

Remarks on some types of Carboniferous CRINOIDEA, with descriptions of new Genera and Species of the same, and of one ECHINOID.

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Since the publication of the second volume of the Illinois Geological Reports, in 1866, other engagements have, until recently, prevented us from attempting any further investigations of the Crinoidea, beyond the preparation of some specific descriptions for the third volume. On several occasions we have expressed the opinion, that the classification of these animals, as *entirely* based upon the number and arrangement of the pieces composing the walls of the body below the arms, without regard to the most *extraordinary* differences in other parts, is, to a considerable extent, artificial; and that when larger collections, containing perfect specimens, showing the whole structure of a greater number of species of various types could be obtained for study, considerable modifications in the limits of genera, as most generally understood, would be found necessary. Impressed with this opinion, we separated in the third volume of the Illinois Geological Reports and elsewhere, either as distinct genera, subgenera, or less important sections, various types that had already been named by different parties in this country and Europe, as distinct genera, but which had been almost entirely overlooked or neglected by most authors, while to a few other types we gave, for the first time, distinct names.

Having recently had an opportunity to study in Mr. Wachsmuth's collection at Burlington, Iowa, what we really believe to be by far the most extensive collection of finely preserved Carboniferous Crinoids ever brought together, either in this country or Europe, we have been more than ever impressed, not only with the importance of the separations we had previously admitted, but with the necessity for giving even greater prominence to some of those groups than we have hitherto done, as well as for making other divisions. It is only when we can study a great collection like this, in which specimens may be counted by hundreds, showing the whole structure of numerous species belonging to various genera, that it can be fully realized how readily we may arrange them into perfectly natural groups, distinguished in part by other characters as well as by the structure of the body. In addition to this, in attempting to classify such a collection as this by taking into consideration the structure of the body *only*, we soon find that we would often have to include in a single genus forms differing very widely, on as important *other* characters, as those distinguishing many of the universally admitted genera of other groups of *Echino-dermata*.

When once we have become familiar with the different groups, as separated by a careful study of the entire structure of these animals, it is surprising to see how readily we may generally separate them, even from very imperfect specimens, upon some seemingly unimportant characters scarcely ever noticed by those who give the widest limits to genera. That such divisions greatly facilitate the study of these fossils must also be evident to any one who will attempt to identify the numerous species of some allied groups contained in a large collection.

With regard to the new species described in this paper, as well as others that we expect to describe hereafter from the same horizon, it may be proper to state, that we have had the advantage of being able to compare them directly (assisted by Mr. Wachsmuth) with authentic specimens of very nearly all the described species from the Burlington rocks. Many of the original typical specimens we have here at hand in Springfield, while Mr. Wachsmuth has in his own collection good specimens of nearly all the described Burlington species. Many of his specimens are also types of species, while most of those that are not, have been identified from direct comparison by him and Mr. Niles and our-
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selves, with the original types in the possession of others at Burlington and here.

The fact that Mr. Wachsmuth is the only person (with the exception of occasional visitors) that has been collecting at Burlington during the last four or five years, and that during this time extensive excavations have been made in working the numerous quarries and in opening new streets in the Burlington rocks, has given him great advantages in collecting; consequently his collection may now be regarded as unrivaled in the number and perfection of specimens, as well as in the number of species.

Mr. Wachsmuth informs us that he also has many duplicates that he is willing to exchange for other Crinoids, or to dispose of in any way that may assist in affording him the means of increasing his collection.

Genus CYATHOCRINITES, Miller.

As properly restricted to true typical species, such as the *C. planus*, Miller and *C. mammillaris*, *C. calcaratus* and *C. bursa*, Phillips, the genus *Cyathocrinites* includes forms with a more or less globose (or perhaps rarely obconic) body, composed of thin pieces, which below the vault consist of the basal, subradial and first radial plates, and but a single anal piece that can be properly regarded as forming a part of the walls of the body below the top of the first radials. Of true interradials there are apparently none. The base consists of five pieces, all normally of the same form, and alternating with these there are five generally larger subradials, one of which, on the anal side, differs in form from the others, being truncated above for the support of the only anal piece inserted between two of the first radials. The five first radial pieces are comparatively large and alternate with the subradials all around.

The succeeding radials are all small, more or less rounded, or sometimes angular, and always free or form no part of the walls of the body, those of each ray being distinctly separated by more or less wide interradial spaces. The number of these free pieces varies from two to some six or seven to the ray, the number being generally different in the different rays of the same individual. The arms are slender, more or less bifurcating and rounded or sometimes angular, and always composed of a single series of pieces provided with a deep ambulacral furrow along the ventral or inner side, and apparently without tentacula (pinnulæ) along its margin. The column is generally if not always round and pierced by a small canal, and not divisible into five sections longitudinally.

The vault in this genus is always much depressed, never being extended upward in the form of a large poriferous trunk, or so-called proboscis, as we see in the typical forms of *Poteriocrinus*. It is very rarely preserved in the specimens as usually found, but according to Phillips' and Austin's figures of *C. planus* it would appear to be provided with a lateral proboscis, or, more properly as we think, anal tube and an apparent central oral aperture. From specimens of *C. malvaceus* and *C. Iowensis*, however, which we have had an opportunity to examine in Mr. Wachsmuth's collection and have described in another place, we are satisfied that, in these species at least, which appear to be typical examples of the genus, the apparent central opening is closed by vault pieces, in perfect specimens. These central pieces, however, are more liable to be removed by any accident than the five larger surrounding pieces, because the latter are more deeply inserted, in order to permit the five rather large ambulacral canals, extending inward from the arm bases, to pass *over* them, or rather along the upper side of the sutures between them, while these furrows pass in *under* the pieces forming the centre of the vault, which are consequently less firmly fixed.

As we have not had an opportunity to examine the original typical specimens of *C. planus*, figured by Phillips and Austin, we of course cannot assert positively that the vault of these types was constructed like that of the Iowa species we have described, but we are strongly inclined to believe such was

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really the case, and that the apparent central opening was closed by vault pieces when the specimen was entire.

Of the American species presenting, so far as known, the characters of this genus as properly restricted, the following examples may be mentioned, though the vault of only the first two of these species is yet known to us, viz., *C. malvaceus*, Hall, *C. Iowensis*, Owen and Shumard, *C. (Poteriocrinus) Burreisii*, *C. viminialis*, *C. lamellosus*, *C. divaricatus* and *C. rotundatus*, Hall; also *C. Saffordi* and perhaps *C. Farleyi*, M. and W., and *C. rigidus*, White.

New species.

CYATHOCRINITES FRAGILIS, M. and W.

Body subsphæroidal, a little oblique, rather regularly rounded to the column below, from near the middle, and a little contracted above; composed of remarkably thin plates. Facet for the attachment of the column not excavated and very small. Base having the form of a very shallow, subpentagonal basin; basal pieces with a general subquadrangular form, but really pentagonal, from the slight truncation of their smaller inner ends at their connection with the column. Subradial pieces comparatively large, hexagonal, excepting the one on the anal side, which is larger than the others and heptagonal in outline. First radial pieces rather smaller than the largest subradials, somewhat wider than high, with a general subpentagonal form; all strongly incurved above between the free radials; facet for the reception of the second radials about one-third the breadth of the first radials and rather deeply excavated. Anal piece rather smaller than the first radials, longer than wide, irregularly hexagonal and supporting the outer side of the ventral tube (proboscis), which, like the body, is composed of very thin plates. Second (first free) radials very small, short and not always extending entirely across the excavation for their reception; succeeding radials, excepting the last, quadrangular, as viewed on the outside, about twice as wide as long, and abruptly rounded or subangular on the outside; last one pentagonal and generally a little longer than the others. Of these free radials four may be counted in one of the posterior rays, six in the other, three in one of the lateral rays, and seven in the anterior ray.

Arms at their origin on the last radials rather divergent, and in one of the posterior rays seen to bifurcate on the sixth piece, above which one of the divisions can be traced to the sixth piece without farther bifurcation, though there are probably other divisions beyond; arm pieces about as long as wide, and, like those of the free radials, all deeper than wide, and profoundly grooved within for the reception of the ambulacral organs. Surface smooth or only very finely granular.

Height of body, 0.50 inch: greatest breadth of same, about 0.75 inch.

This species is related to *C. rotundatus*, Hall, but not only differs in having its free radial series much stouter (judging from the facets for their reception in the typical specimen of that species now before us), but in having all of its body plates very decidedly thinner, while its first radials also differ in curving strongly inward, between the bases of the free rays. It likewise comes from the lower division of the Burlington beds, while the *rotundatus* came from the upper, and it has been found that scarcely any of the species are common to those two horizons.

Locality and position.—Burlington, Iowa; lower part of Burlington limestone. Mr. Wachsmuth's collection.

CYATHOCRINITES TENUIDACTYLUS, M. and W.

Body, exclusive of the free rays, deeply cup-shaped, rounded below, composed of moderately thick plates for a true *Cyathocrinus*. Column comparatively rather stout, composed near the base of alternately thin and somewhat thicker pieces, the latter of which project a little and seem to show a slight tendency to become minutely nodular; central canal distinctly pentapetalous in the form of its cross section. Base unknown (being accidentally shoved 1868.]

into the body with the end of the column in the specimen studied). Subradials of moderate size, those seen hexagonal. First radials somewhat larger than the subradials, a little wider than long, with a general subpentagonal form; facet for the reception of the second radials about one-third as wide as the upper side of the plate and excavated about one-third of the way down. Second radial pieces very small, wider than long, and with the succeeding radials curving outward. Third radial in one of the rays nearly as long as wide, expanded above and contracted below, and in this ray surmounted by a fourth, which, like the third in each of the only two other rays seen, is a triangular axillary piece, on which the arms rest, the upper angle being acute and so produced as entirely to separate the arm-bases, while the lateral slopes, on which the arms rest, are distinctly concave. Anal piece unknown.

Arms distinctly divergent at their origin on the last radials, as well as at their succeeding bifurcations, dividing on the third piece in two of the rays seen, and on the fourth in another, the pieces being rounded, nearly as wide as long, somewhat constricted in the middle and a little dilated at their upper ends, while all of the axillary pieces at the various bifurcations have much the same form as the last free radials. Beyond the first bifurcations mentioned, above the last free radials, several of the arms are seen to bifurcate again on the fifth piece and twice to three times more at various distances above, while they all gradually decrease in thickness with each bifurcation until they become much attenuated, though the pieces of which they are composed maintain their length to such a degree that those of the smaller divisions are nearly twice as long as wide.

Surface of body plates slightly beveled at the sutures and more or less roughened by small ridges or nodes, which on the subradial pieces present the appearance of nearly continuous, radiating, somewhat nodulous ridges, while those of the first radials have more the character of irregularly disposed nodes.

Length of body below the top of first radial pieces, 0.40 inch; breadth of same about 0.64 inch; length of arms from their origin on the last radials at least 2 inches and perhaps a little more.

This species seems to be more nearly allied to specimens in Mr. Wachsmuth's collection that have been identified with *Poteriocrinus Barrisi*, Hall, than to any other form with which we are acquainted. It differs entirely, however, in its sculpturing, that species having its body plates marked with numerous, rather fine, thread-like, radiating costæ. The arms, however, are more similar to those of our species, though they are rather stouter below in the latter.

We have not had an opportunity to see the type of *Poteriocrinus Barrisi*, but the form in Mr. Wachsmuth's collection, referred to that species by all the Burlington Geologists, is a true *Cyathocrinus*, or more properly *Cyathocrinites*.

Locality and position.—Lower division of the Burlington beds (Lower Carboniferous) at Burlington, Iowa. Mr. Wachsmuth's collection.

Genus BARYCRINUS, Wachsmuth, MS.

(*βαρύς*, heavy; *λίον*, a lily; in allusion to the ponderous nature of the plates and arms.)

Amongst the various American Carboniferous species that have been referred by different authors to the genus *Cyathocrinus*, there is a group of species which, although agreeing with that genus almost exactly in the number and arrangement of the pieces composing the body below the top of the first radials, that still differs in several rather strongly-marked characters. In the first place, these species are all more robust,* and have distinctly thicker and more ponderous plates and arms than in the typical forms of *Cyathocrinus*. They also differ in generally having a more or less developed, quadrangular subanal

* Some of them attain the gigantic size of more than 3.25 inches in breadth of body.

piece, inserted obliquely under one side of the first radial of the right posterior ray, and connecting with the only other anal piece above by a short oblique truncation of its right lower margin. This subanal piece varies in its proportional size, even in different individuals of the same species, and is sometimes very small, or even occasionally wanting, while it is very rarely, if ever, large enough to separate the first radial and the true anal piece above entirely from each other. A more constant difference, however, is the uniform presence of but two of the free primary radial pieces to each ray (instead of an irregular number), excepting perhaps sometimes in the anterior ray, where there may be one or two more. These free radials are also proportionally wider and shorter than in the typical forms of *Cyathocrinus*, particularly the second radial, which is often so short and wide as to present a nearly transversely linear appearance, as seen on the outer side.

As in *Cyathocrinus*, the species of this group have their arms and all their divisions composed each of a single series of pieces, apparently without pinnulæ; but here these pieces are always very much stouter, distinctly rounded, and only provided with comparatively very small, or almost linear ambulacral furrows. Again, they present marked differences in their method of division. That is, instead of regularly dichotomizing, so as to form equal divisions more or less frequently subdividing in the same way, the subdivisions regularly diminishing in thickness, they are often simple from their origin on the last radials, and merely give off along their inner lateral margins, at regular intervals, alternately on opposite sides, stout, rounded, simple armlets. In some instances one arm of each lateral ray, and sometimes one of each posterior ray, dichotomizes once or oftener, but even in these cases the other arms remain simple. and, like the principal branches of those that bifurcate, merely throw off alternately, at regular intervals along their inner lateral margins, stout armlets. If these armlets in this group performed the same offices as pinnulæ in other Crinoids, as we have every reason to believe the ultimate subdivisions of the arms in *Cyathocrinus* proper did, the sacks for the reception of the ova must have protruded considerably beyond the edges of the merely linear ambulacral furrows.

In the column of *Barycrinus* we also observe some more or less defined differences from that of *Cyathocrinus*. For instance, in the former group it is proportionally stouter, with a much larger canal, which is also rarely, if ever, perfectly round, but apparently always obtusely subpentagonal. But the most remarkable difference consists in its being often divisible longitudinally into five sections in *Barycrinus*. This character is not *always* well marked, being apparently sometimes obliterated by the sutures becoming ankylosed. In some cases, however, it is so strongly defined that we find the column with these sutures more or less separated along its entire length, and in some species there were apparently pores passing through these sutures to the cavity within. We are aware that several other types of Crinoids had the column in this way divisible into five parts longitudinally, but we have not seen any indications of it in the typical forms of the genus *Cyathocrinus*.

In regard to the vault of this group nothing is known, not a single individual of the numerous specimens belonging to various species hitherto found, showing, so far as we are aware, any traces of it. From this very fact, however, it seems probable that its vault differed from that of *Cyathocrinus* proper in being merely a soft ventral disc, without any covering of calcareous plates. If it had possessed the power of secreting vault pieces, it seems probable, from the thick ponderous nature of all its other parts, that these would have been sufficiently firm to have been found in place, in some of the numerous specimens now known. In addition to this, the upper inner edges of the first radial pieces, on each side of the free radials, are beveled off to an obtuse edge, and show no facets for the attachment of vault pieces.

Whatever may be thought in regard to this group being entitled to rank as a distinct genus, or as a subgenus, from *Cyathocrinus*, we can only say that the

various species of the two groups can be as readily separated, even without specimens showing the arms, as those of any other two allied genera. Indeed, they can be far more readily separated than *Scaphioerinus* and *Zeacrinus*, or than the former can in all cases be separated from *Poteroicrinus*.

Believing that a systematic classification of the *Crinoidea* really requires the separation of the group under consideration from the types for which the name *Cyathocrinus* was originally proposed, we cheerfully adopt for it Mr. Wachsmuth's appropriate manuscript name, *Barycrinus*. Mr. Wachsmuth refers to this group the following species, the first of which he regards as the typical form,—viz.: *B. spurius*, *B. crassibrachiatus*, *B. bullatus*, *B. tumidus*, *B. magister*, *B. Hoveyi*, *B. latus*, *B. Lyoni*, *B. sculptilis*, *B. Thomæ* and *B. protuberans*, all described by Prof. Hall under the name *Cyathocrinus*; also *B. cornutus* (= *Cyathocrinus cornutus*, Owen and Shumard).

We likewise place in this group our *B. Wachsmuthi*, *B. angulatus* and *B. sub-tumidus*, all of which were originally described by us under the name *Cyathocrinus*. It is possible our *Cyathocrinus? Sangamonens* may belong here, as it has the same thick body plates, as well as the small quadrangular intercalated subanal piece. Still, as all its first radial pieces are evenly truncated, their entire breadth straight across above, and provided with a transverse furrow, as if for the articulation of the second radials, it is probable these and the succeeding radials and arms (which are unknown) had a different structure and arrangement. It is certainly not a true *Cyathocrinus*, however, as properly restricted, but more probably belongs to an undescribed genus.

BARYCRINUS MAGNIFICUS, M. and W.

Body attaining a gigantic size, cup-shaped, or widening rather rapidly, with moderately convex sides from the column to the top of the first radials. Base shallow, basin-shaped, or about four and a half times as wide as high, with a large concave facet for the attachment of the column, and a large, obscurely five-lobed perforation for the connection of the central cavity of the column with the visceral cavity of the body. Basal pieces regularly pentagonal. Subradial plates about five or six times as large as the basal pieces, as wide as long or slightly wider, all regularly hexagonal, excepting one on the anal side, which is a little shorter than the others, and truncated above for the reception of the anal piece, so as to present a general heptagonal outline. First radial pieces about one-third wider than high, and larger (particularly wider) than the subradials, each presenting a general pentagonal outline, and provided with a rather shallow, outward sloping, concave facet, occupying more than one-third its entire breadth, for the reception of the succeeding radials. Second radial pieces very much smaller than the first, extremely short, or only about one-fourth as long in the middle as wide, and becoming much thinner, or wedge-shaped, on each side. Third radials a little longer in proportion to their breadth than the second, and presenting a subtrigonal outline, supporting on their sloping upper sides, broad, short, rounded arm-pieces. Anal piece about half as wide, and nearly of the same length as the first radials, and subquadrangular in form. Surface marked with small pustules, which often become confluent, so as to produce a peculiar corrugated roughness, somewhat similar to the ornamentation we see on the body plates of the true *Amphoraerinus*, but coarser.

Breadth of body 3.33 inches; height of do., 2.20 inches; breadth of base, 0.60 inch; breadth of facet for the reception of the column, 0.85 inch; do. of largest first radial piece, 1.70 inches; height of same, 1.30 inches. Thickness of one of the arms at base, 0.70 inch.

This splendid Crinoid was found by Mr. Green, of the Illinois Survey, with its plates detached and lying near together in the rather soft matrix. After working out the pieces, we succeeded in building up the entire body to the third radials and first arm-pieces, inclusive, excepting the anal piece, which was not found. It presents a very striking appearance, and is the largest Cri-

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noid we have ever seen. If its arms were as long in proportion as those of some other species of this group, they must have been near twelve inches in length, and with its column, body and arms together, it may have been more than four feet in height. It is evidently related to *Barycrinus magister*, Hall (sp.), but differs from that species, the type of which is now before us, in having its surface roughened by numerous small pustules, showing a tendency to run together into vermicular markings, with an obscure effort, on some of the plates, to assume a radiating arrangement. It is true, the typical specimen of *B. magister* consists of only the basal pieces and a portion of the column, but these basal plates show no traces of the peculiar surface markings seen even on the base of our species, while we have before us, from the same original locality, another specimen of that species, consisting of the whole body, in a flattened and crushed condition, and, although the surface of its plates is well-preserved, they show no indications whatever of the surface markings seen on our species.

Those who give a wide latitude to genera will probably not regard such forms as this as being generically distinct from *Cyathocrinus*; even if that view should ultimately prevail, however, we should insist upon their separation as a strongly marked subgenus, and continue to write the name of our species *Cyathocrinites (Barycrinus) magnificus*.

Locality and position.—Henderson county, near Biggsville, Illinois; from the Keokuk group of the Lower Carboniferous.

BARYCRINUS HOVEYI, var. HERCULEUS.

Amongst other Crinoids from Crawfordsville, Indiana, we have before us several very large, fine specimens, agreeing well with Prof. Hall's description of his *Cyathocrinus Hoveyi* (Bost. Jour. Nat. Hist. vol. vii, p. 293), excepting in some important points in the structure of the arms. We suspect that these specimens are specifically distinct, but as neither any measurement, nor figures of the *C. Hoveyi*, have yet been published, we cannot feel quite sure of this, and therefore place them, provisionally, as a variety of the species *Hoveyi*, under the name *Herculeus*, which we propose to retain for the species if the differences to be noted are found to be constant, and of specific value.

The differences to which we allude are the following: In *C. Hoveyi* the arms of the antero-lateral rays are said to "have the anterior division twice bifurcating, above which the divisions give off branchlets, and the same feature marks the entire length of the lateral arm of the antero-lateral ray, which is smaller than the other." In the specimens before us, the anterior lateral rays have each the posterior division bifurcating *once* near the base, while the anterior division is *simple*, and *larger*, instead of smaller, than the other. Again, the *Hoveyi* is said to have, "in the postero-lateral arms, the lateral division of the rays bifurcating on the fourth piece, above which branchlets are thrown off, as in the others." In the specimens before us, however, *both* arms of the posterior rays are, like those of the anterior ray, and one of each lateral (or anterior lateral) rays, simple from their origin on the third radials, very long, stout, and give off along their inner lateral margins stout, simple armlets, alternately at regular intervals. As we have seen several specimens all agreeing in these characters, we are inclined to think this may be a specific difference.

In one of the specimens before us the body measures 1.10 inches from the base to the top of the first radials, and about 1.40 inches in breadth. The arms show a length of 4 inches, and are broken at the ends, so as to appear to have been, when entire, nearly one inch longer. They are very straight, nearly cylindrical, and measure 0.22 inch in diameter near the middle, where each arm-piece measures about 0.15 inch in length, and the lateral armlets nearly the same in diameter.

Genus NIPTEROCRINUS, Wachsmuth, MS.

(*νιπτήριον*, a washing vessel; *κρίνον*, a lily; in allusion to its basin-shaped body.)

Mr. Wachsmuth has proposed the above name, in manuscript, for a type 1868.]

agreeing with *Cyathocrinus* proper in the thinness of its body plates, in the nature of the bifurcations of its arms, and apparently in the general structure of its body, excepting that it has no anal plate, the first radials being large, wide, and in contact all around, so as to leave no spaces for anal or interradial pieces. The succeeding radials after the first are comparatively small, and number from three to four (so far as yet known) to each ray, the first always resting in rounded sinuses in the upper edge of the large first radials, much as in *Cyathocrinus*, excepting that these free radials are very short, more as we see in *Barycrinus*. They differ, however, from those of both *Cyathocrinus* and *Barycrinus*, in each having its lower edge along the outer side of the arms produced downward, into a corresponding sinus in the upper outer edge of each succeeding piece below, so as to present much the appearance seen in the arms of *Taxocrinus*, *Onychoocrinus* and *Forbesiocrinus*, excepting that the produced part does not seem to be separate patelliform pieces, but merely the downward produced lower outer edge of each arm-piece itself.

None of the specimens yet found show the *number* of basal pieces, but we can see that its body is composed of small basals, with five well-developed subradials of uniform shape, and five large first radials. This structure of the body, it will be seen, is exactly that of *Erisocrinus*,—that is if the base is composed of five pieces, which is very probable. The whole structure and aspect of the parts above, however, is entirely different in these groups, since in *Erisocrinus* there are always but two primary radial pieces to each ray, while the second radials are as large as the first, and instead of merely resting in small sinuses in the upper part of the latter, the two *articulate* together by straight edges across their entire breadth, the articulating edges being always provided with a crenated transverse ridge and furrows. The arms of *Erisocrinus* are also much stouter, and present none of the characters of the type under consideration, while all of its body and arm pieces also differ in being very thick.

It is an interesting fact that the column of the genus here described, as well as its arms, present a striking similarity to that of *Taxocrinus* and allied groups, being round, and composed near the body of exceedingly thin pieces, connecting by crenate surfaces, and provided with a comparatively small central canal. Notwithstanding these points of resemblance, however, to *Taxocrinus*, it is evident that this group is more nearly allied to *Cyathocrinus*. If it has, as seems to be the case, five basal pieces, the formula of the genus would be as follows:

Basal pieces 5; subradials 5, all of the same form; radials 4 to 5 \times 5, the first being large and forming the larger part of the body, the others small and free; anals 0; interradials 0; arms bifurcating, and resembling those of *Taxocrinus*.

Some five or six specimens of this type show that the absence of anal pieces is not an abnormal, but a constant character.

NIPTEROCRINUS WACHSMUTHI, M. and W.

Body rather deeply basin-shaped, or a little more than twice as wide as high, rounding under from the top of the first radials to the column. Base small, flat, and nearly hidden by the column. Subradial pieces of moderate size, somewhat wider than long, and all pentagonal, there being no visible angle at the middle of the under side of any of them. First radials comparatively very large, or about three times the size of the subradials, twice as wide as high, and all alike pentagonal; while each is provided with a rather deep rounded sinus above, equaling about one-third of its breadth, for the reception of the succeeding radials, on each side of which its upper margin is nearly straight, horizontal, and not incurved. Second radials so short as scarcely to fill the sinus in the upper side of the first, and owing to the concave outline above, often presenting a narrow transversely crescentic form. Third and fourth radials (where there are five) very short, or several times as wide as long, and usually somewhat arcuate inversely. Last (fourth or fifth)

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radials a little longer than the next below, and generally trigonal or subpentagonal (the upper angle being somewhat salient), and supporting the arms on its sloping sides. Arms rounded, rather divergent, and bifurcating on the sixth or seventh piece above their bases, and again once or oftener farther up, the divisions above each bifurcation being about half as large as the main arm below; arm-pieces about twice as wide as long, not wedge-shaped, but all showing the downward curvature quite distinctly, and slightly constricted on each side. Surface merely finely granular, and the plates of the body neither beveled nor tumid. Column composed of such thin pieces that about fifteen of them may be counted in a length equaling its own thickness, near the base.

Height of body of the largest specimen to top of first radials, about 0.43 inch; breadth near 1 inch.

Thickness of column of same, near base, 0.20 inch; diameter of its subpentagonal canal, 0.05 inch.

This Crinoid is so unlike all others known to us, that it is scarcely necessary to compare it with any of the described forms. The specific name is given in honor of Mr. Charles Wachsmuth, the author of the genus, to whom we are indebted for the loan of the typical specimens.

Locality and position.—Upper Burlington beds of the Lower Carboniferous. Burlington, Iowa.

Mr. Wachsmuth's collection.

Genus CATILLOCRINUS, Troost.

CATILLOCRINUS BRADLEYI, M. and W.

Body small, basin-shaped or rather broadly truncated below for connection with the column, and moderately expanding upward to the top of the radials supporting the arms. Lower series of plates visible around the top of the column, ankylosed together, and presenting the form of a broad low dish, many times wider than high, with the margins sinuous above for the reception of the next range of pieces. Succeeding range of plates presenting the usual irregular form of the genus, two of them being much larger than the others, very wide at the top, and supporting nearly or quite all of the arms; between these on one side there is a much smaller triangular piece on the same range, and extending up as high as the others, but so narrow at the top that it could not have supported more than one or two, if any, of the small arms. On the opposite side there are two other small intercalated pieces, the smaller of which is triangular and scarcely extends up to the top of the cup, while the other is oblong, extends to the top of the cup, and supports either another somewhat smaller (anal?) piece above, or the base of an arm much larger than the others. Arms about 44, in contact at their bases, and all slender and composed of joints two or three times as long as wide. Surface smooth. Column comparatively very large (circular?), with a large round central canal, and composed near the base of rather thin pieces of uniform size.

Height of body, 0.18 inch; breadth at top, 0.24 inch; breadth of column at the base of the body, 0.13 inch.

This species will be at once distinguished from *C. Tennesseeæ* of Troost by its much smaller size, and smooth instead of coarsely granular plates. It is much more nearly allied to our *C. Wachsmuthi*, from the Burlington group, but its body is less expanded at the top, and it also differs in having a comparatively large anal? piece, or larger arm, between the others on one side. Named in honor of Prof. Frank H. Bradley, of Hanover College, late of the Illinois Geological Survey, who discovered the only specimen known.

Locality and position.—Crawfordsville, Indiana; Keokuk division of Lower Carboniferous series.

Genus DICHOCRINUS, Munster.

DICHOCRINUS EXPANSUS, M. and W.

Body expanding rather rapidly from the facet for the attachment of the col-
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umn, to the top of the base, and still more rapidly from there to the top of the first radials, so as to make the breadth at the latter point about twice the height. Base forming less than half the height of the body, somewhat basin-shaped, though narrow below, or ornamented with small irregular wart-like nodes, which show some tendency to form three or four vertical rows, or ridges on each basal piece. First radial pieces comparatively large, somewhat oblong in form, being longer than wide, with the widest end above, all convex along up the middle, and strongly beveled, or excavated along the sutures on each side,—while the surface of each is ornamented with small, irregular, wart-like nodes, similar to those on the base; these sometimes coalesce into irregular ridges, but are usually arranged in three rows, starting from the most prominent upper end of the plates, and radiating to the base; facet for the reception of the second radial pieces about one-third the breadth of the upper end of the plates, and somewhat excavated. Anal piece of much the same size, and general nodose appearance as the first radial on each side, but somewhat longer, and having an irregular hexagonal form. Second radial pieces small, about twice as wide as long, and more or less quadrangular in form. Third radials slightly larger than the second, with a pentagonal form, the upper sloping sides supporting the first division of the arms.

Arms rounded, composed at first of pieces about as long as wide, upon the second or third of which they bifurcate, the outer divisions remaining simple, and the inner ones bifurcating again on the second or third piece, the outer division, as before, remaining simple, and the inner bifurcating a third time on the second pieces, thus making in the posterior rays (the only ones seen) eight arms to each ray, or forty in the whole series, if other rays have the same number. All the simple arms are long, slender, rounded, and but slightly tapering; near their bases they are each composed of a single series of somewhat wedge-formed pieces, but gradually pass into a double series of minute interlocking pieces.

Breadth of body, 0.98 inch; height about 0.43 inch. Length of one of the simple arms, about 1.60 inches; thickness of same at base, 0.05 inch.

Associated with the specimen from which the foregoing description was drawn up, several other imperfect examples were found, differing more or less in form and in the arrangement of their ornamentation, which either indicate considerable variations in these characters, or the existence of several allied species. One of these has the first radial and anal plates more abruptly spreading, and proportionally wider than in the typical form, while its nodes are more coalescent, so as more generally to run into continuous ribs. On the base, for instance, each of the two plates has three somewhat nodulous vertical ridges, with intervening rows of the little nodes, while the three rows of nodes on the first radial and anal pieces often run together so as to form mere nodulous ridges. It is possible this would be found to be a distinct species, if we could examine a specimen showing the arms. If so, it may be called *D. stelliformis*, in allusion to the star-like appearance produced by its spreading first radial pieces, with their little ridges running outward and converging to the outer extremity of each.

In another individual the nodes and ridges are all nearly obsolete, excepting a few of the former, which are very prominent at the middle of the outer ends of the first radials; while another has a single prominent node near the small facet in each first radial, for the reception of the second, with a few irregularly scattering nodes on other parts, and slender, obscure, nodular ridges near the lateral margins. From the general appearance of these specimens, we are rather inclined to the opinion that they are all varieties of one variable species.

Locality and position.—Same as last.

Genus DORYCRINUS, Roemer.

In the second volume of the Reports of the Geological Survey of Illinois, we distinctly recognized the *Dorycrinus* group as forming a well-defined genus,

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clearly separated from *Actinocrinus* (as properly restricted), to which genus they have generally been referred; but owing to the fact that at that time we had never seen either a specimen or a figure of an *Amphoracrinus* showing the arms, body, and parts connected with the opening of the vault, all preserved together, we were under a misapprehension in regard to the true characters of that group, and consequently placed *Dorycrinus* as a synonym under it. Recently, however, we have been so fortunate as to see in Mr. Wachsmuth's extensive collection beautiful specimens of both types, in a remarkably fine state of preservation, and from these we are satisfied that a systematic classification of the *Crinoidea* requires these two groups to be separated as distinct genera.

In the first place, it may be proper to remark that in both of these groups the structure of the body, so far as regards the number and arrangement of the pieces below the arm-bases, is almost exactly the same as in *Actinocrinus*.* The structure of the parts above, however, is very different. For instance, in *Dorycrinus* the opening of the vault is never at the end of a more or less prolonged tube, or so-called proboscis, nor even in the slightest degree proboscidi-form, but is merely a simple aperture penetrating a somewhat thickened protuberance, and nearly always situated and opening laterally. The vault in this group is generally provided with a more or less prominent spine over each ray, and a sixth one in the middle. Sometimes these are all, or in part, merely represented by nodes, or even in some instances nearly obsolete, while in others they are extravagantly developed. Again, *Dorycrinus* differs from both *Actinocrinus* and *Amphoracrinus* in having, so far as yet known, always *two arms springing directly from each arm-opening, and these arms always simple*. Our attention was first called to this by Mr. Wachsmuth, who is a very careful and accurate observer, and we found it to be so in all the specimens in his collection, while he assures us that this is the case in all the specimens found by the various collectors at Burlington, as well as all of those he has yet seen from other localities, with the arms attached. Hence in all of the species of this group described by Prof. Hall and others, where the number of arms has been given from merely counting the arm-openings,—and specimens of these have since been observed with the arms attached,—their number is found to be *just double that stated in the descriptions*. It is also worthy of note that in this group the body plates are either plane, more or less tumid, or tuberculiform, and never marked with proper radiating costæ, as we often see in *Actinocrinus*.

The following is a list of the described species belonging to this group, all of which are, so far as known, exclusively American types, and confined to the Lower Carboniferous, viz.: *Dorycrinus Mississippiensis*, Roemer, and *D. Gouldi*, † *D. cornigerus*,* *D. divaricatus*,* *D. trinodus*, *D. quinquelobus*,* *D. symmetricus*,* *D. desideratus*, *D. unispinus*,* and *D. subaculeatus*, Hall (sp.), all of which were described by Prof. Hall under the name *Actinocrinus*. It likewise includes *D. Missouriensis** (= *Act. Missouriensis*, Shumard) and *D. unicornis** (= *Act. unicornis*, † Owen and Shumard), as well as our *D. subturbinatus*,* originally described as an *Actinocrinus*.

It might at a first glance be supposed also to include *Actinocrinus corniculatus* and *A. brevis* of Hall, but these forms (which Mr. Wachsmuth's collections clearly show to be only varieties of one species) have but a *single arm* from each arm-opening (two to each ray), and these arms with the proportional stoutness, general structure, and broad pieces at their bases, of *Agaricocrinus*. Hence this species can only be regarded as a somewhat aberrant form of the latter genus.

To the genus *Dorycrinus* we also refer the following new species:

* *Dorycrinus*, however, differs from *Actinocrinus* in having the second radial pieces nearly always short and quadrangular, instead of hexagonal.

† Specimens of all the species marked with an asterisk have been found with the arms attached, and presenting the characters mentioned above. The arms of the others remain unknown.

‡ The proposed species *A. tricornis* and *A. pendens*, Hall, are believed to be only varieties of *unicornis* of O. and S.

DORYCRINUS ROEMERI, M. and W.

Body somewhat urn-shaped, being obconical below the arms to the truncated base, and moderately prominent above, the vault forming rather more than one-third of the entire height; greatest breadth at the arm-bases. Base truncated and somewhat concave below, about twice as wide as high, slightly expanded and a little angular below, with broad, rather shallow notches at the sutures. First radial pieces about twice and a half as wide as high, two heptagonal and three hexagonal, each one swelling out so as to form a moderately prominent, rather obtuse, transversely elongated node. Second radials one-third to nearly one-half as long as the first, quadrangular, a little wider than long, and more or less tumid. Third radials rather larger than the second, wider than long, pentagonal, hexagonal and heptagonal; each one supporting on each of its superior sloping sides a pentagonal secondary radial, of rather smaller size, each of which in the posterior rays supports, in its turn, on each side above, one, or sometimes two, brachial pieces, making four arm-openings to each of these rays. This seems to be the case also in the right lateral ray, while one of the secondary radials, in the specimen studied, appears to be merely truncated, so as to support (perhaps abnormally) only one brachial piece, thus making only three arm-openings to this ray. The brachial and secondary radial pieces of the anterior ray are broken away in the specimen, but it is probable there were four arm-openings in this ray. If so, there would be nineteen arm-openings (probably normally twenty) in the entire series, and thirty-eight to forty arms, counting two to each opening.

First anal piece of the same size and form as the first radials, and, like them, swelling out into a transversely elongated node. Above this there are two heptagonal, and one apparently hexagonal, rather tumid pieces in the second range, and above the latter several other pieces extending up between the arm-bases, so as to connect with a series of pieces forming a thickened protuberance rising even slightly higher than the summit of the vault, and pierced by the anal opening, which is situated considerably above the horizon of the arm-bases, but still directed laterally. Interradial pieces three to each area, the first being about half as large as the subradials, heptagonal or octagonal, and supporting two somewhat elongated irregularly formed pieces that are scarcely convex, and connect, by their narrow upper ends, with vault pieces above. Vault somewhat rounded, with lateral spines very short, or merely having the form of rather prominent conical nodes; central piece somewhat tumid, but not even conical. Arms and column unknown.

Named in honor of Dr. F. Roemer, the founder of the genus *Dorycrinus*.

Height of body to top of vault, 1.40 inches; do. to top of anal protuberance, 1.45 inch; breadth at arm-bases, 1.30 inch; breadth of base, 6.55 inch.

This species is perhaps more nearly allied to *D. Missouriensis*, Shumard (sp) than to any other yet known. It will be readily distinguished, however, by several well-marked characters. In the first place, its base is not thickened and expanded as in that species. Again, its vault is not so flattened on top, nor the spines, or tumid pieces over the rays, near so large. In the *Missouriensis* the latter character is so strongly marked as to place the widest part of the body above the arm-bases, which consequently have the appearance of being attached half-way down the sides of the body, while in the species under consideration the body is distinctly wider at the arm-base than above. Our species also has seven or eight arms more than Dr. Shumard's.

Those who prefer to view the *Dorycrinus* group as only a section of *Actinocrinus* will, we hope, at least write the name of this species *Actinocrinus (Dorycrinus) Roemeri*.

Locality and position.—Upper part of the Burlington beds, of the Lower Carboniferous series, at Burlington, Iowa. No. 127 of Mr. Wachsmuth's collection.

DORYCRINUS QUINQUELOBUS, var. INTERMEDIUS.

On comparing this form with the typical specimen of *D. quinquelobus* (= *Actinocrinus quinquelobus*, Hall, Supp. Iowa Geol. Report, vol. i, p. 15), we find that

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it agrees very closely in the structure of its body, as well as in the number of arm-openings to each ray (that is, four to the anterior and each posterior ray, and two in each of the lateral rays), but at the same time it presents some other differences, that we suspect may be even of specific importance. In the first place it is larger and more robust, and has a proportionally smaller base, and rather distinctly tumid, instead of even body plates, while its interradial and anal spaces are not near so deeply excavated between the arm-bases as in the type of *quinquelobus*. Its third radial pieces also differ in form, being so narrow in all the rays as to let the secondary radials come in contact with the first interradial and the second range of anal pieces, instead of extending around so far laterally as to separate these pieces. Its vault is likewise more flattened on top.

In the typical specimen of *D. quinquelobus* the spines of the vault have all been accidentally removed, but in the form under consideration they seem to have been short and stout, though their entire length is not known, as they were apparently broken off during the life of the animal, since they each have the broken end somewhat rounded and indented in the middle. In size and general appearance it is more like *D. Mississippiensis* of Roemer, but it differs in having rather more tumid body plates, as well as in the number of the arm-openings, that species having four of these openings to each ray all around. It also has a more protuberant anal opening, and probably had much shorter vault spines. It therefore seems to be somewhat intermediate between the *D. Mississippiensis* and *D. quinquelobus*, but is probably distinct specifically from them both. As we have but a single specimen, however, of it, and the typical specimen of *D. quinquelobus* for comparison, we prefer to place it, for the present, as a variety of that species, under the name *intermedius*, and if it should hereafter be found that the differences we have pointed out are constant, it can take the name by which we have proposed to distinguish it as a variety, as a specific name.

Locality and position.—Upper part of the Burlington division of the Lower Carboniferous series, at Burlington, Iowa. No. 164 of Mr. Wachsmuth's collection.

Genus AMPHORACRINUS, Austin.

As already stated, this group agrees with *Actinocrinus* in the number and arrangement of the pieces composing the under side of the body, as well as in having the parts adjacent to the arm-bases forming five projecting lobes, distinctly separated from each other by the anal and interradial sinuses. It differs from them both, however, in the structure of the parts above, as well as in having the body generally more depressed, or even flat below, and the vault proportionally more ventricose; while its second radial pieces are more generally hexagonal than in *Dorycrinus*. From the latter it also differs in having the opening of the vault more or less proboscidiform,* and placed nearly half way between the middle and the anal side, instead of being a simple generally lateral aperture, penetrating laterally a merely thickened protuberance. The proboscidiform extension of its vault, however, is never so long and slender as we usually see in *Actinocrinus*, and also often differs in being crowned with small spines surrounding the very small terminal aperture, which seems always to open upward. As in *Dorycrinus*, the vault is generally more or less spiniferous, though the spines are differently arranged, and, as far as yet known, never so extravagantly developed as we sometimes see them in that

* In all the foreign specimens of the typical species of *Amphoracrinus* that we have seen, only the broken base of this short proboscis remains; and this also seems to have been the case with nearly all those from which the published figures which we have had an opportunity to examine, were drawn. Cumberland, however, has given a figure in his *Reliquie Conservate*, (pl. C.), apparently of the typical species *amphora*, with the short oblique proboscis well preserved. This will be seen to differ materially from the merely slightly protuberant thickening in which the opening in *Dorycrinus* is situated.

group. Some of the species are known to have one of the vault pieces over each ray more or less protuberant, and it may be the case that species existed in which those were developed into spines, somewhat as in *Doryerinus*, though we are not aware that any such have yet been found. Near the middle of the vault there is also a large tumid piece, sometimes developed into a short spine, while around the anterior side of this, four or five similar pieces are semi-circularly arranged, which also often become well developed spines.

We have never seen any figures or specimens of the European typical species of *Amphoraerinus* showing the arms, but there are in Mr. Wachsmuth's collection several beautiful specimens, found at Burlington, agreeing exactly in all other characters (not merely specific) with the types of the genus, in which the arms are perfectly preserved. In these we observe marked differences, both from *Doryerinus* and *Actinoerinus*. For instance, in *Amphoraerinus divergens* (= *Actinoerinus divergens*, Hall), the arms, although bifurcating so often as to form altogether about fifty-three or more divisions, they are each, as well as each of these divisions, composed of a double series of very short alternating pieces all the way down, even below all the bifurcations to their very bases, with the exception of one to two or three simple brachial pieces, at the origin of each main arm on the last primary or secondary radials.

The structure of the arms, it will be seen, is the same as in *Saccoerinus* (an otherwise different type), but widely different from what we see in *Actinoerinus*, in which the arms are always composed of a single series of pieces below such bifurcations as take place. It is also even more decidedly different from that of *Doryerinus*, in which the arms not only never bifurcate in any of the species in which they are known, but are also arranged so that two of them spring directly from each arm-opening without imparting to the brachial piece on which they rest the usual form of an axillary piece.

In one species, however, (*Actinoerinus spinobrachiatus*, Hall), having apparently all the other characters of *Amphoraerinus*, the arms do not bifurcate after their origin on the axillary secondary radial pieces. It seems, therefore, probable that there are some species of this group with simple arms, and others that have them more or less frequently bifurcating. The probability is, however, that in all cases when they do bifurcate, that they are equally composed of a double series of small alternating pieces below the bifurcations as well as above, the same as in the species *divergens*. Whether we include such species as the *spinobrachiatus*, however, with merely simple arms, composed like the others of a double series of alternating pieces throughout their entire length, as a separate section of *Amphoraerinus*, or view them as forming a distinct group, they need not for a moment be confounded with *Doryerinus*, from which they not only differ in form, surface markings, opening of the vault, &c., but also in never having two arms springing directly from each arm-opening.

In all the species of *Amphoraerinus* known to us, either foreign or American, it is also worthy of note that the surface of the body plates is never ornamented with proper radiating costæ, such as we often see in *Actinoerinus* and other allied types, nor yet smooth, or properly tuberculiform, as in *Doryerinus*, but always presents a peculiar vermicular style of sculpturing or corrugation difficult to describe, but very characteristic and easily recognized again after being once observed.

To this group Mr. Wachsmuth has, in MS., correctly referred the following American species, viz: *Amphoraerinus divergens*, *A. planobasalis*, *A. spinobrachiatus*? and *A. intatus*, described by Prof. Hall, under *Actinoerinus*; also *Actinoerinus quadrispinus*, White; all from the lower division of the Burlington beds.

AMPHORAERINUS DIVERGENS, Hall, (sp.)

Actinoerinus divergens, Hall, Supp. Iowa Report, p. 36, 1860.

This species was apparently described by Prof. Hall from imperfect specimens, showing only a few of the lower bifurcations of the arms, since he

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thought it probably had only twenty-two arms, while perfect specimens in Mr. Wachsmuth's collection show that they continued bifurcating farther up, so as to make the whole number about fifty-three or more, as already stated in another place.

Amongst Mr. Wachsmuth's specimens there is one (No. 136) with arms, body, vault and proboscis all in a remarkably fine state of preservation, which appears to agree very closely with the *A. divergens* in most of its characters, and yet differs in several respects. It has very nearly the same number of ultimate divisions in the entire series of arms, though there are differences in the details of their mode of divisions, so that the number of arms in any one of the rays is different from what we see in the corresponding ray of *A. divergens*. In each of its posterior rays there are, as near as can be made out, thirteen to fifteen arms; in one of the lateral rays and the anterior one, each eight, and the other lateral one eleven or twelve. Its ventral tube (proboscis) is rather stout, about one inch in length, and crowned by some six or seven small unequal spines, subspirally arranged. At the anterior side of the base of the proboscis, and nearly at the centre of the vault, there is a large tumid piece, and on each side of this a spine about three-fourths of an inch in length, directed obliquely outward, upward and forward, and in front of these two other prominent or subspiniiform pieces. In the typical *A. divergens*, these two anterior lateral larger spines each *bifurcate*, while in the specimen under consideration they are *simple*. The usual vermicular markings of the body plates in the specimen are well defined, and on the upper anal and vault pieces, as well as on those composing the proboscis, and even on the spines, the whole surface of which is occupied by rather coarse granules. As in the other species of this group, the arms of which are known, they extend at their bases, first horizontally outward, or even a little downward, and then curve upward.

It is probable that this specimen, with simple instead of bifurcating vault spines, and somewhat differently divided arms, may be specifically distinct from the *A. divergens*. If so, we would propose to call it *Amphocrinus multiramosus*.

Genus BATOCRINUS, Casseday.

From deference to the most generally prevalent opinions of palæontologists, we have elsewhere included *Batocrinus* as a subgenus under *Actinocrinus*, though we did so with a protest, stating that we were strongly inclined to view it as a distinct genus. Our recent study of Mr. Wachsmuth's extensive collections has still more decidedly impressed us with necessity for separating these groups generically.

As we have in other places stated the genus *Batocrinus* presents no essential difference from *Actinocrinus* in the number and arrangement of the pieces composing the walls of the body below the arms, nor in the vault and its elongated central or subcentral tube, though its second radial pieces generally differ in being proportionally shorter and quadrangular, instead of hexagonal or pentagonal. One of the most obvious differences, however, consists in the arrangement of the brachial pieces and adjacent parts, which in *Batocrinus* form a nearly or quite continuous series all around, instead of being grouped into five protuberant lobes, separated by more or less wide and deep interradial and anal sinuses. Again, in *Batocrinus* the arms never bifurcate as we often see in *Actinocrinus*, all the divisions of the rays taking place in the walls of the body below the brachial pieces; while the arms, (which in all cases yet known, with one exception, spring singly from each arm-opening), are generally much shorter in proportion to the length of the proboscis, which often projects from one-third to one-half its entire length, beyond the extreme ends of the arms. Another difference is to be observed in the surface of the body plates, these pieces never being sculptured or ornamented with radiating costæ, as is often seen in *Actinocrinus*, but merely even, more or less tumid, or tuberculiform. The vault pieces in *Batocrinus* are also generally tuberculiform, or
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sometimes produced into short spine-like projections, but even where they assume the character of spines they never have the regularity of arrangement, nor do they ever attain the length we often see in *Dorycrinus* and *Amphocrinus*. The species of *Batocrinus* also present a much greater diversity of form than we see in *Actinocrinus*, since we find amongst them every variety of shape, from globose to turbinate, biturbinate, pyriform, discoid, and even in some rare aberrant types apparently belonging here, a conical or stelliform outline.

The species of this genus may be variously grouped to facilitate their study into sections and subsections, based upon their differences of form, and other more or less marked peculiarities, but for the present we merely propose to give a general list of them, and to notice a few types that we have elsewhere included in this group, but which we are now rather inclined to think may yet be found to be entitled to more prominence than has generally been supposed. These are the forms for which the names *Alloprosallocrinus* (= *Coenocrinus* of Troost's list) and *Eretmocrinus*, Lyon and Casseday, were proposed.

The first of these we only know from specimens consisting of the body without the arms or other parts. Its most striking peculiarity, so far as yet known, consists in its remarkable conical form, the body being nearly or quite flat below the arm-bases, which are at first directed out horizontally and then curve up; while the vault, which forms the whole visceral cavity, is produced upward in a conical form, so as to pass rather gradually into the central or sub-central tube, or so-called proboscis. This mere peculiarity of form, however, might be of little importance in a group presenting such great differences in this respect, but we observe that the arm-bases in the specimens of this type we have seen, are usually stouter and composed of rather wide short pieces, more like those composing the arm-bases of *Agaricocrinus*. From this fact we suspect that this type may present some marked differences in the nature of its arms from the typical *Batocrinus*.

The other group (*Eretmocrinus*) is mainly distinguished by a remarkable flattening of the upper part of the arms, by which they are made to present a very curious paddle-shaped or spatulate outline. In some instances this character is so strongly marked, that the breadth of the arms is not less than six times as great above as below the middle. Below, the arms are, as in other types, usually rounded and slender, but farther up the flattening commences, first, by a slight angularity along each side, with often crenate margins, and increases upward above the middle until they sometimes present a very extraordinary alate appearance. The flattened part, however, is always as distinctly composed of a double series of alternately arranged pieces as that below, and these pieces are not only extended laterally to give breadth to the arms, but have also often as much as twice the diameter, in the direction of the length of the arms, of those further down. The ambulacral furrows, however, do not increase in size with the breadth of the arms, but even seem to be smaller above than below. We have not *seen* tentacula attached along the flattened upper part of the arms, but they probably existed there, as we have observed minute indentations at the inner ends of the flattened pieces, apparently for their attachment. The pieces composing the flattened part of the arms are thicker at their inner ends and thin off to their outer extremities, with slight outward curve, so as often to make the dorsal side of the arms not merely flat, but even slightly concave.

If these were free Crinoids, we might suppose this flattening of the arms a natural provision to adapt them for use as swimming organs, as *Comatula* is known to employ its arms for that purpose; but the species presenting this character have the column as well developed as we see in any of the other types, and were evidently attached to one spot during life. It is not improbable, however, that this peculiarity of the arms may have been a provision for the protection of the ova in the tentacula (pinnulæ), for, when these broad flattened arms were folded together, they must have covered these delicate parts within as if by a coat of mail.

The species presenting the character of arms described above, agree so closely in other respects with the typical forms of *Batocrinus*, that it is perhaps not always possible to distinguish them from specimens with the arms removed, though they seem generally to have a smaller number of arms, which are also generally longer in proportion, and a rather more excentric ventral tube, or proboscis, which appears also to be more liable to be bent to one side, and is often more or less swollen in the middle and narrow below.

These two groups (*Alloprosallocrinus* and *Eretmocrinus*) should, we think, be at least separated subgenerically from the typical forms of *Batocrinus*, and may even be found to belong properly to distinct genera. We should certainly be disposed to view the *Eretmocrinus* group as a distinct genus, if it were not for the fact that the peculiarity observed in the structure of its arms is subject to considerable variation in the degree of its development in the different species, being not very strongly marked in some species, while we also observe some slight tendency to a similar flattening of the upper part of the arms in other types of the *Actinoecrinidae*, such, for instance, as in some species of *Dorycerinus*, and other forms usually referred, in this country, to *Actinoecrinus*.

Below we add a list of the species of *Batocrinus*, which, it is worthy of note, are entirely confined to America, and, so far as yet known, nearly, if not entirely, to the lower Carboniferous rocks. We give first the names of the species of true *Batocrinus*, and under separate divisions those of *Eretmocrinus* and *Alloprosallocrinus*. We cannot, however, be positively sure, in all cases, in regard to the separation of the species of the subgenus *Eretmocrinus* from those of true *Batocrinus*, where specimens showing the arms are unknown. It will also be seen that, even as restricted by the separation, subgenerically, of *Eretmocrinus* and *Alloprosallocrinus*, the species referred to *Batocrinus* are susceptible of division into two sections, that may be entitled to greater prominence than is apparent from the specimens yet known.

1. BATOCRINUS, Casseday.

Section (a).—Species with arm-openings directed outward. Arms from 20 to 26. *Batocrinus icosidactylus* and *B. irregularis*, Casseday, and *B. formosus*, *B. discoideus*, *B. papillatus*, *B. æqualis*, *B. doris*, *B. lapidus*, *B. turbinatus*, *B. inornatus*, *B. longirostris*, *B. calyculus*, *B. biturbinatus*, *B. similis*, *B. lagunculus*, *B. mundulus*, *B. clavigerus* and *B. planodiscus*, Hall (sp.), all of which were described by Prof. Hall under the name *Actinoecrinus*. Also *B. Andreesianus* and *B. subæqualis*, described by Prof. McChesney under *Actinoecrinus*. Likewise our *B. pistillus*, *B. pistilliformis* and *B. quasillus*. Also *B. rotundatus* (= *Actinoecrinus*, O. and S.), as well as *B. Christyi*^{*} and *B. Konincki*,† described by Dr. Shumard under *Actinoecrinus*.

Section (b).—Species with arm-openings directed upward, and arm bases usually more in groups than in Section (a). Arms, so far as known, 20.

B. Nashvillei (= *Actinoecr.*, Troost); also *B. laura* and *B. sinuosus* (= *Actinoecrinus*, Hall), *B. æquibrachiatus* (= *Actinoecrinus*, McChesney), and our *B. asteriscus* and *B. trochiscus*.

2. Subgenus ERETMOCRINUS, Lyon and Casseday.

Species with arms flattened and alate above, and generally numbering from 12 to 20. Proboscis or ventral tube excentric, usually slender below, and sometimes swollen in the middle, and more or less bent to one side. Vault usually depressed. Brachial pieces more or less in groups, separated by interradial and anal sinuses.

Batocrinus (Eretmocrinus) magnificus, Lyon and Casseday, and *B. (Eretmocr.)*

* This is the only species of the whole *Batocrinus* group known to have two arms springing from each arm-opening, and this does not arise from a proper bifurcation, as the two arms rest directly upon the brachial pieces, without imparting to them the character of axillary pieces.

† This species has its arms slightly flattened, but not expanded above, showing a gradation towards *Eretmocrinus*.

calyculoides, *B. (Eretmocr.) remibrachiatus*,* *B. (Eretmocr.) clio*, *B. (Eretmocr.) matuta* and *B. (Eretmocr.) clodia*, Hall (sp.), all described under *Actinoecrinus* by Prof. Hall. Also *B. (Eretmocr.) Vernueilianus*,† Shumard (sp.), described under *Actinoecrinus*.

In all of the above species the arms have been seen, and are known to possess the characters of *Eretmocrinus*. The following species are believed to belong here from the general appearance of the body vault, proboscis, etc., though their arms have not yet been seen. They all certainly belong to *Batocrinus*, even if not to the group *Eretmocrinus*, viz.: *B. corbulus*, *B. carica*, *B. oblatus*, *B. sinuosus* and *B. gemmiformis*, all described by Prof. Hall under *Actinoecrinus*. Also *B. urnæformis* and *B. Hageri*, described by Prof. McChesney under *Actinoecrinus*. Also our *B. dodecadactylus*.

3. Subgenus ALLOPROSALLOCRINUS, Casseday and Lyon (= *Conocrinus* of Troost's lists).

Body distinctly conical, being flat below the arm-bases (which are directed outward on a plane with the flattened under side), and produced upward to the central proboscis so as to bring the whole visceral cavity above the arm-bases. Branchial pieces stout.

B. (Allopros.) conicus, *B. (Allopros.) depressus*, Lyon and Casseday, described under *Alloprosalloecrinus*. Also our *B. (Allopros.) euconus*.

New Species.

BATOCRINUS QUASILLUS, M. and W.

Body rather depressed, wider than high, nearly as prominent above as below the arm-bases; sides spreading very rapidly from the top of the first radials to the brachial pieces, which are in close contact all around, so as entirely to isolate the anal and interradial pieces from the vault. Base comparatively rather broad, being nearly three times as wide as high, truncated and rather deeply excavated below, so as to overhang the end of the column; somewhat spreading below, with broad shallow notches at the sutures. First radials nearly twice as wide as high, two heptagonal and three hexagonal, and, like all of the other body plates (excepting the second radials), moderately tumid. Second radials generally very short, and sometimes, in part, merely transversely linear, or even entirely obsolete, all quadrangular, and flat on the outer side. Third radials small, generally pentagonal, and in all but the two posterior rays supporting on each of its superior sloping sides one, or sometimes two, secondary radials, the last of which (where there are more than one) is an axillary piece, and bears, in direct succession on each of its superior sloping sides, two brachial pieces, thus making four arms to each of these rays. In each of the posterior rays, however, there are two other bifurcations, that make six arm-openings to each of these rays, or twenty-four to the entire series. First anal plate of much the same size and form as the first radials, and supporting, in an arching series above, three smaller pieces in the second range, while above the latter, one, or perhaps sometimes two smaller pieces connect with the brachials above. First interradials about two-thirds as large as the first radials, and each supporting a smaller piece extending up to the brachials above. Vault composed of tumid, or sometimes rather obtusely pointed pieces, and provided with a subcentral proboscis, which is usually about as broad below as the base.

Height of the largest specimen to top of vault, about 0.70 inch; greatest breadth (which is at the arm-bases), 0.80 inch; breadth of base, 0.35 inch.

This species seems to be related to our *B. pistillus*, but may be easily dis-

* Prof. Hall mentioned, in describing this species, that it has the characters of *Eretmocrinus*.

† This species has the arms less distinctly alate than the others, the transition from *Batocrinus* to *Eretmocrinus* being through this and the species *Konincki*.

tinguished by its much more depressed form, particularly below the arm-openings, caused by its much shorter basals, and first and second radial pieces. Its base also differs in being much more excavated, and not near so expanded below, while its brachial pieces are proportionally stouter, and more crowded. Although the whole number of arm-openings is the same in these two forms, this arrangement is different, the formula of *B. pistillus* being $\frac{5-4}{5-5} = 24$, and that of the form under consideration $\frac{4}{5-4} = 24$.

Locality and position.—Lower division of Burlington beds of Lower Carboniferous at Burlington, Iowa. No. 14 of Mr. Wachsmuth's collection.

BATOCRINUS CASSEDAYANUS, M. and W.

Body rather broad subtrubinate below, or with the vault subglobose, being a little larger below than above the arm-bases. Base short, or about four times as wide as high, a little thickened, and slightly overhanging the end of the column, and more or less notched at the sutures, so as to present a somewhat trilobate appearance. First radial pieces of moderate size, and, like all of the other body plates, rather distinctly tumid, wider than long, two hexagonal and three heptagonal. Second radials about half as large as the first, nearly twice as wide as high, normally quadrangular, but some of them occasionally with one or both of the superior lateral angles a little truncated, so as to present an irregular pentagonal or hexagonal outline. Third radials sometimes a little smaller, and in other rays a little larger, than the second; all pentagonal, and (excepting in the anterior and one of the anterior lateral rays of the typical specimen) each supporting on each of its superior sloping sides, in direct succession, two secondary radials, generally of near its own size, the upper ones of which are also axillary pieces, and bear on each of their superior sloping sides two brachial pieces in direct succession (the last of which is generally larger than the first), thus making four arms to each of these rays. In the anterior ray, however, the third radial merely bears on each side above, three brachial pieces in direct succession, and the same is also the case on one side of one of the anterior lateral rays, thus only giving origin to two arm-openings in the first, and three in the latter, making seventeen arm-openings to the entire series. First anal of the same size and form as the first radials, excepting that it is proportionally a little longer; above this there are three smaller pieces in the second range, three in the third, and two or three in the fourth. First interradials of the same size as the second anals, hexagonal or heptagonal in form, and supporting two smaller pieces in the third range, with two to three or four still smaller pieces above, the upper one of which, like that of the anal series, separates the brachial pieces a little, so as to form a small sinus between the arm bases belonging to each ray.

Vault slightly ventricose, composed of very irregular, unequal, merely tumid pieces, and provided with a rather stout, nearly central proboscis, which is inclined a little forward in the typical specimen.

The specific name is given in honor of Mr. S. A. Casseday, deceased, the author of the genus *Batocrinus*.

Height of body to arm-bases, 0.70 inch; do. to base of proboscis, 1.07 inch; greatest breadth (at arm-bases), 1.20 inch.

This species is perhaps most nearly allied to *B. longirostris*, Hall (sp.), and if we suppose the presence of only three arm-openings in one of its anterior lateral rays to be abnormal, which is almost certainly the case, it would present no difference in its arm-formula, nor any marked difference in the details of its structure, excepting in the proportional sizes of certain plates. This latter character, however, imparts a material difference to the whole form of the body,—a difference, indeed, that is so striking as to be apparent at a glance. For instance, in *B. longirostris* the first and second primary radials and first anal, as well as the first interradial pieces, are all proportionally so much

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larger (particularly longer) as to make the body below the arms always distinctly longer and proportionally narrower. Another marked difference consists in the convexity of the body plates, those of *longirostris* being only slightly and evenly convex, while in the form under consideration they are decidedly tumid, and sometimes even angular. The arm-bases of the *longirostris* are also more distinctly separated by sinuses, and less robust. In short, the characters mentioned in the species *longirostris* impart to it a peculiar and very characteristic neatness and symmetry of appearance not seen in the form here described.

In form and general appearance our species resembles specimens sometimes supposed to be a broader and more robust variety of *B. subaequalis*, McChesney (sp.), but in that there are four arms to each ray, and the brachial pieces are in close contact all around, while its body plates are not merely tumid, but decidedly tuberculiform and projecting.

Locality and position.—Lower Burlington beds of the Lower Carboniferous, at Burlington, Iowa. No. 13 of Mr. Wachsmuth's collection.

BATOCRINUS TROCHISCUS, M. and W.

Body broad discoidal or wheel-shaped, being very narrow at the base and widening gradually to the top of the first radials, thence spreading very rapidly to the brachial pieces, which are large and nearly in contact all around, or but slightly separated by small sinuses over the anal, interradial and axillary spaces. Vault flat, or a little concave from the periphery about half-way in toward the middle, thence rising moderately to the subcentral proboscis; composed of unequal pieces, the larger of which are rather tumid and arranged in radiating rows coincident with the rays and their division below, while the smaller pieces between are depressed so as to form concavities between the larger.

Base narrow, truncated, but not spreading or provided with a distinct rim below, wider than high, and widening very gradually upward. First radial pieces about of the size of the basal, but proportionally longer, though they are generally wider than long, two of them heptagonal and three hexagonal. Second radial pieces comparatively very small, and all wider than long, or transversely oblong, being, as usual in this group, regularly quadrangular. Third radial pieces about twice as large as the second, wider than long, and all pentagonal, excepting those of the two posterior rays, one of which is hexagonal and one heptagonal, in the specimen from which the description is drawn up; each supporting on each of its superior sloping sides, in direct succession, two secondary radials nearly or quite as large as the third primary radials themselves, while each of the upper of these secondary radials is an axillary piece, supporting on each of its sloping sides, in direct succession, two large brachial pieces, thus making four arm-openings to each ray all around, or twenty in the entire series. First anal piece about of the size of the smaller first radials, longer than wide, and heptagonal in form; above this there are in the second range three smaller hexagonal pieces, and, arching over the latter, four in the fourth range, with a small wedge-formed piece succeeding the latter above, though it is scarcely large enough to separate the brachial pieces over the anal area. First interradial pieces nearly as large as the first radials, and all irregularly nine-sided; above this there are two smaller pieces in the second range, two, or sometimes only one, in the third, and above this one or two succeeding each other in a direct line, the last one being usually narrow, and partly or entirely wedged in between the brachial pieces so as, in some cases, to separate them a little. Between the first divisions of each ray on the third radials there are usually one or two interaxillary pieces, the first resting upon two short sloping upper sides of the first secondary radials, and supporting the second, which sometimes separates the brachial pieces a little, while in other instances it is so narrow and short as to allow them to come in contact over it. (Arms and column unknown.)

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The surface seems to be nearly smooth, or finely granular, and the body plates are nearly even, excepting the secondary radials, which, with the brachial pieces, are sometimes a little tumid, so as to project slightly beyond the plane of the interrarial and interaxillary areas, which consequently have a somewhat sunken appearance.

Height of body to arm-openings, 1 inch; breadth, 2·10 inches.

This fine species seems to be most nearly related to *B. planodiscus*, Hall (sp.), from the Keokuk beds, with which it agrees nearly in form and general appearance. It differs very materially in structure, however, since the rays in that species bifurcate so as to make eight arm-openings to each ray, or forty to the whole series, being just double the number seen in our species. The *planodiscus* also appears to have the arm-openings directed outward, while the species under consideration belongs apparently to the section of this genus with these openings directed upward.

It is an interesting fact, to which our attention has been called by Mr. Wachsmuth, that not only this species, but several others only found in the very highest part of the Upper Burlington formation, are more nearly allied to species found in the Keokuk beds than to any forms in the Lower Burlington beds.

Locality and position.—Upper bed Burlington division of the Lower Carboniferous at Burlington, Iowa. No. 27 of Mr. Wachsmuth's collection.

BATOCRINUS (ERETMOCRINUS?) NEGLECTUS.

Body small, inversely campanulate below the arms, and rather ventricose above; the sides expanding gradually from the base to the third radials, and thence curving out rapidly to the outer edges of the brachial pieces, which are slightly grouped, but nearly or quite in contact all around. Base about three times as wide as high, truncated and concave below, but not thickened or expanded. First radials comparatively large, generally wider than long, and, as usual, two heptagonal and three hexagonal; all like the other body plates convex, but not properly tumid. Second radials much smaller than the first, quadrangular and nearly twice as wide as long. Third radials as long as the second, or slightly larger, wider than long, and all normally pentagonal; each supporting on each of its superior sloping sides a secondary radial, which in its turn bears on each side above two brachial pieces in direct succession, thus making four arm-openings to each ray, or twenty to the entire series. In one specimen, however, agreeing exactly in other respects, the third radials in the anterior and one in the posterior rays is immediately succeeded by brachial pieces without any further bifurecations, so as to give origin to only two arms to each of these rays; but this is almost certainly an individual abnormal development.

First anal plate a little longer, but not otherwise differing from the first radials; above this there are three smaller pieces in the next range, and sometimes one or two still smaller ones in the third range. Interrarial pieces one to three in each space, the first being one-third to one-half as large as the first radials, seven to nine sided, and usually supporting one or two smaller pieces in the second range above.

Vault convex, and composed of very unequal, irregular, moderately convex plates, provided with a tube or proboscis of moderate thickness, and placed generally about half way between the middle and the anal side. (Column and arms unknown.)

Height to base of proboscis, about 0·58 inch; do. to arm-openings, 0·33 inch; breadth, 0·55 inch. The specimen presenting the irregularity mentioned in the arrangement of the arms, is proportionally wider than that from which the above measurements were taken.

This little species is apparently nearer *B. elio*, Hall, (sp.), than to any other yet described. Its base, however, is much less thickened and expanded than in that species, and its body plates more even and smoother; while its brachial

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pieces are less prominent, so as to give its body a less spreading appearance. Judging from the description, the *B. laura*, Hall, (sp.), would seem to be somewhat like our species, but that form must be more depressed and proportionally wider, and is also said to have the arm-openings directed upward, which would even place it in a different section of the genus.

We place this species provisionally in the *Eretmocrinus* group, from its general appearance, as we have not seen any specimens showing the arms.

Locality and position. Lower division, Burlington group, of Lower Carboniferous, at Burlington, Iowa. No. 14 of Mr. Wachsmuth's collection.

Genus PENTREMITES, Say.

PENTREMITES (*TROOSTOCRINUS*?) WOODMAN, M. and W.

Body attaining a large size, pyramidal-subovate, as seen in a side view, being broad below, and produced and gradually narrowing upward; strongly pentagonal as seen from above and below, in consequence of the projecting and actually carinated character of the radial pieces. Base strong, from two and a half to three times as wide as high, trilobate in general outline below, and very broadly and profoundly excavated along the three sutures, (the excavations being continued out beyond the base into the lower ends of three of the radial pieces); two of them pentagonal and tricarinate, and one quadrangular and bicarinate, the carinae projecting considerably below the deeply sunken facet for the attachment of the column, so that when placed erect on a level surface the body stands upon these carinae, like a tripod upon its legs. Radial pieces long and narrow, or about three times as long as wide, and gradually tapering upward; all extremely prominent along the middle and sloping strongly inwards laterally, very sharply carinate below the pseudo-ambulacral areas. Summit openings very small and closely approximated. Interradials very small, or only about one-tenth as long as the radials. Pseudo-ambulacral areas remarkably narrow or sublinear, and deeply sunken, extending down rather more than half the entire length of the body, or about two-thirds the length of the radial pieces; pore pieces minute, slightly oblique, and numbering about 100 to each side of each area, the two rows of each area being separated by a deep mesial furrow, along which the inner ends of the pore pieces are minutely crenate, lanceolate and supplementary pore-pieces unknown. Surface marked with microscopic lines, as fine, regular, and crowded, as if made by an engraver's ruling machine.

Height, 2.25 inches; breadth, 1.64 inches. Breadth of base, 1.14 inches; height of do., 0.50 inch; depth of excavations along the sutures of base, 0.20 inch; breadth of do. from 0.45 to 0.56 inch. Length of pseudo-ambulacral areas, 1.45 inch; breadth of do., 0.08 inch.

This extraordinary form differs so widely from all other known species, as to render a comparison of its specific characters with any of those hitherto described entirely unnecessary. It seems to be related to a group of species characterized by a triangular base, and very narrow pseudo-ambulacral areas, for which Dr. Shumard has proposed the name *Troostocrinus*. Still it presents some rather strongly marked differences from that group, the species of which have the body narrow, fusiform, and more or less elongate and tapering below, with the triangular base merely flattened on each of the three sides. In our type however, the body is broadest below, while the base is comparatively very short and wide, and has the three spaces corresponding to the flattened sides of the typical species of *Troostocrinus* so very profoundly and broadly excavated, as to impart a very remarkable appearance to the lower part of the fossil. Should it be thought desirable to designate this type by a distinct subgeneric name, it might be called *Tricalocrinus*, in allusion to the three deep excavations of the base.

The specific name of this form is given in honor of Mr. H. T. Woodman, of Dubuque, Iowa, to whom we are indebted for the use of the only specimen we have seen.

Locality and position.—Salem, Indiana. Lower Carboniferous, Keokuk Group?

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Genus AGELACRINITES, Vanuxem.

AGELACRINITES (LEPIDODISCUS) SQUAMOSUS, M. and W.

Depressed discoidal; outline circular, or somewhat oval. Rays slender, long, and strongly curved as they radiate from the middle toward the periphery, around which they are each extended for some little distance; all sinistral excepting the right posterior one, which curves to the left, with its outer half extending around within that of the next one on the left, near which it terminates at the so-called ovarian protubance; each composed of two zigzag rows of very small pieces, with some irregular ones apparently not belonging properly to either row. Disc composed of large, thin, irregular, strongly squamose or imbricating plates, the imbrication being inward from the periphery, that is, the inner edge of each plate laps upon the outer edge of the next within. Ovarian? pyramid situated near the left outer margin of the posterior interbrachial space, and closed by ten pieces, apparently imbricating laterally and forming a depressed cone, around the base of which there are numerous small, short, but comparatively wide imbricating disc plates. Surface minutely granular.

Greater diameter of an apparently distorted specimen, 1.70 inch.

The only specimen of this species we have seen is somewhat crushed and distorted, so that it is rather difficult to make out the exact details of the structure of the rays, though they are apparently not provided with *open* ambulacral furrows, the rows of minute plates on each side, apparently closing up and interlocking. There appear, however, to be pores arranged along them in a zigzag row between the pieces. The body plates around the margin are much wider than high, and strongly imbricating upward. No central opening is visible.

On comparing this species with *A. Kaskashiensis*, Hall (the only other known Carboniferous species), the type of which is now before us, we find that our species differs in the important character of having its disc plates all very distinctly imbricating, while those of Prof. Hall's species show no tendency to imbricate, the whole surface of each being clearly exposed, their straight edges being merely joined together like those of a true crinoid. From Prof. Hall's description, it might also be supposed that this species differs in the number of its rays, as he described it as having six rays. A careful examination, however, of the typical specimen has clearly satisfied us that this is certainly not the case, as it has only five, the usual number, as represented in the figure. It is the incurved extremity of the dextral right posterior ray, that has been mistaken for a sixth ray. The specimen is somewhat crushed and distorted, but by carefully cleaning it and removing some adhering portions of the matrix, this ray can be traced straight out to the periphery, where it curves abruptly around and extends inward to near the middle of the posterior interbrachial space, where it terminates at a point near which was doubtless situated the so-called ovarian pyramid; though the specimen is too much crushed there to show the latter.

It is worthy of note that our species, although agreeing with most of these that have been referred to *Agelacrinites*,* in the imbricating character of its disc plates, as well as in the direction of the curvature of its rays, still differs from *A. Hamiltonensis*, of Vanuxem, the type of the genus in both of these characters. Vanuxem gives no description, but judging from his figure, (Geol. Report Third Dist. N. Y., p. 306) one would naturally sup-

* By some oversight, Prof. Pietet figures, on pl. xcix, fig. 25, of his valuable *Trait de Paléont.*, a true *Agelacrinites*, and probably one of the Cincinnati species, under the name *Hemicystites parasitica*, Hall, a very different fossil from the Niagara group. He also alludes to Vanuxem's *Agelacrinites Hamiltonensis* in the text as a Silurian species, but it is a Hamilton group (Devonian) fossil. Dujardin and Hupé (*Hist. Nat. Echinod.* pl. 5, fig. 8) copy Pietet's figure under the name *Agelacrinites parasitica*, as an illustration of *Agelacrinites*, saying *Hemicystites* ought not to be separated from *Agelacrinites*. The real *Hemicystites parasitica*, however, although related to *Agelacrinites*, differs in several important characters.

pose the disc plates of his species to have the usual imbricating arrangement. Prof. Hall, however, has recently described it in detail, (Twentieth Report Regents Univ. N. Y. on State Cab. Nat. Hist. p. 299, 1868), and distinctly states that its interbrachial or disc plates are not imbricating, as in other species. He also mentions the fact that this typical species differs from others in having its anterior and right anterior and posterior lateral rays sinistral, and its left anterior and posterior-lateral rays curved to the left, as shown in Vanuxem's figure. It therefore certainly seems to us doubtful whether species differing in two such important characters as these are strictly congeneric. If they are not, then a new generic name should be applied to our species, and the others agreeing with it in these characters; in which case we would propose to designate this group of species under the name *Lepidodiscus* (*λεπίς*, a scale, and *δίσκος*, a quoit). At least we should think they ought to be separated subgenerically.

Locality and position. Crawfordsville, Indiana. Keokuk beds of Lower Carboniferous.

ECHINOIDEA.

Genus OLIGOPORUS, Meek and Worthen.

OLIGOPORUS NOBILIS, M. and W.

Large, globose, composed of very thick plates. Ambulacra nearly flat, or slightly convex, and without proper furrows, narrow lanceolate in outline, or only about two-thirds as wide as the interambulacral areas; pore pieces comparatively small, wider than high, those of the two outer rows rather more irregular in size, and some of them a little larger than any of those of the two inner rows; pores two to each piece, forming four double rows, those of the two outer ranges of pieces being placed near their inner ends, and those of the inner ranges near their outer ends. Interambulacral areas comparatively large, moderately convex, and composed of five rows of large plates, all of which extend to the disc above, while the middle one ends within about 0.65 inch of the oral opening below. Vent and apical disc much as in *Melonites multipora*. Surface of all the plates, both ambulacral and interambulacral, ornamented with coarse granules, separated by spaces generally a little wider than their own breadth, with sometimes a few smaller ones between. Of these granules, about 40 to 60 may be counted on each of the larger interambulacral plates.

Height and breadth, about 3.75 inch; breadth of ambulacral spaces, 0.60 inch; do. of interambulacral areas, 1.06 inch. Height of largest interambulacral plates, 0.26 inch; breadth of do., 0.40 inch; thickness of do., 0.25 inch.

The only specimen of this fine species yet known to us is mainly a silicious cast of the interior. The connection of the plates, however, are so distinctly defined by sharply raised lines formed by the silicious matter deposited in the sutures between all of the pieces before they were dissolved, that the entire structure can be made out as well as if the plates themselves had been preserved. A few of the plates, however, or rather casts of their external surface, remain so as to show the surface granules as well as the thickness of the plates themselves.

The apical disc seems to be very similar, as already stated, to that of *Melonites multipora*,—the arrangement and comparative sizes, as well as form of the ocular and genital plates, being much the same. In two of the latter, five pores may be counted in each, while one other also shows obscure indications of five pores and the other two had four each, as near as can be made out from the little projecting points representing them in the cast. No satisfactory indications of pores, however, are to be seen in the ocular pieces.

Although the ambulacral areas are not properly furrowed, as in *O. Danae* and *Melonites multipora*, they are slightly depressed below the most convex cen-

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tral region of the interambulacral areas. The depression, however, also includes the two marginal rows of each interambulacral series. There is likewise a faint narrow, almost linear, impression on the internal cast, extending from the apical disc about half way down the middle row of plates in each interambulacral field.

This form can be at once distinguished from *O. Danae*, the only other known species of this type, by its proportionally much larger and less numerous interambulacral plates, of which there are only *five* instead of *eight or nine* rows to each area. Its ambulacral areas are also proportionally narrower, and, as already stated, differ in not being furrowed along each side, with a ridge along the middle.

As we have elsewhere suggested, the group *Oligoporus* seems to be exactly intermediate in its characters between *Melonites*, Owen and Norwood, and *Palæchinus*, (Seouler) McCoy. That is, it differs from *Palæchinus* in having *four* rows of ambulacral pieces and four double rows of pores, instead of *two* of each, as well as in having the ambulacral areas more or less sunken below the interambulacral fields. In the last character it agrees more nearly with *Melonites*, from which, however, it differs widely in having only *four* rows of ambulacral pieces and *four* double rows of pores instead of *ten* of each to each area. In the nature of its apical disc the species under consideration shows that in this type it agrees well in its general characters with *Melonites*. We also know, from a crushed specimen of *Oligoporus Danae*, that the species of this group have the jaws very like those of *Melonites*. The question may therefore arise whether or not these differences in the *number* of pieces and pores of the ambulacra are of generic importance, and whether we ought not to regard them as only subgeneric and call our species *Melonites (Oligoporus) nobilis*. On the same grounds, however, we would have as good reason to regard both *Oligoporus* and *Melonites* as mere sections or subgenera of *Palæchinus*. We cannot, however, believe so important and constant a difference of less than generic value, no gradations being yet known in this character between *Oligoporus* and *Melonites* on the one hand, or between the former and *Palæchinus* on the other. It is true we yet only know one species of *Melonites*, but we now know two well marked species of *Oligoporus*, while there are eight or nine known distinct species of *Palæchinus*, all of which latter agree in having but two rows of ambulacral pieces to each area.

At the time we proposed the name *Oligoporus* we were not aware that Prof. Desor had designated a section (not a genus) of the family *Cidaridae* by the name *Oligopores*. In case this should be regarded as a serious objection to our name *Oligoporus* we suggested, in the second volume of the Illinois Geological Reports, the name *Melonopsis* for this group instead; and if it should be adopted, the species here described would have to be called *Melonopsis nobilis*. The name *Oligopores*, however, from its different termination, we should think sufficiently distinct.

Locality and position.—Calhoun County, Illinois, from the Burlington division of the Lower Carboniferous series.

Description of Seven New Species of AMERICAN BIRDS from various localities, with a note on *Zonotrichia melanotis*.

BY GEO. N. LAWRENCE.

1. DENDRÆCA CAPITALIS.

Male. Front and crown of a deep rich reddish brown; back and smaller wing coverts yellowish olive-green, becoming more yellow on the rump; central tail feathers and the outer webs of the others dark olive-brown, edged the color of the back, the inner webs of all except the central tail feathers are yellow; the quill feathers and the larger wing coverts are blackish brown, the primaries and secondaries with margins the color of the back, the terti-
1868.]