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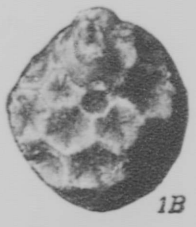
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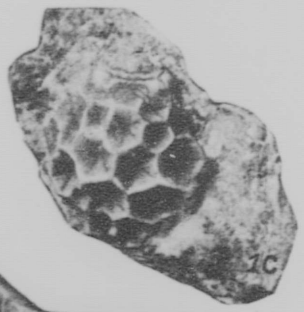
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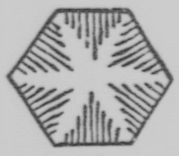
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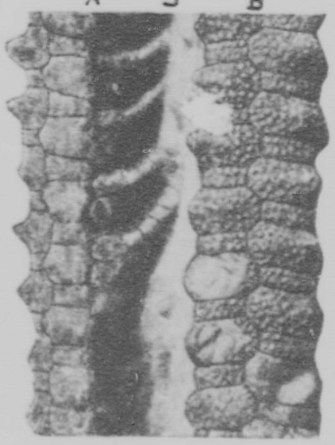
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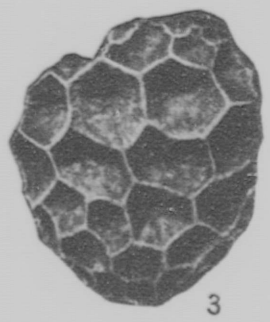
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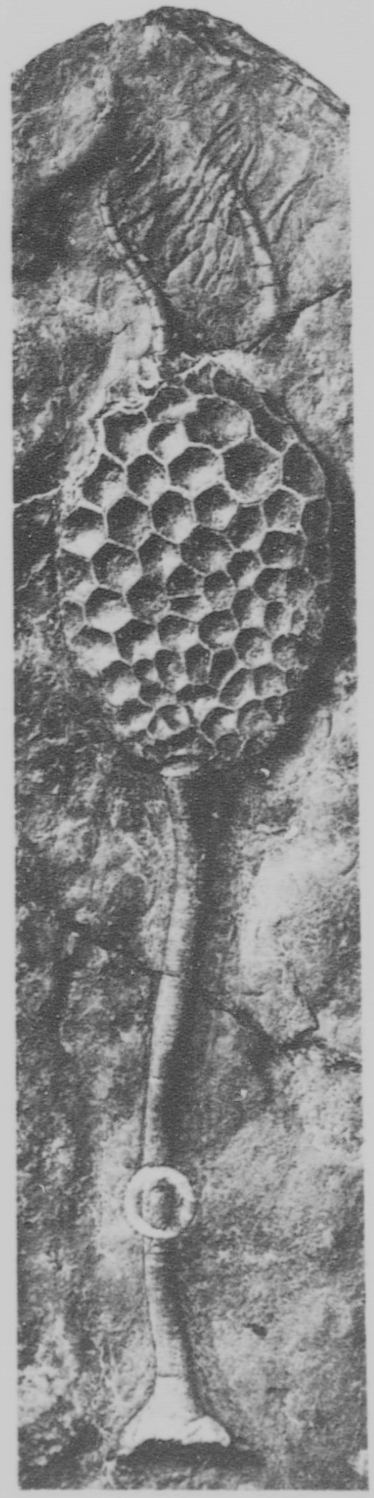

THE OTTAWA NATURALIST

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COMAROCYSTITES AND CARYOCRINITES.

Cystids with Pinnuliferous Free Arms.

By A. F. Foerste, Dayton, Ohio.

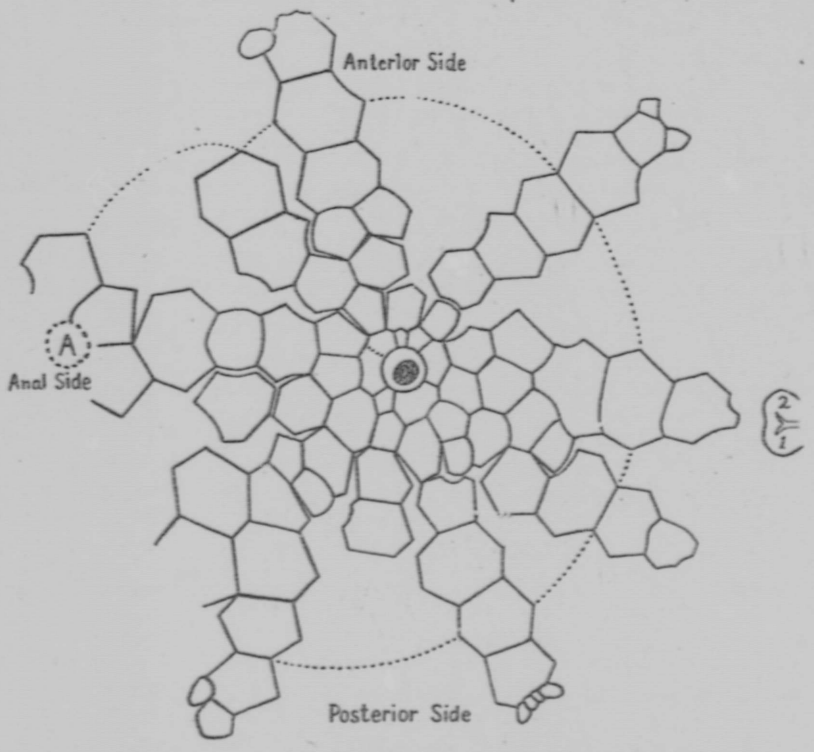
(Continued from page 93.)

Detailed Description of Comarocystites shumardi, Meek and Worthen.

21. *Comarocystites shumardi,* (Figures 1A, B, C, on plate IV) differs from *Comarocystites punctatus* chiefly in the more deeply and more angularly concave thecal plates. These features are well shown by the type specimen illustrated by figures 1A, and 1B on plate I in volume III of the Geological Survey of Illinois. In plates eight to ten millimeters in width the depth of the concavity usually is about three millimeters, in one case equalling four millimeters. From the center of the concavity the inversely pyramidal flattened walls of the concavity slope upward and outward; along lines leading from the center to the angles of these concavities, the flattened walls are separated by more or less distinct narrow grooves, giving the exterior surface of each thecal plate a stellately indented appearance (Fig. 1C). The number of thecal plates in the type specimen probably was somewhere between 65 and 70. The general shape of the theca is shorter and more globose-obovate than in *Comarocystites punctatus.* The line of demarcation between the basal plates is indistinctly defined, but these plates probably numbered more than three.

In his original description of *Comarocystites punctatus* (Canadian Journal, 2, 1854, p. 268) Billings stated that "upon the upper joint of the column stand three low but broad pentagonal plates, with serrated edges above. These form a narrow circular pelvis, and are so closely united at their sides that it is difficult to detect the lines of division between them." It probably was the attempt to make their

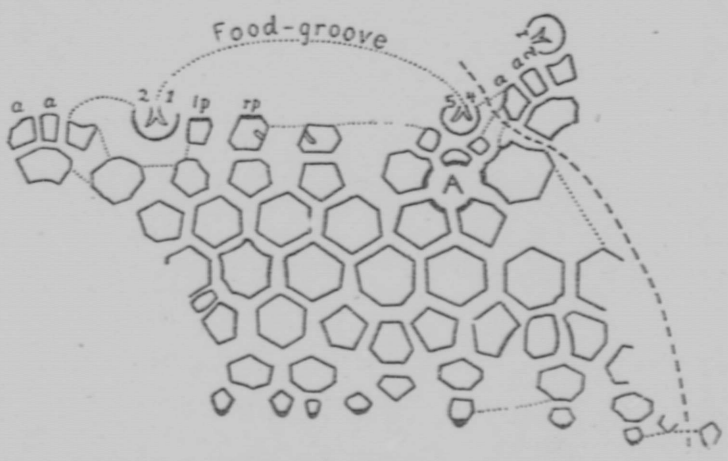
type specimen agree with the description of *Comarocystites punctatus* given by Billings which lead Meek and Worthen to diagram *Comarocystites shumardi* as having three basal plates. (Geol. Surv. Illinois, 3, p. 292). At the time this diagram was prepared a part of the plates of the type specimen of the latter species still were covered by the matrix. Recently the writer removed this matrix and a new diagram has been prepared (Text diagram, No. 4).



Text figure No. 4. Diagram of the thecal plates of the type specimen of Comarocystites shumardi, replacing the diagram published by Meek and Worthen in the report of the Geological Survey of Illinois, volume III, page 292. In order to compare this diagram with that in the Illinois report, the page should be turned so that the part marked anal side forms the bottom of the figure. Additional plates have been exposed recently by removing the matrix. The position of the nodular stereom protuberance supporting the left pair of arms is indicated at 1, 2. The approximate location of the anal pyramid is indicated by A. The apical part of the theca surrounding the right pair of arms, as far down as the plates bordering on the lower side of the anal opening, is missing. The diagram is not intended to suggest any radiate structure in the arrangement of the thecal plates. It is intended, however, to suggest the presence of more than three plates in the basal series, although the evidence in the particular specimen here diagrammed is obscure.

The height of the type specimen equals 39 millimeters, the lateral diameter is 34 millimeters, and the diameter from front to rear is 30 millimeters. The top of the column at its junction with the theca was 6 millimeters in diameter. The left half of the apical transverse food-groove, with its bifurcation on the proximal side of the stereom mass supporting the left pair of arms is distinctly shown, but the right half and all adjacent parts, including the anal area, are missing. Both the apical area, as far as preserved, and the basal series of thecal plates appear compressed in a vertical direction, and there is no reason, judging from other specimens, for believing that the horizontal position of these basal plates is a specific characteristic.

Most of the specimens of *Comarocystites shumardi* so far seen exceed 25 millimeters only slightly in length. In thecal plates 6 millimeters in width, the depth of the concavity may equal 1.7 millimeters. At the bottom of the concavity there frequently is found a circular flattened or slightly convex area, about three-fourths of a millimeter in diameter.



Text figure No. 5. Diagram of the thecal plates of the specimen represented by figures 1A, 1B, on plate IV. The plates on the right side of the vertical sinuous dotted line on the right side of the diagram duplicate some of the plates at the extreme left of the diagram. The anterior peristomial plates are lettered a, a; the right and left posterior peristomial plates are lettered rp and lp respectively. From plate rp the linear hydropore extends diagonally downward and toward the right toward the middle of the next plate. The relative position of the four arms is indicated by the numbers 2, 1, 5, 4. The location of the anus is indicated by the letter A. The basal plates in actual contact with the top of the column, seven in number, are heavily margined at the bottom. Several of the thecal plates on the left side of the specimen are missing.

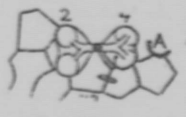
In the specimen in the Chicago University Museum, illustrated by figures 1A and 1B on plate IV, the area surrounding the anus is

distinctly flattened, the area facing diagonally upward· thus producing a strongly angular outline a short distance above mid-height on the right side of the the theca. The arrangement of the thecal plates on this specimen is indicated by diagram No. 5. A part of the thecal plates are missing· the specimen being imperfect, but all of the basal plates are preserved, and, of these, seven appear to be in direct contact with the top of the column. These are indicated in the diagram by the heavy basal margin·

In most other respects, than those cited above, *Comarocystites shumardi* closely resembles *Comarocystites punctatus*· The transverse apical food-groove (Figures 1 A, B, C, and diagram No. 6) branches at each end dichotomously, along the adoral side of the nodular stereom protuberance which supports the right or left pair of arms. Only the facets for the attachment of these arms are preserved, the arms themselves not being retained in any specimen at hand.

The mouth or entrance into the theca consists of a small opening located at mid-length along the transverse apical food-groove, at the proximal end of the suture between plates *a*, *a*, in the diagram. The food-groove is covered by a double series of covering-plates. Two peristomial plates typically are in contact with the posterior margin of the transverse apical food groove, and of these the right peristomial plate is distinctly the larger (Diagram No. 5). From the center of the latter, the linear hydropore ridge (Figure 1C on plate IV, also diagrams 5 and 6) extends diagonally downward and toward the right, toward the center of the plate adjoining it on that side. One specimen shows a minute pore immediately beyond the upper left hand end of the hydropore ridge. There is no evidence of this being a constant feature.

The anal pyramid is not preserved in any specimen at hand· but the circular opening into which this pyramid fitted (Figure 1B on plate IV) is preserved in several specimens, and this shows a diameter of 3 millimeters in a specimen 25 millimeters in height. This circular opening is surrounded by five thecal plates occupying the same position as in *Comarocystites punctatus*.



Text figure No. 6. Diagram of a few of the thecal plates at the apical end of the specimen represented by figure 1C on plate IV; the numbering and lettering as in text figure No. 4. The transverse apical food groove, branching at each end, where the facets of the two pairs of arms are located, the location of the mouth, the anus, and the linear hydropore also are indicated. Special attention is called to the monopolizing of the space posterior to the transverse food-groove by the plate marked rp. In other specimens there is room for smaller plates on the left.

In one specimen (Diagram No. 6) showing the transverse apical food-groove very well, the posterior margin of this food-groove appears occupied exclusively by the plate marked *rp* in the diagram. The stereom protuberances, supporting the arm pairs, appear to rest upon the margins of the adjacent thecal plates. These stereom protuberances appear to be deposits made by the bases of the arms at the ends of the transverse apical food-groove, and not to be a part of the thecal plate system. The peristomial plates, on the contrary, are ordinary thecal plates. Judging from the presence of small plates along the margin of the stereom protuberances in some specimens, and their absence in others, these small plates may be additions during the later stages of growth of the individual.

In *Comarocystites punctatus* the number of thecal plates in a vertical series often numbers 9 or 10; in *Comarocystites shumardi* this number usually is only 6 or 7. The theca grows in size chiefly by growth at the margin of the individual thecal plates. It is quite evident from the absence of small intercalated plates in some of the specimens at least that the enlargement in growth does not depend upon the introduction of intercalated plates within the general body of the theca, although it is not impossible that additional plates, during earlier stages of growth, may be added at the base. The evidence in favor of such a suggestion is not very clear and consists chiefly in the presence, at the base, of plates of small size inserted between those of larger size.

22. *The so-called variety obconicus.*—Meek and Worthen probably were in error in attempting to distinguish a variety *obconicus*, as distinct from *Comarocystites shumardi*. Close examination of the type specimen (Figure 2a, on plate 1, Geol. Surv. Illinois, vol. III) fails to show any distinguishing features excepting that presented by the more attenuate base. As a matter of fact, however, there is no evidence that this attenuate base is anything more than an individual characteristic. The second specimen figured by Meek and Worthen under the variety name *obconicus* (Figure 2b, on plate 1, of the Illinois report cited above) does not differ in any respect from ordinary specimens of *Comarocystites shumardi*, and certainly does not possess an obconical base. The first specimen presents clear evidence of the division of the mesostereom into vertical plates, shorter toward the angles of the plates, and separated by very narrow interspaces. The column has a width of 2.8 millimeters, and 17 columnals of about equal size occur in a length of 5 millimeters. The surface of the column is minutely granulate, as in *Comarocystites punctatus*. The second specimen does not differ in any respect from small specimens of *Comarocystites shumardi*. Only the left half of the theca is exposed but this half includes all, from the base to the stereom protuberance supporting the left pair of arms. Even the forking of the left end of

the transverse apical food-groove, on the adoral side of the protuberance, and traces of the facets for the attachment of the arms are preserved. The presence of vertical plates belonging to the mesostereom is seen along the strongly weathered sutures between the plates. Several of the plates present very clear evidence of the arrangement of the pores, through the continuous exterior surface of the mesostereom, in pairs, and directly beneath the epistereom these pores evidently are elongated in a direction parallel to the narrow spaces between the mesostereom plates beneath.

23. *The structure of the thecal plates.*—A fuller knowledge of the plate structure of *Comarocystites shumardi* is presented by the specimens belonging to the Walker Museum, at Chicago University, and by the specimens belonging to the Illinois State Museum of Natural History (Plate IV, figure 3). The structure evidently is identical with that of *Comarocystites punctatus*. There is the same grouping of pores traversing the mesostereom. The thin epistereom is non-porous, but when weathered away the outer terminations of the pores traversing the mesostereom are seen to be arranged in more or less alternating pairs. Directly beneath the epistereom, each of these pores is connected with a semi-lunate pore parallel to the outer surface of the plate, the concave sides of each of the semi-lunate pores belonging to the same pair, facing each other. As in *Comarocystites punctatus*, some specimens show no indication of the presence of these pairs of semi-lunate pores on their exterior surfaces; in others, their presence is indicated by low, short, semi-lunate ridges. The mesostereom consists chiefly of more or less vertical plates, from 6 to 9 in a width of 3 millimeters, intercepted by much narrower spaces apparently connected directly with the interior of the theca without the intervention of a hypostereom. Directly beneath the epistereom, however, the mesostereom forms a continuous sheet penetrated only by the pores connecting the narrow spaces between the vertical mesostereom plates with the semi-lunate pores immediately beneath the epistereom. The thecal plates appear to have grown from the margin outward, so that the pores originating at the sutures later were located in the more central parts of the plates.

24. *Horizon and Distribution of Comarocystites shumardi.*—From the preceding statements it is evident that *Comarocystites shumardi* is a typical representative of the genus *Comarocystites*. The so-called variety *obconicus* is founded, it is believed, upon individual characteristics, and the name should not be retained, even as the name of a variety.

Both *Comarocystites shumardi* and its so-called variety *obconicus* were described from the Kimmswick limestone at Cape Girardeau, Missouri. By Ulrich, this Kimmswick limestone is placed at the top of the Black river group beneath the Curdsville horizon at the base of

the Trenton, while Bassler cites *Comarocystites punctatus* from the Curdsville at Ottawa, in Ontario, Canada. From this it is evident that Bassler correlates at least the lower Trenton horizons at Ottawa with the Curdsville of central Kentucky. The two horizons at which *Comarocystites* occurs, even if referred to different groups, evidently are not far removed from each other.

25. *Literature on Comarocystites shumardi and obconicus.*

Comarocystites shumardi, Meek and Worthen.

Meek and Worthen, Proc. Acad. Nat. Sci., Philadelphia, 1865, p. 143. Geol. Surv. Illinois, 3, 1868, p. 292, fig.; pl. 1, figs. 1a, b.

The diagram on page 292 is so drawn as to suggest the presence of only three basal plates; in the preparation of this diagram the authors probably were influenced by the original description of *Comarocystites punctatus* (Canadian Journal, 2, 1854, p. 268) in which Billings states that "upon the upper joint of the column stand three low but broad pentagonal plates, with serrated edges above." As a matter of fact, however, these serrated edges suggest the presence of more than three basal plates, although the sutures separating these plates are not clearly defined in the type specimen diagrammed. A line drawn vertically through the center of the diagram would be parallel to the transverse apical food-groove of the specimen, the plates on the left side of the theca being indicated at the top of the diagram, and those on the anal side, at the bottom of the diagram. At the time the diagram was prepared, the upper part of the left side of the theca was concealed by the matrix. Traces of the transverse apical food-groove, bifurcating at the end, were present on the left side of the top of the theca, but were not recognized by the authors. The specimen has been cleaned by the present writer and redrawn for this paper. (Text diagram No. 6). Figure 1a on plate 1 is oriented exactly opposite to the diagram, the anal side facing the top of the figure and the left side facing the bottom. Figure 1b presents the right or anal side of the specimen; the parts immediately surrounding the anal pyramid and all of the upper left hand part of the theca is missing, the extreme top of the figure representing the broken edges of that part of the theca which is beyond the break.

Keyes, Missouri Geol. Surv., 4, 1894, p. 132, pl. 18, fig. 2, Figure 2 presents the basal view of the theca, copied from the Illinois report.

Jaekel, Zeitsch, d. deutsch. geol. Gesellsch., 52, 1900, p. 676.

Comarocystites obconicus. Meek and Worthen.

Meek and Worthen, Proc. Acad. Nat. Sci., Philadelphia, 1865, p. 144. Geol. Surv., Illinois, 3, 1868, p. 294, pl. 1, figs. 2a, b.

The total length of the theca of the specimen represented by figure 2a probably did not exceed 20 millimeters. The appearance of the figure suggests that the plates on the left side of the theca were of enormous thickness, compared with their width. This appearance is due, however, to the growth of calcite in the interior of the theca, the actual thickness of the plates thus represented varying from about 1.5 millimeters, towards the bottom, to almost 2 millimeters at the top of the theca. Figure 2b represents the left side of another specimen with the stereom protuberance, formerly supporting the left pair of arms, at the top.

Keyes, Missouri Geol. Surv., 1, 1894, p. 132, pl. 18, fig. 1. Figure 1 is a republication of figure 2a of the Illinois report.

26. *The zoological position of Comarocystites.*—In 1896, Haeckel separated from the remaining *Cystidea* those forms in which no radial branching of the food-groove system, either trimerous or pseudo-pentamerous, can be detected spreading over the upper surface of the theca. These forms he distinguished as a co-ordinate group under the name *Amphoridea*. Among the *Amphoridea* were placed not only the asymmetric and bisymmetric forms but also those in which the arms branch off radially from the top of the theca, without, however, being attached dorsally, for at least a part of their length, to the upper surface of the theca. To these *Amphoridea* with radially arranged arms he applied the term *Palaeocystida*, and evidently regarded them as ancestral to the *true Cystidea*, especially to the *Glyptocystidae*. Among these *Palaeocystida*, he placed the genus *Comarocystites*.

Bather (Echinoderma, 1900) retained the group *Amphoridea*, but as one of the subdivision of the *Cystidea*, characterized by the absence of radial symmetry in both food-grooves and thecal plates. *Comarocystites*, however, is referred by him to the *Rhombifera*. In the *Rhombifera*, as defined by Bather, radial symmetry affects the food-grooves, and the stereom and stroma are arranged in folds and

strands at right angles to the sutures between the thecal plates. In order to bring *Comarocystites* in line with pseudo-pentamerous *Rhombifera*, the former presence of an anterior ray of the food-groove system is imagined.

Jaekel, in 1900, separated from the *Cystidea*, under the name *Carpoidea*, a considerable number of the genera included by Haeckel in his *Amphoridea*, adding also the genera *Malocystites*, *Canadocystites*, and *Amygdalocystites*, included by Haeckel under his *Cystidea*, in the restricted sense. The chief characteristics of the *Carpoidea* were supposed to be: a loose relation of the ambulacral organs to the theca, leaving only slight traces on the latter; theca never pentamerous, often distorted, usually compressed dorso-ventrally, more or less symmetrical toward the right and left; ambulacra extending into two radii; the brachials bearing the ambulacral grooves uniserial as far as known; base tetramerous or trimerous. Those *Carpoidea* possessing biserial columnals Jaekel placed in the subdivision *Heterostelea*, and those possessing a single series of ring-shaped columnals he placed in the subdivision *Eustelea*. The *Eustelea* included *Malocystites*, *Canadocystitis*, *Amygdalocystites*, and *Comarocystites*.

It must be acknowledged that the four genera here listed form a very coherent group in which trimerism or pseudo-pentamerism seems never to have prevailed. Under Bather's term, *Malocystidae*, this group has been placed among the *Amphoridea* in the more recent editions of Zittel. The relationship between *Canadocystis*, *Amygdalocystis*, and *Comarocystites* appears especially close. All of these forms are bisymmetric with the main apical food-groove extending laterally from the mouth, the anal pyramid being on the right side of the theca. Both the brachials and pinnulars are arranged in uniserial order. When the arms are oriented so that the ventral side faces away from the observer and the distal side of the arm points upward, then, in all three genera, the pinnules are seen to form a single row on the right side of the arms. In *Comarocystites* the arms are free. In *Amygdalocystites* and *Canadocystis* the arms are twisted in contrasolar direction and are attached by their left sides to the theca, leaving the right side free for the pinnules.

In the structure of their thecal plates, however, all three genera differ greatly. In *Comarocystites*, the vertical plates of the mesostereom, as exposed on the inner side of the theca, suggest strongly the plates characterizing the pectinirhombs of the *Rhombifera*, although the spaces between these plates do not open at the top in slit-like pores, as in true pectinirhombs. In *Amygdalocystites*, the inner surface of the thecal plates is marked by radial ridges, which in some specimens are sufficiently defined to be called short plates. One radial ridge always extends to each of the angles of the plate, and in some specimens another ridge extends to the middle point of each side. In some

specimens pores exist along the sutures between the plates, either a single pore at the middle of each side, or two pores along each side, close to the radial ridges extending to the angles of the plate. Half of each pore occurs on half of each of the adjoining plates. It has not been proved, however, that these pores are open in unweathered specimens. They may be covered by the epistereom, as in the case of the pores of *Comarocystites*. In *Canadocystites*, neither pores nor vertical mesostereom lamellae are present. This difference in plate structure in the three genera is remarkable in view of the close relationship suggested by the structure of the food-groove system. Owing to the entire absence of true pectinirhombs, notwithstanding the suggestive structure of the thecal plates of *Comarocystites*, the separation of these three genera from the *Rhombifera* seems desirable. Regarding *Malocystites*, which appears related to *Canadocystis*, too little is known at present. The recumbent food-grooves extend over the upper surface of quadrangular plates arranged in uniserial order, but it is not known whether the pinnules were attached in a single row, and whether the pinnulars were arranged in uniserial order or not.

V—ADDENDA.

27. *Notes on Caryocrinites ornatus* Say.—In *Caryocrinites ornatus* both the brachials and pinnulars are biserial in arrangement (Plate IV, figs. 4, 5). This was recognized by Hall (Pal. New York, 2, 1852, p. 219, pl. 49, figs. 1 i, k, m), although he did not get a clear idea of the structure of the pinnules from his specimens. Much better material is present in the collections of Frank Springer, in the U.S. National Museum, at Washington, and this material has been placed freely at the disposal of the writer. Compared with the length of the arms, the pinnules are very short. In a specimen, with a theca 30 millimeters in height, the pinnules attached to an arm 55 millimeters in length were 4 millimeters long. In another specimen, with a theca 12 millimeters in height, and with arms from 36 to 40 millimeters in length, the pinnules were only 3.5 millimeters long (Plate IV, fig. 4). In this specimen, each of the two series of pinnulars rests upon a separate brachial, the lower brachial of each pair being shorter. In other specimens, however, the shorter brachials occasionally are reduced to mere transversely elongated vestiges remaining between the horizontal sutures separating the larger brachials, and in those cases the two series of pinnulars rest practically against the same brachial.

Since typical crinoidal pinnules should present only a single row of pinnulars, it might be emphasized that these so-called pinnules of *Caryocrinites* are not homologous to the pinnules of crinoids, but to the brachioles of cystids. These brachioles, among the *Rhombifera* and *Diploporita*, are uniformly biserial, the individual ossicles alternating in position across the width of the brachiole. As a matter of fact, it is

possible to diagram these brachioles so as to suggest a uniserial origin, and this is true also of the so-called pinnules of *Caryocrinites*, the ossicle in contact with the lower brachial being regarded the first.

The pinnulars of *Caryocrinites* are long and narrow in a direction parallel to the length of the pinnule, and are arranged in alternating series, as already indicated. The covering plates are long and narrow in a direction transverse to the length of the pinnule, about three or four occurring in the length of one pinnular.

The arms of *Caryocrinites* apparently varied in length. In an individual having a theca 30 millimeters in height, the arm nearest the left side of the anal opening has a length of 55 millimeters, while the second arm anterior to the latter, but on the same side evidently was considerably longer since the part remaining, lacking the tip, is 75 millimeters in length. Possibly the posterior arms were shorter than the anterior arms also in other specimens.

The number of arms attached to the same theca varies in number in different individuals. In the youngest specimens, of which two occur in the Springer collection, the facets for 3 arms are distinctly developed. In one of the largest specimens, 14 arms are present. These are arranged in three groups, the anterior and left posterior groups including 5 arms, while the right posterior group includes only 4 arms. This varies in different individuals.

The question arises how and where the additional arms arise. It is noticed that in addition to the facets supporting the arms, the theca presents also smaller depressions, apparently for the attachment of appendages. Some of these depressions are traversed by a single median ridge placed in a radial direction, suggesting former articulation with some appendages. While no appendage actually ever has been found attached to these depressions it has been noticed that the order of appearance of these depressions is also the order of appearance of the additional arms, when a comparative study is made of the larger and smaller specimens of the same species. From this it is evident that these depressions are the points of emission of the additional arms.

Since similar depressions are present even in the largest specimens, and the position of these, of course, is never occupied by arms, it is possible that some of the later appendages were never strongly articulated with the theca, probably always remained comparatively small, and were specialized for the purpose of bearing the genital glands. Jaekel (Thecoidea und Cystoidea, 1899, p. 302, fig. 70) figures the relative position of the arm bases and of the smaller openings. Wachsmuth and Springer, (1881, Revision of the Palaeocrinoidea, Proc. Philadelphia Acad. Nat. Sci., vol. II, p. 51), long ago called attention to similar small depressions or pores at the sides of the arm facets of *Batocrinus*, and suggested respiratory purposes.

The area of attachment at the base of the column of *Caryocrinites*

consisted of a more or less flattened expansion of small area, with a tendency toward radicular extensions at the margin, similar to the form of attachment of certain crinoid columns.

28. *Acknowledgments.*—The present paper could not have been written without the assistance of numerous individuals. The writer is under great obligation to the Director of the Geological Survey of Canada not only for the privilege of examining all of the specimens of *Comarocystites punctatus* preserved in the Victoria Memorial Museum at Ottawa, including the Billings types and the remarkable complete specimen presented to the Museum by Sir James Grant, but also for the excellent photograph of this complete specimen and for the enlarged photograph of that one of the Billings types preserving the pinnulate arm, here reproduced. To Mr. James E. Narraway and Mr. Walter Billings he owes not only the loan of the specimens figured on plate II, but also the use of other specimens, and valuable notes on the distribution of this species in the Ottawa area.

The types of *Comarocystites shumardi* and its so-called variety *obconicus* belong to the Worthen collection at the University of Illinois, and were loaned by Prof. T. E. Savage. The type of *Comarocystites shumardi* is here figured. Of the specimens of *Comarocystites shumardi* in the Walker Museum, at Chicago University, loaned by Prof. Stuart Weller, two are here figured. Of two specimens of the same species, belonging to the Illinois State Museum of Natural History, at Springfield, loaned by the curator Dr. A. R. Crook, one is here figured.

The arm bearing specimens of *Caryocrinites ornatus,* preserving the pinnules, in the U. S. National Museum, at Washington, were placed at the disposal of the writer by Mr. Frank Springer, to whose collection they belong; and to his assistant, Mr. Herrick E. Wilson, the writer owes the excellent photographs of the pinnulate arms here reproduced. To all of these named the writer wishes to acknowledge the favors freely granted and gratefully received.

PLATE IV.

Fig. 1. Comarocystites shumardi, Meek and Worthen. Specimens No. 10974, belonging to Walker Museum, at Chicago University. A, anterior view of theca, specimen tilted so as to show the peristomial plates along the anterior side of the apical transverse food-groove. The quadrangular plate and the more pentagonal plate on its left margin correspond to the plates marked a, a, in the diagrams of Comarocystites punctatus. The mouth is situated at the posterior end of the suture between these plates. The branching of the transverse apical food-groove is indicated on the proximal side of the left stereom protuberance. The cavity occupied by the anal pyramid is seen on the left side of the figure. On the right side of the figure, the theca is defective. B, right side of same specimen, tilted so as to show the anal opening and the immediately adjacent thecal plates. For diagrammatic purposes the stellate grooving of the thecal plates has been accentuated and the remote (left) end of the apical transverse food-groove is represented as branched, although the specimen here is too imperfect to show this branching. C, posterior view of a second specimen, tilted so as to show the thecal plates on the posterior side of the transverse apical food-groove. The plate posterior to the middle of this apical food-groove corresponds to the plate marked rp in the diagrams of Comarocystites punctatus. From this plate the linear hydropore passes diagonally downward and toward the right, across the

suture, to the plate bordering on the posterior margin of the right stereom protuberance. The stellate grooving of the deeply concaved plates is clearly defined. The specimen is still partly imbedded in the rock. Kimmswick limestone, Cape Girardeau, Missouri. 1D, diagrammatic representation of arrangement of lamellae on interior surface of one of the thecal plates.

Fig. 2. Comarocystites shumardi, Meek and Worthen. Specimen No. 10472, in the Worthen collection at the University of Illinois. Type, used for figures 1a, and 1b, on plate I and diagram on page 292, Geol. Surv. Illinois, Vol. 3, 1868. Anterior side with the apical part flattened by pressure and depressed toward the left. The thecal plates surrounding the left pair of arms, as far down and including the anal pyramid, are missing. (Comarocystites shumardi obconicus forms No. 10473 in the Worthen collection). Cape Girardeau, Missouri.

Fig. 3. Comarocystites shumardi, Meek and Worthen. One of two specimens numbered 1574 in the Illinois State Museum of Natural History. Left anterior side of the theca, weathered away so as to expose the vertical mesostereom lamellae at the sutures separating the thecal plates. The stereom protuberance supporting the left pair of arms is located in the upper left hand corner of the figure, and the base of the theca lies beyond the opposite corner. The plate supporting this protuberance shows traces of the lamellae and of the inter-lamellar spaces connected with the respiratory system, corresponding to the more striking evidence of this system in the other plates. Three thecal plates are represented in the figure toward the right of the protuberance, both along the upper and lower margins of the figure. Each plate exposes two sets of lamellae, directed perpendicularly to two different suture lines. In each set, the lamellae extending from the middle of the suture lines are longer, and those nearer the angles of the thecal plate are shorter. The grooves separating the sets of lamellae belonging to the same plate from each other narrow toward the angles. The deep triangular pits at the angles of junction of the thecal plates produce a similar appearance. The sides of five additional plates are exposed in parts extending beyond the lower right hand corner of the figure, but these did not show up well in the photograph utilized in the preparation of this figure.

Fig. 4. Caryocrinites ornatus, Say. Arms with pinnules attached. Opposite the number 4, and near the base of the figure, are two pinnules which are entire.

Fig. 5. Caryocrinites ornatus, Say. A, arm with pinnules attached, only the basal parts of the latter well seen near the middle of the figure. Several of the larger brachials bear a strongly nodose protuberance. B, an adjacent arm of the same specimen, showing the granulate surface, and the pronounced alternation of longer and shorter brachials. Figures 4 and 5 are enlargements of specimens in the collection of Frank Springer in the U.S. National Museum, at Washington, and were prepared by Mr. Herrick E. Wilson.

PLATE V.

Comarocystites punctatus, Billings. Specimen retaining the entire length of the column, including the basal attachment disk (described on page 89 of present volume). Figure reduced to about eight-tenths of the natural size. Only the left arm in the figure is attached to the theca. The right arm may have belonged to another individual. Presented to the Victoria Memorial Museum by Sir James Grant, who published the first description and figure in 1880. (Trans. Ottawa Field-Nat. Club, 1, pl. 1, fig. 1.)

KILDEER PLOVER.

Ten years ago the Kildeer Plover (*Oxyechus vociferus*) was a rare summer resident in the Province of Quebec. During the past five seasons the bird has become very numerous and is now a common breeder, nearly one hundred nests having been found in the past four or five years. Several observers agree that the Kildeer is spreading rapidly throughout the Province, as in the case of the Meadowlark, which was also very rare a few years back.

The Killdeer usually arrives during the first week in April and a little later the birds have chosen their summer homes. Pebbly or rocky pastures and hillsides, near ponds, are their favorite grounds for nesting purposes. From April 24th to May 6th the set of three or four eggs may be found in such localities. The novice may have some difficulty in discovering the nest amongst pebbles and lichens so cunningly are the eggs placed and so well do they harmonize with their general surroundings; but the experienced eye can detect the eggs some yards off. The saucer-shaped nest is generally encircled by pebbles or stones and is lined with lichen, pieces of wood and weeds, manure and pebbles. One nest was located amongst stones near a stone fence. One pair of birds were successful in raising a brood alongside a wagon road running through a pasture.

During the mating season the birds are evidently nervous, as they make many attempts in excavating holes or nests in the ground, or perhaps these are only decoy nests. The real nest, however, is usually not very far away from such endeavors. In two instances the bird has been flushed off the nest a few feet away, but this is the exception rather than the rule. If one is watchful the bird may be seen running quietly away from the nest, but I believe the birds are off feeding most of the time, especially in bright, warm weather. The eggs have often been found with no birds in sight. Usually, however, they are very alert and soon make their presence known should anyone pass near the vicinity of the nest. After the nest is found it is rather amusing to watch the actions of the female. The bird, of course, is endeavoring to lead the intruder away and will squat down in some slight hollow in the ground as if she were about to settle on the nest, and will keep this performance up for some distance should she be successful in her efforts, returning to the nest by a circuitous route. I have only seen one bird feign a broken wing and turn somersaults, thus displaying the beautiful plumage of this species. The Killdeer raises at least two broods in a season.

W. J. BROWN.

BIRD NOTES.

BY FRANK C. HENNESSEY, B.A.

RAPACITY OF THE BRONZED GRACKLE. (*Q. q. aeneus.*)

At Albion, Michigan, on May 25, 1916, and also on the 29th of the same month, I observed an action which, so far as I know, has not been attributed to the bronzed grackle.

While passing down a street of the suburbs of Albion, I noticed an English sparrow feeding in the dusty road. As I came within forty feet of it, a grackle, seemingly without provocation, swooped down from a nearby tree and fell upon this unsuspecting bird. With a succession of rapid blows the grackle killed the sparrow outright. Before I could prevent it, a friend who was with me ran out to drive off the grackle. The grackle was a male. On examining the bill and feathers of the dead sparrow, I found that this bird was not young, in fact, I am certain that it was mature. On plucking the sparrow I found that the neck and base of the skull were badly bruised. The injury seemed to indicate that it had been killed by sheer impact of blows.

On the other occasion my attention was caught by a great clamoring of English sparrows. A grackle in their midst was being pursued, and finally floundered into some nearby trees. A mature, dead sparrow was left behind on the road.

On both occasions, unfortunately, I was prevented from witnessing what the grackle would have done with its victim if left undisturbed. This, of course, deprives one of determining the significance of the action in question. My friends at Albion told me of witnessing two other instances of similar action by "blackbirds."

RESTRICTED BREEDING COMMUNITIES OF THE HENSLOW'S SPARROW.

From May 25 to June 2, 1915, at Barbee Lake, Kosciosko County, Indiana, and from June 2 to June 11, 1916, at Albion, Michigan, I had an opportunity of studying the Henslow's sparrow.

On both occasions the sparrows occurred in low, wet meadows. The interesting point to me is that although there were many spots identically the same as those frequented by the sparrows, the birds occurred at one spot only in both of the regions studied.

At Barbee Lake, Indiana, the birds were found only over an area of about one-quarter of a mile square, at the south end of the Lake. Here there were about twenty birds, and the conditions of the cloaca and the egg stages in the oviduct of the female specimens collected showed that they were on their breeding ground. The females were always in greater evidence than the males, and most of the birds collected were of this sex.

At Albion, Michigan, the birds were found only over an area of about one-half a mile square. I explored extensively the country about Albion to within a radius of seven miles of the town, and although this region abounded with suitable localities for the breeding of Henslow's sparrow, I found them only at one spot east of the town. I estimated that here there must have been from forty to sixty birds.

The question arises, do these observations tend to show that the species group during the breeding period?

EUROPEAN BUTTERFLY FOUND AT LONDON, ONT.

During the past few years Mr. John A. Morden, of London, Ont., has captured an unkown butterfly of a shaded orange colour, belonging to the skipper family. On sending it to the authorities at Washington it was determined as *Adopea* (*Pamphila*) *lineola*.

This European insect does not seem to have been previously reported from America. Mr. Morden first found it near the Dundas Street Bridge where refuse had been dumped. Possibly the eggs of the insect came from Europe with something that was thrown out and when hatched the larvæ found food in close proximity.

Mr. Morden says that the butterfly is now moderately common during July and is apparently spreading over the city.

The first capture was made July 21, 1910, when 10 specimens were taken, mostly worn. In 1911, most of the quack grass (*Agropyrum repens*) around the dump where the insects were taken had been killed and none were seen at that locality, but two were taken at Paul street not far away, in a waste lot overrun with quack grass.

Each year since then he has found them in a strictly wider area and, in 1914, one was taken in Hyde Park, five miles away.

To Mr. A. A. Wood, Coldstream, who has been working on the matter in conjunction with Mr. John A. Morden, I am indebted for these facts.

W. E. SAUNDERS, London, Ont.

BOOK NOTICE.

"Water Powers of Manitoba, Saskatchewan and Alberta," issued by the Commission of Conservation, is a valuable contribution to the literature respecting the natural resources of Western Canada. This report, by Leo G. Denis and J. B. Challies, comprises the results of special surveys by the Commission of Conservation and a compilation of records from other reliable sources.

While the Prairie Provinces, as a whole, are not lavishly endowed with water-powers, the report demonstrates that the utility of their rivers for power development can be vastly enhanced through proper storage of flood waters. At present in the absence of conservation dams, and of adequate natural regulation, the great volume of flow is lost during high water seasons. Methods of development to ensure the maximum utilization are now being carefully worked out on the Winnipeg, Bow and other large rivers. The more northerly regions possess numerous sites of great potential value for pulp, electro-chemical and other special industries.

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