

ON NEW AND OLD MIDDLE DEVONIC CRINOIDS

BY ELVIRA WOOD

The Devonian crinoids in the collection of the United States National Museum include a considerable number of unusually interesting specimens. Of these, two genera and seven species are new, while others show minor but noteworthy variations from forms already described.

These crinoids have been submitted to the writer for study through the courtesy of Mr. Charles Schuchert, Assistant Curator. It gives the writer pleasure, also, to acknowledge her indebtedness to Dr. Charles D. Walcott, in whose laboratory a portion of the work was done.

The specimens in the collection of the Massachusetts Institute of Technology were studied while the writer was connected with that institution.

The new forms, with one exception, are from the Traverse (Hamilton) formation of Michigan, and belong mainly to the genera *Megistocrinus* and *Dolatocrinus*. A single specimen from the Onondaga of New York appears to be referable to no described genus.

TRIPLEUROCRINUS n. gen.

τρί-, three; πλευρά, side; κρίνον, lily.

Dorsal cup including the patina only. Arms attached to a nearly circular facet on the outer surface of the radials. Arms unbranched and uniserial; composed of thick plates; ambulacral furrow deep; axial canal large. Column obscurely triangular, with one central and three smaller accessory canals.

Genotype.—*Tripleurocrinus* Levis n. sp.

This genus appears to be closely related to those of the family Gasterocomidæ so far as the parts preserved admit of comparison. The structure of the anal area, if known, might show a different relationship, but the genus may be referred provisionally to that family. It differs from the genus *Gasterocoma*, of the Devonian of Germany, and from other genera of the Gasterocomidæ in possessing

a triangular column with three secondary canals instead of a four-angled column and four peripheral canals.

TRIPLEUROCRINUS LEVIS n. sp.

(PLATE XVI, 2, 2a.)

Description.—Body small, sides diverging at an angle of about 45° . Surface smooth. Infrabasals not observed, but their presence may be inferred from the truncated lower edge of the basals. Basals pentagonal. Only two of these plates are preserved on the single specimen found. Radials one-third larger than the basals, four-sided below, the upper portion of the plate curving inward and backward on either side to form a deep food groove. The structure of the anal area cannot be determined. Arm facets occupying two-thirds the width of the radials, and directed obliquely upward. Width of the arm plates about twice their thickness.

Plates of the column vary in size, every second or third plate being larger. The central canal is triangular in section, with three small circular canals opposite its sides and connected with it by short transverse canals (see pl. XVI, fig. 2a).

Formation and locality.—Onondaga limestone: Le Roy, New York.

Cat. No. 35,146 (holotype) U. S. N. M.

MEGISTOCRINUS Owen and Shumard

1852. OWEN AND SHUMARD, U. S. Geol. Rep't. Iowa, Wis., Minn., p. 594.

For abnormal calyx development see *M. spherialis*.

MEGISTOCRINUS TUBERATUS n. sp.

(PLATE XV, 2, 2a-c. PLATE XVI, 3, 3a.)

Description.—This is a large crinoid with thick plates. The general form of the body is globular, with the base flattened to the middle of the first costals.

The center of each plate of the dorsal cup bears a large and extremely prominent node which may vary in shape from a broad cushion, covering nearly the whole surface of the plate, to a blunt wedge or a rounded knob. Some of the nodes, more particularly those on the radials, show a tendency to divide, forming a bi- or tri-tuberculate crest. All these variations in form may be seen on the surface of a single individual. The entire surface of the dorsal cup is covered by extremely delicate, discontinuous ridges which radiate from the center of each plate, covering the nodes as well as the spaces

between them, but interrupted at the suture lines between the plates (pl. xv, fig. 2*b*).

Basals three, the suture lines between them distinctly visible. The form, size, and relative position of the plates of a nearly complete individual are shown by the accompanying diagram (fig. 1). Arms sixteen, four in the anterior and postero-lateral rays, and two in each antero-lateral ray. A ray with four arms has usually one interdistichal, followed by two interpalmars placed side by side, but

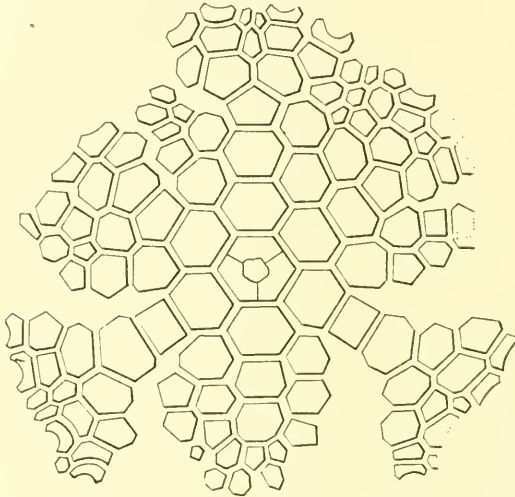


FIG. 1.—*Megistocrinus tuberatus* n. sp. Arrangement of calyx plates.

the number of these plates is not constant. The number of interbrachial plates beyond the second row is also variable, but there are commonly three plates in the third row with two in each succeeding row. The anal plate is similar in size and surface ornament to the radials. It is followed by three large plates in the second and four in the third row. Plates of the succeeding rows vary in number in different specimens, and are irregular in arrangement.

The tegmen is moderately convex, and but slightly depressed between the arm bases. It is formed of thick plates, large near the center, but small and very numerous toward the arm regions. The posterior oral is large and strongly spinose; the other orals are gently convex and but little larger than the neighboring plates of the tegmen. The radial dome plates bear stout spines. Anal tube subcentral.

Column circular in section, with large pentalobate canal.

Remarks.—This species of *Megistocrinus* differs from those already described in the presence of prominent nodes on all the plates of the calyx, in the form of the nodes, and in the delicate surface markings of the test. The specimen figured as the type of this species (pl. xv, 2, 2a) is incomplete, little more than half of the dorsal cup being present, but it is not compressed, and shows the form of the body and the surface markings extremely well. The diagram of the plates is from a more complete but badly distorted individual. On the surface of the latter specimen the delicate ridges have been entirely effaced, and the height of the tubercles considerably reduced by solution, but the suture lines between the plates are distinctly visible and the number and arrangement of the arms clearly indicated. The specimen from which the tegmen is drawn (pl. xv, 2c) is the largest specimen studied, and though somewhat crushed, measures approximately 45 mm. from the base to the posterior oral, and 53 mm. in greatest diameter. The calyx of a young individual is nearly complete. The full number of plates is present in the dorsal cup, and the surface nodes are unusually prominent. A slightly smaller specimen is abnormal in possessing but three arm openings in each of the postero-lateral rays. The space between the existing arm bases is, however, sufficient for two additional arms and their absence may be due to an injury received during the life of the crinoid. Figs. 3, 3a, pl. XVI, represent a very young specimen, measuring 9 mm. in height, and 11.5 mm. in diameter. In this the distichals are the highest plates of the dorsal cup, and the arm plates rest directly upon them. The arms are sixteen in number and arranged as in the adult. Tubercles on the surface are large and prominent, occupying nearly the whole surface of each plate. Plates of the tegmen are strongly convex, and three of the radial dome plates bear short spines.

Formation and locality.—Upper Traverse limestone: Partridge Point, south of Alpena, Michigan.

Cat. No. 26,395 (holotype and paratypes); 36,015 Rominger collection, U. S. N. M.

MEGISTOCRINUS REGULARIS n. sp.

(PLATE XV, 4, 4a.)

Description.—Dorsal cup low and broad; base flattened; sides straight, forming an angle with the base of about 60°.

Entire surface of the basals elevated. Radials often flat or even depressed at the center. Other plates of the dorsal cup strongly

convex, or occasionally having the form of a low cone. Arms sixteen, four in the anterior and postero-lateral rays, two in the antero-lateral rays. Arrangement of calyx plates similar to that of other sixteen-armed species (see fig. 1). Arm bases rather small, forming a continuous row around the calyx, without interradial depressions.

Tegmen moderately elevated, not depressed between the arm bases, composed of numerous small, convex plates. The radial dome plates and a variable number of other tegmen plates bear short spines. Anal tube situated about one-third the distance from the center to the dorsal margin.

Column circular, with large, obscurely pentalobate canal.

Remarks.—This species is closely related to *Mcgistrocrinus spinosulus* Lyon, but differs in having sixteen arms instead of forty, and the anal tube is less eccentric. The plates of the dorsal cup, though strongly convex, are less distinctly spinose. A single individual has seventeen arms, *i. e.*, three in the right antero-lateral ray, but as it is otherwise similar to eight specimens having sixteen arms, this may be regarded as an abnormal feature. The largest specimen studied measures 27 mm. in height, and 36 mm. in greatest diameter; the smallest is 15.5 mm. high, and 22 mm. in diameter.

Formation and locality.—Middle Traverse or Alpena limestone: Richard Collins' quarry,¹ Alpena, Michigan.

Cat. No. 36.013 (holotype), Rominger collection, and 35,144 U. S. N. M.

MEGISTOCRINUS SPHÆRALIS n. sp.

(PLATE XV, 1, 1a-b.)

Description.—Body nearly spherical in form, but slightly flattened at the base.

Surface of the basals elevated above the radials, forming a hexagonal plate which is nearly covered by the proximal plate of the column. Each plate of the dorsal cup, with the exception of the radials, bears a short spine. The radials may be ornamented by low ridges, or they may be smooth. Spines of the higher calyx plates cone-shaped, becoming more slender and longer as they approach the region of the arms.

Arms sixteen, arranged in a continuous row around the calyx, without interradial depressions. There are, as usual with this number of arms, four each in the anterior and postero-lateral rays, and two in the antero-lateral rays. The arm openings are large and vertical in position.

¹ Grabau, *Ann. Rep't Geol. Surv. of Mich. for 1901*, p. 176.

The arrangement of the plates of the calyx is shown by fig. 2; and fig. 3 shows the normal arrangement of plates in the anterior and upper portion of the calyx. It will be seen that this form differs from most species of *Megistocrinus* in including the lower plates of the biserial arms in the upper portion of the cup. As shown in the diagram (fig. 2) the type specimen appears to have but one costal in the left postero-lateral ray, but the specimen is broken, and this point cannot be determined with certainty.

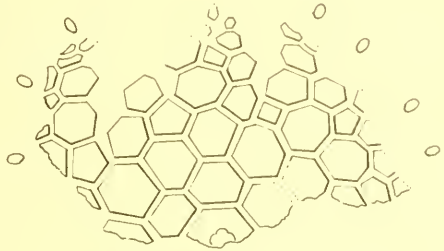


FIG. 2.—*Megistocrinus sphaeralis* n. sp. An incomplete individual, the holotype.

Tegmen elevated, regularly dome-shaped, its plates small, smooth, or rarely spinose. The radial dome plates bear large spines. Anal tube slightly eccentric.

Column circular; canal large, and obscurely pentalobate.

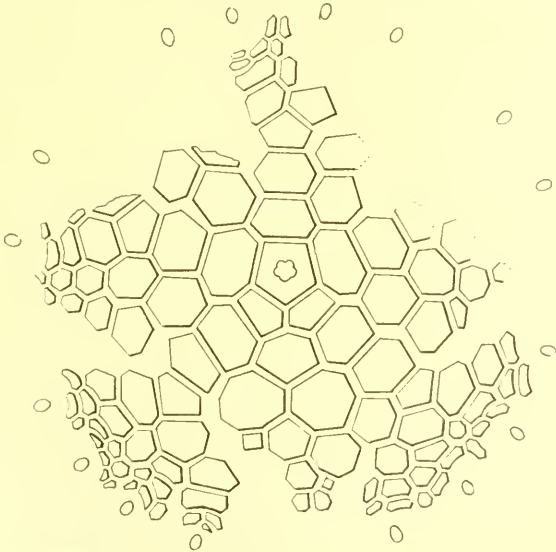


FIG. 3.—*Megistocrinus sphaeralis* n. sp. Plates of the specimen represented by fig. 1a, pl. xv.

Remarks.—This species somewhat resembles *Megistocrinus nodosus* (Barris), but differs from it in the presence of spines on the higher plates of the calyx, and in the form of the tegmen which is

more elevated than in the latter species and is not depressed in the interradial areas. From *M. tuberculatus* n. sp. the present species differs in the pointed spines of the surface, the higher tegmen, and the absence of fine surface sculpture.

The type specimen is imperfect, only half the crinoid being present, as indicated by the diagram of its plates (fig. 2). The flattening of the base represented by fig. 1, pl. xv, is due to crushing. The base is normally but slightly flattened.

The large specimen represented by fig. 1a, pl. xv, closely resembles the type of *M. sphaeralis*, and differs from it only in the arrangement of its posterior plates. In this respect the specimen is unique. The fused basals form a five-sided plate. The plates adjoining the basals on three sides are normal radials, and the structure of the crinoid in the anterior and antero-lateral rays does not differ from that of the type specimen so far as can be determined. Between the basals and radials of the postero-lateral rays are two small plates which, notwithstanding their position, appear to belong rather to the anal series than to the ray, since the otherwise normal ray is complete without them. These plates are without ornament, but resting upon them is a large plate ornamented like the radials. This plate is followed by two and four plates in the succeeding rows. The higher plates of the anal interray are few and small (see fig. 3). The whole number of plates in this area, thirteen, does not differ widely from that of the type which has about sixteen plates.

The arrangement of the calyx plates is considered of fundamental importance in the classification of crinoids, and upon such evidence alone this specimen would represent a new genus, but its close resemblance in other respects to three specimens undoubtedly of the genus *Megistocrinus* leads the writer to consider it an abnormal variation, and to place it, at least provisionally, with *M. sphaeralis*. The development of such an abnormal individual may be accounted for if we imagine a bisection of the young anal plate, the halves of which, owing to some downward-acting force, grew laterally instead of vertically, and became intercalated between the adjacent basals and radials, while the middle plate of the second row moved downward until it came to lie wholly below its neighbors. The cause of such a downward acting force remains to be determined, but the tendency for higher plates to occupy lower positions in the calyx is shown, not only by such forms as *Tylocrinus novus* n. sp., described below, but by the inclusion of higher brachials within the calyx as in the Camerata.

Formation and locality.—Middle Traverse (Hamilton) or Alpena limestone: Richard Collins' quarry, Alpena, Michigan.

Cat. No. 26,397 (paratype), 26,398 (holotype and paratype), and 36,012 Rominger collection, U. S. N. M.

MEGISTOCRINUS ABNORMIS (Lyon)

(PLATE XV, 3)

1857. LYON. *Actinocrinus abnormis*. Geol. Rep. Ky., III, p. 479, pl. 4, figs. 1, 1a-b.

The statement is made by Wachsmuth and Springer¹ that this species is "devoid of ornamentation," and in the original description of the species no mention is made of the character of the surface ornament. An exceptionally well-preserved specimen of *Megistocrinus abnormis* (Lyon) from the Hamilton of Louisville, Ky., retains the surface ornament in a nearly perfect condition. This consists of fine ridges radiating from the center to the sides of each plate (pl. xv, fig. 3). The center of the plate is slightly depressed, and the ridges disappear in the region of the elevated and often truncated margin. This ornament suggests that of *M. depressus* (Hall), but differs in the absence of minute tubercles at the center of the plates. The ridges are also straighter and more regularly arranged.

Formation and locality.—Hamilton: Beargrass quarry and elsewhere about Louisville, Ky., Clark county, Ind., and Marion county, Ky.

Cat. No. 36,017 (Rominger collection), 42,429 (Ulrich collection), and 35,145 U. S. N. M. Also in Massachusetts Institute of Technology, No. 1,222.

MEGISTOCRINUS RUGOSUS Lyon and Casseday

1859. LYON and CASSEDAY, Amer. Jour. Sci. (2d ser.), xxviii, p. 243.

A well-preserved individual of this species differs from the type in the structure of the anterior ray. In this the first interdistichal is a comparatively large plate, and is moved downward until it rests upon the truncated apex of the second costal. The first distichals are consequently widely separated. The interdistichal is followed by two plates, and these in turn by two minute interpalmaris. The specimen corresponds with the type in other respects.

Wachsmuth and Springer² state in their description of *M. rugosus*, "Anal plate followed by rows of 4, 5, and 4 plates," etc. This description may have been written of an abnormal individual, for in

¹ *North American Crinoidea Camerata*, p. 546.

² *Ibid.*, p. 543.

all the specimens studied, and in the type, according to the original description, there are but three plates following the anal plate.

Formation and locality.—Hamilton: Beargrass quarry, Louisville, Ky., and Clark county, Ind. Onondaga: Columbus, O.

Cat. No. 35,141, 36,019 (Rominger collection), and 43,154 (Ulrich collection), U. S. N. M. Also, No. 1,220, Massachusetts Institute of Technology.

MEGISTOCRINUS DEPRESSUS (Hall)

1862. HALL, 15th Rep. N. Y. State Cab. Nat. Hist., p. 134.

1895. *Megistocrinus ornatus* MILLER and GURLEY. Ill. State Museum of Nat. Hist., Bull. 7, p. 42, pl. II, figs. 15, 16, 17.

A comparison of the figures and descriptions of *M. depressus* (Hall) and *M. ornatus* M. and G. shows but slight differences between the two forms. The tegmen of the former is said to be "depressed" while that of the latter is "highly convex." In a series of specimens otherwise indistinguishable the height of the tegmen varies considerably, and the depressed tegmen may be due to mechanical pressure.

The base of *M. depressus* is said to be "flattened but not excavated," but specimens possessing all the other characteristics of the species have the base "a little concave below" as in *M. ornatus*. This certainly cannot be relied upon as a distinctive characteristic.

The only other difference recorded is in the absence of central nodes on the plates of *M. ornatus*, but as these nodes on *M. depressus* are extremely minute and easily worn away their absence is of little value as a distinguishing feature.

None of the differences noted appears sufficient for the separation of the species, and *M. ornatus* M. and G. becomes a synonym for *M. depressus* (Hall).

Formation and locality.—Hamilton: Louisville and Lebanon, Ky., and Charlestown, Ind. Onondaga: Columbus, O. Probably also in the Hamilton at Bartlett's Mills, near Thedford, Ontario.

Cat. No. 36,018 (Rominger collection), 42,430 and 42,433 (Ulrich collection), and 26,467 U. S. N. M. Also 1,224 Massachusetts Institute of Technology.

MEGISTOCRINUS FARNSWORTHI White

1876. WHITE, Proc. Acad. Nat. Sci. Phila., xxviii, p. 29.

The specimens of this species are reported by their collector as rare fossils at the type locality.

Formation and locality.—Middle Devonian: Solon, Iowa.

Cat. No. 35,142.

MEGISTOCRINUS MULTIDECORATUS (Barris)

1885. *Megistocrinus nodosus multidecoratus* BARRIS, Davenp. Acad. Nat. Sci., iv, p. 99, pl. II, figs. 3, 4.

This species is represented in the collection of the U. S. National Museum by several well-preserved individuals from the type locality.

Formation and locality.—Upper Traverse limestone: Partridge Point, Alpena, Michigan.

Cat. No. 36,021 U. S. N. M.

MEGISTOCRINUS NODOSUS Barris?

1878. BARRIS, Proc. Davenp. Acad. Nat. Sci., II, p. 285.

A large individual is referred with some doubt to *M. nodosus*. It differs from the type in the presence of nodes on the calyx plates above the first two rows, but the number of nodes on the surface of a crinoid is usually a variable feature.

The tegmen is slightly, not deeply depressed in the interradial areas.

The nodes on the upper calyx plates resemble those of *M. spheralis* n. sp., but the tegmen is much flatter and is composed of smaller and more numerous plates.

A young individual measuring 11 mm. in height and 17 mm. in diameter is referred to this species on account of the flat tegmen and deeply indented interradial spaces.

Formation and locality.—Middle Traverse (Hamilton) limestone: Collins' quarry, Alpena, Mich. The species is first reported from the Middle Devonian of Davenport, Iowa.

Cat. No. 35,143 U. S. N. M.

MEGISTOCRINUS CONCAVUS Wachsmuth

1885. WACHSMUTH, Proc. Davenp. Acad. Nat. Sci., iv, p. 96, pl. I, figs. 5, 6, 7.

Formation and locality.—Upper Traverse limestone: Partridge Point, near Alpena, Michigan.

Cat. No. 36,016 (Rominger collection) U. S. N. M.

MEGISTOCRINUS SPINOSULUS Lyon

1861. LYON, Proc. Acad. Nat. Sci. Phila., p. 413, pl. IV, figs. 7a, b.

Formation and locality.—Onondaga: Columbus, O. Reported also from the Hamilton of Louisville, Ky.

Cat. No. 42,431 (Ulrich collection) U. S. N. M.

MEGISTOCRINUS EXPANSUS Miller and Gurley

1894. MILLER and GURLEY, Ill. State Museum of Nat. Hist., Bull. 4, p. 35.
pl. III, figs. 18, 19, 20, 21.

A specimen in the collection of the U. S. National Museum resembles this species in form and general proportions. Some of the lower plates of the calyx are slightly elevated at the center, three or four of them sufficiently to form obscure nodes, but its correspondence with the type in this respect could not be determined as the surface of the latter is not preserved. This crinoid has lost two of its arms, evidently during the life of the animal, for the openings are covered by small, irregularly-shaped plates.

Formation and locality.—Middle Traverse limestone: Collins' quarry, Alpena, Mich. Hamilton: Clark county, Ind., and Louisville, Ky.

Cat. No. 36,014 (Rominger collection) U. S. N. M.

MEGISTOCRINUS LATUS Hall

1858. HALL, Geol. Rep't. Iowa, 1, pt. II, p. 480.

Formation and locality.—Traverse (Hamilton): Petoskey, Mich. The type locality is at New Buffalo, Ia., in the Middle Devonian.

Cat. No. 36,020 (Rominger collection) U. S. N. M.

TYLOCRINUS n. gen.

(*τύλος*, a knob; *κρινον*, lily.)

Similar to *Megistocrinus* in form and general structure, but differing from it in the presence of numerous plates in the posterior inter-ray, having two plates in the radial series and four in the second row. Two arms in the anterior and postero-lateral rays, and two or four in the antero-lateral rays. Of these characteristics, the arrangement of the arms and the large number of plates in the anal interray should be considered most important, as the presence of seven plates in the radial series may prove to be an abnormality.

Genotype.—*Tylocrinus novus* n. sp.

TYLOCRINUS NOVUS n. sp.

(PLATE XVI, 5, 5a.)

Description.—Calyx very small; base flattened; sides convex. The surface of each radial is ornamented by an elevated rim which follows the outline of the plate, and includes a depression at the center. Above the radials, each plate of the cup bears one (rarely two) prominent nodes which do not cover the whole plate. The surface of

the plates between the nodes appears to have been ornamented by fine ridges similar to those of *Megistocrinus tuberatus* n. sp., but this feature is not well preserved.

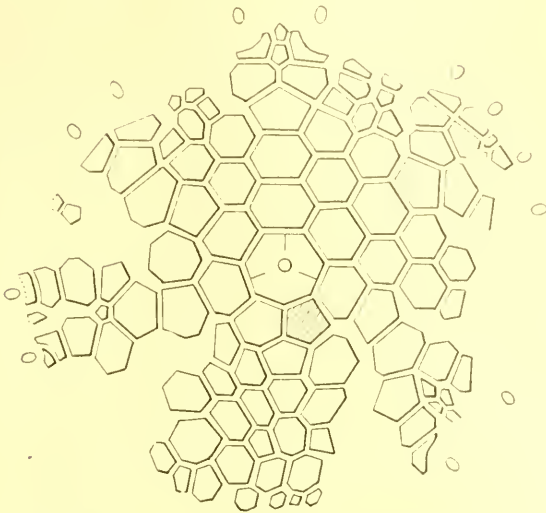


FIG. 4.—*Tylocrinus novus* n. gen. et sp. Arrangement of calyx plates.

Basals three; radials five; costals two times five. The right antero-lateral ray is the only one having four arms. In this the distichals bear on each axillary edge a first and second palmar. In the left antero-lateral ray there is only one distichal and but two palmars, though the second costal in this ray has the form of an axillary plate. The form of this plate seems to suggest the possible crowding out of the second distichal and the two arms required to make the right and left antero-lateral rays correspond in structure. Palmars are absent from the remaining three rays, the first distichal being followed by one or two additional distichals, and these by the two arms of the ray. The interbrachial formula is normally 1, 2, 3, 2, but in the left postero-lateral interray the brachial plates meet above the first interbrachial, probably a result of crowding due to the wide anal area. There are two minute interbrachials between the arm bases. A variable number of minute interdistichals or interpalmars are present in all but one of the rays.

The anal interray is peculiar in possessing two plates in the radial series. The formula for the succeeding rows of plates is 4, 4, 5, 4, 7. The plates of the sixth row merge into those of the tegmen.

Tegmen moderately elevated and formed of minute, strongly convex plates. Anal tube subcentral.

Column circular with minute canal. The single specimen found measures 10 mm. in height and 13 mm. in greatest diameter.

Remarks.—In this specimen the presence of two plates in the radial series of the anal interray is a remarkable feature, and were that the only variation from a normal *Megistocrinus* it might be considered an abnormality, but the plates of the anal interray are more numerous than in *Megistocrinus*, there being twenty-six plates in this specimen as compared with seventeen in *Megistocrinus tubercatus* n. sp., the species to which this is most nearly related, and the latter is four times as large as *Tylocrinus nocus*. It might also appear that the wide posterior area is due to some accident which has displaced the left posterior arms, and crowded out the adjacent interbrachials and brachials, were it not that the elimination of calyx plates begins only above the first interbrachial while the widening of the anal interray begins in the radial series. Some difference in the size or arrangement of the internal organs may have caused a widening of the posterior area, necessitating the growth of more plates to cover this portion of the body. The crowding out of lateral plates would thus be a result and not a cause of the wide posterior area.

Of the two posterior plates in the radial series the left is ornamented like the radials with an elevated rim and central depression, while the right bears a node like those of the higher calyx plates. This fact seems to indicate that the right is the true anal plate, and the left is a higher interbrachial which has moved downward to its present position.

Whatever the cause of the variation, the present species possesses, in addition to the single extra plate in the radial series, a large number of well developed and regularly arranged posterior plates, whose presence has affected in a marked degree other structures of the calyx. Moreover, if two of the arms have been lost by crowding, as the structure of the left antero-lateral ray indicates, this species was derived from a form having four arms in each of the antero-lateral rays and two in the others, the reverse of the arrangement common in *Megistocrinus*, of two arms in the antero-lateral rays and four in the other three rays. Such important structural differences from *Megistocrinus*, its nearest ally, seem to entitle this form to rank as the type of a distinct genus, of which *Tylocrinus nocus* is the only known species.

Formation and locality.—Upper Traverse limestone: Partridge Point, near Alpena, Mich.

Cat. No. 35,150 U. S. N. M.

DOLATOCRINUS Lyon

1857. LYON, Geol. Rep't Kentucky, III, p. 482.

The number and arrangement of the arms has long been considered of fundamental importance for the separation of species in the genus *Dolatocrinus*, but the present study has led the writer to regard this feature as of less value for purposes of classification. Some of the reasons which have led to this view are as follows: We find individuals of the genus which would be referred to the same species except for differences in the number of the arms. The differences in the arms vary in degree from a slightly unlike arrangement to wide variation in both number and arrangement. For example, specimen No. 672 in the collection of the Massachusetts Institute of Technology has the arm formula¹ 2-1 . . . 2-2 . . . 2-1 . . . 2-2 . . . 2-2, while that of *Dolatocrinus venustus* M. and G., which it otherwise resembles, is 1-2 . . . 2-2 . . . 1-2 . . . 2-2 . . . 2-2. Another specimen in the same collection, identified as *D. greenei*, has the following arm formula: 2-2 . . . 2-2 . . . 2-1 . . . 2-2 . . . 2-2. The formula for the type is 2-1 . . . 2-2 . . . 2-2 . . . 2-2 . . . 2-2, from which it will be seen that the two specimens differ only in the grouping of the arms with reference to the anterior ray.

Differences in the number of arms are illustrated by *D. triadactylus* Barris and *D. hammelli* M. and G. The former has three arms to the ray (1-2 . . . 2-1 . . . 1-2 . . . 2-1 . . . 1-2), and the latter one more arm, thus, 1-2 . . . 2-1 . . . 2-1 . . . 2-1 . . . 2-2. A similar difference exists between *D. salebrosus* (see below) and a specimen which has been referred to that species.

So far as can be determined from the figures and descriptions, *D. bellulus* M. and G. differs from *D. nodosus* M. and G., and *D. aspratilis* M. and G. from *D. argutus* M. and G. only in the presence of one additional arm. A greater difference is shown by *D. sacculus* M. and G. and *D. salebrosus* M. and G. The former has four arms to each ray while the arm formula for the latter is 2-2 . . . 2-2 . . . 1-2 . . . 1-1 . . . 1-2; yet the two are closely related if not identical forms. The great variation in the number of arms in this genus is further illustrated by the occasional presence of a fifth arm in one ray as in *D. neglectus* M. and G. The arms are arranged as follows: 1-2 . . . 2-1 . . . 2-3 . . . 2-1 . . . 1-2. It is believed that a comparison of the type specimens would furnish many illustrations of this

¹The arm formulæ used in this paper represent the number of arms beginning with the anterior ray and passing from left to right around the tegmen. The halves of a ray are separated by a hyphen, and adjacent rays by a row of dots.

kind, but the evidence at hand seems sufficient to show that the number of arms is of value when taken in connection with the other features, yet it cannot be relied upon as the sole characteristic by which species are to be distinguished.

Wachsmuth and Springer¹ have noted that the number of arms cannot be used for specific separation in the genus *Dizygocrinus*, and this appears to be true also of *Dolatocrinus*.

DOLATOCRINUS COSTATUS n. sp.

(PLATE XVI, 6, 6a.)

Description.—This is a large species with a low dorsal cup about two and one-half times as broad as high. Base deeply indented, the depression including all, or nearly all, of the radials. The sides of the dorsal cup bend abruptly upward and stand at right angles to the base. They are slightly constricted below the arm bases.

The surface is ornamented by thick, somewhat irregular ridges diverging from the center of each plate to the middle of its sides. The center of the first interbrachial is marked by a circular pit, or depression, from which the ridges pass to the sides of the plate. Distinct nodes appear to be absent from the surface, though the center of a plate may be elevated by the intersection of the strong ribs. Suture lines between the plates depressed.

Basals not observed. Radials five; costals two times five; distichals one time ten; palmars two times twenty. The first interbrachial is the largest plate of the calyx, and is succeeded by two small plates placed one above the other. A variable number of minute interpalmars is between or just below the arm bases. Arm openings four to the ray and vertical in position. Interradial and interbrachial pores four to six. Calyx slightly indented between the rays.

Tegmen but slightly elevated, its plates large and smooth with beveled edges. Anal tube subcentral. The surface of the tegmen is slightly depressed between each pair of arms, the interradianal depressions being deeper than the others.

Remarks.—This species is most nearly related to *D. icosidactylus* Wachsmuth and Springer, from which it differs in the flatter tegmen with its smooth surface and faint interradianal depressions, the absence of nodes on the surface of the dorsal cup, and the deeper basal excavation.

Formation and locality.—Middle Traverse or Alpena limestone; Collins' quarry, Alpena, Mich.

Cat. No. 26,396 U. S. N. M.

¹ *North American Crinoidea Camerata*, p. 414.

DOLATOCRINUS ASTERIAS n. sp.(PLATE XVI, 1, 1*a*.)

Description.—Dorsal cup low and broad; sides vertical, base flattened, with a deep and narrow basal indentation which includes a little more than half of the radials. Plates very thick, with the suture lines usually deeply impressed, though this is a variable feature, and in some specimens the depressions are not strongly marked.

Surface highly ornamented. In the most typical specimens the ornament consists of sharply elevated ridges which pass from the center of each plate to the middle of its sides. These ridges are stronger on the radials and first interbrachials, forming a star-shaped figure whose points are at the middle of the interbrachials. At these

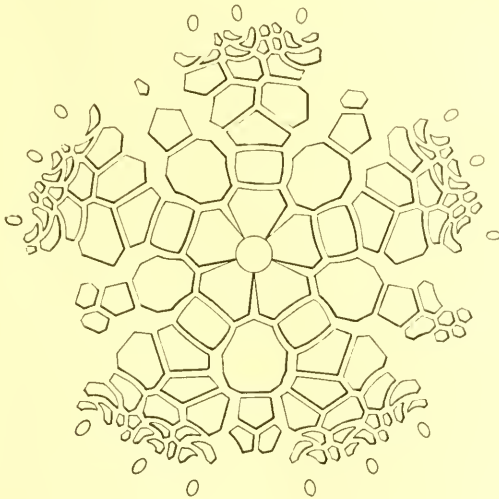


FIG. 5.—*Dolatocrinus asterias* n. sp. Arrangement of calyx plates.

points there is usually a circular depression, though occasionally a low node replaces the depression. Other ridges from the center of the radials outline the basal depression, forming a five-sided rim around it. The ridges of the higher calyx plates are nearly as distinct as those of the radials and first interbrachials. The ornament of the surface, while always strongly marked in well-preserved specimens, varies considerably in general appearance on different individuals. On some specimens the center of each plate, where the ridges intersect, is elevated, giving the surface a nodose rather than a ribbed appearance. These varieties of ornament are readily seen to belong to the same type, the differences being dependent mainly

on the relative amount of material deposited at the intersections or throughout the length of the ridges, and also upon the strength of the sutural depressions. The specimens studied form a series connecting the extreme types of ornament by insensible gradations.

The arrangement of the calyx plates is shown in the accompanying diagram, fig. 5.

Arms fifteen, three to the ray. The arm bases are large, and the openings are directed obliquely upward. Interradial pores three, with one or two between adjacent brachia.

Tegmen slightly elevated, composed of thick, rugose plates with deeply sunken suture lines. The anal tube is nearly central in position.

Column small, circular, with pentalobate canal.

Remarks.—This species somewhat resembles the preceding in surface ornament, but differs from it in size, in the number of arms and

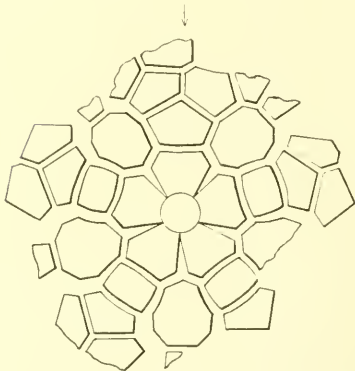


FIG. 6.—Plates of an abnormal individual of *Dolatocrinus asterias* n. sp.

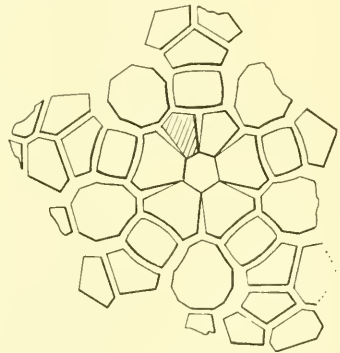


FIG. 7.—Plates of an abnormal individual of *Dolatocrinus asterias* n. sp.

respiratory pores, and in the direction of the arms as they leave the body. The basal depression is deeper, narrower, and more definitely outlined. The tegmen of this species differs widely from that of *Dolatocrinus costatus* n. sp., both in its more convex form and in its small, elevated, and rugose plates.

Among those referred to this species are two incomplete specimens which are abnormal in the number of their calyx plates. The specimen from which fig. 6 was drawn retains the characteristic surface ornament of *D. asterias* n. sp., and differs from the type only in the absence of one costal, as represented in the diagram. A young specimen also showing the characteristic form and ornament of this species is unique in possessing six plates in the radial series. The

plates of this specimen are represented, so far as they are preserved, by fig. 7. It is believed that both these specimens represent abnormal variations, since the absence of a single plate in one case, and the presence of an extra plate in the other, are the only means by which they can be distinguished from thirteen normal specimens with which they have been compared.

Formation and locality.—Alpena limestone, and Upper Traverse limestone: Richard Collins' quarry, Alpena, and Partridge Point, near Alpena, Mich.

Cat. No. 36,022-23 (Rominger collection), and 35,140 U. S. N. M.

DOLATOCRINUS sp.

A crinoid from the Hamilton of Louisville, Ky., is represented by a mold of the lower portion of the interior only, but the suture lines between the plates are distinctly shown, and faint ridges are present which probably indicate the position of ridges on the outer surface of the crinoid (see fig. 8). The specimen is referred to *Dolatocrinus* as an abnormal individual, since a similar variation occurs in an individual which may, with little doubt, be referred to *Dolatocrinus asterias* n. sp. (compare fig. 7). The fine lines on fig. 8 represent the faint ridges above referred to. These seem to strengthen the evidence in favor of placing the specimen with the genus *Dolatocrinus*. It is too imperfect for specific identification.

Cat. No. 36,027 (Rominger collection) U. S. N. M.

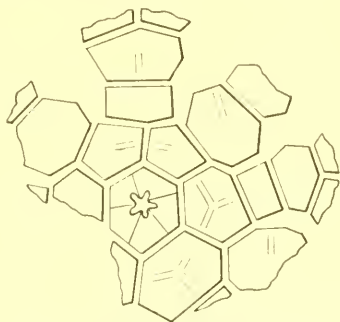


FIG. 8.—*Dolatocrinus* sp. Arrangement of plates.

DOLATOCRINUS LACUS Lyon

1857. LYON, Geol. Rep't Kentucky, III, p. 482, pl. IV, figs. 2, 2a-c.

Formation and locality.—Onondaga: Columbus and Dublin, O. Hamilton: Charlestown, Ind. The type locality is in the limestone bed above the "Black Slate," Louisville, Ky.

Cat. No. 36,025 (Rominger collection), 43,107 and 43,109 (Ulrich collection) U. S. N. M. Also in Massachusetts Institute of Technology, No. 654.

DOLATOCRINUS GREENEI Miller and Gurley

1894. MILLER and GURLEY, Ill. State Museum of Nat. Hist., Bull. 4, p. 28, pl. III, figs. 10, 11, 12.

The original description of *Dolatocrinus greenei* mentions the occurrence, in two of the interrachial areas, of two plates in the first row of interbrachials. These could not be made out with certainty in any of the specimens examined, but a specimen from Louisville, Kentucky, has one interrachial area much wider than the others and wide enough for two plates. Another specimen referred to *D. greenei* agrees with the description and figure of that species except that the interrachial areas are alike in possessing but one first interbrachial. There is also, as noted above, a slight difference in the grouping of the arms with reference to the anterior ray. The occurrence of additional interbrachials in the type may be abnormal, as suggested by the authors of the species.

Formation and locality.—Hamilton(?): Louisville, Ky., and Charlestown, Ind. Apparently also in the Onondaga near Dublin, Ohio.

Cat. No. 35,139 and 43,108 (Ulrich collection) U. S. N. M. Also in Massachusetts Institute of Technology, No. 655.

DOLATOCRINUS CHARLESTOWNENSIS Miller and Gurley

1896. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 8, p. 44, pl. III, figs. 10, 11, 12.

A specimen lacking the surface ornament, hence with some doubt referred to *D. charlestownensis* Miller and Gurley, apparently differs from it only in having two instead of three arms in one of the rays. Another specimen in the collection of the Massachusetts Institute of Technology shows the characteristic features of the species.

Formation and locality.—Hamilton: Thedford, Ontario, and Charlestown, Ind.

Cat. No. 26,466 U. S. N. M. Also No. 652 Massachusetts Institute of Technology.

DOLATOCRINUS TRIADACTYLUS Barris

1884. BARRIS, Proc. Davenport Acad. Nat. Sci., iv, p. 100, pl. II, figs. 5, 6, 7.

1896. *Dolatocrinus aplatus* MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 8, p. 48, pl. III, figs. 16, 17, 18.

This species is represented in the National Museum collection by several well-preserved specimens. A comparison of the figures and

descriptions of *D. triadactylus* and *D. aplatus* shows a close correspondence between the two. The chief difference appears to be in the number of upper brachial plates in the dorsal cup. *D. triadactylus* is said to have on one side of each ray two distichals and on the other one distichal bearing on each upper edge a single palmar, while *D. aplatus* has four distichals on one side of the ray with one distichal on the other side followed by four palmars on each of its upper edges. The specimens in the collection of the National Museum are all from the type locality of *D. triadactylus*, yet they agree in the number of brachial plates with *D. aplatus* which is from Charlestown, Indiana. An incomplete specimen from the latter locality also agrees with those from Alpena so far as it is preserved. The smaller number of distichals and palmars reported for *D. triadactylus* may perhaps be accounted for by the fact that the arms are biserial above the first palmars and the small wedge-shaped plates may have been counted by the author of the species as arm plates. On the other hand the fact that these plates are incorporated into the calyx has led Miller and Gurley to count them as calyx plates.

Respiratory pores have not hitherto been reported for *D. triadactylus*, but well-preserved material reveals their presence to the number of thirty or more. There seem to be no constant characteristics which separate this species from *D. aplatus*, and the latter becomes a synonym for *D. triadactylus*.

Formation and locality.—Upper Traverse limestone: Partridge Point, near Alpena, Mich. Hamilton: Charlestown, Ind.

Cat. No. 36,024 (Rominger collection), and 26,394 U. S. N. M. Also in Massachusetts Institute of Technology, No. 651.

DOLATOCRINUS HAMMELLI Miller and Gurley

1895. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 6, p. 52, pl. 5, figs. 4, 5, 6.

The chief difference between this species and *Dolatocrinus triadactylus* appears to consist in the presence of one additional arm in *D. hammelli*, the arm formula being 1-2 . . . 2-1 . . . 2-1 . . . 2-1 . . . 2-2. Further study may show that they constitute one species, but with the incomplete material at hand their identity could not be determined.

Formation and locality.—Hamilton: Near Charlestown, Ind.
Cat. No. 653 Massachusetts Institute of Technology.

DOLATOCRINUS MAJOR Wachsmuth and Springer

1897. WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, p. 322, pl. XXV, fig. 5.

A large specimen from Columbus, Ohio, is of this species. The figure of the type specimen shows two or three plates in the second row of interbrachials, while the description reads: "The plate of the second row is approximately as large as the first costal, but higher than wide and hexagonal." In this respect the National Museum specimen agrees with the description.

Formation and locality.—Onondaga: Price's quarry, Columbus, O.; Falls of the Ohio.

Cat. No. 42,428 (Ulrich collection) U. S. N. M.

DOLATOCRINUS GLYPTUS (Hall)

1862. *Cacabocrinus glyptus* HALL, 15th Rep't New York State Cab. Nat. Hist., p. 140.

Formation and locality.—Onondaga: Dublin, O. Hamilton: Beargrass creek, Louisville, Ky. The species is reported from Columbus, Ohio; Hamilton (Livingston county), and Pavilion (Genesee county), New York.

Cat. No. 42,410 and 42,432 (Ulrich collection) U. S. N. M.

DOLATOCRINUS ORNATUS Meek

1871. MEEK, Proc. Acad. Nat. Sci., Phila., p. 57.

This species is regarded by Wachsmuth and Springer as a synonym for *Dolatocrinus glyptus* (Hall), but the specimens in the collection of the National Museum do not seem to warrant such a reference. They agree perfectly with the original description of *D. ornatus* while differing widely from that of *D. glyptus*. The surface of the latter, as shown by the figures of Wachsmuth and Springer,¹ bears a few short, discontinuous ridges, or according to the original description, "lines of nodes," while that of *D. ornatus*, as it appears on the surface of an exquisitely preserved specimen, is closely covered with thin, sharp carinæ which are continuous from the center of one plate to that of its neighbor. Distinct nodes, if present at all, are not a characteristic feature of the ornament. The base of *D. ornatus* is deeply indented, the depression including about one-third of the radials. That of *D. glyptus* is flat.

No figure accompanies the original description of *D. ornatus*, but

¹North American Crinoidea Camerata, pl. XXVI, figs. 2a, b.

the specimens studied agree with Miller and Gurley's figure of that species in the Illinois State Museum Nat. Hist., Bulletin 4, pl. 11, figs. 7, 8, 9. This figure differs widely from that of *D. glyptus* referred to above. It appears, therefore, that *D. ornatus* Meek should stand as a valid species.

Formation and locality.—Onondaga: Columbus, O. A few plates from the Hamilton, at Beargrass creek, Ky., have a similar surface ornament and are referred with doubt to this species.

Cat. No. 42,427 and 43,110 (Ulrich collection) U. S. N. M.

DOLATOCRINUS CÆLATUS Miller and Gurley (?)

1896. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 8, p. 46, pl. III, figs. 13, 14, 15.

A small nodose individual is referred to this species with doubt since the upper part of the calyx is not sufficiently preserved to show the number of arms.

Formation and locality.—Onondaga: Dublin, O. Reported from Charlestown and Speed's quarry, Clark county, Ind.

Cat. No. 42,434 (Ulrich collection) U. S. N. M.

DOLATOCRINUS INDIANENSIS Miller and Gurley (?)

1896. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 8, p. 40, pl. III, figs. 1, 2, 3.

Two imperfect individuals are referred with doubt to this species.

Formation and locality.—Louisville, Ky. The type locality is Hamilton, near Charlestown, Ind.

Cat. No. 36,028 (Rominger collection) U. S. N. M.

DOLATOCRINUS WACHSMUTHI n. nom.

1897. *Dolatocrinus lyoni* WACHSMUTH and SPRINGER (name preoccupied by Miller and Gurley). North Amer. Crinoidea Camerata, p. 314, pl. XXV, figs. 6a, b, c, d.

A specimen in the collection of the Massachusetts Institute of Technology has been referred to *Dolatocrinus lyoni* Wachsmuth and Springer, but the specific name *lyoni* was given by Miller and Gurley in 1896¹ to a widely different species. As the "North American Crinoidea Camerata" did not appear until 1897, Miller and Gurley's name has priority. It is here proposed to name the present species for one of its distinguished describers.

This species is closely related to *D. amplus* Miller and Gurley, but the latter has four arms in each ray instead of three to the ray

¹ Ill. State Museum Nat. Hist., Bull. 9, p. 44, pl. III, figs. 4, 5, 6.

as in *D. wachsmuthi*. Such a wide difference in the number of arms may indicate a difference in species. There are also slight differences in the surface ornament.

Formation and locality.—Hamilton: Charlestown, Ind.
Cat. No. 624 M. I. T.

DOLATOCRINUS AMPLUS Miller and Gurley

1894. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 5, p. 45.
pl. iv, figs. 6, 7, 8.

Formation and locality.—Hamilton: Charlestown, Ind.
Cat. No. 650 M. I. T.

DOLATOCRINUS SALEBROSUS Miller and Gurley

1895. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 7, p. 59,
pl. III, figs. 13, 14, 15.

A well-preserved specimen differs from *Dolatocrinus salebrosus* mainly in possessing an additional arm. The structure of the two-armed ray in the type specimen of *D. salebrosus* is like that of a three-armed ray as far as the top of the first distichals, beyond which the additional distichals and the arm are lacking from one side of the ray. The normal structure of this ray is probably represented by a three-armed ray, as in the specimen under consideration. The arm formula for the latter is 1-2 . . . 2-2 . . . 2-2 . . . 1-2 . . . 2-1, and that of *D. salebrosus* 2-2 . . . 1-2 . . . 1-1 . . . 1-2 . . . 2-2, from which it will be seen that there is a difference in the arrangement of the arms with reference to the anterior ray, but, as noted above, this feature, in the genus *Dolatocrinus*, cannot be considered of value for specific determination.

The presence of respiratory pores has not been determined for the type, but they are plainly visible in the specimen studied.

Formation and locality.—Hamilton: Charlestown, Ind.
Cat. No. 656 M. I. T.

DOLATOCRINUS EXCAVATUS Wachsmuth and Springer

1897. WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, p.
321, pl. xxv, fig. 1; pl. xxxvi, figs. 7, 8.

An individual retaining the lower portion of the dorsal cup only, has been identified with this species. The species is closely related if not identical with *D. grandis* Miller and Gurley. The chief difference seems to be the presence of sharp carinæ on the lower brachial plates of *D. excavatus*. These are not mentioned in connection with *D. grandis*, but the basal depression of the type of that

species is filled with the matrix which may conceal this feature. Other slight differences have been noted in the number of respiratory pores and the number of higher interbrachial plates, but these may be due to differences in the age of the individuals compared. It is thought best, however, to retain *D. arcuatus* as a distinct species until further evidence can be obtained from specimens.

Formation and locality.—Hamilton: Falls of the Ohio. Reported from Clark county, Ind.

Cat. No. 658 M. I. T., also 36,029 (Rominger collection) U. S. N. M.

DOLATOCRINUS GRANDIS Miller and Gurley

1894. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 4, p. 14, pl. II, figs. 1, 2, 3.

A well-preserved tegmen has been referred to this species. The dorsal cup is not preserved, hence comparison could not be made with the specimen of *D. arcuatus* to determine if they belong to the same species.

Formation and locality.—Hamilton(?): Falls of the Ohio.

Cat. No. 657 M. I. T.; also 36,026 (Rominger collection) U. S. N. M.

DOLATOCRINUS VENUSTUS Miller and Gurley

1894. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 4, p. 23, pl. II, figs. 16, 17, 18.

A large individual differs from the type in the arrangement of the arms as described under the genus *Dolatocrinus*, but this feature is of little value for the identification of species.

Formation and locality.—Hamilton: Clark county, Ind.

Cat. No. 672 M. I. T.

DOLATOCRINUS PULCHELLUS Miller and Gurley

1895. MILLER and GURLEY, Ill. State Museum of Nat. Hist., Bull. 6, p. 55, pl. v, figs. 13, 14, 15.

Formation and locality.—Hamilton: Charlestown, Ind.

Cat. No. 1,228 M. I. T.

STEREOCRINUS Barris

1878. BARRIS, Proc. Davenport Acad. Nat. Sci., II, p. 282.

STEREOCRINUS BARRISI Wachsmuth and Springer

1897. WACHSMUTH and SPRINGER, North Amer. Crinoidea Camerata, p. 326, pl. XXV, figs. 9a, b.

This species is represented in the National Museum collection by many large and well-preserved specimens.

Formation and locality.—Upper Traverse limestone: Partridge Point near Alpena, Mich.

Cat. No. 36,031 (Rominger coll.) U. S. N. M.

GENNÆOCRINUS Wachsmuth and Springer

1881. WACHSMUTH and SPRINGER, Revision Palæocr., pt. II, p. 160 (Proc. Acad. Nat. Sci. Phila., p. 334).

GENNÆOCRINUS KENTUCKIENSIS (Shumard)

1866. *Actinocrinus kentuckiensis* SHUMARD, Trans. Acad. Sci. St. Louis, II, p. 345.

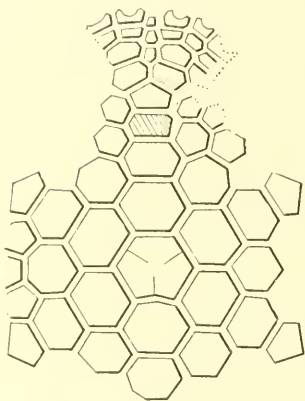


FIG. 9.—*Gennæocrinus kentuckiensis* (SHUMARD). Plates of an abnormal individual.

A somewhat imperfect specimen differs from *Gennæocrinus kentuckiensis* only in the presence of three costals in the anterior ray. The position and relative size of the plates, so far as they can be determined from the specimen, are shown by fig. 9. Although the genus *Gennæocrinus* is characterized by great regularity in the arrangement of the plates, the presence of a single extra costal does not seem sufficient ground for a separation of the specimen from it, and this may be regarded as an instance of abnormality occurring in a genus different from those already noted.

Formation and locality.—Hamilton: Beargrass quarry, Louisville, Ky.

Cat. No. 35,149 U. S. N. M.

GENNÆOCRINUS CARINATUS Wood

1901. WOOD, Amer. Jour. of Sci., ser. 4, XII, p. 297, pl. v, figs. *a, b, c*.

The collection of the Mass. Institute of Technology contains the type specimen of this species and a young individual which differs from the type in unimportant details of the surface ornament only.

Formation and locality.—Hamilton: Charlestown, Ind.

Cat. No. 1,229 M. I. T.

GILBERTSOCRINUS Phillips

1836. PHILLIPS, Geology of Yorkshire, p. 207.

GILBERTSOCRINUS INDIANENSIS Miller and Gurley

1895. MILLER and GURLEY, Ill. State Museum Nat. Hist., Bull. 6, p. 38, pl. III, figs. 16-22.

Formation and locality.—Hamilton: Near Charlestown, Ind.
Cat. No. 1,231 M. I. T.

VASOCRINUS Lyon

1857. LYON, Geol. Survey Kentucky, III, p. 485.

VASOCRINUS SCULPTUS Lyon

1857. LYON, Geol. Survey Kentucky, III, p. 486, pl. IV, figs. 3b-c.

Formation and locality.—Onondaga(?): Louisville, Kentucky.
Cat. No. 36,011 (Rominger collection) U. S. N. M.

TAXOCRINUS Phillips

1843. PHILLIPS, Morris Cat. British Fossils, p. 90.

TAXOCRINUS LOBATUS (Hall)

1862. *Forbesiocrinus lobatus* HALL, 15th Rep't N. Y. State Cab. Nat. Hist., p. 124.

Formation and locality.—Hamilton: Thedford, Ontario. The type locality is in Ontario county, New York.
Cat. No. 26,379 U. S. N. M.

ARTHACANTHA Williams

1883. H. S. WILLIAMS, Proc. Amer. Philos. Soc. (April), p. 84.

ARTHACANTHA PUNCTOBRACHIATA Williams

(PLATE XVI, 4)

1883. WILLIAMS, Proc. Amer. Philos. Soc. (April), pp. 83, 86.

Among several fine specimens of *Arthracantha punctobrachiata* from the Hamilton of Thedford, Ontario, there is one on which the arms are exquisitely preserved. A figure of this specimen is introduced to show the character of these structures which have not, so far as known to the writer, been fully illustrated. The delicate pinnules and the rectangular form of the upper portion of the arms are especially to be noted. Other specimens show the spine bases and the delicate, ribbed spines which closely resemble those of the *Echinoidca*.

Cat. No. 26,380, 26,464-65 U. S. N. M.

CALYX ABNORMALITIES IN CAMERATE CRINOIDS

It is worthy of note that we have in this comparatively small collection a relatively large number of abnormal individuals. If the more unusual of these, such as *Megistocrinus spherialis* n. sp. and *Dolatocrinus asterias* n. sp., had occurred as isolated specimens, they would doubtless be considered representatives of new genera, but they are associated with a series of forms having a peculiar surface or other feature by which their relationship can be determined. This being true for the more extreme forms, cases in which the abnormality is confined to a single plate may reasonably be accounted for in the same way. Mention of abnormal individuals has occasionally been made by other students of the *Crinoidea*. Bather¹ considers the type of *Mitrocrinus* as probably an abnormal individual. Miller and Gurley state, with reference to *Dolatocrinus ornatus* Meek, "In one ray of the typical specimen the second radial is abnormally wanting, while the other is larger than usual," etc. The occasional presence of such abnormal individuals does not destroy the force of the rule calling for a definite number of basals and radials in each species, but it is of interest as showing the amount of variation which may occur within the limits of a species, and is probably no more than could be found among recent organisms.

A table is appended showing the geological and geographical distribution of the crinoids studied in the preparation of this paper.

TABLE SHOWING THE DISTRIBUTION OF DEVONIC CRINOIDS AS ILLUSTRATED BY THE COLLECTIONS OF THE UNITED STATES NATIONAL MUSEUM AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

	O, Onondaga, T, Traverse (Hamilton), H, Hamilton.	Alpena, Mich.	Potoskey, Mich.	Solon, Iowa.	Theedford, Ont.	Charlestown, Ind.	Falls of the Ohio.	Columbus and Dublin, Ohio.	Le Roy, N. Y.
<i>Arthracantha punctobrachiata</i>					H				
<i>Dolatocrinus amplus</i>						H			
<i>Dolatocrinus asterias</i>	T					H		O?	
<i>Dolatocrinus calatus?</i>						H			
<i>Dolatocrinus charlestonensis</i>					H?	H			
<i>Dolatocrinus costatus</i>	T								
<i>Dolatocrinus excavatus</i>						H	H		
<i>Dolatocrinus glyptus</i>							H	O	
<i>Dolatocrinus grandis</i>							H?		
<i>Dolatocrinus greenii</i>						H	H?	O?	
<i>Dolatocrinus hammelli</i>						H			
<i>Dolatocrinus indianensis?</i>						H	O?		
<i>Dolatocrinus lucus</i>						H	H	O	
<i>Dolatocrinus major</i>						H	O?	O	
<i>Dolatocrinus ornatus</i>							H?	O	

¹ *A Treatise on Zoology*, ed. E. Ray Lankester.

	O, Onondaga, T, Traverse (Hamilton), H, Hamilton.	Alpena, Mich.	Petoskey, Mich.	Solon, Iowa.	Theford, Ont.	Charlestown, Ind.	Falls of the Ohio	Columbus and Dublin, Ohio.	Le Roy, N. Y.
<i>Dolatocrinus pulchellus</i>						H			
<i>Dolatocrinus salebrosus</i>						H			
<i>Dolatocrinus</i> sp.....							H?		
<i>Dolatocrinus triadactylus</i>	T					H			
<i>Dolatocrinus venustus</i>						H			
<i>Dolatocrinus wacksmuthi</i>						H			
<i>Gemmecrinus carinatus</i>						H			
<i>Gemmecrinus kentuckiensis</i>							H		
<i>Gilbertocrinus indianensis</i>						H			
<i>Megistocrinus abnormis</i>							H		
<i>Megistocrinus concavus</i>	T						H		
<i>Megistocrinus depressus</i>					? H	H	H	O	
<i>Megistocrinus expansus</i>	T					H	H		
<i>Megistocrinus farnsworthi</i>				X					
<i>Megistocrinus latus</i>			T						
<i>Megistocrinus multidecoratus</i>	T								
<i>Megistocrinus nodosus?</i>	T								
<i>Megistocrinus regularis</i>	T								
<i>Megistocrinus rugosus</i>							H	O	
<i>Megistocrinus sphaeralis</i>	T								
<i>Megistocrinus spinosulus</i>							H	O	
<i>Megistocrinus tuberatus</i>	T								
<i>Stereocrinus barrisi</i>	T								
<i>Taxocrinus lobatus</i>					H				
<i>Tripleurocrinus levis</i>									O
<i>Tylocrinus novus</i>	T								
<i>Vasocrinus sculptus</i>							O?		

EXPLANATION OF PLATES

(All figures are natural size unless otherwise stated.)

PLATE XV

Megistocrinus sphaeralis n. sp.....p. 60

FIG. 1. Posterior view of a specimen with the base flattened by compression. The holotype.

1a. Lateral view of an uncompressed specimen showing normal outline.

1b. Fragment of base.

Megistocrinus tuberatus n. sp.....p. 57

FIG. 2. Basal view of an incomplete specimen, the holotype.

2a. Lateral view of specimen represented by fig. 2.

2b. Enlargement of portion of surface of specimen represented by fig. 2. $\times 2$.

2c. Tegmen of a large individual which has been somewhat crushed.

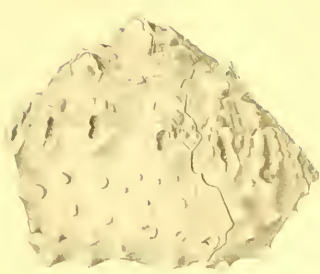
This figure is drawn with the dorsal side uppermost, as the plates are better shown with the specimen in that position.

See plate XVI, figs. 3, 3a.

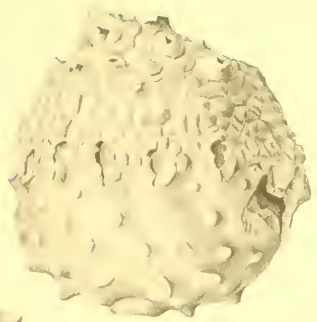
- Megistocrinus abnormis* (Lyon).....p. 63
- FIG. 3. Enlargement of a portion of the surface of a well-preserved specimen. $\times 2$.
- Megistocrinus regularis* n. sp.....p. 59
- FIG. 4. Lateral view of holotype.
- 4a. Basal view of specimen represented by fig. 4.

PLATE XVI

- Dolatocrinus asterias* n. sp.....p. 71
- FIG. 1. Lateral view of holotype.
- 1a. Basal view of another specimen.
- Tripleurocrinus lewis* n. gen. et sp.....p. 57
- FIG. 2. View of type specimen embedded in limestone matrix.
- 2a. Top view of a stem joint. $\times 3$.
- Megistocrinus tubercatus* n. sp.....p. 57
- FIG. 3. Posterior view of a young individual.
- 3a. Basal view of same specimen.
- See plate xv, figs. 2-2c.
- Arthracantha punctobrachiata* Williams.....p. 71
- FIG. 4. Dorsal view of well-preserved individual embedded in shale.
- Tylocrinus novus* n. gen. et sp.....p. 66
- FIG. 5. Lateral view of holotype.
- 5a. Base of specimen represented by fig. 5. $\times 2$.
- Dolatocrinus costatus* n. sp.....p. 70
- FIG. 6. Tegmen of holotype.
- 6a. Lateral view of specimen represented by fig. 6.



1



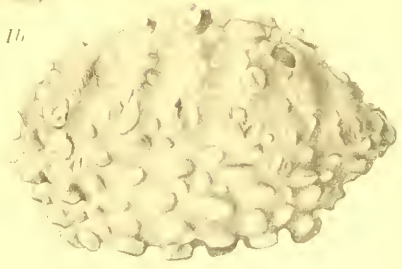
1a



1b



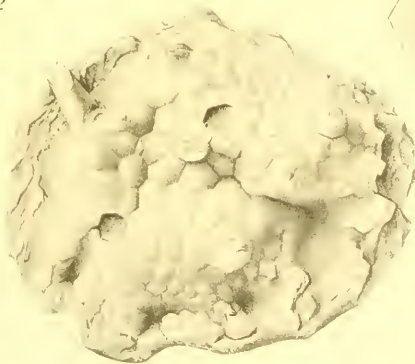
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2a



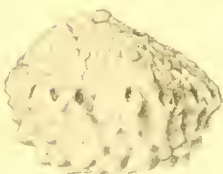
2b



2c



3



4



4a



1



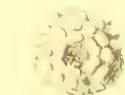
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1a



3



3a



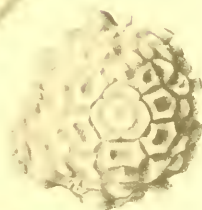
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2a



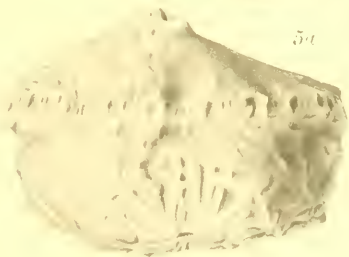
5



5a



6



6a