# ZYGOTOCRINUS, A NEW FOSSIL INADUNATE CRINOID GENUS.

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ABSTRACT. This new genus is placed in the Parisocrinidae, representing the second genus referred to the family. The novelty of its structural characters is of exceptional interest. Furthermore, the genus helps elucidate the remarkable genus *Parisocrinus*.

## ZYGOTOCRINUS, new genus.

*Genotype.*—*Zygotocrinus fragilis* Kirk, new species.

*Generic diagnosis.*—

Crown. Compact, subcylindrical in habit. The arms are long, comprising approximately nine-tenths the height of the crown.

Dorsal cup. Crateriform.

IBB. Of medium size, about one-fifth the height of the cup wall.

BB. Large, somewhat more than two-fifths the height of the cup wall. *Post B* is somewhat higher than the other *BB* and considerably wider. It is heptagonal in outline and supports *X* on its distal face.

RR. Large, somewhat more than two-fifths the height of the cup wall. The *r post R* is wider and the *l post R* considerably narrower than the other *RR*. The facet is lunate and approximately one-half of the width of the distal face of the radial in the three anterior *RR*. The facet width is the same in the *post RR*, taking up practically the entire width of the *l post R* and proportionally less in the case of *r post R*.

IBR. Because of the slenderness of the arms and the difficulty of distinguishing between sutures and fractures, the number of brachials and their length is somewhat uncertain, and to some extent would be a matter of individual judgment. My count of *IBrr* in the type of *Z. fragilis* is: *r post*, 2; *r ant*, 4; *ant*, 3 plus; *l ant*, 2; *l post*, 3 (4?). In the type of *Z. enor-*

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*mis*, Meek and Worthen give *ant*, 4, and in the remainder of the rays, 2 or 3. My count of the holotype is: *r post*, 2; *r ant*, 2; *ant*, 4 or possibly 5; *l ant*, 2; *l post*, 3. In all cases the first primibrach is relatively short. Owing to the paucity of complete specimens one cannot say to what extent uniformity in number of *IBrr* obtains in different specimens.

Arms. The arms are long and slender, holding a remarkably uniform width throughout. For instance, in *Z. fragilis* the first primibrach in one ray has a width of 1.3 millimeters. The terminal brachial of one ramus in this ray has a width of slightly more than 1 millimeter. In *Z. fragilis* there is a single isotomous division above *IAx* in the *r post R*. In *l post R* there is no division above *IAx*. My notes on the holotype of *Z. enormis* give the arms as endotomous, but unfortunately do not give the number of divisions. Meek and Worthen give one, two, or more divisions above *IAx*. In another specimen of the type lot of *Z. enormis* I noted that the first inner ramus in one ray divided. The brachials are relatively deep, with somewhat flattened sides. The ventral groove is closed with a double series of covering plates. The brachials vary greatly in length, ranging from approximately 1.5 millimeters to 7.4 millimeters in *Z. fragilis*, as seen. There is some reason to believe that the long brachials are compound, resulting from the anchylosis of two or more short brachials. This is not certain, however. What appear at times to be partially obliterated sutures may be fractures.

Post IR. Resting on *post B* is a large plate that could be called either anal *X* or a tube plate. It is seated well down within the circlet of radials and makes contact with *r post R*. For brevity and without prejudice to subsequent nomenclature, it will be styled *X*. Wedged between *X* and *r post R* is a somewhat smaller petagonal plate that under the same conditional usage will be called the right tube plate. The possible homologies of this plate will be discussed later.

Ventral sac. In the type of *Z. fragilis* three pairs of large tube plates are visible following *X* and *RT*. The first two pairs consist of plates approximately the size of *X*. The plates of the third pair are larger and flex inward. There is no sign of the tube on the anterior side of the crown. It would appear that the sac is very short. The ventral sac of *Z. enormis* has a similar structure.

Column. Judging by the scant evidence available, the column is circular in section and has a pentagonal lumen. The latter is uncertain, however.

*Species referred to the genus.—*

Zygotocrinus enormis (Meek and Worthen), new combination.

*Poteriocrinus? enormis* Meek and Worthen, 1861, p. 137.
"Burlington limestone, Burlington, Iowa." (Lower Burlington.)

*Cyathocrinus enormis* (Meek and Worthen), 1865, p. 152.

*Cyathocrinus enormis* (Meek and Worthen), 1868, p. 481, pl. 16, figs. 3a, b.

*Cyathocrinus enormis* Wachsmuth and Springer, 1880, p. 85 (310).

Zygotocrinus fragilis Kirk, new species.

For description, see below.

*Geologic and geographic distribution.*—The genus is known at present only from the lower Burlington at and near Burlington, Iowa.

*Relationships.*—The only known genus with which *Zygotocrinus* may be compared is *Parisocrinus*. The structure of the posterior interradius in *Zygotocrinus* is such that one might consider it a very early stage in the ontogeny of *Parisocrinus* rather than an earlier stage in phylogeny. There is a fair number of specimens of *Z. enormis*, all of considerably smaller size than *Z. fragilis*. We have large collections of crinoids from the horizons carrying both species, and no larger crinoid has been found that could be derived from these species. Again, we have fairly young specimens of *Parisocrinus* from the upper Burlington, Keokuk, and Borden. These young forms agree with *Parisocrinus*. On the other hand, it is a matter of some difficulty to separate *Z. enormis* and very young *Cyathocrinus*. Unless the preservation is excellent this can be done only if the posterior interradius can be seen. In any event, one may safely assume that in the two species of *Zygotocrinus* we are dealing with adult crinoids. The peculiar structures shown represent a true evolutionary stage rather than a juvenile character.

*Zygotocrinus* may readily be distinguished from *Parisocrinus*.

The long brachials and the isotomous or simple endotomous division of the arms in *Zygotocrinus* are in sharp contrast to the short brachials and slender, much-divided arms of *Parisocrinus*. The difference in the disposition of the plates in the posterior interradius is obvious. The structure in *Zygotocrinus* is unlike any known elsewhere among inadunate crinoids. The ventral sac of *Parisocrinus* is large and composed of large numbers of small plates. The sac of *Zygotocrinus* on the dorsal side is composed of a double series of large plates. Furthermore, from all evidence available, the sac was short, stout, and abruptly flexed ventrad.

*Phylogeny.*—It seems probable that *Zygotocrinus* represents the immediate ancestor of *Parisocrinus*. The Devonian forms hitherto referred to *Parisocrinus* certainly do not belong there. *Zygotocrinus* itself was doubtless derived from a small form much like itself, but with a single anal plate in the posterior interradius. Such a form if found will doubtless be called *Cyathocrinus*. There can be no doubt but that the *Parisocrinidae*, including *Zygotocrinus*, are properly referable to the Cyathocrinoidea.

*Parisocrinus* is described as a cyathocrinoid with a poteriocrinoid posterior interradius. In a sense there is some justification for this. On the other hand, *Parisocrinus* does not have the authentic poteriocrinoid structure. Scarcely any two *Parisocrinus* have identical plate arrangement. There is a new species represented by two specimens from the upper Burlington in which there is a single anal. In all other respects it is *Parisocrinus*. The same structure has been observed in one specimen of *P. salignoideus* (White). I have seen a specimen of *Parisocrinus* from the Borden in which *X* and the plate that in other specimens would be called *RA* lie side by side in the same horizontal plane. Another variant is for *RA* to support two plates. A fully illustrated description of the posterior interradius of *Parisocrinus* is much to be desired, but the brief outline given above should show that we are not dealing with the formal grouping of plates that is commonly designated as poteriocrinoid.

Homologies of plates and probable lines of evolutionary change are often indicated by variant structures found within series of specimens of indisputable generic and specific affinities. We have so long been preoccupied with the upward migration and disappearance of the plates of the *post IR*, as shown par-

ticularly well in Carboniferous crinoids, that we have paid too little attention to the process whereby the plates originally came into being as components of the dorsal cup. I have long believed that a downward passage of a true tube-plate between *X* and *r post R* is the answer to the third plate, *RT*, in the poteriocrinoid *post IR*. This, I think, has been tacitly assumed by many and seems to be implicit in Bather's terminology. In the present series we find a tube-plate in *Zygotocrinus* taking a fixed position, that of *RT*. In *Parisocrinus* we go a step farther. This same plate descends and becomes *RA* as to position. Whether this plate is truly homologous to *RA* of other genetic lines is questionable. It is, however, a possibility that must be kept in mind.

*Remarks.—Parisocrinus* was placed in the family *Cyathocrinidae* by Wachsmuth (1896), in the family Sphaerocrinidae by Bather (1900), and in the subfamily Carabocrininae by Springer (1913). Jaekel (1908) erected the family Parisocrinidae, with *Parisocrinus* the sole genus referred to it. To a considerable extent this variation in treatment is due to different conceptions of the relative weight given to the different units of classification. In the present uncertain state of our knowledge it would seem better to err on the side of too small family units based on reasonable evidence of relationship. For this reason I am using the family Parisocrinidae.

### Zygotocrinus fragilis Kirk, new species.

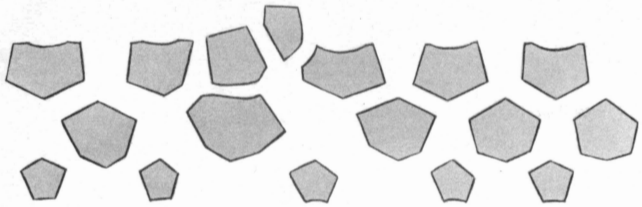
PLATE 1.

This species is represented by a single, almost perfect crown. After being photographed as shown on the plate the specimen was prepared still further. The dorsal cup was freed completely from the matrix and the arms on the anterior side exposed as far as it was felt could be done safely.

The crown is compact and subcylindrical in habit. It has a height of 56.0 millimeters, of which the dorsal cup takes up one-tenth.

The dorsal cup has a height of 5.5 millimeters and a maximum breadth at the arm base of approximately 6.0 millimeters, making allowances for slight distortion. The dorsal cup is narrow at the base, expanding slightly to the top of the *IBB* and then widening rapidly.

The *IBB* are 1.6 millimeters in height, with a maximum



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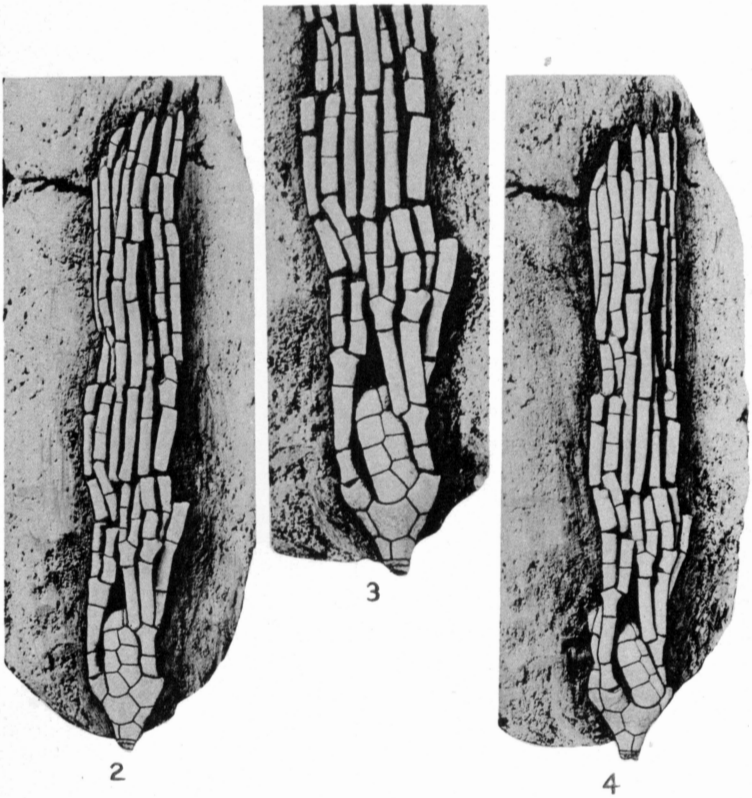

2 3 4

PLATE I

Zygotocrinus fragilis, new genus and species
1, Plate diagram of dorsal cup; 2, posterior view of holotype, x 1½; 3, posterior view, x 2; 4, left posterior view, x 1½.

breadth of equal amount. The *BB*, with the exception of *post B*, have an average height of 2.4 and a maximum breadth of 2.2 millimeters. *Post B* has a height of 2.6 millimeters and a maximum breadth of 3.5 millimeters. The *RR*, with the exception of the *l post R*, have a height of 2.6 millimeters. The average maximum breadth of the *RR*, with the exception of the two posterior, is 3.0 millimeters. *L post R* has a height of but 2.2 millimeters and a breadth of 2.2 millimeters. *R post R* is 3.3 millimeters in breadth. The arm facets in all cases have a width of 1.7 millimeters. *X* has a height of 2.2 millimeters and a maximum breadth of 2.1 millimeters. *RT* has a height of 2.2 millimeters and a breadth of 1.7 millimeters.

The arms are long and slender. The union between brachials seems to have been very weak. In most cases successive brachials have separated. Fortunately there are only minor vertical or horizontal displacements, and the linear series are still in alignment. The odds against the preservation of such a specimen must have been great. The length of the brachial units varies greatly. A few measurements will be given. In the right posterior ray $IBr_1$ has a height of 1.7 millimeters and *IAx* 2.8 millimeters. $IIBr_1$ has a height of 5.2 millimeters and *IIAx* 2.2 millimeters. The longest *Br* seen, also in this ray, has a height of 7.4 millimeters. There are no visible indications that this particular *Br* is compound. In the *l post R*, $IBr_1$ has a height of 2.2 millimeters; $IBr_2$ 4.2 millimeters; and *IAx* 2.6 millimeters.

The ventral sac is stout and apparently very short. As seen, it consists of two series of large plates. But three pairs of tube-plate are shown following *X* and *RT*. The distal pair flex ventrad abruptly. It is probable that this is near the end of the sac. The ventral side of the sac when seen probably will be found to consist of an integument of small plates.

Two fractured columnals are preserved. The columnals are relatively high. The lumen seems to be pentagonal.

*Horizon and locality.*—This specimen was found in a lot of uncleaned material collected for Frank Springer at Leek's quarry on Flint Creek, probably about five miles north of Burlington, Iowa. I am not familiar with the quarry, which seems to have been opened after my time in Burlington. The hori-

zon in the lower Burlington is a well-known one and is also found at Picnic Point, some miles south of Burlington.

*Type.*—The holotype and only known specimen is S 4410 in the Springer collection in the United States National Museum.

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