

ART. XXXI.—*Notes on some of the Fossils figured in the recently-issued Fifth volume of the Illinois State Geological Report; by F. B. MEEK.*

[Continued from page 193.]

Actinocrinites, Cyathocrinites, Codonites, etc.; Plate IX.—Most of the figures on this plate were drawn to illustrate the remarks on the structure and habits of the Paleozoic Crinoidea, commencing on page 323, and originally published by us, without figures, in the Proceedings of the Philadelphia Academy of Natural Sciences, some years back. As only a few references to these figures are given in that article as reprinted in

* See also the report of Prof. Ramsay, in the Report of the Coal Commissioners (England), vol. i, pp. 121 and 145.

the text, I have thought it desirable to indicate here more fully the particular figures on this plate, to which the student should refer while reading certain paragraphs of the remarks mentioned.

For instance, in connection with what is there said in regard to the structure of *Cyathocrinites* on pages 325 and 326, figures 13 and 14 of plate IX should be consulted. Figure 14 represents the upper side of *Cyathocrinites malvaceus*, as seen with the ventral tube and some other parts removed. In this condition, there would, on a hasty examination, seem to be two principal openings above, directly into the visceral cavity. That is, the posterior one (*an*), at the lower part of the figure, for the connection of the ventral tube, and a large central one (*h*); the former corresponding to the position of the anal opening, and the latter to that of the mouth, in *Comatula* and other existing Crinoidea. Previous to the discovery of these specimens, here for the first time illustrated, this was supposed to be the normal structure of *Cyathocrinites*, which has been described by the highest European authorities as having two openings through the vault. Our figure 13, however, of the same plate, representing the upper side of *C. lowensis*, a closely allied species, clearly shows that, when the vault is *uninjured*, the central opening, as well as the ambulacral canals (*amc* of fig. 14), are covered over by small pieces, so that, during the life of the animal, the only communications to the central opening (seen at *h* in fig. 14) were through these covered ambulacral canals (*amc* of fig. 13), and under the small central vault-pieces covering the central opening itself.*

The discovery of this structure of the vault of *Cyathocrinites* is one of considerable interest, since it brings to light one of the most marked distinctions between this genus and *Poteriocrinites* (including as subgenera *Scaphiocrinus*, *Zeacrinus*, *Homocrinus*, &c., &c.), in which no such vault-structure exists, the whole ventral portion in these latter types being, on the contrary, enormously produced, in the form of a great cylindrical or ventricose upward extension, or so-called proboscis, composed of numerous small hexagonal pieces, with pores passing in through the sutures between them; the extension being often as wide as, or sometimes even wider than, the body below, and nearly or quite as long as the arms, as may be seen in *Zeacrinus acanthophorus*, plate XXIV, fig. 11a; as well as in several species figured in former volumes of the Illinois Reports. Although much has been written by authors respecting the distinctions between *Cyathocrinites* and *Poteriocrinites*, and some have even questioned the propriety of viewing them as distinct

* The form and size of these central vault-pieces may not be *exactly* as represented in fig. 13, as the sutures there are very obscure in the specimen, and they are too strongly and decidedly defined in the engraving.

genera, this very strongly marked and striking difference between them seems to have been entirely overlooked as a distinguishing feature.*

This peculiarity of the vault in *Cyathocrinites* also (along with other differences) appears to distinguish this genus from those great ponderous species, often referred to *Cyathocrinites*, for which Mr. Wachsmuth has proposed the name *Barycrinus* (see fig. 2, pl. XII; figs. 1, 2 and 3, pl. XIII; and fig. 8, pl. XX), because we have the strongest possible negative evidence for believing that in the latter no solid calcareous vault-pieces of any kind ever existed. It likewise has an important bearing on the much mooted question, to be mentioned farther on, in regard to the position of the mouth, and the manner in which the food is conveyed to the same, in the Paleozoic crinoids.

While reading the remarks on pages 327 to 329, on the internal convoluted organ so often seen in the *Actinocrinitidæ*, the student should turn to figures 6, 7 and 12, of plate IX, as well as to fig. 3 of plate VII. Since these remarks were published, however, farther examinations of other specimens have led me to think it quite probable (contrary to the statement on page 328, in regard to its structure in *Batocrinus Verneuilianus*) that this organ was, in *all* cases, composed of a delicate net-work of calcareous bars, as shown much magnified in fig. 6*b* of plate IX; and that the apparently more dense structure illustrated by figs. 8*b*, 12*c* and 12*d*, of the same plate, was produced by the deposition of crystalline inorganic matter on the delicate bars of the net-work.

Figures 7*a*, *b* and *c* of plate IX were also drawn to illustrate the remarks commencing on page 329, on the existence of ambulacral canals composed of minute calcareous pieces, and converging inward from the arm-openings to the top of the large internal convoluted organ, in the *Actinocrinitidæ*. Fig. 10 of the same plate, it will also be seen, shows deep furrows in the under side of the vault of *Actinocrinites? ornatus*, for the reception of these internal ambulacral canals, as mentioned on page 332; and fig. 9 illustrates casts of these furrows as exhibited in a cast of the interior of the vault of apparently the same species. Upon examining these figures, it will be observed that the deep furrows in the under side of the vault do not converge to the single opening (*an*) in the vault, but, as in the ambulacral furrows of *Cyathocrinites* (figs. 13 and 14), to a

* I certainly must believe that Goldfuss was much nearer right in referring his *Cyathocrinites geometricus* to that genus, than those who have placed it in the genus *Poteriocrinites*; though it does agree more nearly with the latter in the much less important character of its anal series of pieces. Its nearly flat vault, however, scarcely, if at all, rising above the arm-bases, without any traces of the great ventral extension, composed of numerous small hexagonal pieces with pores between, as we see in *Poteriocrinites*, seems to me to separate it from the latter group entirely.

central point in advance of it; precisely as the ambulacra in *Comatula* converge to the mouth in front of the anal opening, excepting that in the latter neither the mouth nor the ambulacral canals are covered by solid calcareous vault-pieces.

As widely different as the *Blastoidea* would, at a first glance, seem to be from the typical crinoids, in the structure and arrangements of the parts mentioned above, an attentive comparison will show that, fundamentally, there is less difference between these types than might be supposed. For instance, if we examine a *Pentremites* or a *Granatocrinus* (see fig 4b, pl. IX), as the specimens are most generally found, we observe that they show two principal openings above; that is, a central one, to which the ambulacra converge, and another behind this, just as in the incomplete *Cyathocrinites* represented by figure 14 of same plate. Specimens in a better state of preservation, however, such as those represented by our figures 2a and 2b, of *Granatocrinus Norwoodi*, and fig. 5 of *Codonites stelliformis*, show that, when the parts of the summit are intact, the central opening, and perhaps a part of each ambulacral furrow, are covered over by minute fixed pieces, as in the more complete *Cyathocrinites*, fig. 13; the ambulacral canals in both cases passing under the vault-pieces, inward to the central opening.

In the *Blastoidea*, there are, however, other, small lateral openings in the summit, as seen at *ir, ir*, in figures 2a and 2b, and at *s, s*, in figure 5 of plate IX. These are the so-called ovarian apertures of many authors, and have been called hydrospires by Mr. Billings, who, with several others, regards them and a curious series of internal parts with which they connect, as the water-breathing organs of the animal. Although some recent investigations of the anatomy of existing crinoids, by Metschenhoff,* would seem to cast doubts on the correctness of this conclusion, it is certainly more probable than that these were ovarian openings; which would apparently be against all analogy from what is known of the reproductive system of the existing crinoids, in which the ambulacral and reproductive organs are directly connected.

Whatever office these openings may have performed in the animal economy of these types, however, we have some reasons for believing that, in the *Actinocrinitidae* at least, there were analogous apertures, which were also called ovarian pores by Prof. McChesney, in describing certain species of this group. These are small pore-like openings, very regularly disposed with relation to the interradianal and other spaces around at the connection of the body and vault; one being placed near one side of the base of certain arms, at regular intervals, all around.

* Bull. Acad. St. Petersburg, XV. p. 508.

These little openings have often attracted my attention; and, although once inclined to attach more importance to them, at the time our remarks on the structure of the Paleozoic crinoids were written, I could not feel quite satisfied that they might not have been for the attachment of the inner pinnule of that side of each arm-base where they occur, and concluded to wait until their true nature could be more clearly determined, before calling attention to them. Mr. Wachsmuth subsequently assured me, however, that, after examining a great number of specimens in every condition of preservation, he has never seen any evidence of the connection of pinnules with these openings; and consequently he suggested that they may correspond to the so-called ovarian apertures of the *Blastoidea*;* a conclusion that seems to derive support from the following additional fact. That is, that on tracing these openings through the wall of the body, they do not, so far as my observations have gone, appear to take the direction that would indicate any immediate connection with the ambulacra, but, on the contrary, turn more downward, increasing in size as they pass in, thus appearing as if they might have connected with some internal cavity, or system of cavities, between the outer wall and the visceral sack. In fact, we also observe, in some instances, evidences that some such cavities were partitioned off, as it were, by an incomplete inner calcareous wall, secreted (perhaps only in old individuals) by the perivisceral membrane, as represented by our figure 11 of plate IX.

The unmistakable evidence presented by some of the specimens figured on plate IX, that the ambulacral canals continued on converging inward *under* the vault, from the arm-openings to a central point at the top of a large convoluted organ believed to be the digestive sack (as seen in fig. 7a), led us, as suggested on page 334 of the reproduced remarks, to think that the positions of the mouth and anus, with relation to the ambulacra and other parts, in these older types, were essentially the same as in the recent crinoids. That is, we believe that, in the Paleozoic types, as in the recent *Comatula*, the mouth was situated centrally at the radial point of the ambulacra, and that the microscopic organisms, on which these animals doubtless subsisted, were converged by the action of cilia along the ambulacral canals, to an internal mouth or esophageal opening, situated under the center of the vault; while the single opening of the vault, always located at some point behind the center of radiation, whether simple or passing

* I think Mr. Billings has alluded to these openings in *Actinocrinites*, in some of his papers (which I have not at hand for reference at this time), after receiving specimens from Mr. Wachsmuth, with the same suggestions from the latter gentleman in regard to their nature.

through a more or less produced tube, we regard as the anal aperture, as in the existing crinoids; and not the mouth, or both mouth and anus, as believed by some.* The only difference, therefore, as we understand the facts, is that, in the recent types, the ambulacral canals and mouth are directly exposed externally, the former merely passing to the latter across the upper surface of a membranaceous ventral integument; while, in the ancient crinoids, the whole ventral surface (excepting the anal opening), as well as the ambulacral canals and mouth, was very generally, if not always, covered over by a vault of fixed, solid, calcareous pieces.

That some of the most distinguished naturalists of Europe, including Professor Wyville Thomson, of Belfast, the lamented Prof. Michael Sars, of Christiania, and others, to whom we several years back sent photographs of plates IX and XVI, substantially concurred with us in the foregoing interpretation of the facts presented by the specimens illustrated on the same, we have been assured, both by private letters from these gentlemen, and in some instances by their publications.†

It is proper, however, to state here, that Mr. Billings, the very able paleontologist of the Canadian Geological Survey, who is one of the highest authorities on the Paleozoic crinoids, dissents from these views, and maintains, with much ability, that the single opening in the vault of these old types performed both oral and anal functions; or, in other words, that the mouth, unlike that of the existing crinoids, was, in the former, removed from the center of radiation, and consequently from all direct connection with the ambulacral system.

Codonites stelliformis, figures 5 and 5a, b.—In connection with the foot-note on page 464, in regard to the parts described by

* That the single opening seen in the vault of these ancient crinoids could not have performed both oral and anal functions, at least in *Platycrinites*, seems almost demonstrated, by the fact that we often find (as mentioned on pages 334 to 339 inclusive, and illustrated by figures 6a, b, c, of plate XVI) specimens with the shell a *Platyceras* growing firmly over this opening, under circumstances clearly showing that it grew there *during the life of the crinoid*. In these cases, we can readily understand how the excrementitious droppings of the crinoid may have passed out under the foot of the mollusk; but it would be exceedingly difficult to explain how food could have passed in under such circumstances.

† In justice to Dr. L. Shultze, of Bonn, I avail myself of this opportunity to call attention to the fact, that he had, in his beautiful Monograph of the Echinodermata of the Eifel limestone, published in 1866, expressed very similar views in regard to the internal position of the mouth, and the mode of alimentation, in the Paleozoic crinoids; though the specimens at his command for study were far from being as clearly satisfactory on these points as those figured by us are believed to be.

At the time we first published our remarks on this subject, in 1868, we had not seen his work, and had no knowledge of the fact that he had ever expressed similar views, or we should certainly have mentioned it. I regret that I have not his Monograph at hand now, so that I could quote his words, or refer more precisely to the pages on which they occur.

Mr. Lyon as the true basal pieces, in the *Blastoidea*, but which we have viewed as belonging more properly to the column, fig. 5a, referred to above, should be consulted. In this side-view of a young *C. stelliformis*, it will be seen that this part is composed of anchylosed upper disc-pieces of the column, divided longitudinally by three sutures, coincident with those between what we regard as the true basals above. The engraving makes the divisions between the discs too distinct, but they are well enough defined in the specimen to show their true nature.

Pholidocidaris irregularis M. and W. ; plate xv, figs. 9a, b and 4c, d, e.*—This very extraordinary echinoid, as yet only known from flattened fragments, was at first supposed by us to be related to *Lepidocentrus* of Müller, to which we referred it provisionally, in the Proceedings of the Philadelphia Academy, in 1869. At the same time, however, we remarked that a comparison of the ambulacra might show our fossil to be entirely distinct, and suggested that in that case it might be called *Pholidocidaris*. At that time we knew nothing of the ambulacra of *Lepidocentrus*, which was founded by Müller on detached interambulacral pieces, some of which resembled certain corresponding parts of our type. On seeing Dr. Shultze's figure, however, of Müller's genus, published in his Monograph of the Eifel *Echinodermata*, we were at once satisfied that our echinoid belongs to an entirely distinct genus, the ambulacra of *Lepidocentrus* being (as shown in Dr. Shultze's figure) each composed of only two ranges of widely different pieces, as in *Palæechinus*. Consequently, in republishing the description of our type, we have adopted the name *Pholidocidaris* for it.

In this connection, it may be worthy of note, that it is evident from Dr. Shultze's figures that *Lepidocentrus* Müller, 1856, and *Lepidechinus* Hall, 1861, are in all respects congeneric; and, as Müller's name has priority of date, it will have to be retained for the group; thus making *Lepidechinus* a synonym. Consequently, the names of the American species, *Lepidechinus imbricatus* Hall and *Lepidechinus rarispinus* Hall, will have to be written *Lepidocentrus imbricatus* and *Lepidocentrus rarispinus*.

Pentremis (Troostocrinus?) Woodmani M. and W. ; plate xvi, figs. 4a, b, c, d.—In describing this fine species, we inadvertently omitted to mention that the central pit seen in the base was evidently left by the accidental removal of the parts we have called the supplementary basal pieces, in other types of the *Blastoidea*. (See the foot-note on page 464, already cited in these notes, in connection with *Codonites stelliformis*, as illustrated by fig. 5a, pl. ix.)

* Figures 4c, d, e should have been 9c, d, e, in the explanations of the plate.
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It is highly probable that the group including this species should be separated as a distinct genus from the typical *Pentremites*, such as *P. Godoni*, *P. pyriformis*, &c. Our deceased friend, the late Dr. B. F. Shumard, of St. Louis, proposed the name *Troostocrinus* for a group to which he referred at least one species (*Pentremites obliquus* Roemer) evidently closely allied to our type. Roemer's species was founded on a single radial (fork) piece, but its lower end shows an oblique flattening or excavation, similar to (though more shallow than) the deep concavities seen in the corresponding parts of our species.

Whether such forms should be included in the same group with those very narrow, elongated, fusiform species, such as *Pentremites Rheinwardtii* of Roemer, with the base and lower parts of the body much attenuated and merely a little flattened on three sides, may admit of some doubts; though Dr. Shumard included the latter in his genus *Troostocrinus*. Another reason why we hesitate in retaining his name for the group including our type, is, that he mentions *Pentremites laterniformis* of Owen and Shumard in such connection with his genus that, according to the rule followed by many eminent naturalists, that species *only* could be regarded as the type of the same. Unfortunately, however, it is now rendered almost morally certain, by specimens in Prof. Worthen's collection, that *P. laterniformis* was founded on the internal cast of a true typical *Pentremites*. Consequently, if we adopt that as the type of *Troostocrinus*, we would have no other alternative than to regard that name as merely a synonym of *Pentremites* Say.

Although far from being inclined to "strain a point," in order to set aside a published name, and really desiring to retain that proposed by Dr. Shumard, for the group to which our species belongs, if it can be consistently done, we have proposed, in case serious objections should be raised against such an arrangement, to call our type *Tricæliocrinus*.

(To be continued.)