ART. XXVIII.—*Remarks on Glyptocrinus and Reteocrinus, two Genera of Silurian Crinoids;* by CHARLES WACHSMUTH and FRANK SPRINGER.

IN the second part of our Revision of the Palæocrinoidea, at page 185, and following, we undertook to define the character and relations of *Glyptocrinus* and allied genera, in such a manner as to render it possible to group the species thereunder with some approach to their natural order. As is well known to every one who has attempted to identify the species, the American Silurian Crinoids are an extremely difficult group to understand. There are a few well marked species, of which ample collections have been made in Ohio and Indiana, but a large number of species have been described by Billings, Hall and others, from very meagre and imperfect material. Of many of these forms specimens are exceedingly rare, and we are often obliged to rely upon illustrations which are unsatisfactory, and descriptions which are necessarily defective in the delineation of specific and even generic characteristics. Under these circumstances it was scarcely to be expected that our conclusions would prove entirely satisfactory, even to ourselves.

Our treatment of the genera *Glyptocrinus* and *Reteocrinus* has been somewhat sharply criticized by Mr. S. A. Miller, in the Journal of the Cincinnati Society of Natural History for April, 1882, in connection with the description of some new species un-

der the first name. He objects to our definition of the characters of the former, to our rectification of the latter, and to our reference of species thereto. He also intimates that we have taken unwarrantable liberties with Billings' genus, and been guilty of a lack of proper respect for the work of its founder.

We have given to the remarks of Mr. Miller the consideration that is due to the observations of a gentleman of acknowledged learning, and whose researches in the literature of this branch of Natural Science have lightened the labors, and merited the thanks of every American Paleontologist; and have reviewed the species referred to the two genera in question with the aid of somewhat better material, as to some of them, than was at our command before.

With regard to *Glyptocrinus*, Mr. Miller states that we "seem to have been practically unacquainted with the genus;" in support of which he instances the fact, that our diagnosis requires that the surface of the plates should be "ornamented with radiating striæ in the form of elevated ridges, which divide into numerous triangular, impressed areæ;" that the basals should "scarcely extend to the sides of the body;" that the second radials should be "hexagonal," the third radials "pentagonal," and that there should be "twenty arms."

It is true that we have in our diagnosis ascribed these characters to the typical form of the genus, but in singling them out as the essential characters by which we define the genus and separate it from others, Mr. Miller is either somewhat uncandid, or else he has overlooked our distinct statement, under the head of *Glyptocrinus* on pages 186 and 187, of the characters by which it is separated from *Glyptaster* on the one hand, and *Reteocrinus* on the other. When we began the systematic investigation of this group, we found an assemblage of species referred to the above named genera, in such a manner as to render the recognition of generic limits impossible. This was especially the case with *Glyptaster* and *Glyptocrinus*. After much perplexing study we recognized the three types, into which these species might be grouped somewhat more satisfactorily than before; one of which was represented by the two species described by Billings as *Reteocrinus*, but with a misconception of their true characters.

It may probably be said with justice, that in this case, as perhaps in some others, we have adhered in our diagnosis of generic characters rather closely to the particular form which we regard as typical, and have not in express terms indicated the limits to which variations of these characters may and do extend. That modifications of characters and departures from the typical form in various directions are to be expected within the limits of every genus, is a fact which we have always

admitted and repeatedly asserted. We do not know of a single genus, illustrated by any considerable number of specimens, in which there are not some forms exhibiting a variation of one or more of the typical characters, and constituting transitional forms between that and some allied genus. The same may be said of some of the best defined species, and indeed, this observation may be extended to almost every group, whatever be its rank, which naturalists have attempted to separate and define. For example, one of the best characters of *Actinocrinus* is the simplicity of the arms, which almost universally remain undivided after becoming free. Yet we find in one of the latest species, *A. Lowei*, which otherwise retains and exaggerates all the characteristic features of the genus, that some of the arms in each ray bifurcate beyond the body; and isolated specimens of other species have been found in which such a bifurcation occurs in one or two arms out of the whole number.

No method of systematic classification has as yet been devised to adequately provide for all such cases; and we do not believe it possible so to limit and define the characters of a genus, as to escape the difficulties arising from modifications due to individual growth, and the variations of types in geological time.

A modification of the phraseology of our generic descriptions of *Glyptocrinus* and *Reteocrinus*, by which the existence of certain of the less important characters, such as surface ornamentation, the number of arms, and the geometric form of plates should be stated in less absolute terms, and with greater allowance for exceptional cases, would apparently meet the objections urged by Mr. Miller on this point; and we may find it advisable to make such alterations hereafter in this and perhaps other cases. It did not occur to us that our language was liable to misconception in this respect, in view of our frequent expressions as to the value of such characters, and our explicit statement of the leading characters. We do not regard the number of arms, for instance, as an absolute specific distinction, much less generic, although it is often an *important* character in connection with others, and a useful guide to the recognition of types; but departures from the prevailing rule are of frequent occurrence in genera, species, and even in the different rays of the same individual. This fact we have time and again pointed out in our writings. (See Rev. II, pp. 40 to 50 and other places: Transition forms in Crinoids, Proc. Philad. Acad. 1878, p. 224 et seq.) These considerations, however, and any modifications we might make in our language to avoid further misunderstanding, would not in the least affect the validity of the separation of the two genera *Glyptocrinus* and *Reteocrinus*

as we have defined them, or the reference of species thereto, in any substantial respect.

Mr. Miller expresses the opinion that our "separation of the species under this genus *Reteocrinus* and that of *Glyptocrinus*, shows to one familiar with the structure such a cross mixture of character as to indicate a want of general acquaintance with the genera and species," and after referring to Billings' statement of the generic characters of *Reteocrinus*, he asserts that "up to this time no Crinoid possessing the characters ascribed to this genus has been found in the Hudson River group of this locality" (Cincinnati).

We freely admit the great advantage which flows from an intimate familiarity with the fossils at the locality from which they are derived. An accurate knowledge of the mode of occurrence and distribution of the respective species, and their association with other fossils, such as can only be gained by the collector himself, furnishes an aid to the interpretation of their systematic relations, whose importance cannot be underestimated. For this reason, upon questions relating to these genera, we attach much weight to the opinions of our Cincinnati friends, who not only are themselves collectors as well as investigators, but have access to the other numerous fine collections that have been made in that locality; and we are gratified to be able to avail ourselves of the benefit of their observations, whether critical or otherwise. In a work of the nature of ours, so beset with difficult problems in classification, we do not expect to be exempt from error and shall be only glad if others are led to the investigation of these questions independently, because we are sure that by the operation of different minds, considering the subject from other points of view, and with other material than ours, a nearer approach to correct results will be gained.

When it appears, however, that the two leading naturalists of Cincinnati, after such critical study of the subject as is necessary to enable them to describe new specific forms, have reached conclusions diametrically opposite with regard to the characters and relations of *Reteocrinus* and *Glyptocrinus*, we may perhaps be warranted in attaching somewhat more importance to the results of our own studies, which we can see no reason to think less reliable, in any material respect, on account of any thing that has been thus far advanced against them.

Prof. Wetherby, in connection with the description of his interesting species *Reteocrinus* (*Glyptocr.*) *Richardsoni* (Journ. Cin. Soc. Nat. Hist. 1880, vol. ii, Pl. 16) observes, that the different species of *Glyptocrinus* found in the Cincinnati group "naturally fall into two groups, the extremes being represented by *Gl. decadactylus* and *Gl. Nealli*;" that "these two groups are

closely united by a series of intermediate forms, of which the *Gl. Richardsoni* is the last and most important link;" and also that "the *Gl. Nealli* . . . . seems to be as closely allied to *Reteocrinus* of Billings as to *Glyptocrinus*." Afterward, in the April, 1881, number of the same Journal, Prof. Wetherby, with his new species *Reteocrinus gracilis* under consideration, makes the following statement, under the head of *Reteocrinus:* "Under this generic name, Mr. Billings described two species from the Trenton rocks of Canada, in the publication cited above. Like most of the fossils of the locality whence they were obtained, these were in a very poor state of preservation. Enough is shown, however, by Mr. Billings' figures to make it conclusive that several forms of our so-called *Glyptocrinus* should be referred to this genus. Among them I should place *Gl. Nealli* Hall, *Gl. Richardsoni* Wetherby, and the species of which the description is to follow" (*Reteocr. gracilis.*) This opinion of Wetherby was before us when preparing the second part of our Revision for the press, both in its published form, and more at length in private notes, and as he could scarcely be said to be "practically unacquainted with the genus," we naturally attached much importance to it as a confirmation of our own views.

Furthermore, Meek, in re-describing "*Gl. Nealli*" in the Paleontology of Ohio, vol. i, p. 34, and having before him at the time many of the finest Cincinnati collections, alluded to the characters of this species as "showing a decided approximation toward *Reteocrinus* of Billings."

These extracts will be sufficient to show that so far as authority, and the discoveries of the latest and most competent observers, could furnish a guide, we were fully warranted in referring *Gl. O'Nealli* and allied species to *Reteocrinus.* A consideration of what we have stated in our generic descriptions, and our repeated allusions to these two genera in the discussion of family relations, will also show that we made such reference after due deliberation and careful study, and for reasons still more conclusive than those stated by the above mentioned authors. We have considered *Glyptocrinus* a form of the utmost interest and importance, and have made it the foundation of our discussion of the family relations of the Actinocrinidæ and Rhodocrinidæ.

Let us now endeavor to ascertain what the *Reteocrinus* of Billings really is; and we wish to state in this connection, that we yield to none in admiration for the work done by E. Billings in fossil crinoids. He was continually embarrassed by the poverty of his material, and the wonder is not that he made mistakes, but that he made so few. His excellent judgment, keen discrimination and scientific methods, we have

reason to appreciate, not only from his published works, but from an extended correspondence with one of the writers during the preparation of his admirable articles on the structure of Crinoidea, Cystidea and Blastoidea, in 1869.

Billings established his genus *Reteocrinus* upon two species, *R. stellaris* and *R. fimbriatus*, which are described in Decade iv, of the Geol. Surv. of Canada, pp. 64 and 65, and illustrated on pl. ix, figs. 3, 4. Of *R. stellaris*, which he took for the type of the genus, he had four specimens, three of which were fragmentary, and all of them in such a poor state of preservation, that Billings himself says at the end of the description, that "none of the specimens collected are perfect, and the characters of the species, therefore, have not been fully ascertained." The interradial spaces were very deeply depressed and filled with a hard matrix of limestone, which concealed from view the whole interradial portion of the calyx, with the exception of some small stellate points, which are now known to be the projecting summits of the plates. His principal specimen, fig. 4*a*, was so imperfect that Billings seemed to think that the ridge-like series of anal plates on the azygous side might possibly be an arm, and that there might be six (primary) arms in the species, although the generic description calls for but five primary radials. He considered the plates following the first primary radials to constitute arms, and found that the right (left posterior) of these "arms" divided on the fourth joint, but the others he could not see distinctly. The genus, of which this was the best specimen of the typical species, he considered to have "no perfectly formed plates," and its cup to consist of a "reticulated skeleton, composed of rudimentary plates, each consisting of a central nucleus, from which radiate from three to five stout processes," (Dec. iv, p. 63), characters which do not exist, as subsequent investigation of the type specimen has fully demonstrated.

R. fimbriatus, the second species, was described from a singl specimen, Dec. iv, pl. 9, fig. 3*a*, and this, as Billings states, is "very imperfect." There is enough, however, in his figure and description to show, that in the opinion of the founder of the genus, a species having a pentagonal column; the "basals" (underbasals of our terminology) minute; the "subradials" (basals) one line in height; the arms several times divided (but only once in the body); a bifurcation on the third primary radial; and the spaces between the rays "*filled with very small plates*," might properly be referred to *Reteocrinus*. These characters apply equally well, and with scarcely any variation, to the so-called *Glyptocrinus O'Nealli* Hall, *G. cognatus* Miller, *Gl. Bœri* Meek, and *Reteocrinus gracilis* Wetherby, and with the exception of the column, to *Gl. Richardsoni* Wetherby, *Gl.*

Pattersoni Miller, and *Gl. subglobosus* Meek, all from the Hudson River Group at or near Cincinnati; and this may be taken as a sufficient answer to Mr. Miller's statement, on page 13 of the author's edition of his paper before cited, of the essential characters of *Reteocrinus*.

In 1869, in a letter to one of the writers, Billings himself stated that *Glyptocrinus O'Nealli* was certainly not a *Glyptocrinus*, and indicated its probable relationship to *Reteocrinus*. Unfortunately we are unable to find his letter, or we should quote his exact language.

In order to obtain, if possible, some additional information as to the exact condition and character of the typical specimens of *Reteocrinus*, we applied to Mr. Walter R. Billings, of Ottawa, Canada, a nephew of E. Billings, and himself a very acute observer and ardent naturalist, and requested him to examine the original types deposited in the Museum of the Canadian Geological Survey, and advise us of the facts. This Mr. Billings has done, with an intelligence and care which merits the highest commendation, and a generous kindness for which he has our warmest thanks. We quote the following extract from his letter of July 10th, 1882:

"Your communication contains an uncleaned but very perfect specimen of *Glyptocrinus O'Nealli* Hall, (*Reteocrinus O'Nealli* of Wetherby, Wachsm. and Spr., and others) with a request that I compare it with the type specimen of *Reteocrinus* in the Canadian Survey Museum, and inform you as to the facts. Prof. Whiteaves, Palæontologist G. S. C., with his characteristic kindness, granted me full permission to examine the type specimens of *R. stellaris*, and I have given special attention to those figured in Decade iv, G. S. C., as 'figs. 4*a*, 4*d*.' Both these specimens are obscured by a hard adherent matrix, which in so valuable specimens would require a skilled lapidary to remove; however, with a soft brush and a little moisture, I readily removed small loose portions of shale, and made the determination of the leading points easy.

"The column is as originally described.

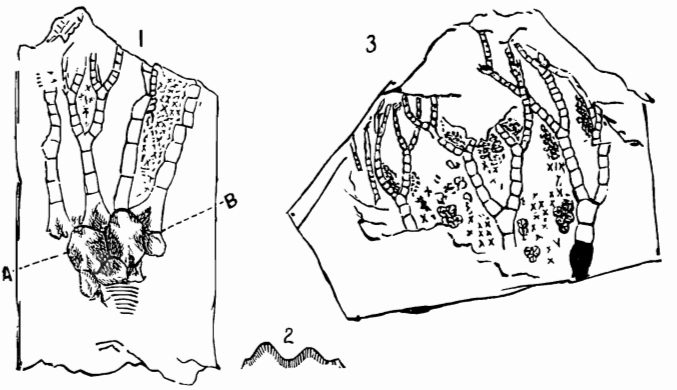
"In the specimen figured '4*d*,' I find a series of five (5) subequal plates, resting on the column, each bearing a bow-shaped ridge with sinus upward, not in contact with the margins, except where it meets corresponding ridges on the succeeding plates above; the remaining portions of these plates are depressed from $\frac{1}{2}$ to $\frac{3}{4}$ of a line. The plates of the second order alternate with those of the first (two are tolerably well shown on the specimen 4*a*), and are heptagonal, resembling a hexagon slightly truncate, they have ridges corresponding with, and forming continuations of, those on the plates below, which meet in the center, and divide to become continuous with

ridges on the succeeding series of plates. The plate of the azygous side has three ridges passing upward; one from the center to become continuous with a ridge following the median part of the azygous interradius; the remaining two, which are directed obliquely, meet with similar ridges on the adjoining plates of the third order. The depressions between the ridges of the plates of the second order extend slightly to the plates of the first and third order; they are deep, especially the larger one at the azygous side, which has a depth of $\frac{3}{4}$ of a line. The plates of the third order, which alternate with those of the second, are radial in position, and support in an upward direction a row of other plates with strong, rounded, arm-like ridges, which in the specimen resemble closely arm plates, as which they were described by E. Billings. They are, however, evidently radials with elevated ridges, similar to the primary radials of *Gl. O'Nealli* Hall, which, like these, were connected laterally by interradial plates, and formed a part of the calyx. This is indicated by the numerous stellate pieces interspersed between the ridges, which in all probability represent interradial plates, of which only the elevated central portions are exposed to view, while their depressed margins are obscured by matrix. These stellate pieces are continued as high as the third plate of the secondary radials, and I have observed one within the axis of the first bifurcation to the left of the azygous series, thus indicating that the body in this species is not confined to the three lower angles of the plates, as suggested by E. Billings, but that it extended to the secondary radials.

"So far as the imperfection of the material will admit of comparison, there is a strong resemblance between *Reteocrinus stellaris* and *Glyptocrinus O'Nealli* Hall, which extends not only to the arrangement and form of first, second and third ranges of plates, but to the entire radial and interradial series, in view of which, and in the absence of any points of more than specific distinction, I am led to think the two forms congeneric.

"In addition to the two specimens on which these remarks have been founded, and to those figured in Pl. 9, Dec. iv, G. S. C., there is in the G. S. C. collection a flattened specimen, showing the side opposite to that shown in fig. 4*a* (loc. cit.), but wanting the first three ranges of plates, leaving the identity of the species not quite positive. This specimen (fig. 3, infra), has the interradial series more clearly and fully shown, and is filled with stellate pieces as high as the third secondary radials, below which they are interspersed with smaller and flatish plates, which grow smaller above, and disappear either lost in the matrix or through preservation. At one point at least, these small plates are seen to be continued with the arm pieces; they may represent the vault, and if so, this is another point of resemblance to *Gl. O'Nealli* Hall."

In addition to the above expressed details, Mr. Billings has furnished us drawings of the type specimen (fig. 4*a*), as it appears after being somewhat developed by cleaning, which shows that the three lower ranges of plates, instead of being "rudimentary," are perfectly formed, connected with each other by distinct sutures; much elevated in the middle and marked with strong radiating ridges, and having greatly flattened wing-like margins, which were before obscured by the matrix. He also figures the flattened specimen referred to in his letter, but not figured in the Canada Reports.



Reteocrinus Billings.

Fig. 1. Billings's type specimen (Geol. Rep. Can., Dec. iv, Pl. 9, fig. 4*a*). Fig. 2. Section A–B, to show depression of margins of plates. Fig. 3. Specimen in G. S. C. collection not figured before. All from drawings by Walter R. Billings.

We think that with these figures, and the notes above quoted, the question of the generic identity of *Gl. O'Nealli*, and allied forms with *Reteocrinus*, may be considered at rest.

By following the strict letter of the rules of nomenclature, we might have been justified in setting aside Billings' genus entirely, and re-describing the type under a new name, for the reason that the leading characters ascribed to it as generic, do not in fact exist in his own species or elsewhere. This has been partly done both by Zittel and De Loriol, neither of whom recognize *Reteocrinus* at all. But the true spirit and intent of the rules of scientific nomenclature do not require such a course. We consider it far more just to the original observer, who has called attention to a new generic type, to assign to it the true characters as disclosed by subsequent investigation, and retain the genus so modified as to include such forms as are naturally congeneric with the species first described, than to deprive him, by a technical adhesion to a strict rule, of all credit for his work, and burden science

unnecessarily with new names. If under these circumstances it happens, that the true characters of the group are better and more comprehensively expressed in some other species than the one first described, there is, in our opinion, not the least objection to adopting it as the type of the genus thus rectified. And where the original species is imperfectly known, this is the only rational thing to do, because we cannot well take, as the type of a genus, a species which is not itself accurately defined. The rules are intended to promote accuracy and clearness in scientific determinations. We do not believe they require absurdities, but if any of them does, the sooner it is abrogated the better.

Mr. Miller thinks that in making *Gl. O'Nealli* the type of *Reteocrinus*, we have been guilty of an "open violation of the rules of nomenclature." We think our practice in this respect fully justified by the consideration above stated. At all events we shall adhere to it, and we find that other good authorities do the same thing.

A few words now as to the relations of these two genera. At various places in Pt. II, of our Revision, for example pp. 7, 95, 183–187, we have alluded to the intimate relation which exists between the families Rhodocrinidæ, with two rings of plates below the radials, and Actinocrinidæ with but one. We have shown how *Glyptocrinus* with its rudimentary under-basals, and its interradial series, all above the line of the first radials, formed a connecting link between the two families, approaching the *Rhodocrinus* type in the first character, but in the second departing from all other genera of that family, and exhibiting an approach to some of the earlier forms of the Actinocrinidæ. Its close affinities with *Reteocrinus*, with which we stated (p. 183), it to be "connected by most remarkable transition forms," led us to refer *Glyptocrinus* to the Rhodocrinidæ, although there were almost as good reasons for referring it to the Actinocrinidæ. It might perhaps have been well to place it in a section by itself, on account of the exceptional disposition of its interradials.

It is an important fact that in all Actinocrinidæ, without a single exception, the regular interradial series rest upon the edges of the first radial plates, and are not extended down to the basi-radial suture. In the Rhodocrinidæ, the first interradial and anal plates all rest upon the basals, except in *Dimerocrinus*, *Glyptaster*, *Eucrinus*, *Lampterocrinus* and *Glyptocrinus*. In the first four of these genera, the anals rest upon the basals, though in *Dimerocrinus* the regular interradials sometimes barely touch them. *Glyptocrinus* is the only genus of the Rhodocrinidæ in which neither the anal nor interradial plates are in line with the first radials, or in contact with the

basals, and it is this character, as far as we can discover, which distinguishes it best of all from *Reteocrinus*, and upon which a few species of the type of *Gl. decadactylus* can be satisfactorily grouped. Of the species which we referred to *Glyptocrinus*, it will be observed that *Gl. fimbriatus*, *Gl. nobilis*, *Gl. Shafferi*, and *Gl. subglobosus* were mentioned as doubtful for reasons there stated, and had our printed copy corresponded with our original notes, *Gl. ramulosus* and *Gl. ornatus* would have been noted with like reserve, owing to the impossibility of accurately determining their characters from the specimens described. Of these we have become satisfied that *Gl. subglobosus* is a *Reteocrinus*, very closely related to *Gl. Bœri*, and *Gl. Shafferi* and its variety *germanus* are evidently immature specimens, as to whose generic characters we are unable to satisfy ourselves from the figures and descriptions. *Gl. ramulosus* is probably an *Archæocrinus*. In *Gl. ornatus* the figure shows the upper parts to be so obscured by the matrix, and the base to be so imperfect, that we cannot pass an opinion on it.

Of the remaining species, *Gl. angularis* is a departure from the typical form in the direction of *Glyptaster*, to which, or more likely to its subgenus *Eucrinus*, it might, perhaps, be advisable to refer it. *Gl. priscus* is a young *Glyptocrinus* with strong transitional characters toward *Reteocrinus*. The highly elevated connecting ridges on the larger plates are very similar to the so-called "processes" of Billings' *Reteocrinus stellaris*. *Gl. parvus* is apparently a young example of a typical *Glyptocrinus*, which therefore has the basals comparatively large, but as the anal side is unknown, it is not wholly free from doubt. Of *Gl. Fornshelli* we unfortunately have not the description. Miller's *Gl. Miamiensis*, Cincin. Journ., April, 1882, is apparently a *Glyptocrinus* with variation of characters toward *Reteocrinus*. The genus is therefore typified by *Gl. decadactylus*, *Gl. Dyeri*, Miller's new species *Gl. sculptus*, and probably *Gl. parvus*, whose characters are, as stated in our diagnosis, to wit: a sculptured surface; rudimentary underbasals; small basals; the interradial and anal spaces occupied by plates of definite arrangement, all located above the line of the first radials, and nearly equally distributed among all five rays; and twenty arms. And if we further state that the body plates are "generally" ornate, and that there are twenty arms "as a general rule," it will enable us, without offending against any requirement of critical accuracy, to bring within its limits those transitional species above mentioned, which seem to be nearest to its type. *Reteocrinus* is readily identified by its highly elevated radial ridges and depressed interradial spaces, filled with numerous small plates of irregular arrangement, and extending between the first radials down to the basals; by its under-

basals, often well developed; its strongly marked bilateral symmetry; and by its ten primary arms as a rule. It is typified by *Reteocrinus O'Nealli*, *R. cognatus*, *R. gracilis*, *R. stellaris*, *R. fimbriatus;* while *R. Richardsoni*, *R. Bœri*, *R. subglobosus* and *R. Pattersoni*—the latter described by Miller as a *Glyptocrinus*, Cincinn. Journ., July, 1882—are good examples of it in every respect, except that the underbasals have not as yet been noticed, and perhaps do not exist; although we think it very probable that they may be found to possess these plates in a more or less rudimentary form as in *Glyptocrinus*. We do not consider it necessary or advisable to separate these species from the typical form upon this character alone, since the whole assemblage of species above named forms a group, which is united by other well defined characters. The slight modification of our statement of generic characters renders it easy and natural to include them all.

In the Cincinnati Journal for April, 1881, Mr. Miller described two very interesting aberrant species from the Lower Silurian near Cincinnati. One of these, *Gl. Harrisi*, is a *Glyptocrinus* with a quadrangular column and, possibly, quadripartite base, and having the anal series, as we learn from the figures, extended down to the basals. If it has in fact four basals, it would be a good *Mariacrinus*, were it not for the position of the first anal plate, which is not in contact with the basals in any of the *Melocrinites;* or it would have the calycal structure of *Abacocrinus* without the other characters of that genus; showing thus a tendency toward the Actinocrinidæ. If on the other hand it has five basals, it would represent a variation from the *Glyptocrinus* type in the direction of the Glyptasterites, without however any development of underbasals. The other species for which Miller has established a new genus, *Xenocrinus*, has a quadrangular column and four basals; surface devoid of ornament; the radials highly elevated; interradial spaces deeply excavated and filled with a great number of small irregular plates; ten arms; bilateral symmetry; and no underbasals as yet observed. So far as we can judge from the figures (Journ. Cincinn. Soc., April, 1881, Pl. I, figs. 3*a*, 3*b*, 3*c*; and July, 1881, Pl. IV, fig. 6), all the interradial series rest upon the basals, although the description is silent as to this character. It is, therefore, a *Reteocrinus* with four basals, and represents a differentiation of the *Glyptocrinus* type toward the Rhodocrinoid form, with the basal characters of the *Melocrinites* section of the Actinocrinidæ. We think Miller was perfectly correct in referring it to a new genus, and in case the *Gl. Harrisi* should prove to possess a quadripartite base, and the discovery of other specimens shows this character to be constant, we should be disposed to adopt the same course with that form.

Mr. Miller considers it probable that *Gl. Harrisi* has five basals, because "in all other respects it agrees with *Glyptocrinus*"—not recognizing the difference in the disposition of the anal plates—but states that "if it possesses but four, it would not belong to *Xenocrinus*, but would still be very closely allied to *Glyptocrinus*." We confess we are somewhat at a loss to understand just what Miller's views are, as to the limits of this genus. He objects to our reference of *Gl. O'Nealli* and allied species to *Reteocrinus*, and at one place considers the *Gl. O'Nealli* and his own *Gl. cognatus*, and therefore necessarily *Gl. Bœri*, to be true *Glyptocrinus*. At another, in describing his *Gl. Patersoni* (Journ. Cin. Soc., July, 1882), he states that the species differs from all other species of *Glyptocrinus* in having only ten arms. We can scarcely suppose that, when making this statement, he overlooked the fact that not only the *Gl. O'Nealli* and *Gl. Bœri*, but also *Gl. cognatus* which he had himself described a year previously, have but ten arms; but we infer that he then considered these species to be generically distinct from *Glyptocrinus*. If this be not so, how can it be said that *Xenocrinus priscillus*, which is in every respect a *Gl. Bœri* with four basals and a square column, would be generically distinct from *Gl. Harrisi*? Suppose each of them had five basals; would both be *Glyptocrinus*? Evidently not, according to Miller's reasoning above quoted; and if these two forms are generically distinct by reason of characters other than those at the base, surely *Gl. Bœri* and *Gl. decadactylus*, which differ in precisely the same way, must be.

A reinvestigation of the genera herein discussed, and their allies, has impressed us more than ever with the idea stated frequently in our Revision, that this little group of Lower Silurian Crinoids represents an embryonic type, from which both Rhodocrinidæ and Actinocrinidæ were developed. They are among the earliest forms we know, and they stand in a similar relation to these families that *Heterocrinus* and its allies hold to the Cyathocrinidæ. In both there is the same rudimentary and varying development of characters, which when fixed and constant, become of family importance. In both are found the types of the fundamental structure of the respective families in very simple forms, whose differentiations in various directions led to the several subdivisions and genera, into which these families have been divided. Within each there is found a commingling of characters which is a source of endless perplexity to those who are seeking to discover some clew to a natural classification. We are disposed to think that a further subdivision of the families, whereby these embryonic types should be placed in separate subfamily groups, would tend to eliminate some of the difficulties we have encountered,

and to this end we shall very probably hereafter propose to arrange in a distinct group the genera *Glyptocrinus*, *Archæocrinus*, *Reteocrinus*, *Xenocrinus*, *Glyptaster* and *Eucrinus*, and possibly one or two others, so as to constitute a subfamily, intermediate between the Actinocrinidæ and Rhodocrinidæ, and through which the latter are united to form the great family Sphæroidocrinidæ.