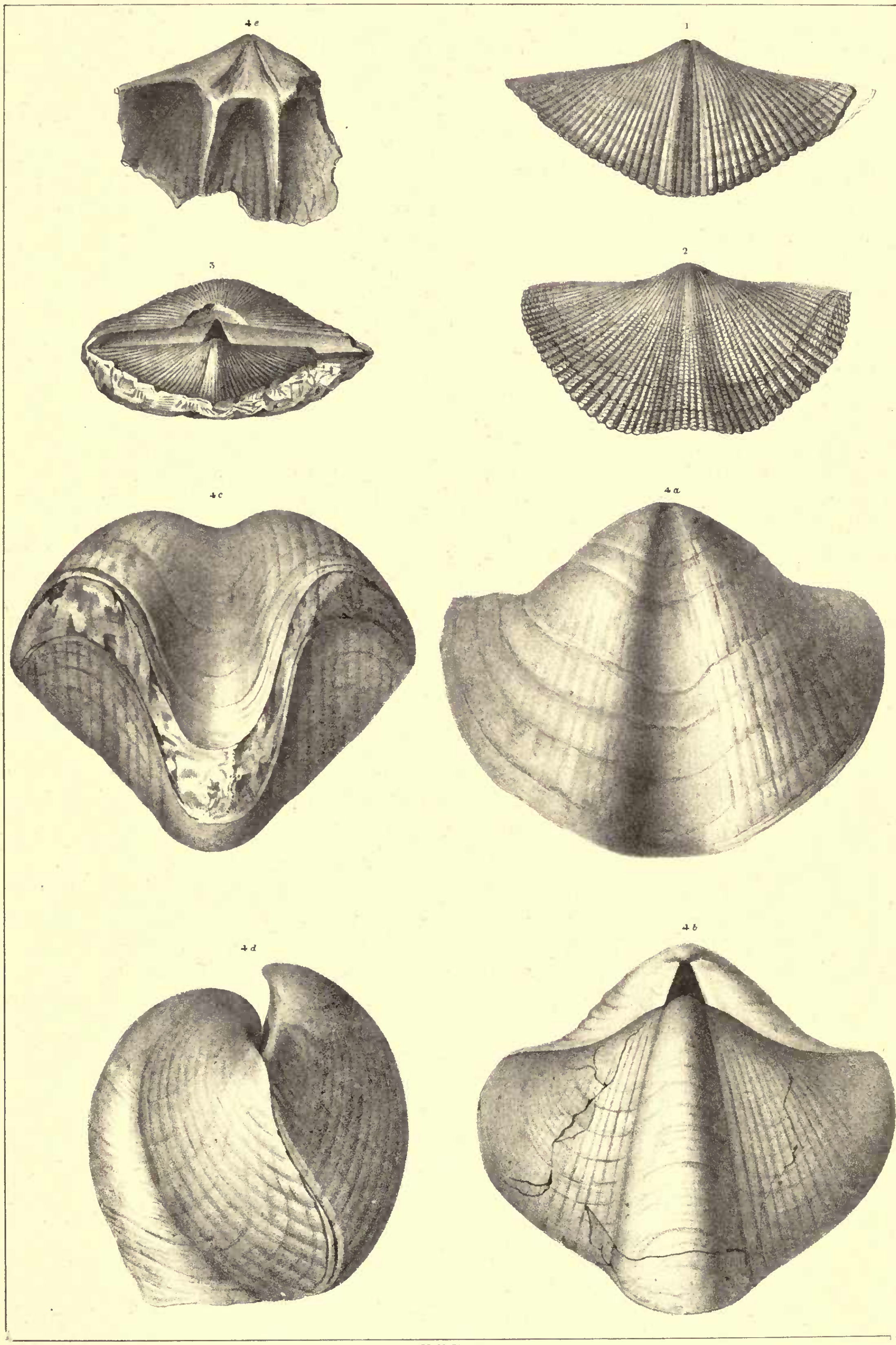
Fig. 3.	SPIRIFER INCERTUS.	602

3. Cardinal view of the specimen, showing the linear area.

Fig. 4.	SPIRIFER PLENUS.	603

4 *a*. Ventral view of a specimen of this species.
4 *b*. Dorsal view and area of same.
4 *c*. Front view of same.
4 *d*. Profile view (the beak of the ventral valve is represented too little arcuate).
4 *e*. Interior of ventral valve.

BURLINGTON LIMESTONE. (Carboniferous.) BRACHIOPODA. ETC.



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BURLINGTON LIMESTONE. (Carboniferous.) BRACHIOPODA.

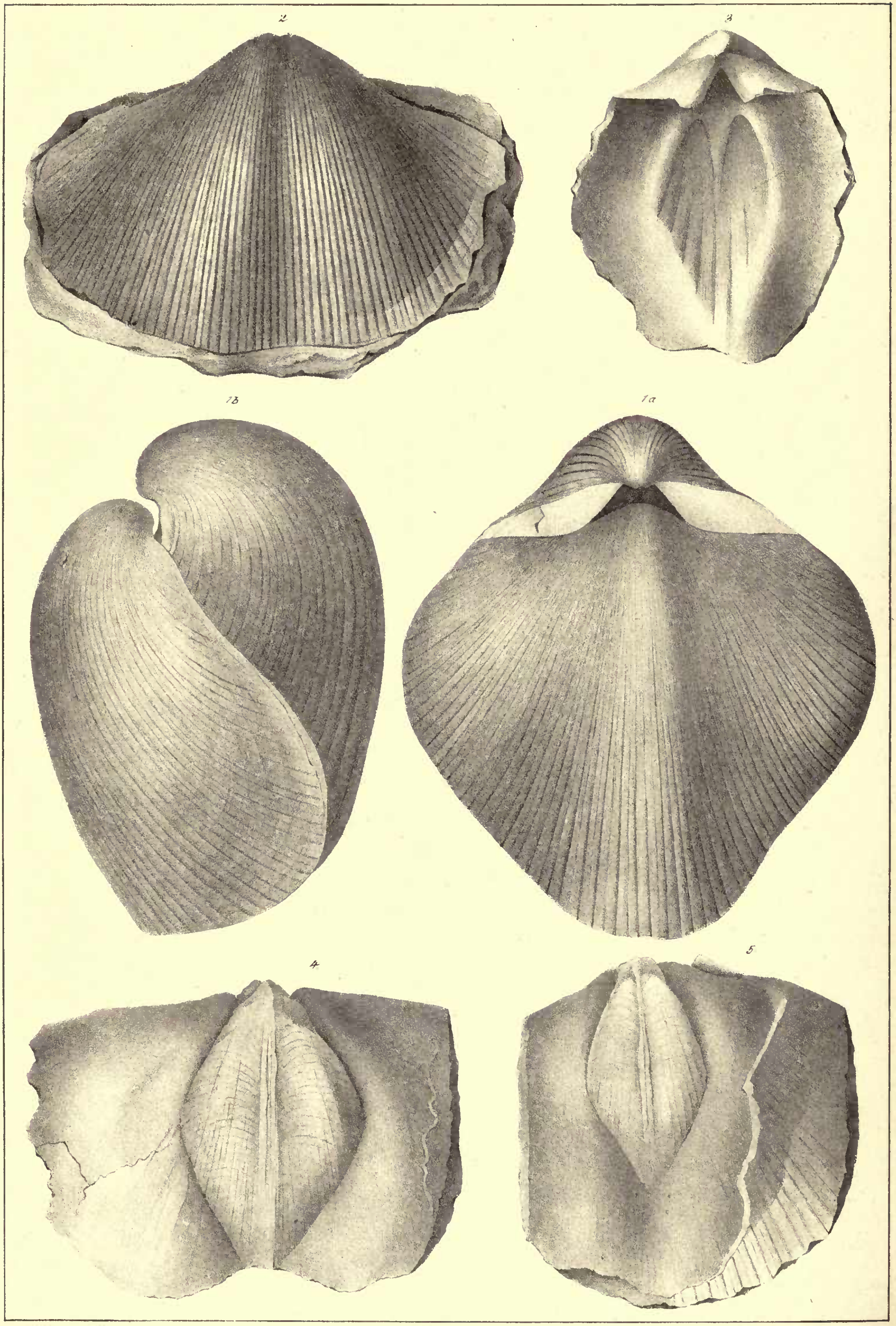

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PLATE XIV.

Page

Fig. 1 – 5. SPIRIFER GRIMESI. 604

1 *a*. Dorsal view and area of an entire specimen.

1 *b*. Profile view of the same.

2. View of ventral valve of a specimen as it ordinarily appears in the limestone.

3. Interior of a fragment of the ventral valve, showing the muscular and vascular impressions, with the low curving dental lamellæ.

4. Cast of the ventral valve, showing the form of the muscular impression and direction of the dental lamellæ.

5. Another similar specimen, showing a smaller muscular impression.

The hinge-line in both these casts is proportionally more extended than in the specimen fig. 1 *a*, *b*; but the external features are similar.

PLATE XV.

		Page
Fig. 1.	PENTREMITES WORTHENI.	606

1. View of a specimen, showing on the left side parts of two pseudambulacral areas. [The number of pieces in the pseudambulacral areas is about twice as many as represented in the figure.]

Fig. 2.	PENTREMITES BIPYRAMIDALIS.	607

2. View of the antero-lateral side. [The summit and base of the figure are too wide, and the number of poral pieces represented is little more than one-half the true number.]

Fig. 3.	ACTINOCRINUS PERNODOSUS.	608

3 *a*. Base of the specimen, the posterior side being uppermost. The right postero-lateral ray has the arm-bases broken off close to the body, which gives a somewhat unequal appearance to the two sides.

3 *b*. Anterior view of same, showing the summit of the third radial plate.

Fig. 4.	ACTINOCRINUS NASHVILLÆ.	609

4. View of the postero-lateral side of a large specimen.

Fig. 5.	ACTINOCRINUS LOWEI.	611

5 *a*. Anal side of specimen.

5 *b*. View of right antero-lateral side, the arm-base of which is smaller than the others. The cavity near the summit is only from the breaking away of some of the plates, and is not an organic feature.

Fig. 6.	ACTINOCRINUS GOULDI.	613

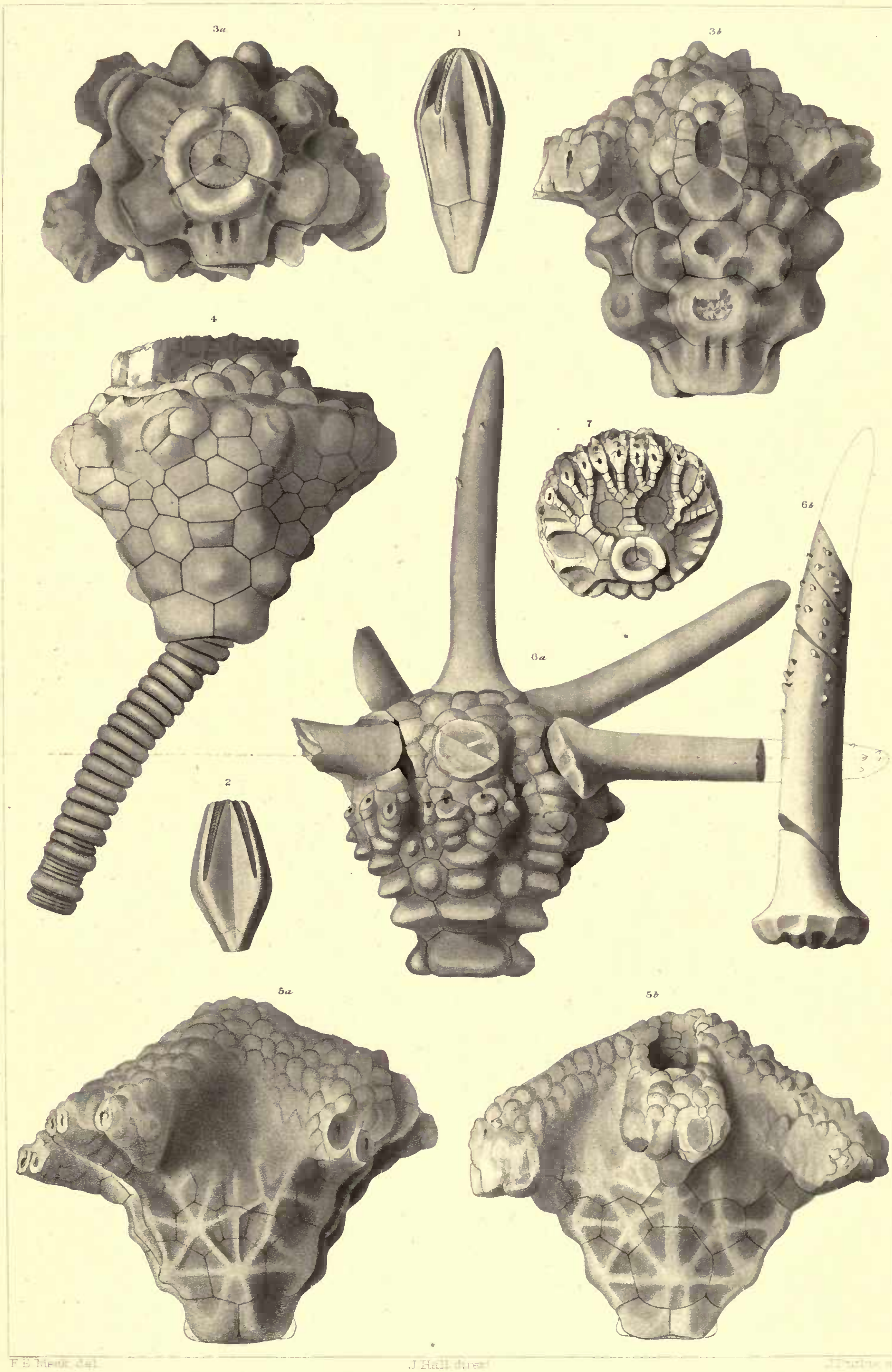
6 *a*. The anterior side of specimen, showing the base of arms and anterior spine, with portions of two others on the left side. The left antero-lateral spine is essentially entire, the representation being to make room for the separate spine on that side. The postero-lateral spine is, by error, represented as smooth in some of the figures.

6 *b*. The central spine of a larger individual, showing the slightly curved form and spiniferous character above, while it is nearly smooth towards the base : the latter feature is not always characteristic.

Fig. 7.	ACTINOCRINUS RAMULOSUS.	615

7. View of a distorted specimen, showing the base and three of the rays.

KEOKUK LIMESTONE. (Carboniferous.) CRINOIDEÆ.



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KEOKUK LIMESTONE (Carboniferous.) CRINOIDEÆ.

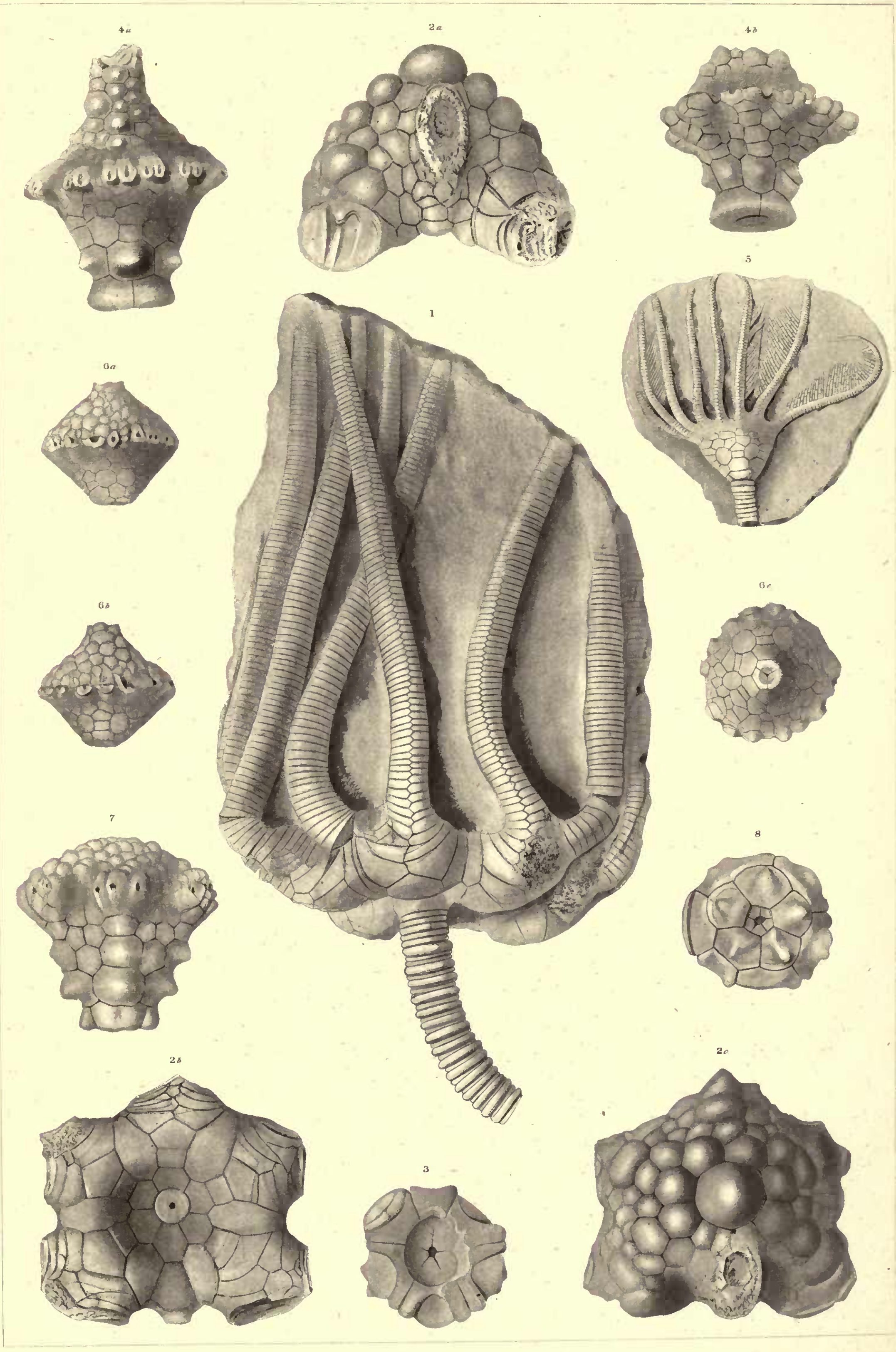

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PLATE XVI.

Page

Fig. 1. AGARICOCRINUS WORTHENI. 619

1. View of a very fine specimen preserving a portion of the column, and the arms to the extent of three and a half inches, with about eighty and in one about ninety joints on each side. The entire number was probably more than one hundred joints.

Fig. 2. AGARICOCRINUS TUBEROSUS. 617

2 *a*. The anal side of a specimen from which the arms have been separated.

2 *b*. The base of the same specimen, the basal plates not being visible beyond the circumference of the column. All the other plates, to the base of the arms, are shown in this figure.

2 *c*. The dome, showing the aperture which opens upwards, the central tuberculiform plate, and the ranges of larger plates from each arm; there being two in the range of the anterior arm, at the base of the central plate.

Fig. 3, 8. CYATHOCRINUS STELLATUS. 623

3. Interior of the cup.

8. View of the exterior of the base.

Fig. 4. ACTINOCRINUS NASHVILLÆ. 609

4 *a*. Anterior side of a well-preserved specimen. [The figure is too broad below, and the brachial margin is not sufficiently prominent.]

4 *b*. A similar view of another specimen, representing more perfectly the form of the base.

Fig. 5 & 6. ACTINOCRINUS BITURBINATUS. 616

5. Anterior side of an individual with the base somewhat longer than usual, preserving the arms and a portion of the column.

6 *a*. Anal side of a specimen without arms, with base of proboscis which is turned obliquely towards the anal side.

6 *b*. Anterior side of same.

6 *c*. Basal view of same.

Fig. 7. ACTINOCRINUS PERNODOSUS, *var.?* 617

7. The anterior side of the specimen.

PLATE XVII.

		Page
Fig. 1.	FORBESIOCRINUS SHUMARDIANUS.	671

1. View of the anterior side of specimen, showing the truncated subradial plates.

Fig. 2 & 4.	FORBESIOCRINUS GIDDINGEI.	633

2. View of the anal and postero-lateral side of specimen.
4. Diagram of plates enlarged, showing their form and arrangement; those of the anal area being determinable only on one side.

Fig. 3.	FORBESIOCRINUS MEEKI.	631

3. View of the base, showing the column, the subradial and radial plates, with those of the first division of the rays, which in four of the rays are three below the second bifurcation.

Fig. 5.	FORBESIOCRINUS WORTHENI.	632

5. Basal view of the specimen, as it lies expanded on the surface of the stone.

Fig. 6.	SCAPHIOCRINUS DACTYLIFORMIS.	670

6. The anterior and antero-lateral rays of the specimen, with a part of the adjacent rays.

Fig. 7.	POTERIOCRINUS MISSOURIENSIS.	669

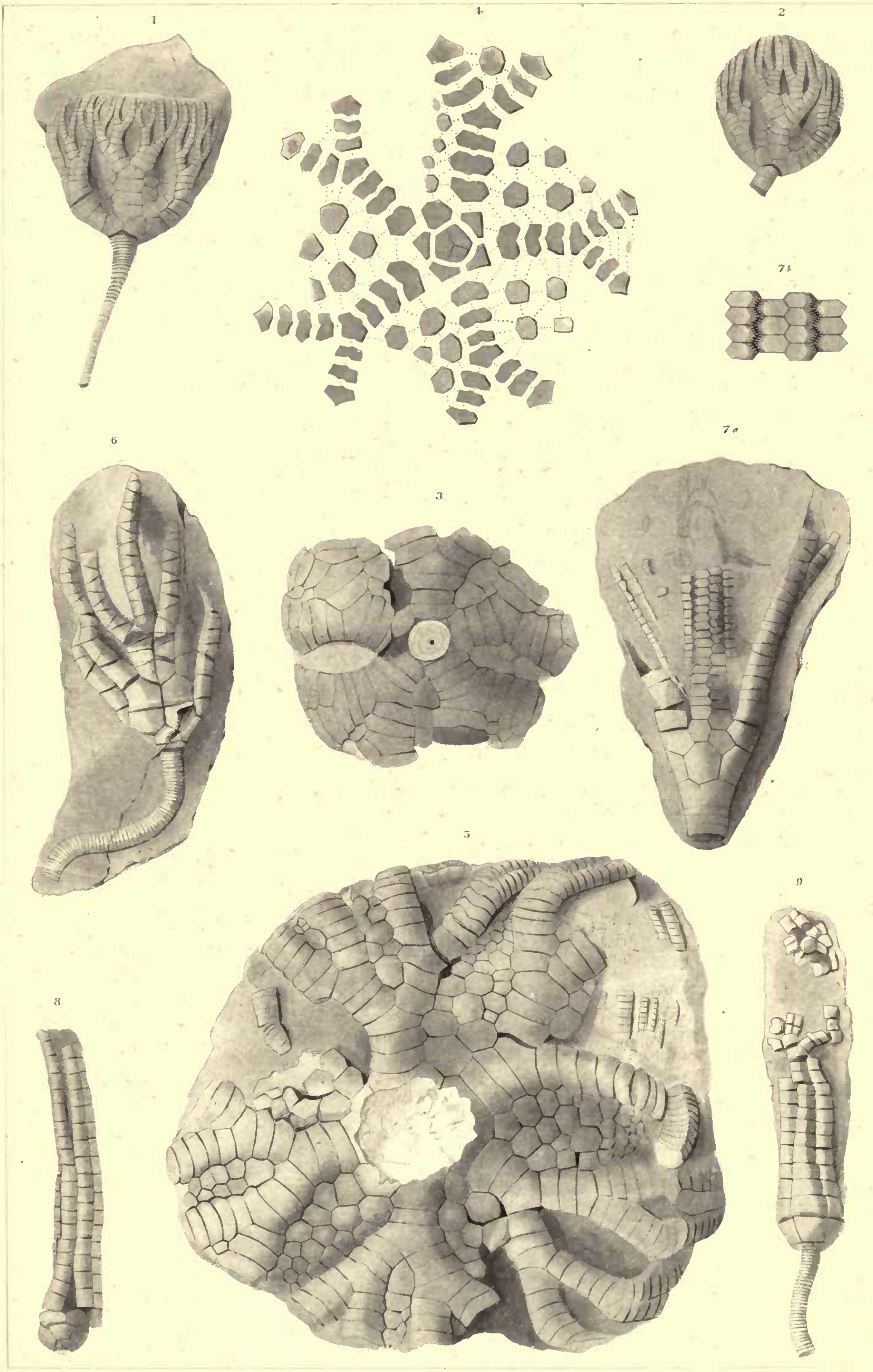
7 *a*. A specimen showing the anal side, with a few joints of the column and the lower part of the arms, and a part of the proboscis.

7 *b*. Enlargement of the plates of the proboscis, showing the pores between the alternate ranges.

Fig. 8 & 9.	SYNBATHOCRINUS SWALLOVI.	672

8. A specimen somewhat distorted from pressure, with arm-joints less distinctly angular than in the other specimen.
9. A specimen preserving a portion of the column, and having the summit broken away.

KEOKUK & ST. LOUIS LIMESTONES. (Carboniferous.) CRINOIDEÆ



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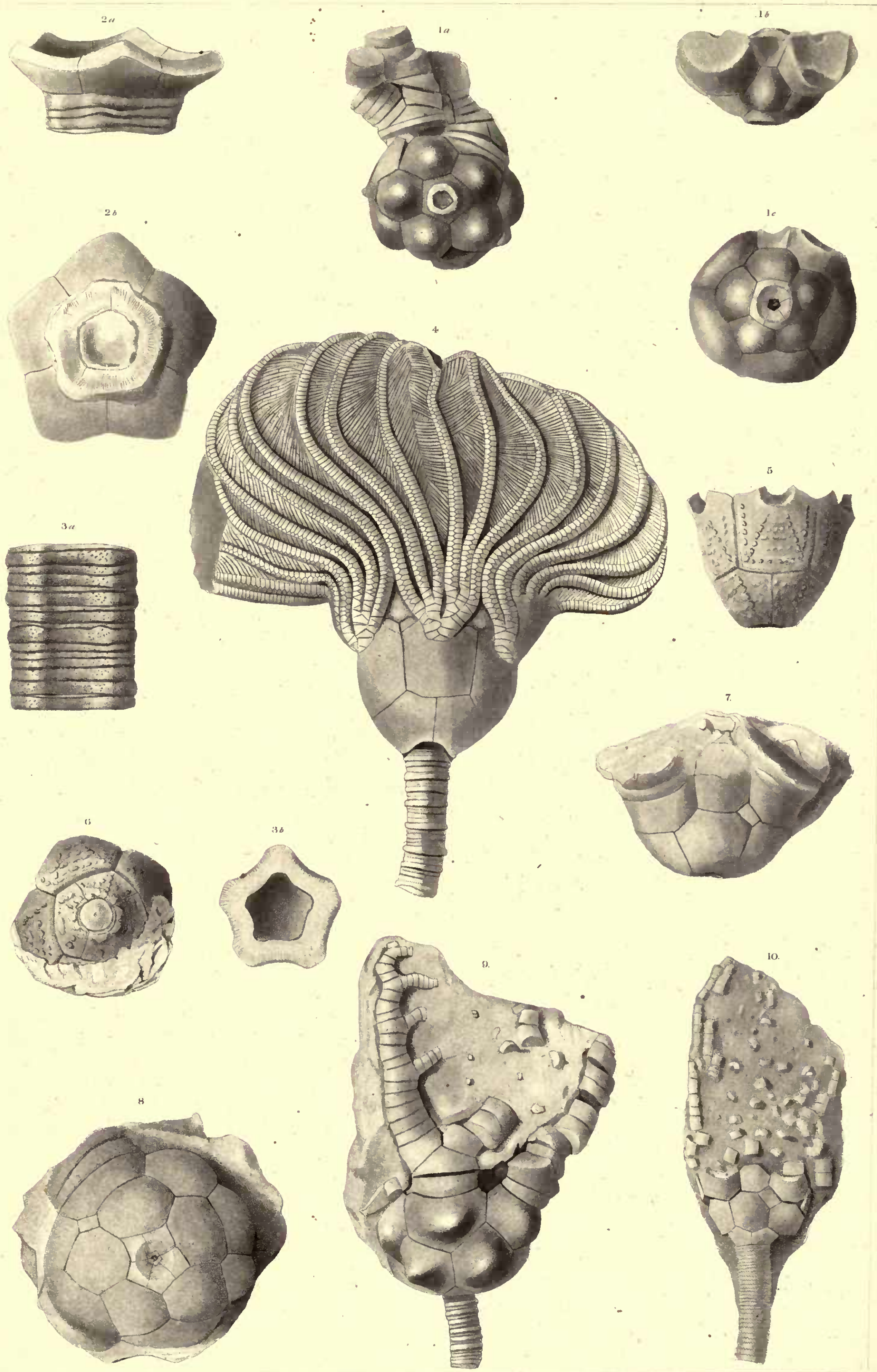
KEOKUK LIMESTONE

(Carboniferous)

CRINOIDEÆ.



J Hall direxit

J Duthie. sc

PLATE XVIII.

Page

Fig. 1. CYATHOCRINUS BULLATUS. 624

1 *a*. View of the base and a part of two arms. [The subradial plates are not represented as sufficiently prominent or globulose.]

Fig. 1. CYATHOCRINUS TUMIDUS. 624

1 *b*. Anal side of specimen.

1 *c*. Basal view of same.

Fig. 2 & 3. CYATHOCRINUS MAGISTER. 628

2 *a*. The basal plates and fragments of column attached.

2 *b*. Base of the same specimen.

3 *a*. Fragment of separate column of apparently the same species.

3 *b*. Transverse section of the column, showing a large obtusely pentagonal foramen.

Fig. 4. PLATYCRINUS SARÆ. 673

4. View of a specimen having the body, arms and tentacula nearly entire, with a small portion of the column.

Fig. 5 & 6. PLATYCRINUS SAFFORDI. 634

5. Lateral view, showing the base and three radial plates.

6. Basal view of an imperfect specimen.

Fig. 7 & 8. CYATHOCRINUS SPURIUS. 625

7. View of anal side of specimen.

8. Basal view of the same.

Fig. 9. CYATHOCRINUS PROTUBERANS. 626

9. View of the left antero-lateral side of specimen.

Fig. 10. CYATHOCRINUS INTERMEDIUS. 627

10. The anal side of specimen, which is much crushed and the plates separated.

PLATE XIX.

		Page
Fig. 1.	PRODUCTUS WORTHENI.	635

1 *a*. Profile view of a specimen.

1 *b*. Ventral valve of the same.

Fig. 2.	PRODUCTUS MESIALIS.	636

2 *a*. The interior of a dorsal valve, from which the ventral valve has been exfoliated.

2 *b*. Profile view of the ventral valve.

2 *c*. Ventral valve of a large individual, which is somewhat broader than the prevailing forms.

Fig. 3.	PRODUCTUS SETIGERUS.	638

3. Dorsal side of specimen, showing the beak and umbo of the opposite valve.

Fig. 4.	PRODUCTUS SEMIRETICULATUS.	637

4 *a*. Interior of dorsal valve, from which most of the shell has been exfoliated, leaving an impression of the external markings.

Fig. 4.	PRODUCTUS SETIGERUS ? *var*. KEOKUK.	639

4 *b*. Cardinal view of a ventral valve.

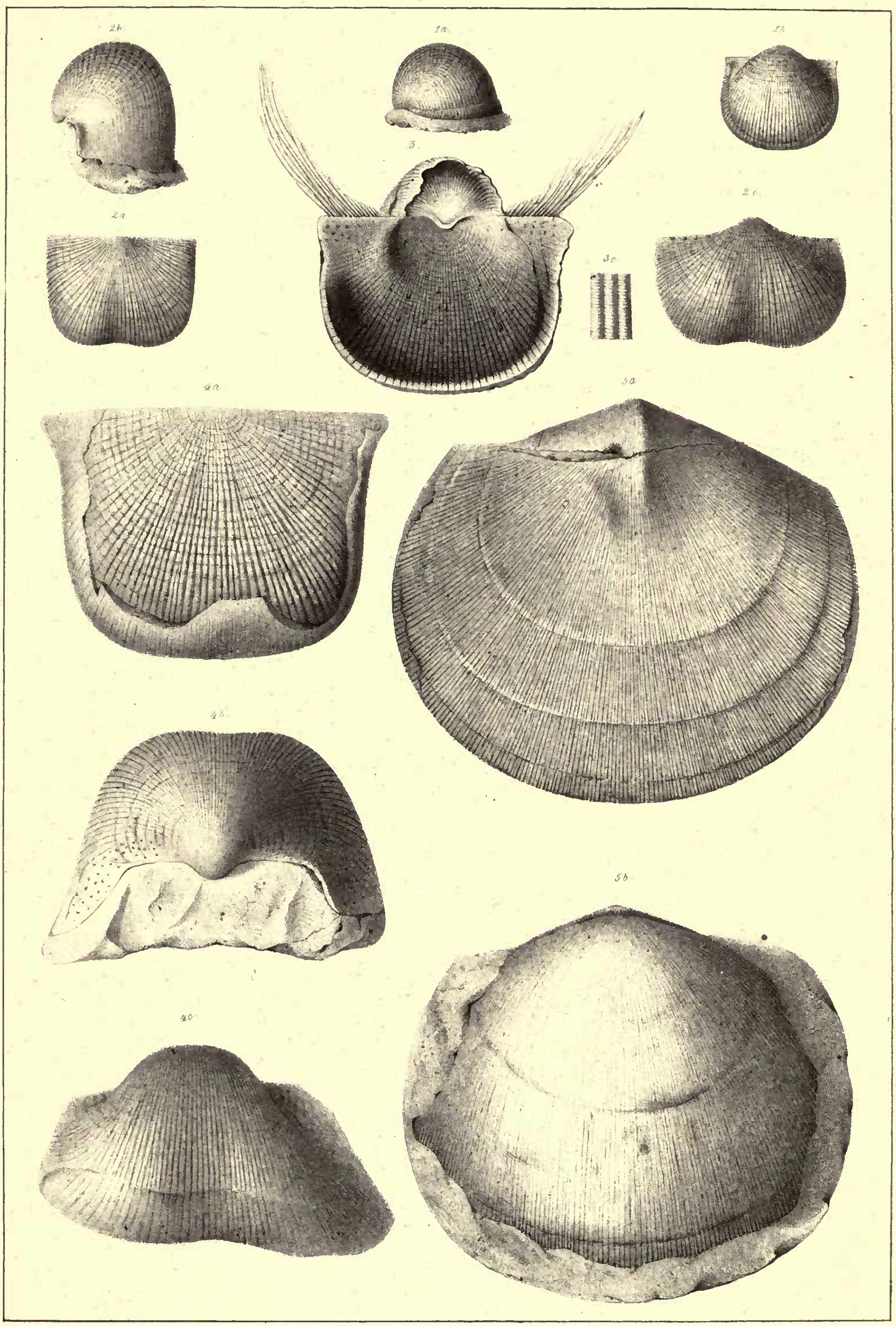
4 *c*. Another view of the same specimen, looking upon the centre of the valve.

Fig. 5.	ORTHIS KEOKUK.	640

5 *a*. View of a ventral valve, which is broken transversely across a little below the beak.

5 *b*. Ventral valve of a specimen which is partially concealed at the margins.

KEOKUK LIMESTONE. (Carboniferous.) BRACHIOPODA.



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KEOKUK LIMESTONE. (Carboniferous.) BRACHIOPODA.

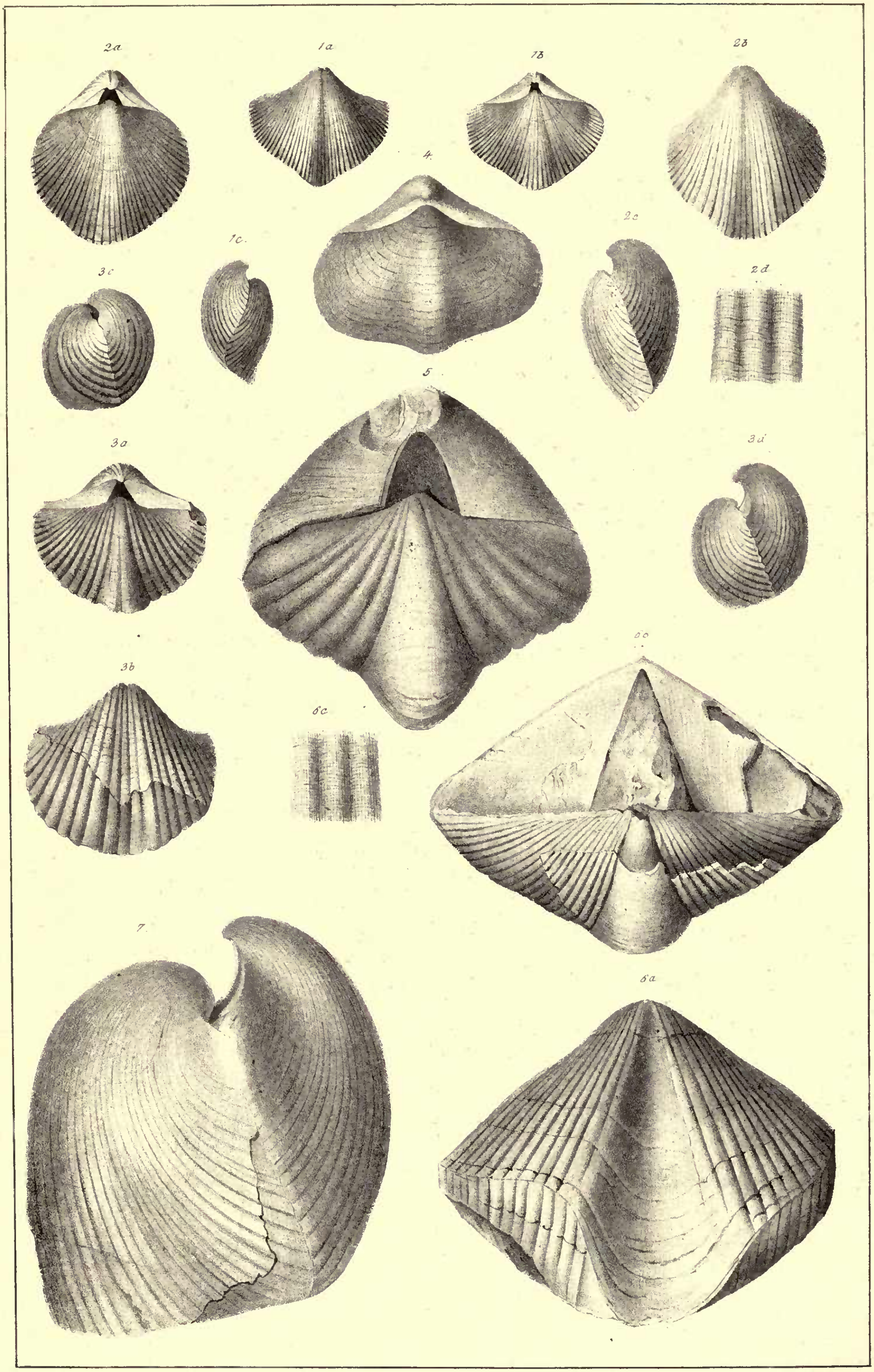

PLATE XX.

		Page
Fig. 1.	SPIRIFER TENUIMARGINATA.	641

1 *a*. View of the ventral valve.
1 *b*. Dorsal view.
1 *c*. Profile view of the same shell.

Fig. 2.	SPIRIFER ROSTELLATUS.	641

2 *a*. Dorsal valve of this species.
2 *b*. Ventral valve.
2 *c*. Profile view.

Fig. 3 & 2.	SPIRIFER KEOKUK.	642

3 *a*. Dorsal view, showing the area and foramen of the opposite valve.
3 *b*. Ventral view of a larger individual.
3 *c*. Profile of a very gibbous specimen, where the beak of the dorsal valve is closed beneath that of the opposite valve.
3 *d*. Profile view of the specimen fig. 3 *a*.
2 *d*. Enlargement of surface, showing the radiating striæ.

Fig. 4.	SPIRIFER PSEUDOLINEATUS.	645

4. Dorsal view of a specimen of medium size.

Fig. 5.	SPIRIFER NEGLECTUS.	643

5. Dorsal view of a specimen distorted by pressure so that the valves are separated, showing the entire area of the ventral valve, the dorsal valve being forced beneath the other along the cardinal line.

Fig. 6.	SPIRIFER SUBCUSPIDATUS.	646

6 *a*. Ventral valve of the same.
6 *b*. Dorsal valve and area of a specimen of ordinary size.

Fig. 7.	SPIRIFER LOGANI.	647

7. Profile view.

PLATE XXI.

		Page
Fig. 1 & 2.	SPIRIFER LOGANI.	647

1 *a*. Dorsal view of a large individual, natural size.

1 *b*. Ventral view of the same specimen.

2. Cardinal view of a separate ventral valve.

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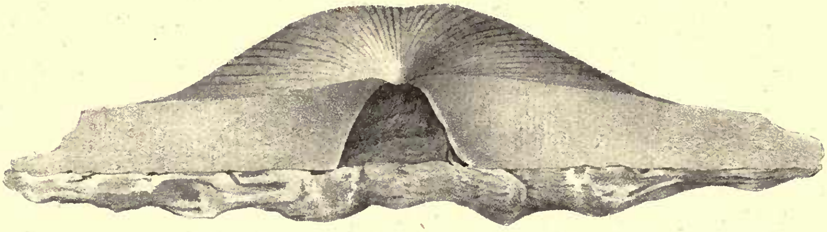

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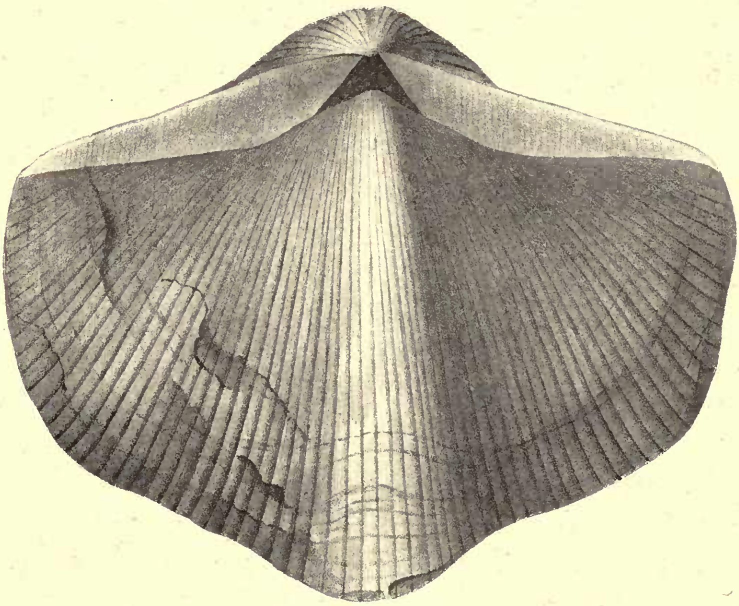

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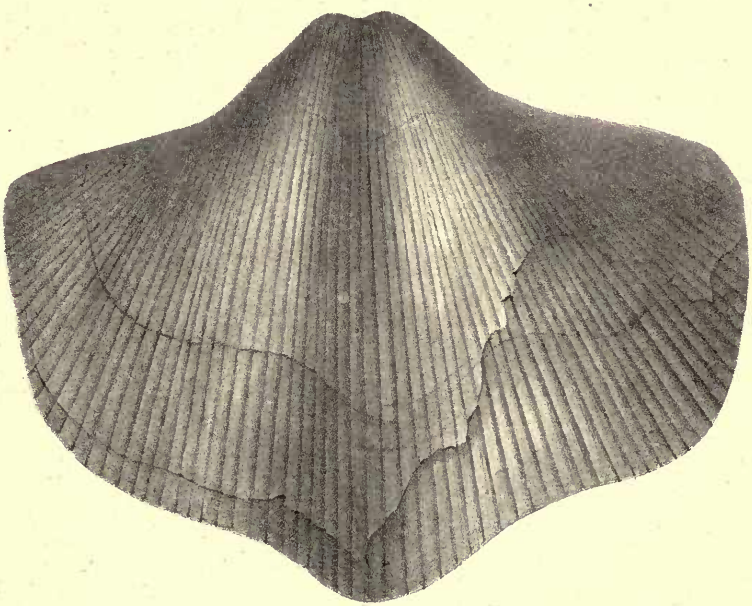

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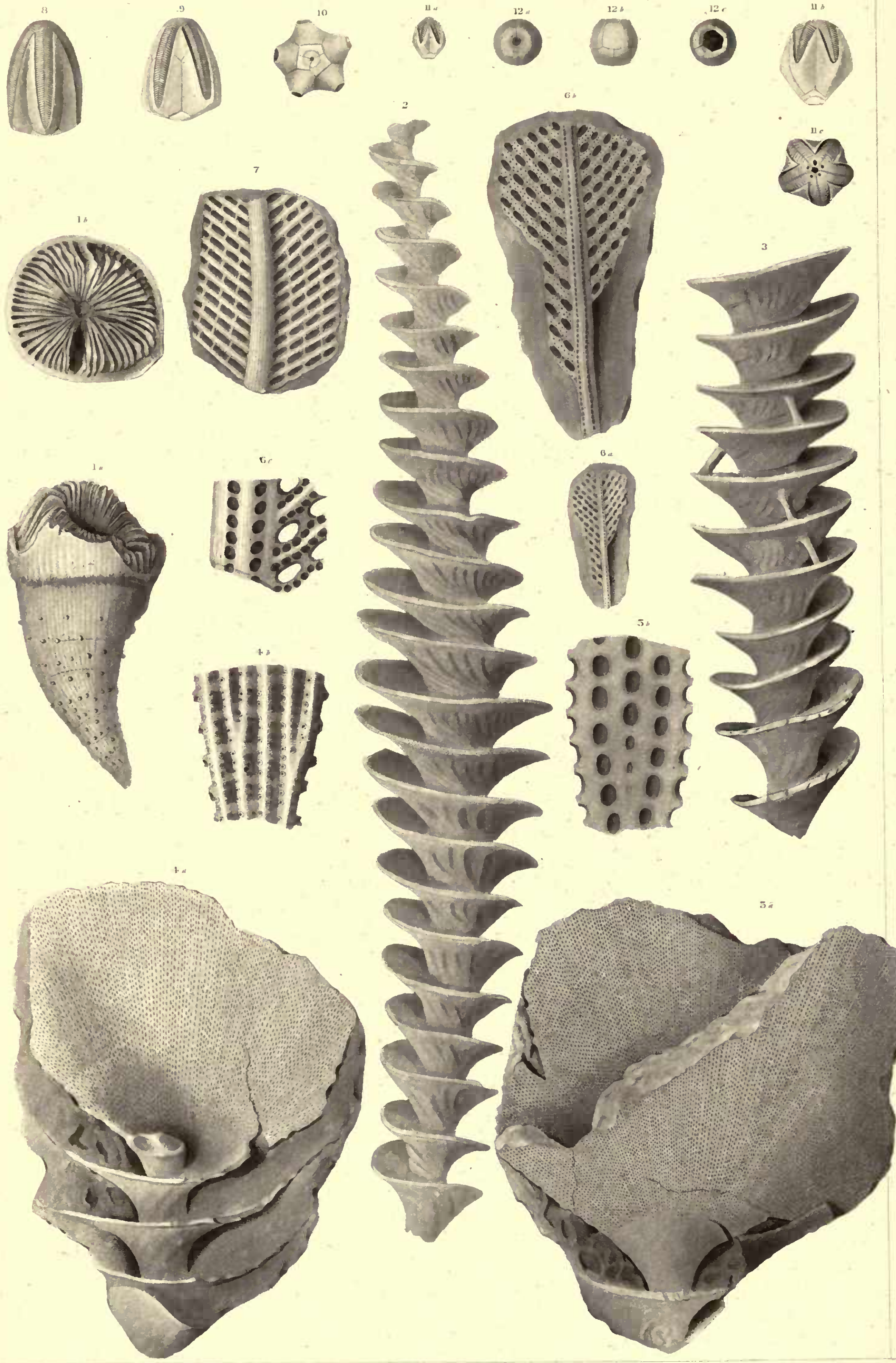
WARSAW LIMESTONE. Carboniferous CORALS, BRYOZOA & CRINOIDEÆ.



J. Hall, direx.

J. Duffus, sc.

PLATE XXII.

		Page
Fig. 1.	ZAPHRENTIS SPINULIFERA.	650

1 *a*. Lateral view of a specimen of medium size.
1 *b*. View of the calyx showing the rays.

Fig. 2. ARCHIMEDES REVERSA. 652

2. The axis preserving the bases of the frond, showing gradual expansion towards the middle and diminution above.

Figs. 3, 4 & 5. ARCHIMEDES WORTHENI. 651

3. A portion of the axis of a specimen of this species, showing the usual characteristics, together with several of the small props or braces extending from one volution to the other.
4 *a*. A fragment of the axis preserving several volutions of the frond, as seen from the inner side.
4 *b*. A portion of the inner celluliferous surface enlarged, showing arrangement of cellules.
5 *a*. Exterior of the same specimen, showing the fenestrules.
5 *b*. Enlargement of surface of fig. 5 *a*, showing form of fenestrule.

Figs. 6 & 7. PTYLOPORA PROUTI. 653

6 *a*. Celluliferous side of a specimen, natural size.
6 *b*. The same enlarged.
6 *c*. A portion still farther enlarged.
7. Exterior of the same species.

Figs. 8, 9 & 10. PENTREMITES CONOIDEUS. 655

8. A full-grown individual, which is more elongated than usual.
9. A specimen of ordinary form and size.
10. The base, showing form of basal plates and bases of the pseubambulacral areas.

Fig. 11. PENTREMITES KONINCKANA. 656

11 *a*. A specimen, natural size.
11 *b*. The same enlarged.
11 *c*. Summit of the same enlarged.

Fig. 12. DICHOCRINUS SIMPLEX. 654

12 *a*. Basal view of specimen.
12 *b*. Lateral view of the same.
12 *c*. View of the summit.

PLATE XXIII.

Page

Fig. 1. RETZIA VERNEUILANA. 657

1 *a, b*. Ventral and dorsal views of a small individual.
1 *c*. Dorsal view of a more elongate specimen.
1 *d*. Enlarged figure of the same.

Fig. 2. RHYNCHONELLA MUTATA. 658

2 *a, b*. Dorsal and ventral views of a specimen of ordinary size.

Fig. 3. RHYNCHONELLA SUBCUNEATA. 658

3 *a, b*. Ventral and dorsal views of a specimen.
3 *c*. Profile of the same.

Figs. 4 & 5. TEREBRATULA TRINUCLEA. 659

4 *a, b*. Dorsal and ventral views of a specimen of the ordinary form.
4 *c*. Profile of the same.
5 Dorsal view of a broader form, showing a wide mesial lobe, with a narrow impression down the centre.

Fig. 6. SPIRIFER SUBCARDIIFORMIS. 660

6 *a*. Ventral valve, the specimen a little distorted from pressure.
6 *b*. Dorsal view of the same, showing the area and foramen of the opposite valve.

Fig. 7. SPIRIFER LATERALIS. 661

7 *a*. Dorsal view, showing the area and foramen of the ventral valve.
7 *b*. Ventral valve of the same specimen, showing the broad undefined mesial depression.
7 *c*. Front view, showing the outline and elevation of the mesial fold.

Fig. 8. SPIRIFER TENUICOSTATUS. 662

8 *a*. Dorsal view, showing the beak and part of the area and foramen of the opposite valve.
8 *b*. Ventral valve, in which the lines of growth and concentric striæ are well preserved. 8 *c*. Profile view of the same.

Fig. 9. SPIRIFER SUBEQUALIS. 663

9 *a*. View of the ventral valve.
9 *b*. Dorsal valve, showing the beak of the opposite valve rising a little above the other.
9 *c*, Cardinal view, showing the area and foramen.

Fig. 10. CYPRICARDELLA NUCLEATA. 663

10 *a, b*. Dorsal view, and view of the right valve. 10 *c*. The same enlarged.
10 *d*. Enlargement of the cencentric striæ.

Figs. 11 & 12. CYPRICARDELLA SUBELLIPTICA. 664

11. View of the right valve.
12. Interior of the same, showing the character of the hinge-line.

Fig. 13. PLEUROTOMARIA WORTHENI. 664

13 *a*. View of the summit, natural size.
13 *b*. Profile view, showing the elevation of the spire.
13 *c*. View of the base.
13 *d*. Enlargement of the striæ and carinations which characterize the surface.

Fig. 14. CAPULUS ACUTIROSTRIS. 665

14 *a, b*. Views of the upper and lower sides of the shell.

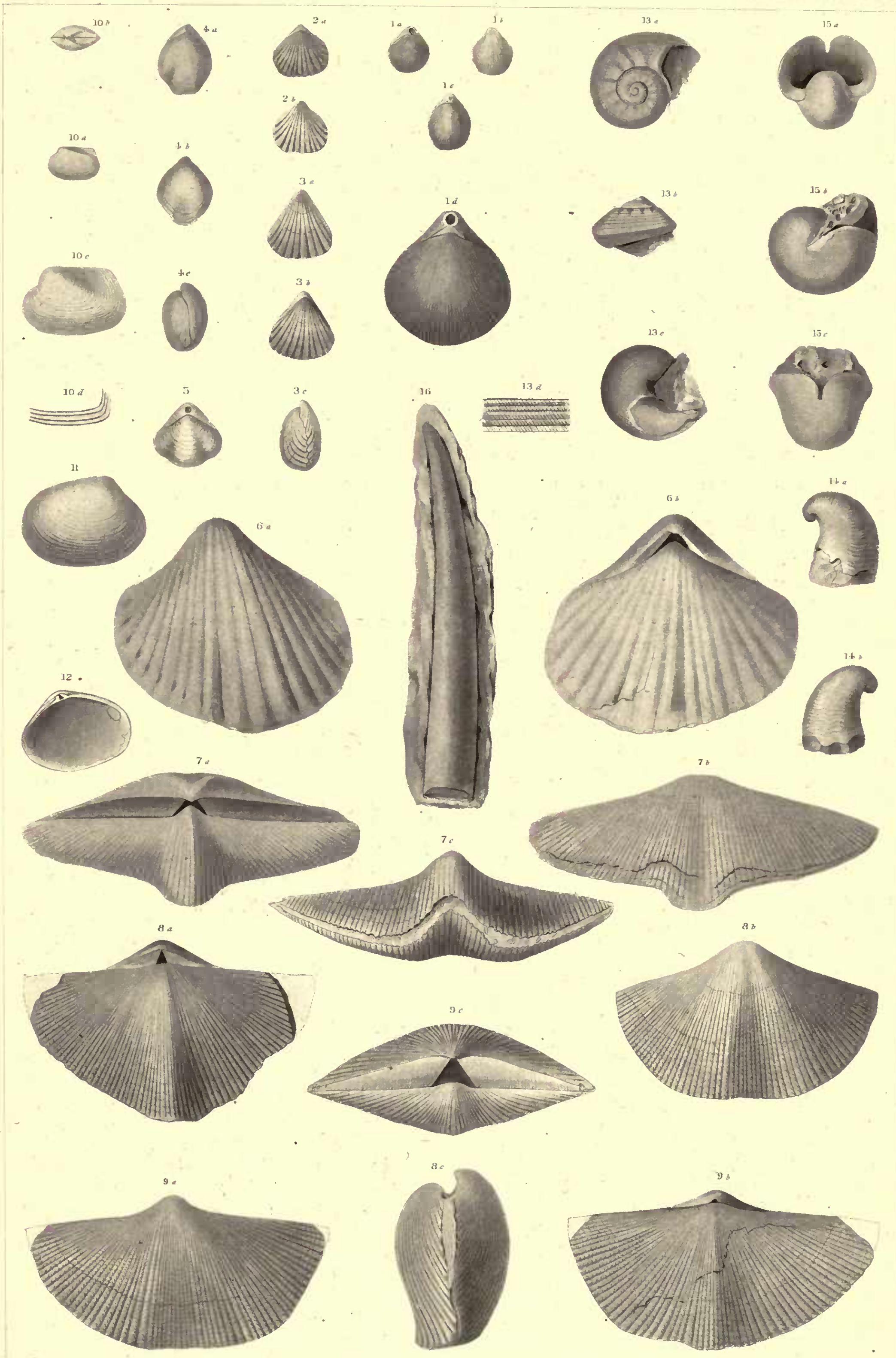
Fig. 15. BELLEROPHON SUBLÆVIS. 666

15 *a*. View of the aperture. 15 *b*. Lateral view of the shell.
15 *c*. Dorsal view of the same.

Fig. 16. DENTALIUM PRIMARIUM. 666

16. Lateral view of the specimen, natural size.

WARSAW LIMESTONE (Carboniferous) BRACHIOPODA ETC.



ST. LOUIS LIMESTONE (Carboniferous) CORALS & BRACHIOPODA

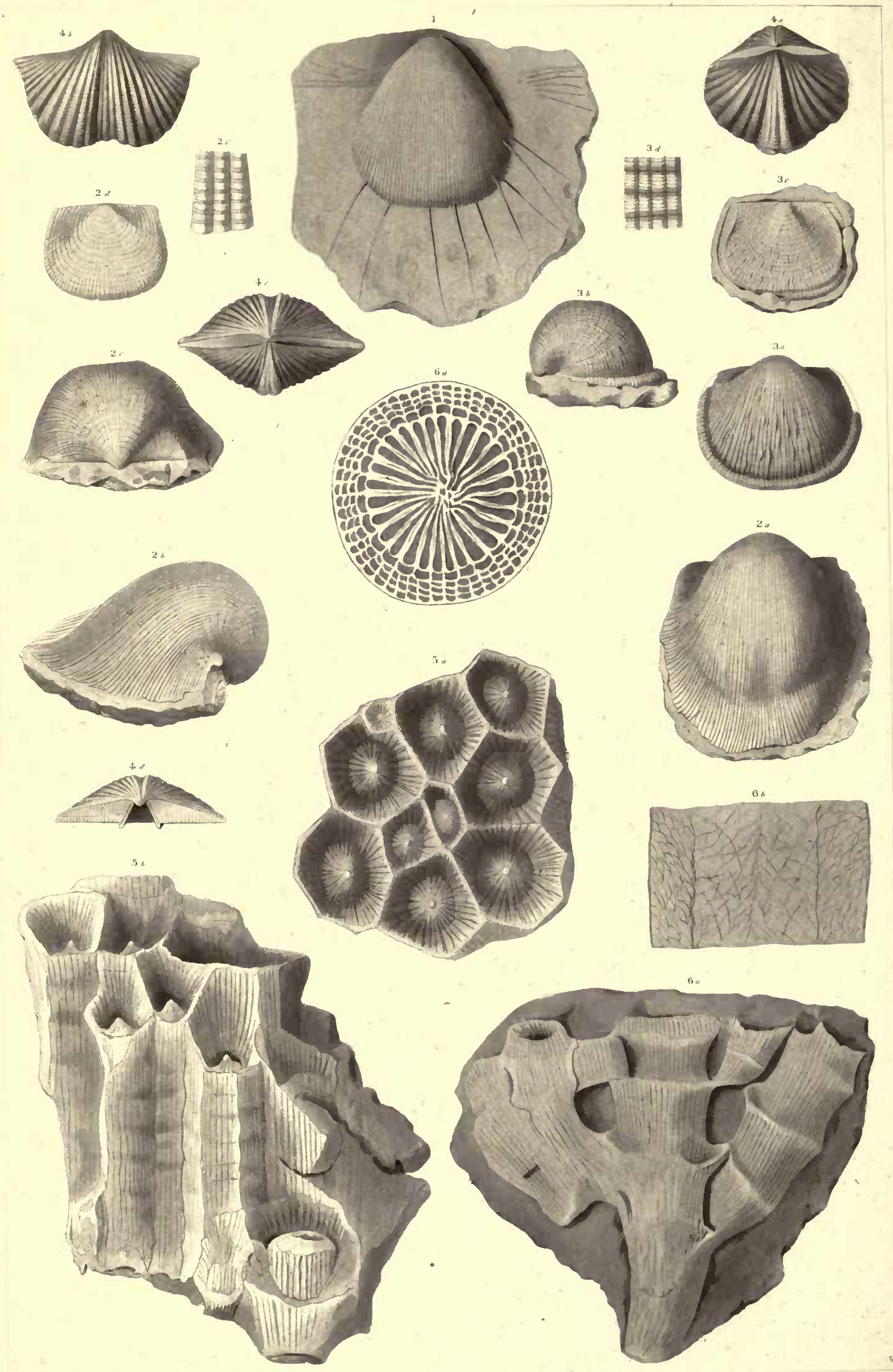


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PLATE XXIV.

		Page
Fig. 1.	PRODUCTUS OVATUS.	674

1. Ventral valve of a specimen of this species.

Fig. 2.	PRODUCTUS TENUICOSTUS.	675

2 *a*. Ventral valve of this species. [The anterior longitudinal folds or undulations are not well shown in the figure.]
2 *b*. Profile view, showing the extremely arcuate character of the shell.
2 *c*. View of the cardinal and upper portion of a ventral valve.
2 *d*. Dorsal valve of this species.

Fig. 3.	PRODUCTUS MARGINICINCTUS.	674

3 *a*. Ventral valve of a specimen of this species. [The figure represents the shell too broad, and the sides too much curved.]
3 *b*. Profile view of the same, showing the arcuate form and prominence of the marginal cincture.
3 *c*. Dorsal valve of another individual.

Fig. 4.	SPIRIFER KEOKUK, *var*.	676

4 *a* (= 4 *d* of text). Dorsal view of a gibbous specimen, with the cardinal extremities rounded.
4 *b*, *c* (= 4 *a*, *b* of text). Ventral and cardinal views of a specimen, with the hinge-line more extended.
4 *d*. Cardinal view of a ventral valve, showing the area and foramen.

Fig. 5.	LITHOSTROTION MAMILLARE.	667

5 *a*. View of the calyces of a small group, showing the varying dimensions.
5 *b*. Vertical section of a portion of the mass, showing the columnar structure where the cells are closely compressed; the elevated columella, etc.

Fig. 6.	LITHOSTROTION PROLIFERUM.	668

6 *a*. A small group, showing the central cup, with the branches arising from proliferous budding.
6 *b*. A longitudinal section, which is a little on one side of the centre.
6 *c*. Transverse section enlarged.

PLATE XXV.

		Page
Fig. 1.	SCAPHIOCRINUS DECABRACHIATUS.	679

1. The anal side of specimen; the right antero-lateral ray somewhat broken and distorted.

Fig. 2. SCAPHIOCRINUS INTERNODIUS. 679

2. The anterior side of a specimen preserving the lower joints of the arms.

Fig. 3. SCAPHIOCRINUS SCOPARIUS. 680

3 *a*. View of anterior side of specimen, natural size.
3 *b*. The same enlarged, showing more distinctly the form and arrangement of the plates.

Fig. 4. ZEACRINUS INTERMEDIUS. 681

4. The anterior side of the specimen, which has the arms of this ray broken off above the first bifurcation.

Fig. 5. CYATHOCRINUS ? PENTALOBUS. 687

5 *a*. Basal view of the specimen.
5 *b*. View of the anal side of the same, showing the protuberant form of the plates.

Fig. 6. AGASSIZOCRINUS GIBBOSUS. 686

6. View of the anal side of the specimen. 6 *b*. Basal view of the same.

Fig. 7. DICHOCRINUS PROTUBERANS. 689

7. View of the base, which shows the two basal plates, three of the protuberant radials, and the narrow anal plate

Fig. 8. ZEACRINUS MANIFORMIS. 682

8. View of the antero-lateral and postero-lateral rays of the left side, the latter having the second radial truncate, and sustaining but a single arm. This feature is probably accidental.

Fig. 9. ACROCRINUS URNÆFORMIS. 690

9 *a*. View of specimen, natural size. 9 *b*. The same enlarged.

Fig. 10. AGASSIZOCRINUS CONSTRICTUS. 687

10. The anterior side of the specimen, natural size.

Fig. 11. PENTREMITES CERVINUS. 690

11 *a*. Lateral view of a specimen. 11 *b*. View of the summit of the same.

Fig. 12. PENTREMITES CHEROKEEUS. 691

12 *a*. Lateral view of a small specimen.
12 *b*. Summit of the same.
12 *c*. Basal view of specimen.

Fig. 13. PENTREMITES GODONI. 692

13 *a*. Lateral view of a specimen. 13 *b*. Basal view of the same.

Fig. 14. PENTREMITES SYMMETRICUS. 694

14. View of a specimen of medium size.

Fig 15. PENTREMITES OBESUS. 695

15. Lateral view of a specimen, natural size. This species frequently attains a larger size.

Fig. 16. PENTREMITES PYRIFORMIS. 693

16. A specimen of small or medium size, with a portion of the column attached.

Fig. 17. PENTREMITES GLOBOSUS. 695

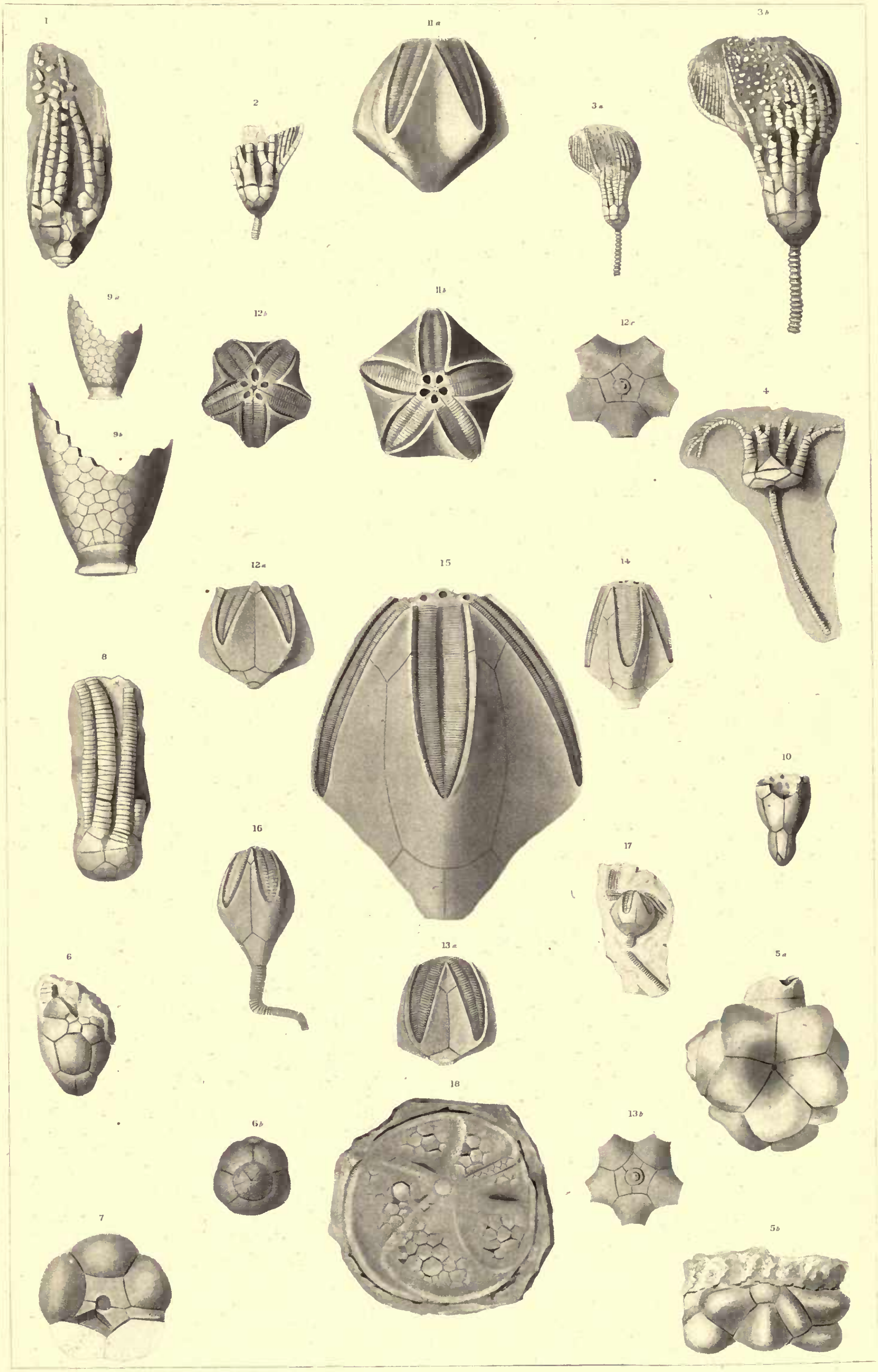
17. A specimen preserving a part of the column and some fragments of the arms or tentacula

Fig. 18 AGELACRINUS KASKASKIENSIS. 696

18. View of the specimen, natural size.

*** Since writing the remarks on page 693, a further comparison of specimens has shown that the *Pentremites koninckana* is quite distinct from *P. tennesseeæ*, which likewise holds a different geological position.

KASKASKIA LIMESTONE. (Carboniferous.) CRINOIDEA.



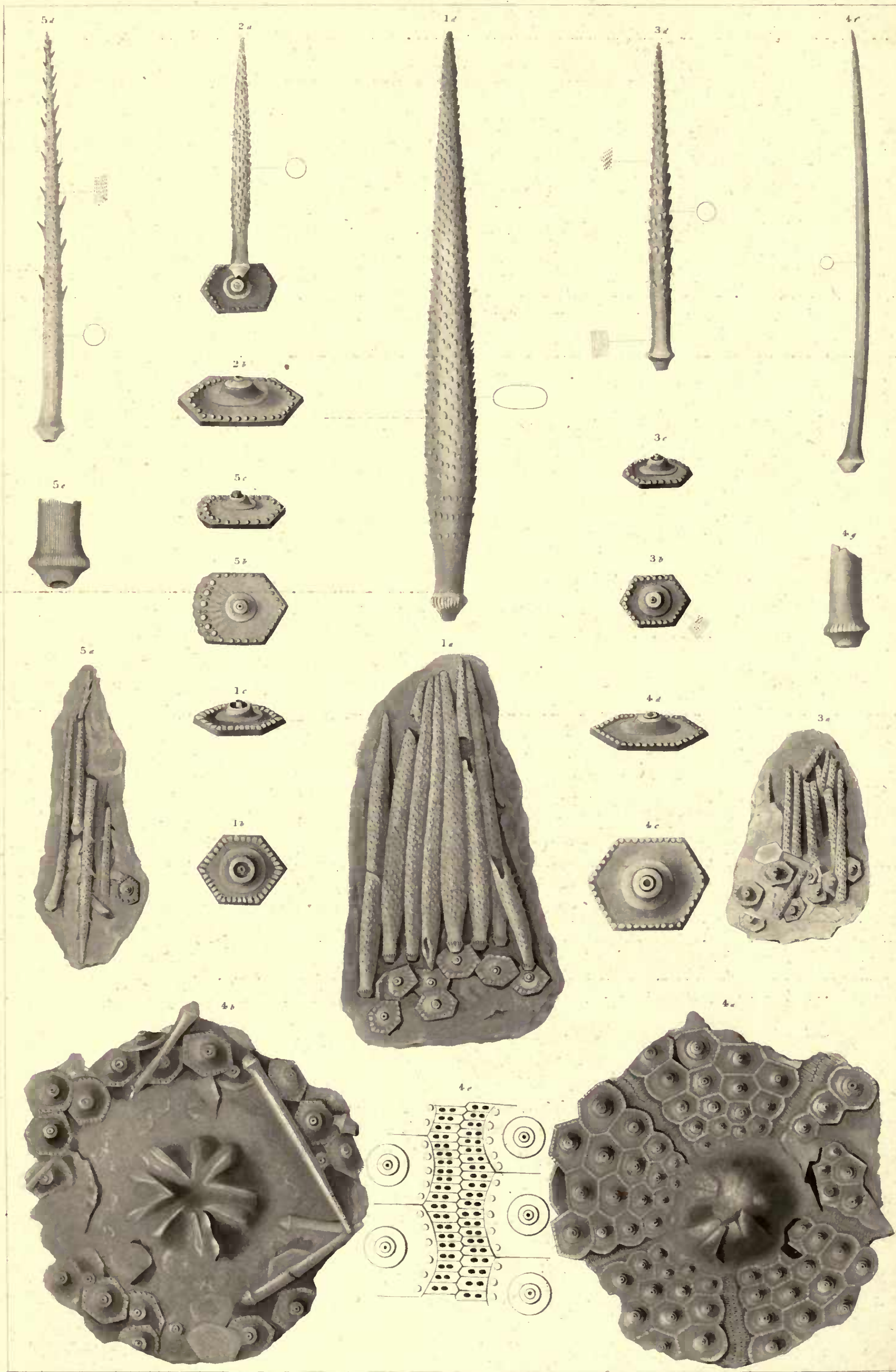


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PLATE XXVI.

Page

Fig. 1. ARCHÆOCIDARIS AGASSIZI. 698

1 *a*. A fragment preserving several plates of the body, with a small group of the spines, natural size.

1 *b*. A single plate enlarged.

1 *c*. Profile view of the same.

1 *d*. A single spine enlarged to twice the natural size.

Fig. 2. ARCHÆOCIDARIS KEOKUK. 699

2 *a*. A single plate with the spine, as it occurs on the surface of the stone. The figure is very slightly enlarged.

2 *b*. Profile view of a single plate enlarged.

Fig. 3. ARCHÆOCIDARIS SHUMARDANA. 699

3 *a*. A fragment, natural size, showing several plates and a small group of the spines. The figure is a part of a much larger mass of plates and spines.

3 *b*. A single plate enlarged.

3 *c*. Profile view of the same.

3 *d*. A single spine twice enlarged. The accompanying figures are a section of the spine, and enlargement of the surface markings on the middle and lower parts.

Fig. 4. ARCHÆOCIDARIS WORTHENI. 700

4 *a*. Upper side of a crushed specimen. The small imbricating plates of the summit are not well shown in the figure.

4 *b*. Base of specimen, showing the displaced and crushed plates, with several broken spines.

4 *c*. A single plate enlarged, showing the mamillary tubercle, the annulation and surrounding disc, etc.

4 *d*. Profile of the same.

4 *e*. Enlargement of one of the ambulacral areas and the adjacent plates in outline, showing the oval pores, etc.

4 *f*. A single spine, natural size; length a little more than two and a quarter inches, imperfect at the extremity, but restored in the figure.

4 *g*. Enlargement of a portion of a spine near the base, showing the crenulations on the edge of the anulation.

Fig. 5. ARCHÆOCIDARIS NORWOODI. 701

5 *a*. A fragment, showing several imperfect spines and a plate of the body.

5 *b*. A plate enlarged, from the range adjacent to the ambulacral area.

5 *c*. Profile view of the same.

5 *d*. A spine nearly twice enlarged, showing the striate lower part, and the muricate and spinulose character of the middle and upper part.

5 *e*. A farther enlargement of the lower part of the spine, showing the longitudinal striæ, which are strongly marked on the annulation above the articulating surface.

PLATE XXVII.

		Page
Fig. 1.	ATHYRIS SUBLAMELLOSA.	702

1 *a*, *b*. Dorsal and ventral views of a specimen of the ordinary size.

1 *c*. Profile view of the same.

Fig. 2.	ATHYRIS SUBQUADRATA.	703

2 *a*. View of the dorsal valve, and beak of the ventral valve, of a specimen of medium size.

2 *b*. Ventral view of the same.

2 *c*. Profile view of the same.

2 *d*. Ventral view of a smaller and more orbicular form, where the shell is exfoliated, showing the vascular impressions.

Fig. 3.	RETZIA VERA.	704

3 *a*. Ventral view of a specimen, each valve of which is marked by fifty costæ : a much smaller specimen has forty.

Fig. 3.	RETZIA VERA, *var.* COSTATA.	704

3 *b*. View of the dorsal valve, showing the beak and broken foramen of the opposite valve.

3 *c*. Ventral valve of the same specimen.

Fig. 4.	SPIRIFER SETIGERUS.	705

4 *a*. View of the dorsal valve, showing the beak of the opposite valve.

4 *b*. Ventral valve of the same specimen.

Fig. 5.	SPIRIFER SPINOSUS.	706

5 *a*, *b*. Dorsal and ventral views of this species.

5 *c*. Enlargement of the surface, showing the punctate character of the shell and the bases of the small spines.

Fig. 6.	SPIRIFER INCREBESCENS.	706

6 *a*. Dorsal view of an individual of medium size, with the cardinal extremities somewhat mucronate.

6 *b*. Ventral view of the same.

6 *c*. Profile of the same.

6 *d*. Dorsal view of an older shell, which is more gibbous, and has the cardinal extremities less extended.

6 *e* & *f*. Ventral and profile views of an old shell, having the cardinal extremities but little extended.

6 *g*. Interior of an imperfect ventral valve, showing the foramen and muscular impressions.

6 *h*. Interior of the ventral valve of an older specimen, which is more gibbous and the beak more arched.

6 *i*. Enlargement of the surface, showing the fine radiating and concentric striæ.

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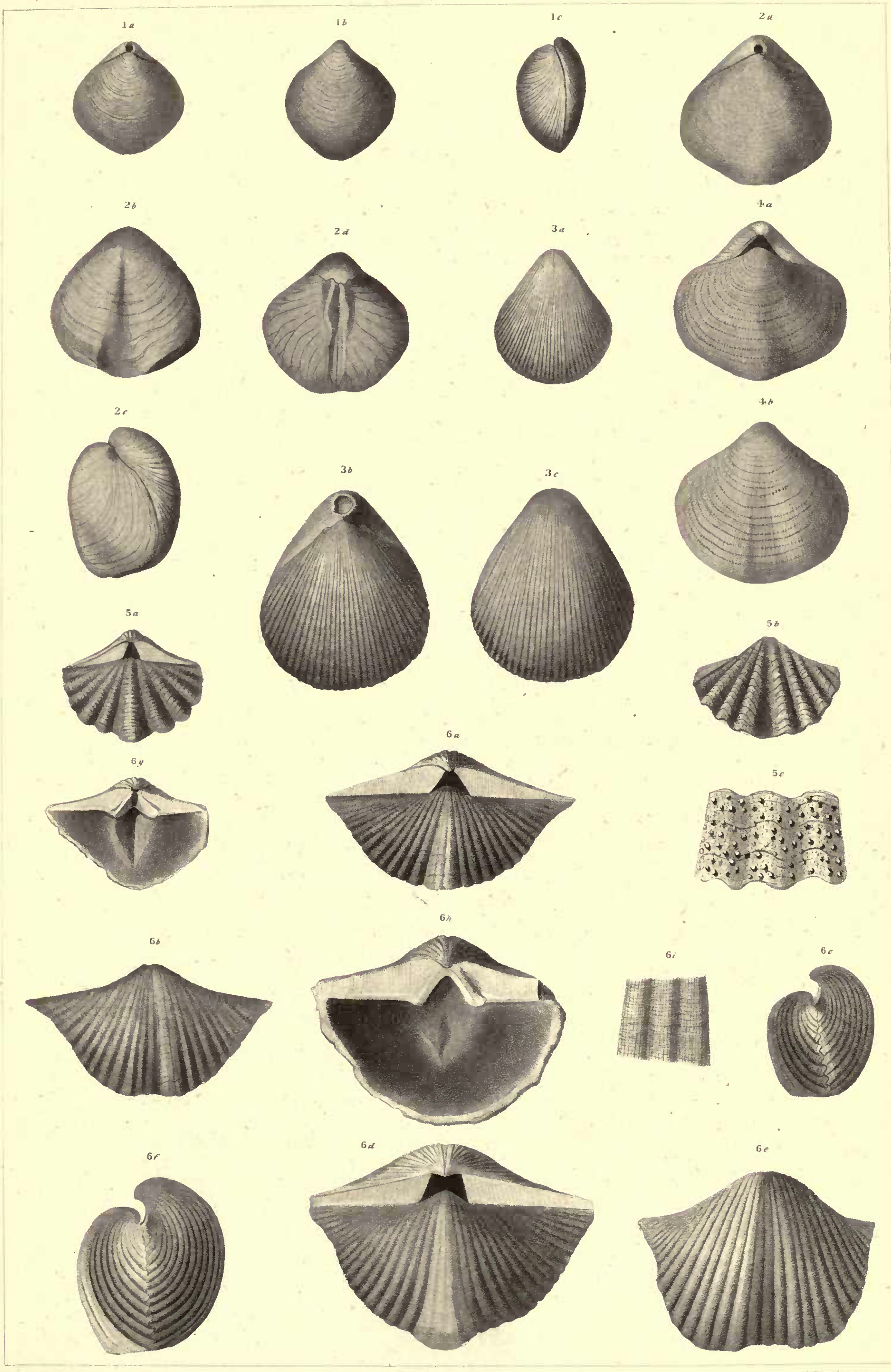
KASKASKIA LIMESTONE. (Carboniferous.) BRACHIOPODA.



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COAL MEASURES (Carboniferous) BRACHIOPODA

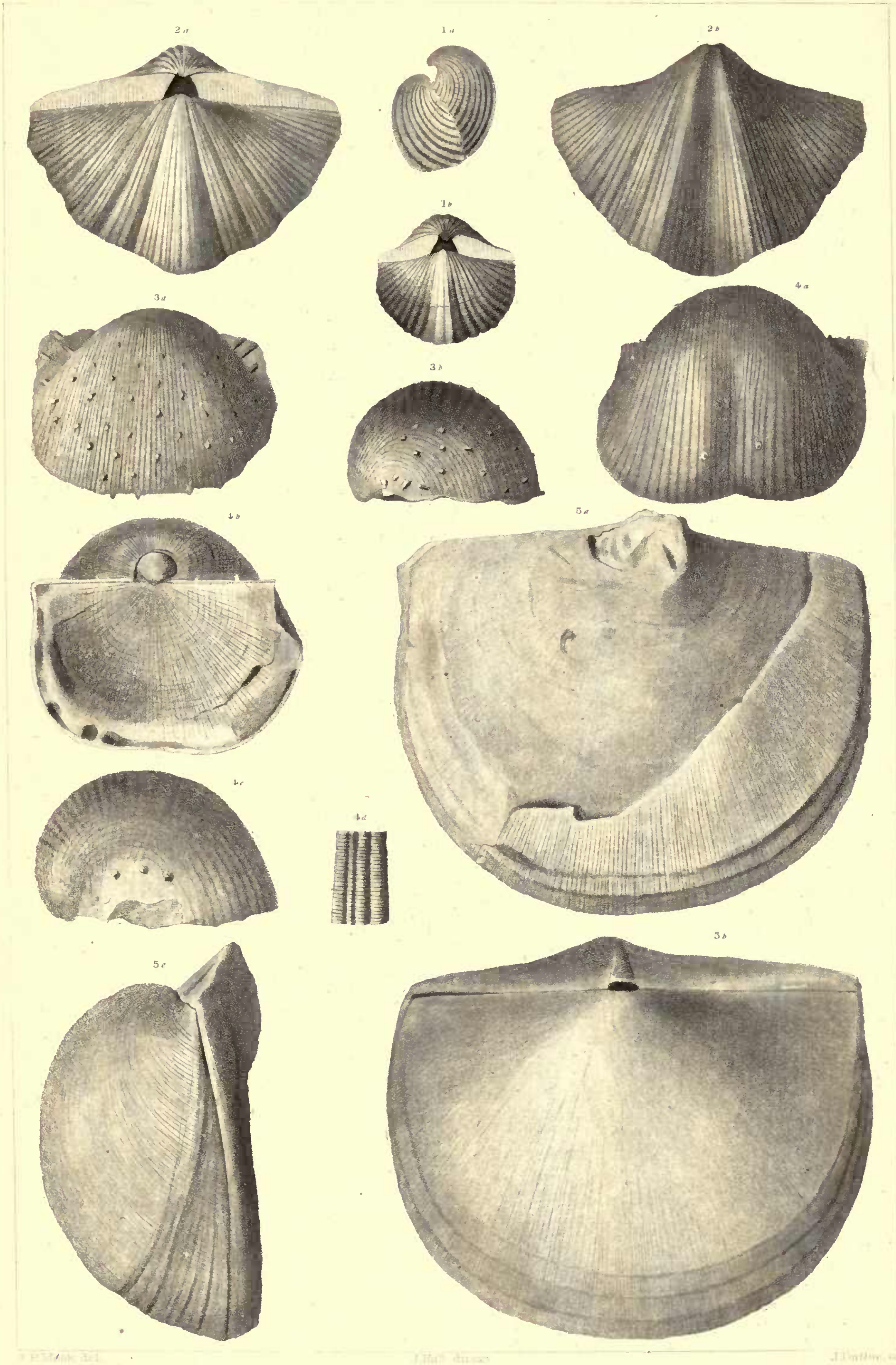


PLATE XXVIII.

		Page
Fig. 1.	SPIRIFER OPIMUS.	711

1 *a*, *b*. Profile and dorsal views of a large individual.

Fig. 2.	SPIRIFER CAMERATUS.	709

2 *a*. Dorsal view of a specimen above the medium size, having the extremities imperfect.

2 *b*. Ventral view of the same.

Fig. 3 & 4.	PRODUCTUS COSTATUS, *var.*	712

3 *a*. Ventral valve of a specimen preserving a greater number of spine-bases than usual.

3 *b*. Profile view of the same.

4 *a*. Ventral valve of a strongly costate specimen with few spines, and a well-marked mesial sinus.

4 *b*. Dorsal view of the same [the radiating costæ and concentric wrinkles are not properly shown in this figure].

4 *c*. Profile view, showing the curving row of spines which extend from near the beak.

Fig. 5.	ORTHIS ROBUSTA.	713

5 *a*. View of the ventral valve, with the greater part of the shell exfoliated.

5 *b*. View of the dorsal valve, from which the striæ are nearly obliterated.

5 *c*. Profile view of the same.

5 *d*. Enlargement of the surface, showing the concentric striæ.

PLATE XXIX.

Page

Fig. 1. ASTARTELLA VERA. 715

1 *a.* View of the exterior of the right valve.
1 *b.* Interior of the same, showing the teeth, etc.
1 *c.* Cardinal view of another specimen, showing the impressed lunule and ligamental area.

Fig. 2. DOLABRA ? ALPINA. 716

2. View of the left valve, natural size.

Fig. 3. EDMONDIA ? RADIATA. 716

3. View of the right valve, from which the shell is partially exfoliated.

Fig. 4 & 5. NUCULA VENTRICOSA. 716

4. View of the interior of a left valve.
5 *a.* Exterior of the left valve of another individual.
5 *b.* Cardinal view of the same.

Fig. 6. LEDA BELLASTRIATA. 717

6 *a.* View of the right valve of a small individual, which is imperfect at the posterior extremity.
6 *b.* Cardinal view of the same.
6 *c.* Interior of the right valve of a larger individual, in which the teeth are broken off on the posterior side.
6 *d.* Enlargement of the concentric striæ.

Fig. 7. MACROCHEILUS FUSIFORMIS. 718

7. View of a specimen (of the natural size), from which the shell is partially exfoliated, and several of the volutions at the apex broken off.

Fig. 8. MACROCHEILUS VENTRICOSUS. 718

8. View of specimen (natural size), showing the entire spire and a portion of the columellar lip.

Fig. 9. MACROCHEILUS NEWBERRYI. 719

9. View of the anterior side of the shell, natural size.

Fig. 10. MACROCHEILUS PALUDINÆFORMIS. 719

10. View of the anterior side of the specimen.

Fig. 11. MACROCHEILUS PRIMOGENIUS. 720

11 *a.* View of the aperture and columella. 11 *b.* Anterior side of the same shell.

Fig. 12. PLEUROTOMARIA TABULATA. 721

12 *a.* View of the anterior side of a large individual.
12 *b.* View of the aperture, which is imperfect. The specimen figured has the striæ much obliterated, and the surface characters are not represented as they exist in other specimens.

Fig. 13. PLEUROTOMARIA SPHÆRULATA. 722

13 *a.* Anterior view of specimen. 13 *b.* View of the aperture.

Fig. 14. EUOMPHALUS RUGOSUS. 722

14 *a.* View of the lower side and umbilicus.
14 *b.* Dorsal view, showing the aperture.
14 *c.* View of the upper side, showing the depressed spire.
14 *d.* Cast of the same.

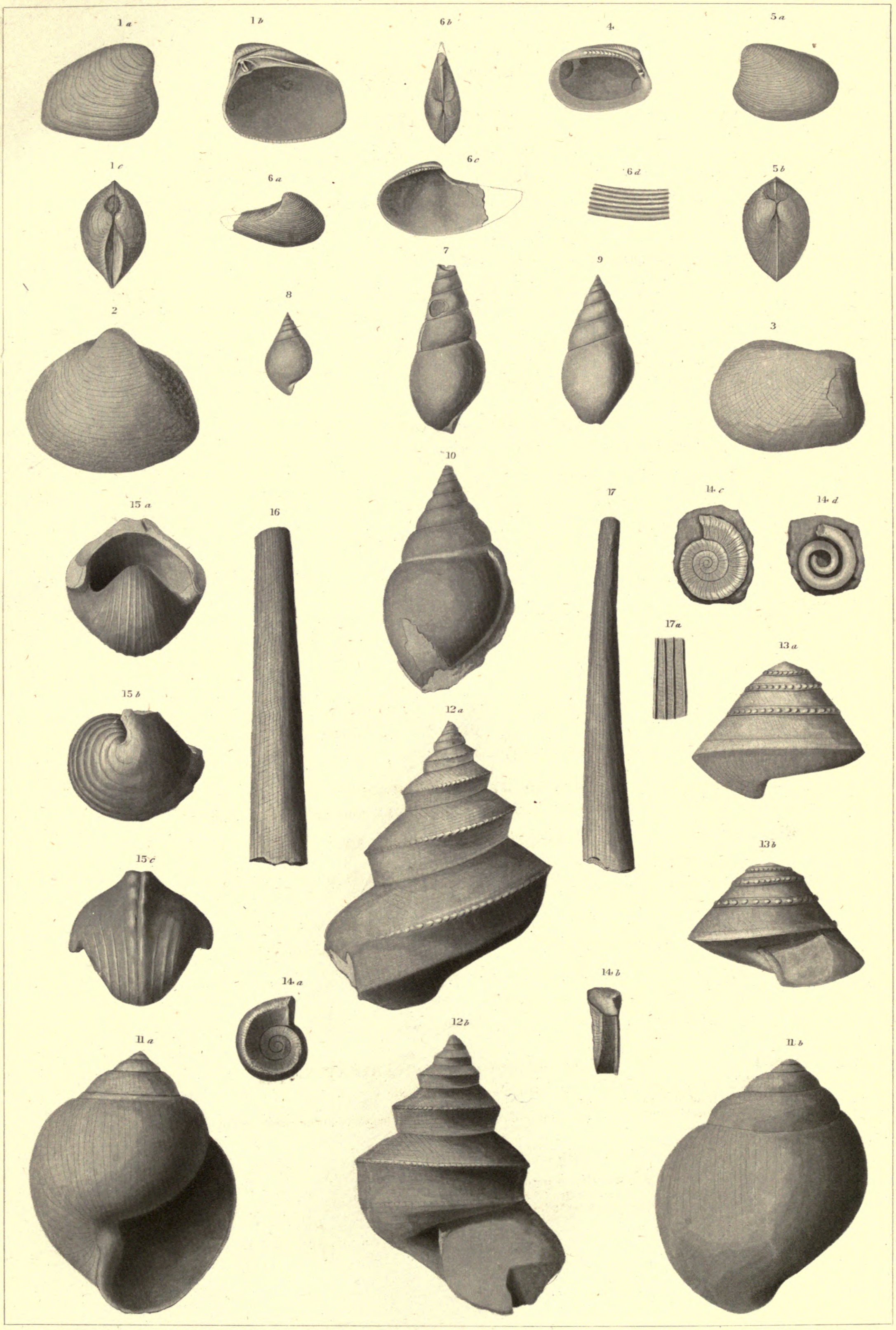
Fig. 15. BELLEROPHON NODOCARINATUS. 723

15 *a.* View of the imperfect aperture and back of the shell.
15 *b.* Lateral view of the same.
15 *c.* Dorsal view, showing the double dorsal carina, which becomes nodose towards the aperture.

Fig. 16 & 17. DENTALIUM OBSOLETUM. 724

16. A fragment near the base of the shell.
17. A more slender fragment from the upper part of the shell.
17 *a.* Enlargement of the longitudinal striæ.

COAL MEASURES (Carboniferous) GASTEROPODA ETC.



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