in the specimen illustrated by us are the oral and adjacent pieces accidentally pushed upward, and seen from the upper or inner side after the removal of the dorsal side or covering; and that the central opening is the oral aperture. At any rate we know of no other way to account for the very different appearances presented by these fossils, when examined in different conditions.

Since we have had some specimens of this type at hand which we have felt at liberty to grind and cut into, so as to reveal more clearly their structure, we find that the arm-pieces, which in the denuded specimen first examined by us presented the appearance of becoming isolated, deeply furrowed lanceolate pieces, at a little distance from the body, and of very little thickness or depth, really appear, when ground off, to extend nearly all the way down from the dorsal to the ventral sides of the arms, and to be connected and articulated together, like those nearer the body by little processes and sockets; the comparatively thin furrowed dorsal edges becoming thicker farther in.

Sometimes these arm-pieces appear as if consisting of two rows joined in pairs at their inner ends along the middle of the dorsal side, there being a rather large pore (or possibly only a deep pit) at the junction of the two pieces forming each pair. In other instances, as seen detached, these pairs of pieces are found to be firmly anchylosed so as to form single pieces, extending across the whole breadth of the arms, without, however, obliterating the appearance of a rather large mesial dorsal pore.

We have not yet had an opportunity to see the under side of the body or arms in any of the Crawfordsville specimens, but Mr. Wachsmuth has a specimen from the Burlington division of the Lower Carboniferous beds of Burlington, which would seem to belong to this genus, though specifically distinct.* This is the form Prof. Hall has described in some preliminary notices of fossils (issued at Albany, N. Y., in 1861), under the name *Protaster? Barrisi.* This fossil has, so far as we have been able to see, essentially the same structure, and shows along the under side of the arms a broad shallow depression in the arm-pieces, somewhat like an ambulacral furrow. None of the specimens of either species we have seen show any indications of any proper extended disc, the body being comparatively small. It also evidently differs in several points of structure from *Protaster.*

So far as its structure is yet known, it seems to be a true *Ophiurian.* We only know the species, *Onychaster flexilis.*

Remarks on the BLASTOIDEA, with Descriptions of New Species.

BY F. B. MEEK AND A. H. WORTHEN,
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In regard to the nature of the functions for the performance of which the openings in the summit of this group of fossils, as the specimens are usually found, were designed, authors do not entirely agree. The central opening has been most generally regarded as the mouth, and the others surrounding this (excepting one that is always larger than the others) as ovarian apertures; while the larger one is usually supposed to be the anal aperture, with, in some types, two of the supposed ovarian apertures opening into it, one on each side.†

*We have not yet, however, seen any of the little articulating knobs on the scales of this Burlington species. These impart the granular appearance to the surface of our typical species, in which each scale has one of these little knobs articulated in its middle. If the Burlington species did not have these, it may belong to another, but allied genus.

† In the genus *Pentremites*, as specimens are usually found, there are five of these openings of the summit, surrounding a central pentagonal aperture. Of these five surrounding openings, four are known to be divided within into two each, and the fifth one into three, the middle one of these three being generally supposed to be the anal opening,

Dr. F. Roemer, who in 1852 published a beautiful and valuable monograph of most of the species of this group then known, giving accurate illustrations of almost the entire anatomy of the genus *Pentremites*, including the arms or pinnulæ, and other parts not previously illustrated, regarded the summit openings in that genus as stated above. He noticed, however, that in *Nucleorinus* (= *Elæcrinus*, Roemer) the central opening is covered in by a series of small plates, and that in *Codaster*, the openings corresponding to the so-called ovarian apertures of *Pentremites* seem to be absent.* At that time Dr. R. was apparently not aware of the fact that Owen and Shumard had, in 1850, announced that all of the summit openings in *Pentremites Godoni* are, in perfect specimens, covered by minute plates,† as had been shown by himself to be the case with the central opening in *Nucleocrinus*, since he seems to have regarded this character as one of the distinctions between the latter genus and *Pentremites*.

Dr. Shumard has also since shown that this character not only occurs in other true *Pentremites*, such as *P. conoideus*, *P. sulcatus*,‡ etc., but that at least the central hiatus in several species of the genus *Granatocrinus* (= *Pentremites*, section *Elliptici*, of Roemer), such as *G. Sayi*, *G melo* and *G. Norwoodii*, is also known to be covered in the same way, in perfectly preserved specimens.

Dr. C. A. White, the present able State Geologist of Iowa, also announced, in a very interesting paper on the summit structure of the Blastoidea, published in 1863, that in well preserved specimens of *Pentremites stelliformis* the central and anal openings are both covered by small pieces ⁋ He likewise stated in the same paper that he had seen specimens of *Granatocrinus Norwoodii* with the central hiatus covered by small pieces, and that from this covering a double series of minute alternating pieces could be seen extending out the mesial furrow of each pseudo-ambulacral area for some distance.‖

We have also seen specimens of *Pentremites stelliformis*, *Granatocrinus melo*, *G. Norwoodii* and *G. Sayi* (most of them belonging to Mr. Wachsmuth's collection), showing the central opening covered by small pieces, and continuing out from

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and the other two, one on each side of this, like those of other lateral openings, are most generally viewed as ovarian apertures. In some species of *Granatocrinus*, however, the openings corresponding to the four in *Pentremites*, divided into two each within, actually appear at the surface as four pairs of distinct openings; while in other types, such as *Nucleorinus*, and some species apparently allied to *Codaster* (more properly *Codonaster*), the supposed ovarian apertures appear as five pairs of separate openings, all distinct from each other, as well as from the anal opening.

As was first illustrated by Dr. Roemer, these so-called ovarian pores are known to connect with a series of compressed tubes within the cavity of the body, extending down along the inner side of each pseudo-ambulacrum so as to connect with the numerous minute pores passing through the lateral margins of these areas. Of these tubes we have ascertained that, in *Granatocrinus melo*, *G. Norwoodii*, and a new species described in this paper (which are all of this genus in which we have seen them), there are two pairs to each pseudo-ambulacral area; while in *Pentremites Godoni*, *P. pyriformis* and *P. Rheinwardtii* there seem to be eight tubes to each field, and in the so-called *Pentremites stelliformis* twelve to each field. We are therefore inclined to think the number of these tubes may be found constant, or nearly so, in each genus, since the area occupied by the twelve tubes in *Pentremites stelliformis* is not so wide as that occupied by eight in some *Pentremites* proper.

* We have not had an opportunity, recently, to examine good specimens of any of the typical forms of *Codaster*, but it has frequently occurred to us that possibly the deep linear furrows seen on the upper surface of these fossils, running parallel to the pseudo-ambulacra, and which Prof. McCoy and others seem to have supposed to be punctured at the inner ends, may connect, by these punctures, with the tubes within, and thus represent the so-called ovarian openings in the other Blastoids. The fact that these openings certainly are represented in *Pentremites stelliformis* of Owen and Shumard, by linear slits, seems to favor this conclusion. But as there is only a *single one* of these slits on each side of each of the pseudo-ambulacra in the last-mentioned type, instead of four to six, and they exist in the anal, as well as the inter-ambulacral areas, it is evident that these and other differences are of sufficient importance to warrant the separation of this species from *Codaster*, to which it has sometimes been referred. And as it differs from *Pentremites*, in having the so-called ovarian pores represented by ten distinct slit-like openings, and in other characters, we would propose to establish for its reception a new genus, with the name *Codonites*.

† Jour. Acad. Nat. Sci. Philad. vol ii (quarto series), p. 65.
‡ Trans. St. Louis Acad. Sci. vol. i, p. 243, pl. 9, fig. 4, 1858.
⁋ Jour. Boston Soc. N. H. vol. vii, p. 482, 1863.
‖ Missouri Geol. Report, p. 186, 1855.

these, a double series of minute alternating pieces a short distance along the mesial furrows of each pseudo-ambulacral area, as Dr. White mentions seeing in *Granatocrinus Norwoodii.** These little pieces do not *fill* the linear furrows, however, but *cover them over*, so as to leave a small canal passing along under them, and under the little vault covering the central opening, in such a manner as to communicate through the latter with the visceral cavity within the body.

From all that is therefore now known, we think there is little room for doubting that at least the little central opening seen in these fossils, in the condition in which the specimens are usually found, is really, in perfect examples, always covered by small pieces in all the different genera. We also regard this little covering of minute pieces as corresponding to the ventral disc, or vault, of the typical Crinoids, this part being here reduced, as it were, to its minimum size by the closing in of the surrounding parts. Hence we incline to concur with Dr. White in the opinion that the pieces composing this disc, at least in *Nucleocrinus*, *Granatocrinus* and *Pentremites stelliformis*, if not indeed in all the Blastoids, were not constructed or arranged for being opened and closed at will, to admit food into the mouth, whatever may have been the nature of those covering the other openings.†

In 1862 M. M. Dujardin and Hupé, who were not aware that any of the openings in the summits of these fossils, excepting the central one in *Nucleocrinus*, were ever covered by small pieces, expressed the opinion, in their valuable work on the *Echinodermata*, that the so-called ovarian apertures in the Blastoids are not such, but that they and the internal tubes‡ with which they connect, along with the pseudo-ambulacral pores, constitute the respiratory apparatus of these animals, while the aperture usually regarded as the anal opening they consider the ovarian orifice. From the fact that they seem to believe that the typical palæozoic Crinoids were probably nourished by surface absorption, or through the agency of the column, rather than by food taken into a digestive apparatus through a mouth, we infer that they suppose the Blastoids had neither anal nor oral aperture.

In regard to the existence in the palæozoic Crinoids of a well developed digestive sack, however, analagous to that seen in the existing Crinoids, the discoveries made in this country certainly seem to leave little room for doubts, while it appears to us more in accordance with all that is now known in regard to the general anatomical structure, and the arrangement of the reproductive organs of the living types of the Crinoidea, to suppose that the opening usually regarded as the anus in the Blastoids was really such, or as Dr. White and Mr. Billings maintain, both mouth and vent, than that it was an ovarian aperture. The fact, too, that there certainly seems to have been no direct passage or communication whatever, so far as we have been able to see, between the interior of the internal tubes under the pseudo-ambulacra and the general visceral cavity, would also appear to be an objection to the conclusion that they and the external openings with which they connect were really respiratory organs.

* These minute pieces we believe extended all the way down the ambulacral furrows in some, if not all types of the *Blastoidea*, and we even suspect that another series covered the little transverse furrows extending across to the bases of the pinnulæ, and possibly up the ambulacral furrows of the latter, as we have seen in the pinnulæ of *Batocrinus Christyi*.

† In *Pentremites conoideus*, as figured by Dr. Shumard, the small pieces covering the central opening have, as suggested by him, in their regularity of form and arrangement, much the appearance of the pieces closing the so-called ovarian aperture of the *Cystoidea*; from which it might be inferred that in this genus these pieces might possibly have been movable, so that they could have opened and closed, as valves. We doubt, however, very much that they could have formed so striking an apparent exception to the corresponding parts of other types of the group. We think it probable that small openings exist under this little group of plates, at the upper terminations of the ambulacral furrows. This seems the more probable because Dr. S. describes these little pieces as being very differently arranged in *Pentremites sulcatus*.

‡ These are generally more properly folds of a thin calcareous plate, but in the so-called *Pentremites stelliformis*, and other types, each separate fold connects with the inner wall all the way down, excepting at the upper end, so as to form a distinct compressed tube.

Dr. White has made the ingenious suggestion (See Bost. Proceedings already cited, that these internal tubes and the openings and pores passing into them* may have been for the purpose of drawing in water and injecting it into the pinnulæ, in order to elevate and move them at will, without the agency of a complex muscular system, apparently so inconsistent with the structure of a being so low in the scale of animal life. It is true the unelastic, rigid nature of these little calcareous tubes would seem to be an objection to this view, but this objection would doubtless apply with equal force against the opinion that they were respiratory organs.† Possibly, however, this apparent difficulty may have been obviated by the presence of thin membranaceous sacks within these tubes, susceptible of contraction and expansion to the extent of their internal cavities.

Our own observations, both of the typical Crinoids and of the Blastoids, have, as already stated, led us to believe that the series of small pieces, probably always originally covering the small central opening seen in imperfect specimens of the latter group, represents the vault, or ventral disc, of the typical Crinoids. We likewise agree with Dr. White and others who reject the opinion that any of the other openings in these fossils were ovarian apertures.

In all the types of the Blastoidea yet known, these little mesial furrows of the pseudo-ambulacra are distinctly seen leading to the central opening, precisely as the ambulacral furrows on the disc of *Comatula* lead to the mouth; and in the few types we have yet seen with this little central opening covered by minute vault pieces these furrows could be distinctly traced, as already stated, *under* the covering, into the central opening. Now, from the exact analogy of these furrows to those we have seen passing inward from the arm bases, under the small vault pieces covering the central opening in *Cyathocrinus*, and as distinct apparently tubular canals, made up of minute interlocking pieces, converging upward from the arm openings in *Actinocrinus proboscidialis*, to connect with the upper extremity of the convoluted digestive sack, nearly *under the middle of the vault*, we think the furrows alluded to in the Blastoids may be properly called ambulacral furrows.

In the true *Pentremites*, with wide lancet pieces,‡ the numerous little transverse furrows seen passing outward from these mesial longitudinal furrows, and along the pore pieces to the bases of the slender pinnulæ, are merely lateral branches of the central ambulacral furrow. In a specimen now before us, supposed to be *Pentremites elegans*, of Lyon and Casseday, the little pinnulæ, some of which are more than twice as long as the body, are each composed of a double series of alternately arranged pieces and provided with a distinct longitudinal furrow along the inner side, exactly corresponding to the ambulacral furrows in the arms and pinnulæ of the typical Crinoids. It is therefore probable, as suggested by Dr. White, that these furrows, in at least a portion of the pinnulæ, were provided with receptacles for the ova as in the true Crinoids.

As widely different as the Blastoids appear to be from the typical Crinoids, it is easy to see that they really possess essentially the same elements of structure; though in several respects they seem to be more nearly allied to the types composing the section Cystoidea than to the typical Crinoids. In trying to trace out the relations of their several parts to those of the Crinoids proper, we have sometimes thought that the lancet pieces might be modified second radials, deeply inserted in the profound sinuses of the first radials. It seems nearly as probable, however, that they may belong to the vault series. In a conversation with Mr. Wachsmuth respecting the structure of these fossils, he

* We have not seen *positive* evidence that the pseudo-ambulacral pores pass into the internal tubes, but we can scarcely doubt that they do.

† Currents of water, however, might have passed into them, by means of the action of cilia.

‡ We use the term "lancet pieces," instead of "lanceolate pieces," often applied to these parts, because they are by no means always lanceolate in form, but often linear, hence it would be an awkward expression to describe "the lanceolate pieces" as being "linear in form."

suggested an idea that had sometimes occurred to us, that probably the pore pieces of the pseudo-ambulacral areas correspond to the recumbent arms in the Cystoidea.* This certainly seems very probable, as it may be seen that the ranges of these pieces merely lap, as it were, down the sides *upon* the lancet pieces, and really form no part of the body, properly speaking. If this view is correct, each of the ranges of pore pieces of each pseudo-ambulacral area must, in the true *Pentremites* with wide lancet pieces, represent half an arm, the two halves being, as it were, split apart by the wide lancet pieces coming to the surface between. In *Granatocrinus*, *Nucleocrinus*, and some other groups with merely linear lancet pieces, however, the two ranges of pore pieces meet along the mesial furrow of each pseudo-ambulacrum, and alternately interlock, just like the arm pieces in *Actinocrinus*, and other types in which the arms are composed of double rows of pieces. If these suggestions are correct, the little delicate free appendages often regarded as arms, would correspond to the pinnulæ, sometimes called tentacles in descriptions of fossil Crinoids proper, and Cystoids. The fact that these little appendages are themselves, at least in some types, composed each of a double series of minute pieces, would be no objection to this view, because this is exactly the structure of the pinnulæ in most of the Cystoidea with recumbent arms. The next question, then, would be in regard to supplementary pore pieces. These, if the so-called pore pieces† can be viewed as arm pieces, may be merely the first pieces of the pinnulæ modified to adapt them to the peculiar structure of the other parts.

Supplementary Note to the foregoing remarks.

A few days before receiving the proof-sheets of this paper from the printer, we were provided, through the politeness of Mr. Billings, with an advance copy of a very interesting and important paper of his on the Structure of the *Crinoidea, Cystoidea and Blastoidea*, to appear in the July number of the American Journal of Science and Arts. We cannot state here in detail the various points in which he agrees with or differs from us, but we will mention a few of the latter. In the first place, he does not concur in a suggestion made by us, in our paper read before the Academy in December, 1868, that certain facts seemed to indicate that in the palæozoic Crinoids the ambulacral canals might have been organized so that, in addition to their reproductive and other functions, they could have conveyed microscopic objects through the arm-openings, under the vault, to the digestive sack. He also thinks the convoluted internal organ and canals radiating from the summit of the same to the arm-openings, belong to the respiratory, and not to the digestive system.

With respect to the first suggestion, we would merely state that we are not disposed to insist upon it, as it was not stated by us as a demonstrated fact, but we rather intended to state facts that seemed to us to point to that conclusion. We were led to do so, in part, by the statements of Bronn, and Dujardin and Hupé, that the food of the recent Crinoids was probably conveyed along the ambulacral canals, by the action of cilia, to the mouth; and partly by the fact that in the palæozoic types, there seems to be no opening whatever in the vault, at the point to which the ambulacra converge, and where, from all analogy among recent Echinoderms, the mouth ought to be situated. We are aware, however, that there are some strong and perhaps insuperable objections to such a conclusion. And yet, there seems to be others of nearly or quite as much weight, against the conclusion that the single opening seen in the vault of these older Crinoids, always performed the double function of mouth and vent. Amongst these may be mentioned the fact that this opening

*Since this was written we learn that Mr. Billings had arrived at the same conclusion in regard to the corresponding pieces in *Codaster*.

† The term pore pieces could not, of course, be applied to any of the pieces of the pseudo-ambulacra in the same sense that we would call the ambulacral pieces of an Echinoid pore pieces, because the pores in the Blastoids do not pierce these little pieces as they do in the Echinoids, but merely pass in between them.

is never situated at the point of convergence of the ambulacral canals, where the mouth ought to be, but more or less removed from it, so that if it performed both the offices of mouth and vent, it would be, as it were, the anal opening that did so, instead of the mouth, as in all of those cases among the existing *Echinodermata* with but one opening to perform both functions. In addition to this, we have, as we believe, demonstrative evidence that species of *Platycrinus* and *Goniasteroidocrinus* could, and did live, in some way, with the only opening (excepting the arm-openings) covered by a *Platyceras* that grew there, and sometimes not only so as to cover the opening, but in the case of the *Goniasteroidocrinus*, so as to cover nearly the whole vault. That these shells did not merely grow upon dead Crinoids lying at the bottom of the sea, is evident from the fact that these Crinoids thus found in such numbers, with a *Platyceras* attached, at Crawfordsville, always have the arms and most delicate pinnulæ perfectly preserved; and in some other instances where the *Platyceras* is attached to the top of the vault, the arms of the Crinoid are found folded over the shell, as they would naturally fold together by the contraction of the muscles at death. Had these Crinoids remained uncoved by sediment at the bottom of the sea long enough after death for the *Platyceras* to grow upon them, their arms and pinnulæ would have fallen to pieces. If the only opening in the vault of these Crinoids was the vent only, we could readily understand how the excrementitious matter might have escaped under the foot of the *Platyceras*; but if it was both mouth and vent it is difficult to understand how, in such a case, food could have passed in.

Again, in many of the *Actinocrinidæ*, the only opening in the vault (except the arm-openings) is situated at the extremity of a long, slender, straight tube, rising from near the centre of the vault, though never from directly over the point of convergence of the ambulacral canals. And it is a remarkable fact, that of the hundreds of specimens we have seen with more or less of this tube preserved, we have never yet seen one that had its extremity unbroken. In several instances we have seen it from one to three inches in length, and so attenuated in the latter cases, that the internal cavity was not more than 0·05 inch in diameter, even in large specimens; and in others we have seen it scarcely more than *one hundredth* of an inch in diameter, and still the end of the tube in all cases broken. How small this canal must be at the end of an unbroken tube, we cannot say, but it must evidently be very small. If this little pore-like opening, situated at the extreme end of this long, straight, rigid tube, performed the functions of both mouth and vent, it would certainly seem to be a very unnatural and inconvenient structure.

In regard to the internal convoluted organ seen in so many of the *Actinocridæ* belonging to the respiratory instead of the digestive system, we would remark that its large size seems to us a strong objection to such a conclusion. In many instances it so nearly fills the whole internal cavity that there would appear to be entirely inadequate space left for an organ like a digestive sack, outside of it, while the volutions within would preclude the presence of an independent digestive sack there. In addition to this, the entire absence, so far as we can ascertain, of any analogous, internal respiratory organ in the whole range of the recent *Echinodermata*, including the existing Crinoids, would appear to be against the conclusion that this is such, unless we adopt the conclusion of Dujardin and Hupé, that the Palæozoic Crinoids had no internal digestive organs, and were nourished by absorption over the whole surface. We should certainly think it far more probable that this spiral organ is the digestive sack, than a part of a respiratory apparatus.

Genus GRANATOCRINUS, Troost.

Granatocrinus melonoides, M. and W.

Body rather under medium size, globose in form. Base very small, nearly even with the prominent lower extremities of the pseudo-ambulacral areas.

Radial pieces nearly equaling the entire length of the body, and divided almost to their base by the pseudo-ambulacral areas, each with a broad deep sulcus extending up on each side of the pseudo-ambulacral areas, the entire length; while between this sulcus and each lateral margin, the surface swells out into a broad rounded ridge, widest near the middle of the body and narrowing upward and downward, these ridges on each two contiguous pieces being separated by a deeply sulcated suture. Interradial and anal pieces very small, subtriangular or cuneate-quadrangular, only about one-sixth the length of the body, measuring over the curve of the sides. Pseudo ambulacral areas very narrow or sublinear, with sides parallel, equaling the entire length of the body, slightly impressed above, but quite as prominent as the immediate margins of the radial pieces on each side below, if not wider; pore pieces about fifty on each side of the mesial furrow; supplementary pore pieces unknown; lancet pieces apparently not exposed externally. Openings of the summit small, but not clearly seen in the specimen.

Body of the typical specimen 0·45 inch in height; breadth, 0·5 inch.

The surface of the typical specimen of this species is not well enough preserved to show fine markings, but another individual of apparently the same species shows the lower half of the radial pieces to be ornamented with rather fine granules, so arranged as to look like fine transverse striæ under a magnifier, while a few stronger longitudinal striæ are also seen on this part of the body. In this specimen, however, the surface of the radial pieces is less convex between their lateral margins and the broad sulcus on each side of the pseudo-ambulacra, than in the typical form.

In form and the narrowness of its pseudo-ambulacra this species reminds one of *G. Sayi*, of Shumard, but it is at once distinguished by the very much larger anal and interradial and shorter radial pieces of that species, as well as by the canaliculate character of the sutures between the latter, with a rounded ridge on each side of this suture. In the comparative size of its radial and interradial pieces, as well as in the canaliculated sutures between its radial pieces, it agrees more nearly with *G. melo*, of O. and S., but is not only distinguished from that species by its subglobose form (a little wider than long) and merely even instead of concave base, but by its much more prominent pseudo-ambulacral areas below the middle of the body, and deep broad rounded sulci immediately on each side of these, and swollen surface between these sulci and the canaliculated suture separating the radial pieces. It moreover comes from the upper division of the Burlington group, while the vastly more common *G. melo* is only found in the lower beds.

Locality and position.—Upper beds of Burlington group, Burlington Iowa. Lower Carboniferous. No. 398 of Mr. Wachsmuth's collection.

Granatocrinus pisum, M. and W.

Body small, oval—subglobose, being slightly longer than wide. Base very small, rather deeply concave, and distinctly pentagonal in outline. Radial pieces long, truncato-subelliptical in general outline, with the lower end narrow, forming a nearly flat surface across between the pseudo-ambulacral fields, excepting below the middle, where these surfaces are concave; all divided nearly to their very bases by the pseudo-ambulacra, and without even the faintest trace of a furrow along up the sutures between their lateral margins. Interradial and anal pieces strongly incurved above, cuneate-subtrigonal in form and longer than wide, the length being about one fourth that of the whole body, measuring over the curve of the sides. Pseudo-ambulacra narrow, or sublinear, with very nearly parallel sides, there being a slight taper from above downward; all quite as convex as the slightly raised linear margins of the radial pieces on each side; pore pieces about twenty-six on each side of the distinct mesial furrow, along which their inner ends are minutely crenate, comparatively rather large, and ranging obliquely outward and downward;

supplementary pore pieces unknown; lancet pieces apparently not visible externally, unless it is along the bottom of the mesial furrow.

Summit, when the minute pieces that doubtless closed the central region are removed, with a pentagonal opening of about the size of the anal aperture; so-called ovarian pores very small, and situated one on each side of each interradial piece, and two others doubtless as usual opening into the anal aperture, which is nearly circular and much larger than the pores.

Surface finely granular, the granules being smaller and more crowded on a lanceolate area, extending up the radial pieces between the pseudo-ambulacra, and terminating just before reaching the interradials, and on each side, and above this space.

Height of body, 0·30 inch; breadth, 0·28 inch.

This little species might be mistaken for a small specimen of *G. melo*, by a hasty observer. It may be readily distinguished, however, by its longer interradial pieces, less numerous and proportionally larger pore pieces, much more prominent pseudo-ambulacra, and particularly by not having even a trace of a linear furrow along up the sutures separating the radial pieces, and these pieces flat instead of convex across between the pseudo-ambulacra. The little projecting points at the bases of its pseudo-ambulacra are also directed more downward.

Locality and position. Upper part of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 397 of Mr. Wachsmuth's collection.

Granatocrinus neglectus, M. and W.

Body small, varying from oval to subglobose. Base slightly projecting, pentagonal in outline. Radial pieces scarcely equaling two-thirds the entire length, and deeply divided by the pseudo-ambulacral areas. Interradial pieces more than one-third the length of the body, cuneate-subtrigonal in form. Anal piece of about the same size as the interradials, but its upper extremity is erect and distinctly projecting, so as to form around the anal opening protuberant margins. Pseudo-ambulacral areas narrow, with nearly parallel sides, almost equaling the entire length of the body, nearly as prominent as the slightly raised margins of the radial pieces on each side; pore pieces twenty-five to thirty on each side of the mesial furrow; supplementary pore pieces unknown; lancet pieces apparently not visible externally.

Mesial opening of the summit very small; so-called ovarian apertures minute and situated one on each side of the interradial pieces; anal opening comparatively large, with very prominent margins.

Surface of the radial plates between the pseudo-ambulacral areas longitudidinally granulo-striate, while that of the interradial and anal pieces is marked in the same way transversely with a downward curvature.

Length of one of the oval specimens, 0·36 inch; breadth, about 0·28 inch; breadth of pseudo ambulacra 0 05 inch. Length of a smaller, proportionately shorter specimen, 0·28 inch; breadth, 0·25 inch.

This is another species having much the general appearanre of *G. melo*, from which, however, it is at once distinguished by its comparatively much larger interradial and anal pieces, flat spaces between the pseudo-ambulacra, without any furrow along the mesial suture, and its more protuberant base and anal pieces.

It is more nearly allied, however, to the last described species in several of these characters, though sufficiently distinct to be readily separated on comparison. For instance, its anal and interradial pieces are nearly twice as large as in that species. Again, its base is proportionally two or three times as large, and so protuberant as to be seen in a side view, instead of being concave; while its pseudo-ambulacral areas do not extend so far down, and the little projections of the radial pieces at the lower extremities of these areas point out horizontally, instead of being directed nearly downward, like five little

legs, upon which the body stands when placed an an even surface, as in the last.

We have seen five specimens, all of which agree in the characters given.

Locality and position.—Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 396 of Mr. Wachsmuth's collection.

GRANATOCRINUS GLABER, M. and W.

Body very small, pentagonal-subglobose, being somewhat wider than long and rather broadly truncated below, with the spaces between the rather prominent pseudo-ambulacral areas almost flat near the middle, and more or less concave below. Base about even with the most prominent part of the lower ends of the radial pieces, nearly flat, and very distinctly pentagonal, or almost pentapetalous in outline. Radial pieces forming about three-fourths the actual height of the body, abruptly incurved below to connect with the base, and all divided quite to the lower side of the body by the pseudo-ambulacral areas. Interradial pieces of moderate size, or about one-third as long as the body, measuring over the curve of the sides from their upper ends to the base; triangular in form and nearly as wide as long, all strongly incurved above; anal piece shorter than the interradials below the anal opening. Pseudo-ambulacral areas rather narrow, tapering slightly from above, and nearly as convex as the margins of the radials on each side. Pore pieces about twenty-five to thirty on each side of the mesial furrow of each area; supplementary pore pieces unknown; lancet pieces apparently not showing externally. Summit depressed in the middle; central and anal openings comparatively rather large; so-called ovarian pores of moderate size, situated one on each side of the inner end of each interradial piece, and of course two others as usual opening into the anal aperture.

Surface apparently quite smooth, even as seen under a magnifier, but probably when entirely unworn, marked by microscopic longitudinal striæ.

Height of one of the largest specimens, 0·21 inch; breadth, 0·23 inch; breadth pseudo-ambulacral areas, 0·04 inch; do. of spaces between the same, at the widest part, 0·13 inch.

This little species is so very clearly distinct from all others known to us, that it is unnecessary to compare it with any of those yet described. Its most characteristic features are its small size, smooth surface, flat space between the pseudo-ambulacral areas, and nearly even pentapetalous base.

We have before us nine specimens, of various sizes, all agreeing in the characters given excepting one, which, from abnormal development, has only four pseudo-ambulacral areas. As this agrees with the others, however, exactly, in all its specific characters, it is evidently a monstrosity of the same species, produced by the non-development of one of the radial pieces, by which means two of the pseudo-ambulacral fields are, as it were, welded together, to form one larger than any of the other three.

Locality and position.—Saint Louis division of the Lower Carboniferous series, in Hardin County, Illinois.

May 4th.

JOS. JEANES in the Chair.

Twenty-seven members present.

The following paper was presented for publication:

"A review of the species of Plethodontidæ and Desmognathidæ." By E. D. Cope.

Mr. J. H. Redfield stated that on the 22d of April, in company with Mr. C. F. Parker, he had visited Cedar Bridge, Ocean Co., N. J., in search of *Corema Conradii*. This plant occurs in Newfoundland, on islands near Bath, Maine,

1869.]