INFRABASALS IN RECENT GENERA OF THE CRINOID FAMILY PENTACRINITIDÆ.

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Although so long ago as 1885 Wachsmuth and Springer showed that *Isocrinus* and *Metacrinus* are constructed upon the dicyclic principle, infrabasals have as yet never been detected in any species of *Metacrinus* nor in any recent species of *Isocrinus*. It is now known that all recent crinoids, with the single exception of *Hyocrinus*, are dicyclic; but infrabasals have never been actually demonstrated except in two species, in *Antedon bifida* by Bury, and in *Calamocrinus diomedæ* by Alexander Agassiz.

Dr. P. H. Carpenter in his monograph on the "Comatulæ" criticizes rather sharply the so-called law of Wachsmuth and Springer for determining by the orientation of the stem whether the infrabasals are present or not in a given species, and positively asserts that they do not exist in the recent Pentacrinitidæ, although he admits that they occur in the liassic genus *Pentacrinus* (i. e., "*Extracrinus*").

The discovery of infrabasals in *Isocrinus* was made by the distinguished palæontologist P. de Loriol who, in 1894, described a new species of the genus, *Isocrinus lenthardi*, and published figures of it showing the five small radially situated infrabasals occupying a position in the center of the star-shaped figure formed by the elongate basals.

With the idea of determining whether the condition shown by de Loriol in *Isocrinus lenthardi* was repeated in the recent members of the genus and in *Metacrinus*, preparations were made of *Isocrinus decorus* and *Metacrinus rotundus* by carefully removing the upper stem joints so as to lay bare the entire dorsal surface of the basals, and it was with considerable surprise that in both species prominent infrabasals were revealed, those of *Metacrinus rotundus* especially being so noticeable that it is considerable of a mystery how they could possibly have escaped the notice of such a careful worker as Doctor Carpenter.

Two specimens of *Isocrinus decorus* were dissected, one being a small, immature example, the other full grown, and apparently mature.

In the former (fig. 1) the infrabasals are five small rounded plates, quite distinct from each other, set close together in a five-lobed rosette in the middle of the star-shaped figure formed by the basals, exhibiting practically the same condition as in the specimen of *I. leuthardi* figured by de Loriol.[a] Their protrusion beyond the dorsal surface of the basals is relatively great; they have a strongly convex dorsal surface, and show no tendency toward degeneration or resorption, as is the case with the quinquelobular rosette representing the fused infrabasals of *Calamocrinus diomedæ*. In the figure only the two infrabasals in the lower and lower left-hand portion are shown entire, the others being more or less covered by portions of the upper stem joints, which could not be removed without risking the specimen.

FIG. 1.—RADIALS, BASALS, AND INFRABASALS OF ISOCRINUS DECORUS (A YOUNG SPECIMEN).

In the adult example figured (fig. 2) the infrabasals are flatter, and appear as roughly triangular plates, with a marked depression forming a notch in the outer edge, the rounded ridge on each side of this depression being a continuation of the lateral ridges on the basals, which bear the dentate processes.

In *Metacrinus rotundus* (fig. 3) the infrabasals are rounded triangular plates, with a flatter dorsal surface than in *Isocrinus decorus*, so that their dorsal surface is even with that of the basals. As in the adult specimen of *Isocrinus decorus*, the petaloid markings are continued onto them, in the form of a prominent U-shaped ridge.

FIG. 2.—RADIALS, BASALS, AND INFRABASALS OF ISOCRINUS DECORUS (A MATURE SPECIMEN).

The topmost columnar of this last specimen appears to be much younger than any heretofore noticed in the Pentacrinitidæ (fig. 4); it is composed of a delicate calcareous network, approximately semicircular, bearing two radiating lobes of unequal size, composed of exceedingly delicate calcareous meshes. It was unfortunately impossible to discover the orientation (in reference to the plane of symmetry of the disk) of the larger lobe. Judging from the condition of this stem joint, the columnars arise at a point close to the axial cord, the growth being in each direction around (and close to) the central opening; when this growing calcareous band reaches the median line of a basal, a radiating lobe is formed which increases very rapidly in height, building up with a much more open structure than the original band. Thus we get the condition shown by this first (i. e., top-

[a] Revue Suisse de Zool., II, 1894, pl. XXIV, fig. 12*a*.

most) columnar, which has two of the primitive lobes, which will eventually become the angles of the stem, well developed, while the primitive ring is as yet barely a semicircle. It is noticeable also in stem joints which have the lobes well developed that the ring immediately around the central canal is always much more dense than the extremely delicate lobes. This points to the conclusion that the pentagonal character of the stem, at least in the Pentacrinitidæ, is derived from an ancestral type, in which the stem is composed of circular columnars, as in *Encrinus;* for, were this not so, we should expect the lobes to be developed at the same time as the inner ring, instead of being merely a delicate network of delicate calcareous threads when the latter is well developed and composed of a comparatively dense deposit.

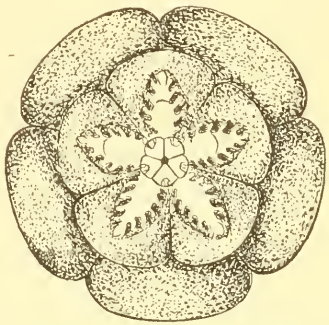

FIG. 3.—RADIALS, BASALS, AND INFRABASALS OF METACRINUS ROTUNDUS.

The second columnar in this specimen consists of a calcareous ring, bearing five unequal lobes of very delicate structure, much more delicate than the comparatively solid ring upon which they are borne; the specimen figured by Doctor Carpenter[a] on Plate XXIII, fig. 1, is very similar, but is somewhat more advanced in growth; the third columnar is similar, but shows a marked thickening all around (see same reference, Plate XXIII, fig. 2), while the fourth has the lobes of almost equal size, and the raised edges of the sectors with the dentate processes are beginning to form (see same reference, Plate XXIII, fig. 3).

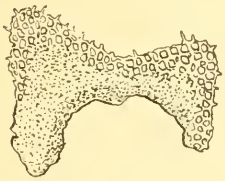

FIG. 4.—UPPERMOST COLUMNAR OF METACRINUS ROTUNDUS.

Encouraged by my success in the demonstration of the infrabasals in *Isocrinus decorus* (Wyville Thomson) and *Metacrinus rotundus* P. H. Carpenter, I decided to carry my investigations still further, and to endeavor to point them out in all the species of both genera of which I could obtain material. I also wished to isolate the infrabasals, if possible, and to determine their size and their relations to the basals. This I did not consider myself justified in doing before, and the specimens figured, therefore, were mounted on glass slides exactly in the state in which they were figured, and have now become part of the collection of recent crinoidea belonging to the U. S. National Museum, where they will be available for future study.

[a] Challenger Reports, XI, Zoology, 1884.

In a large jar containing fragments of arms and stems of *Metacrinus rotundus*, *M. angulatus*, and *M. superbus*, all from the Eastern Sea near Kagoshima, I found the upper part of a stem of *Metacrinus superbus* with part of the calyx attached, and it is on this specimen that the following observations have been based.

The method used in disintegrating the specimen was this: The stem was clipped off as near the basals as possible, and then the stump pared down with a knife as much as could be done without danger of injury to the basals, so as to leave a minimum of work to be done by the caustic. A small cavity was scooped out of the small portion of the stem remaining, and the specimen was then dried. The drying is to insure localization of the action of the caustic; for if the specimen be wet the caustic will rapidly infiltrate through the sutures and articulations, weakening the specimen so that successful manipulation is rendered very difficult; in a dry specimen, on the other hand, the infiltration is comparatively slow, and the action of the caustic may be to some extent gauged by the amount of moistening (and consequent darkening) of the exterior of the specimen. The interior infiltration appears to be more rapid than the spread of the moist area on the exterior, so that, by the time the basals are moistened all over, the specimen is ready for dissection. Dissection is accomplished under a dissecting microscope, using a lens of as strong magnification as can be employed without hindering the work by too great a diminution of the working distance and field of vision. The caustic is applied in the form of a small lump, and is allowed to deliquesce, the solution thus formed passing down the central lumen of the remaining stem joints and infiltrating out between them. When the disintegration is believed to have proceeded far enough, the specimen is soaked in water to remove the caustic, and is then ready for dissection. It will be found that the first few stem joints, being large and thick, are quite difficult of removal, and must be broken up and taken out piecemeal; but the smaller interior joints are perfectly free. If too great difficulties are encountered, as much should be removed as is possible without danger to the specimen, and the caustic applied again for a short time. There are two dangers to guard against; usually, after dissecting away the rapidly decreasing stem joints, until an exceedingly small one is reached, which is also removed, apparently the entire dorsal surface of the basals is laid bare, showing no trace whatever of infrabasals. This, however, is not the case; the appearance is produced by a stem joint nearly full size, and so intimately connected with the basals along the edge that it is practically indistinguishable from them. By inserting the point of the needle into the central lumen and carefully prying upward, this joint may be broken away, when another series of small joints will be exposed. The infrabasals are so patent that it is impossible to overlook them;

if they are not seen, then it is a stem joint that is exposed to view, and not the true dorsal surface of the basals. I believe that it was this mistaking of a stem joint for the dorsal surface of the basal which prevented Dr. P. H. Carpenter from detecting the underbasals in the recent Pentacrinitidæ during his work on the *Challenger* collection. The other danger is that sometimes, when it appears to be a moral certainty that "bottom" has been reached, the infrabasals may be obscured or entirely hidden by a stem joint which is just beginning to form, and is composed of almost invisible limy reticulations, not invisible enough, however, to prevent the detection of the infrabasals through it. After a stem joint has in its growth completely encircled the central lumen, it is obvious enough; but joints consisting of merely two or three exceedingly delicate lobes are very difficult to see. If Doctor Carpenter's specimens were reexamined, I think it would be found that this was also a source of error, as well as the mistaking of a stem joint for the basals. I have found *Metacrinus* much easier to handle than *Isocrinus;* but all my specimens of the former are fresh and well preserved (taken in August, 1906), while those of the latter are more than twenty years old, so that possibly the difference may be due to a difference in the state of preservation.

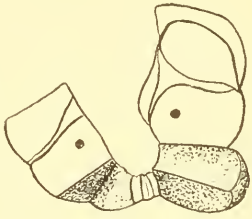

FIG. 5.—SECTION OF CALYX OF METACRINUS SUPERBUS, SHOWING THE INFRABASALS IN POSITION.

FIG. 6.—ISOLATED INFRABASALS OF METACRINUS SUPERBUS.

The infrabasals of *Metacrinus superbus* are apparently identical with those of *M. rotundus*, so that the figure published of the latter (fig. 3) will also serve to show the conditions in the former. After a study of the dorsal surface of the basals and infrabasals in place, by very delicate manipulation three of the basals were removed, leaving the infrabasals in place adhering to the other two. A sketch of the conditions found was immediately made, and is reproduced in fig. 5. The infrabasals themselves were then removed and figs. 6, 7, and 8 were made from them.

FIG. 7.—VENTRAL VIEW OF ISOLATED INFRABASALS OF METACRINUS SUPERBUS.

The infrabasals are long truncated-pyramidal plates, equal in length to the entire height of the inner ends of the basals. A side view of the five infrabasals together is shown in fig. 6: they form a truncated, dome-shaped, sharply angular mass, somewhat broader than high, the angles, of course, extending into the sutures between the basals. Near the bottom (i. e., the dorsal side) the sides curve in somewhat abruptly and the carination ceases, so that in a dorsal view (fig. 8) we get no suggestion of it, the outer edges of the infrabasals then appearing rounded. The sharp notch shown in the central infrabasal in fig. 6

is the end view of the U-shaped ridge and resulting central concavity formed by the extension of the petaloid sectors of the basals onto the infrabasals, as shown in fig. 8. The ventral (upper) end of the circlet of infrabasals is, in common with the adjoining surface of the basals, more or less honeycombed and disintegrated, but this condition does not extend very far down; most of the infrabasals is as solid in structure as the basals, and, so far from being degenerate, they are remarkably well developed, when the very large size of the basals in the specimens dissected is considered.

FIG. 8.—DORSAL VIEW OF ISOLATED INFRABASALS OF METACRINUS SUPERBUS.

A ventral view (fig. 7) shows that the edges of the infrabasals are sharp and clear-cut, and the sutures very distinct; the outer sides are raised into a sharp angle; the ventral surface is somewhat rough and irregular, while the central canal is comparatively small, and quinquelobate.

The dorsal view (fig. 8) does not differ from that figured for the infrabasals of *M. rotundus* (fig. 3). The surface, while smooth, is raised into U-shaped ridges, forming an inward extension of the ridges on the basals, the outer edges are rounded, and the central canal is much larger than in the ventral view, and is round.