A NEW AMERICAN JURASSIC CRINOID.

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The first specimen of a fossil species of Pentacrinidæ from American rocks was described by Meek and Hayden in 1858,[a] under the name *Pentacrinites asteriscus*, from some isolated stem joints found in the Jurassic near the southwest base of the Black Hills of Dakota. They afterwards redescribed and figured the species in their work on the Palæontology of the Upper Missouri.[b] Their figures on Plate 3 were based upon the original specimen; but on page 67 the authors gave a text figure, not very accurate, of some stem fragments with cirri attached, which they referred with doubt to their species. This specimen, according to the label in the U. S. National Museum, came from Red Buttes, Nebraska, a locality now included in the State of Wyoming. The description was stated by the authors to apply "more particularly to the largest sized specimens," which came from a different locality, and which, as represented by the figures on Plate 3, were considered by Dr. P. H. Carpenter[c] to belong to the genus "*Extracrinus*" (*Pentacrinus*, *sensu str.*), although he perhaps based his opinion rather upon the figures given by White[d] of a specimen from Utah than upon those of Meek and Hayden. So far as can be judged from a few isolated joints, there is reasonable ground to believe that the doubt expressed by the authors as to the specific identity of the two specimens is well founded; those of the typical form are nearly twice as large as the others, and the petaloid sectors on the articular face are more sharply angular. The transverse view given in the text figure on page 67 of the work cited is not correct, the structure being rather poorly

[a] Proc. Acad. Nat. Sci. Philadelphia, X, p. 49; XII, 1860, p. 419.

[b] Smithsonian Contributions to Knowledge, No. 172, 1865, p. 67, pl. III, figs. 2 *a*, *b*.

[c] Challenger Report, Stalked Crinoids, pp. 143, 297.

[d] Wheeler, Geol. & Geog. Surv., IV, p. 162, pl. XIII, fig. 6 *a*.

defined in the specimen. The Red Buttes specimen shows a rather obtusely pentangular, smooth stem, with straight sides, having eleven or twelve joints to the internode, and cirri tapering rapidly near the proximal end.

Separate stem joints, more or less similar to both of Meek and Hayden's figures, have since been collected by the staff of the U. S. Geological Survey in various localities throughout the Rocky Mountain and Pacific regions, but no vestige of the crown was obtained until 1899, when the late Prof. W. C. Knight, of the University of Wyoming, in the course of some investigations among the famous Dinosaur beds near Medicine Bow, Wyoming, discovered some small slabs of limestone containing numerous stems and fragments of arms, with one very complete crown. This he reported as *Pentacrinus asteriscus*.[a] In the following year Mr. H. T. Martin, of the University of Kansas, visited the Medicine Bow locality and succeeded in finding a few more pieces of the rock containing the crinoid remains, which by careful cleaning have yielded some additional specimens useful for description. Through the obliging courtesy of these gentlemen this material was placed in my hands, but pressure of other matters has prevented the preparation of the necessary figures for their description until now.

The locality of these fossils is in the same region and horizon as Meek and Hayden's Red Buttes specimens, and they probably belong to the same species. Assuming, for the reasons already given, that they are not included in the typical *Pentacrinites asteriscus*—of which in any event we know nothing beyond the form and size of separate stem joints—it seems proper to describe this form as a new species. I therefore propose to associate with it the name of the lamented geologist to whose researches we are indebted for its discovery.

ISOCRINUS KNIGHTI, new species.

1865. ? *Pentacrinites asteriscus* MEEK and HAYDEN, Pal. Upper Missouri, p. 67, text fig. (not pl. III, figs. 2 *a*, *b*.)

Specimens of moderate size.

Stem smooth, long, slightly increasing in diameter distally; pentagonal with straight sides, except at the proximal end, where for the first few immature internodes the younger joints are stellate. Internodals about 14, but varying from 12 to 17 in the mature parts; distinctly crenulated at the margins; nodals not enlarged, scarcely distinguishable from the others except by the cirrus sockets; these are rather shallow, not extending to the hypozygal, or infranodal joint, but usually encroaching upon the supranodal, in which case the apposed faces of these two joints are more or less indented, producing

[a] Jurassic Rocks of Southwestern Wyoming. Bull. Geol. Soc. America, XI, p. 377.

a marked stellate outline. Conformably to this structure the cirri are directed upward. Interarticular pores extending to the fifth internode. Cirri in whorls of five; round, long, and slender, composed of 40 joints or more; the proximal ones relatively short and broad—about one-third as long as wide—tapering rapidly to about half their breadth, and doubling in length in the first 8 or 10 joints, beyond which they continue uniformly about as long as wide to the end; terminal claw not preserved. Angles of stem interradial; cirri radial; axial canal in stem small, obtusely pentagonal, and apparently interradial in position.

Cup forming a low cone, without any downward projection of basals or radials. Infrabasals well defined, filling half the diameter of the column facet and entirely covered by the proximal columnal. Basals large, smooth, visible in pentagonal outline, and in full contact exteriorly by their lateral faces; they form a closed ring, not protuberent but flush with the plane of the radials, and about equal to them in height. Radials forming also a ring continuous with basals. Primibrachs two, united by articulation apparently bifascial. Arms simple, or bifurcating once from the sixteenth to the thirtieth IIBr, thus varying from 10 to 20; they are long, slender, with strongly oblique articulating faces, and they extend to upward of 90 brachials. Syzygies at IIBr 3+4, and beyond throughout the arm at intervals of about 5 to 10 brachials. Pinnules long, rounded, composed of elongate joints, 15 or more in the distal pinnules, but the number in the proximal ones not observable. Disk unknown.

Dimensions of mature individual.

	mm.
Height of crown	65
Width of axillary IBr	7
Height of axillary IBr	5
Length of cirrus of 40 joints	32
Length of longest stem preserved	140
Diameter of stem at second internode	2
Diameter of stem at tenth internode	25
Diameter to height of second internode	1–2. 2
Diameter to height of tenth internode	1–5. 2
Diameter of stem to length of longest cirrus	1–17

Horizon and locality.—In the Shirley stage of the uppermost Jurassic. Medicine Bow, and Red Buttes, Wyoming.

The occurrence at Medicine Bow was in a band of argillaceous limestone about 1 inch thick, and it is undoubtedly the remnant of a considerable colony. The upper surface of the layer is filled with disintegrated stem joints and brachials closely cemented together, while toward the lower part the crinoids had been embedded as they perished without much disturbance. Unfortunately the layer was

not found *in situ*, all the specimens being derived from small, loose pieces in the débris. Most of the crinoids are therefore broken and imperfect, and only a few preserving parts of the arms and column were recovered. The most complete is the one given me by Professor Knight (Plate 4, fig. 1). Unfortunately the structure was not understood when found, and the stem of this specimen was almost stripped of its cirri by too energetic cleaning in the field; most of those on specimen No. 2 had been removed by weathering, but by careful manipulation of the embedded proximal part of this stem and of some other stem fragments I have developed the cirri so that their length and proportions can be ascertained.

The form under consideration is clearly distinct from species like *Pentacrinus fossilis* and *P. subangularis*, in which the radials project downward over the proximal columnals, and to which type only, as clearly pointed out by Doctor Bather, in his paper on "*Pentacrinus*, a Name and its History,"[a] the name *Pentacrinus* properly belongs. But it falls readily under the genus *Isocrinus* (Agassiz, 1836).

A brief excursion among original sources enables me to add a little to the very elaborate and instructive history of these names given by Bather in the work cited. *Isocrinus*, although described by von Meyer in 1837, as stated, was actually published as a generic name by Agassiz in 1836.[b] Speaking of this form, Bather says on page 250 that "no figure of a fossil crinoid of our type *C* (*Isocrinus*) is known to me before 1800." In an extensive work by Daniel Brückner, entitled "Versuch einer Beschreibung historischer und natürlicher Merkwürdigkeiten der Landschaft Basel," published in 23 parts, or "Stuecke," from 1749 to 1763, there is on pages 2425–2431 of the twentieth Stueck a good figure—No. 37—of a well-preserved specimen of this type, from the Swiss Jura, showing arms, stem, and cirri, accompanied by a long description and a name. The original specimens have been refigured by de Loriol in his "Crinoides de la Suisse," Plate 14, figs. 31–38, under the name *Cainocrinus andreæ* Desor, a genus since considered by him to be identical with *Isocrinus*. The twentieth Stueck of Brückner's work was published in 1761, and to the crinoid figured and described as above stated he gave the name *Entrochites ramosus*, vel *Encrinus*, *Lilium marinum*. So not only was the type figured and described before 1800; but a name was given to it in binomial form, thus raising the question whether the real name of our genus is not the venerable and classic term *Entrochites*, thus for the first time brought into the domain of valid nomenclature.

[a] Natural Science, April, 1908, p. 252.

[b] The Nomenclature of the Recent Crinoids. Austin H. Clark, Proc. U. S. Nat. Mus., XXXIV, 1908, p. 526.

However, Brückner did not employ binomial names consistently, many of those relating to crinoidal remains being polynomial, as, for instance, *Entrochites fungitæ adhærens*, eighth Stueck, page 888; *Encrini minoris pulcre ramificatum*, etc.; and his incidental use of *Entrochites ramosus* may probably be disregarded for that reason.

The case of *Encrinus* is much more serious. Bather credits it to Schulze (1760), who wrote it "*Encrinum*," probably as the accusative of *Encrinus*. Schulze's work was mainly a compilation from former authors, as Linck, Lhuyd, Seba, and Ellis, and he uses their names in the same manner as they did, with but small pretense to binomial application. He did not propose *Encrinum* to represent a genus, but only mentioned by way of recital the fact that certain petrifactions resembling a lily have been called the lily stone, *Encrinum*. This is what he says: "Man findet eine gewisse Versteinerung, die, in Ansehung ihrer Gestalt, einige Gleichheit mit einer Lilie zu haben scheinet; daher man dieselbe anfänglich für die Versteinerung dieser Blume gehalten, und sie den *Lilienstein*, *Encrinum*, genennet hat."[a]

On Plate 4 is a figure of a complete crown of the fossil to which he refers, and in the long description which follows he mentions it four times by the name "Lilienstein," but never again as *Encrinum*. It seems to me there would be as much reason for recognizing as valid names the *Decacnimos* (=*Antedon*) and *Triscadecacnimos* (probably =*Comatula*) which he transliterates from Linck, because it was the first post-Linnæan use of them, as *Encrinum*, which he recites as an equivalent of the name he actually uses in description—*Lilienstein*. Yet nobody recognizes these names, the ground of their rejection being, I suppose, that they are not binomial, which *Encrinum* certainly is not. I regret to find myself led to this impression by an inspection of Schulze's work, because there are serious troubles ahead for the name "*Encrinus*," from which we would be saved but for its doubtful standing there.

The earliest use of the name "*Encrinus*" in a binomial sense that I know of was by Andreae in his "Briefe aus der Schweiz," published in the Hannoverisches Magazin in 1763–64, and afterwards in book form in 1776. On page 4 of this work he formally proposes the name *Encrinus coralloides* for certain fossils which appear to him to be a species of *Encrinus* or Lilienstein not before recognized, and which had been figured on Table 8 of the eighth Stueck of Brückner's work above mentioned. He also refers to figures of similar specimens given by Rosinus[b] on Table 10, A, B, C, D, E.

These fossils are now supposed to be the terminal stem branches or roots of *Millericrinus*, and one of them—Brückner's fig. *h*—has been

[a] Betrachtung der Versteinerten See-Sterne und ihre Theile. p. 21.

[b] Testamen de Lithozois. 1718.

referred to *M. echinatus* by de Loriol.[a] Therefore a strict observance of the rule of priority might seem to require us to transfer the name "*Encrinus*" to the crinoidal remains which we have for three-quarters of a century ignorantly been calling *Millericrinus*, and to relegate to obscurity our still older acquaintance, *E. liliiformis*, until some one introduces it to us afresh under a new name.

But if we hold that Andreæ's name was applied to unrecognizable fragments, and for that reason is not valid, our troubles over *Encrinus* are not ended. The name was used by Blumenbach in 1779 in the first edition of his "Handbuch der Naturgeschichte," page 435, in a strictly binomial sense, for a genus with three species, arranged as follows:

ENCRINUS:

(1) *asteria* (Linnæus, after Guettard).

(2) *mylii* (based on Mylius' Greenland specimen—a Pennatulid).

(3) *boltenii* (based on Boltenius—an Ascidian.)

Here the name is taken out of the domain of Palæontology and applied to a recent crinoid—the type species being Guettard's famous *Palmier marin* of Boisjourdain, best known in literature as "*Pentacrinus*" *caput-medusæ*, or in present nomenclature as *Isocrinus asteria* Linnæus.

In the third edition, 1788, Blumenbach again gives the genus *Encrinus* with *asteria* as the first species; and in 1801 Lamarck, the generally accepted father of *Encrinus* as now commonly known, in the first edition of his "Systeme des Animaux sans Vertèbres," p. 379, recorded the genus as follows:

ENCRINUS:

(1) *caput-medusæ* (=*Isis asteria* Linnæus.)

(2) *liliiformis*.

No. 2 of Blumenbach was made the type of a new genus—*Umbellularia*, and in 1816 Savigny[b] made Blumenbach's species No. 3 the type of another genus, *Boltenia*. Thus by the year 1816 *Encrinus* was definitely restricted, by the removal of two of its original three species, to the group with *asteria* as the type. If Blumenbach's name is to stand, the subsequent references of *asteria* to *Pentacrinus* and *Isocrinus* are invalid, and the reference by Lamarck of *liliiformis* to *Encrinus* must likewise fall to the ground. According to the rules it will have to stand, unless theretofore validly applied to something else; and unless it has been so applied, *liliiformis* can not stand under it.

[a] Crin. de la Suisse, p. 75.

[b] Mem. sur les Animaux sans Vertèbres, p. 140.

The consequences to our literature of a strict application of the rule of priority to either of these nomenclatorial discoveries would be somewhat appalling. Suppose we take—

1. *Encrinus*, Blumenbach, 1779; type, *E. asteria*, which is good unless preoccupied by something earlier. This will require—

a. A new generic name for *Encrinus liliiformis*, which has been used for nearly a century for the best known of all crinoids—one which has been figured and described as such in countless works, and specimens of which are found under that label in all the cabinets and museums of the world.

b. Applying the name, so long associated with the most familiar fossils, to new, different, and unfamiliar use.

c. Supplanting the name *Isocrinus* after it has become thoroughly well established in literature, and is now currently employed by all writers on the recent crinoids.

Or, if we take—

2. *Encrinus*, Andreae, 1776; type *E. coralloides* (=*Millericrinus echinatus*); this, if good, upsets Blumenbach, but does not save us from results equally direful. For it likewise requires us—

a. To provide a new generic name for *E. liliiformis*.

b. To apply the old name, with all its familiar association, to new and different fossil forms, occurring in the same region, well known and abundantly represented in literature under another name for seventy-five years.

c. To give a new name to *Millericrinus*.

This brings us back again to—

3. *Encrinum*, Schulze, 1760; no type-species stated, but the name was probably intended for the fossil commonly known as *E. liliiformis*, which he figured. Schulze's use of the term was not binominal, and the case is a hard one; but he did use some other names binomially, and it may be presumed that he intended to do so with this. To recognize his name as valid would avoid all confusion, and leave the literature as to all three of the names involved undisturbed. And in a case like this, arising in the dawn of our science, before the rules of nomenclature had become formulated, or were even practically thought of, I think that expediency and the question of practical disadvantages or benefits to the scientific public are to be considered where there is a possible alternative and some room for the exercise of discretion. Here, on the one hand, is invited intolerable confusion and the overthrowing of long familiar and classic names to an extent that will bring the rules of nomenclature into disrepute; and this without serving any useful purpose and without benefit to anybody, unless it be the satisfaction of some delver among musty tomes, as I am, in making all the trouble he can. On the other hand, there is the preservation of these names in the sense to which all

general zoologists and palæontologists are accustomed, without injury to anyone, or the infringing of any principle except that of an extreme technical construction of the rules.

The underlying principle of the rule of priority is said, and properly said, to be *fixity*. Yet by insisting upon its absolute and unbending application to all cases, without regard to circumstances, we may destroy the very fixity for which we contend. There is no law more deeply rooted in the foundations of civil government, or more essential to the welfare and stability of society, than that of the fixity of the titles to real estate based on priority. But just as that law in actual administration is subject to exceptions founded upon principles of natural justice and the dictates of public policy, so I think we may find reasonable basis for an exception to the rule of priority in nomenclature which will meet such cases as this.

This would be that such names, irrespective of the actual state of the record as to their dates, should be protected under an exception to the rule, simply on the ground of long use, on the doctrine of prescription, which is a principle well known in law, recognized in continental Europe as coming down from the civil law of Rome, and now embodied in statutes in all English-speaking countries. It is that the right of property will be upheld by the courts in favor of one who can show a long, continuous, and undisputed possession of it, under a claim of right however defective, notwithstanding he has no paper title, and even though the records may show the prior title to be in someone else. This rule of law rests upon the idea that it is for the public interest that there be an end of controversy, and that there shall be some reasonable time after which titles may be held safe from attack on any ground. And this end was attained in the beginning, not by denying or abrogating the law governing the conveyance of property by deeds, but by invoking a simple presumption, founded on the known and usual conduct of men with regard to their interests, that where such long and undisputed possession existed there must have been a good title, the evidence of which is lost.

This principle of jurisprudence is now recognized throughout the civilized world, as one of the most salutary and beneficial provisions for preventing injustice, and insuring that repose of titles which the peace and order of society demand. By virtue of its operation a title by lapse of time merely, if properly proven under all the safeguards which are prescribed in practice to prevent the abuse of it, is as good in the actual possessor as a paper title showing priority by an unbroken chain of recorded deeds. If this be true with regard to matters of such vital importance as the titles to our landed property, why may not the same principle be invoked in favor of repose and stability of names in our scientific literature? It is not a question of "doing justice" to any particular ancient author. The propo-

sition is one of far broader significance, and involves the paramount interest of the scientific public.

I am much in sympathy with the protest voiced by Dr. G. A. Boulenger, at the Dublin meeting (1908) of the British Association, against the extreme application of the rule of priority, where the effect would be, as in this case, to overthrow old and well understood names, or to transfer them from one object to another. He renews a suggestion made by Sir E. Ray Lankester ten years earlier, that there should be created by the International Congress some kind of committee, having the powers of a court of last resort, to decide upon the application of such an exception to the rule of priority in particular cases.

In the meantime, and until overruled by some such higher authority, I shall maintain that, irrespective of the merits of their original titles to priority, the names of *Encrinus* and *Millericrinus* have become valid simply by the lapse of time, by long usage in the sense in which they are now generally understood; and that by reason of universal acquiescence in such use for nearly a century, zoologists are now estopped from disputing them. In this way, by analogy to the practice which prevails in courts of justice touching the most solemn rights of property, a presumably just conclusion can be reached independent of the rule of priority, and without impairing its force in cases to which no such considerations of public policy apply. With these two names thus firmly established, that of *Isocrinus* is *ipso facto* confirmed, and I am enabled to proceed with further comment on the species under consideration, without the necessity of searching for a new generic appellation.

In view of the generally assumed absence of infrabasals in "*Pentacrinus*" (*sensu* P. H. C.) and *Metacrinus* twenty years ago, and in the recent species until the past year, it is interesting to find their presence now fully demonstrated in no less than six species; two fossil—this and de Loriol's *I. leuthardi*—and four recent ones within the past few months. Doederlein described them in *Metacrinus acutus* in November, 1907,[a] and they were independently discovered by Mr. Austin H. Clark, who communicated the facts to me under date of November 29, 1907, in two other species of *Metacrinus*, and also in *Isocrinus decorus*.[b]

The infrabasals in our species were only observable in a single specimen, a rather small individual, in which the stem was broken off at the top joint, by which they had been covered (Plate 4, fig. 5*a*). As thus exposed they are perfectly distinguishable, and are somewhat larger than those figured by de Loriol.

[a] Die Gestielten Crinoiden der Siboga Expedition, p. 20.
[b] Proc. U. S. Nat. Mus., XXXIII, p. 671–676.

There can be no longer any doubt that the Pentacrinidæ are all either actually or potentially dicyclic, though in some species the infrabasals are resorbed at an early stage. This has been shown by Mr. Clark to be the case in *Isocrinus parræ* (*olim mülleri*),[a] and the observations of P. H. Carpenter (Stalked Crinoids, pp. 292–93) would seem to indicate that a similar condition prevails in *I. wyville-thomsoni*, *I. asteria*, and *I. alternicirrus*. I have found the same thing to be the case also in certain species of the palæozoic genus *Ichthyocrinus*.

As to specific relations, it is impossible, with the material available, to make any very satisfactory comparison with European species, a great many of which have been described from isolated stem joints. Although the stem as a whole often affords valuable characters for distinguishing species among the recent crinoids, and even a part of it, if the same parts can be compared, little reliance can be placed in species whose identification depends wholly upon the form and articular markings of joints whose position in the stem can not possibly be known. This has been pointed out by Carpenter (Stalked Crinoids, pp. 226, 298), and the fact is well shown by his Plate 22, where many different forms of columnals from the stem of *I. wyville-thomsoni* are figured. Mr. Clark has recently found by dissection of the stem of a young *I. decorus* [b] that in the different parts of the same stem may be found almost every type of articular face, from stellate to round, and from a bifascial articulation with transverse ridge as in *Rhizocrinus*, to the radiating petaloid sectors of the usual *Isocrinus* type. Several different forms of stem joint are found in the present species, the more common being obtusely pentagonal, while the younger joints near the calyx become stellate. The proximal face of the nodal joint also shows a sharply stellate outline, due to the indentation by the cirrus sockets (Plate 4, figs. 9, 10, 11, 12, 13). In the associated material are thousands of separate joints, besides several considerable portions of stems intact, and there is a general uniformity of size and appearance among them which indicates their probable derivation from a single species. They are uniformly different from the much larger ones on which *P. asteriscus* was founded, and from the Utah specimen referred by Doctor White to *P. asteriscus*,[c] but afterwards separated from it by Dr. W. B. Clark under the name *Pentacrinus whitei*, because of its alternating joints. Clark's comparison was made chiefly with the Red Buttes specimens of *P. asteriscus* (?), but the separation is doubtless well founded, nevertheless, as the character on which he bases it is clear in his specimen, and can not be shown in the type of *P. asteriscus*. The difference between the stem of our species and that of *P.*

[a] Proc. U. S. Nat. Mus., XXXV, 1908, p. 87.

[b] Idem, XXXV, p. 88.

[c] Bull. U. S. Geol. Surv., No. 97, p. 27.

whitei is similar to that between the recent *I. decorus* and *I. parræ*, which is fairly constant.

The most nearly related European species that I know of is de Loriol's "*Pentacrinus*" *beaugrandi*, from the Upper Jurassic, Portlandian stage, near Boulogne-sur-Mer, France.[a] This was the only Crinoid known to the author from the Portlandian stage, and it is the species which he originally proposed to separate from the other Pentacrinidæ on account of having a closed ring of basals, under the name *Pictetocrinus*. In this he found himself anticipated by the *Cainocrinus* of Forbes, and in the work last cited, page 281, he abandoned the distinction, and referred the species to *Pentacrinus* (*sensu* P. H. C.). It has similar large basals, but the arms branch lower down, the stem is more sharply stellate in corresponding portions, and the cirri much more delicate. The stem is preserved to the fourth internode, which has 8 internodals, whereas ours has 14 at the same stage.

Pentacrinus (*Cainocrinus*) *andreæ* Desor[b] is similar to the French species, but with shorter basals and shorter internodes.

The excellent preservation of our specimens enables us to make an interesting comparison with recent species. The stem has a considerable resemblance to that of *I. decorus*, except in the disposition of the cirri. It must have been quite long, as the longest portion, preserved to a distance of 140 mm., shows little sign of any rounding. It is rather more pentagonal for equivalent distances. The cirri are very long and slender; the taper near the base from short and wide joints to long, narrow, and equal ones, is quite marked. The most perfect one has 44 joints, and this was probably near the maximum. The interesting thing about the cirri, however, is the fact that they are directed upward instead of downward or outward. In consequence the sockets do not extend to the infranodal (hypozygal) joint, but slope upward toward the supranodal, the lower margin of which is often incised by them. This is more or less the case in the genus *Metacrinus*, but is not usual in the recent species of *Isocrinus*, most of which have the cirri directed downward, though in some, as *I. asteria* and *I. wyville-thomsoni*, the socket is confined to the nodal joint, and the cirri are given off about horizontally.

The basals, as shown by the five specimens figured and three others, are quite uniform in their form and proportions. They form with the radials a low funnel, with smooth or slightly rounded sides, and without protuberance or projection of any kind. They are connected exteriorly by their lateral faces, giving a pentagonal outline and forming a closed ring (Plate 4, fig. 3*a*), as in the type for which Forbes proposed the genus *Cainocrinus*, instead of appearing as mere triangular points separated from each other by the radials, and tend-

[a] Mon. Étage Jur. Boulogne-sur-Mer, 1875, p. 298, pl. xxvi, figs. 23–25; Paléontologie française, Crinoïdes, XI, 2e partie, p. 278, pl. clxxxi, figs. 1–3.

[b] De Loriol, Crin. Foss. de la Suisse, p. 112.

ing more or less to project downward over the proximal column joints, as in most recent species.

The bifurcation of the arms so far beyond the axillary IBr is an unusual feature, occurring in the largest specimen at the twenty-seventh to the thirtieth brachial (Plate 4, fig. 1), and in other specimens from the sixteenth to the twenty-third. I know of no Pentacrinoid in which arm division takes place so high up; nor in fact any inadunate crinoid, the nearest approach to it being found in the Carboniferous genus *Poteriocrinus*. There is little tendency of the arms to spread out, but they are long and slender, tending rather to lie in a bundle. The general aspect of calyx and arms is somewhat like that of *I. naresianus*, which it also resembles in the number and regularity of the syzygies, which is unusual in the Pentacrinidæ. I can trace them in two arms of specimen A (Plate 4, fig. 1) part way, and in one to the end, and can distinguish them in the distal portion of some other arms. Beginning at IIBr 3+4, they occur at intervals of mostly about 10 brachials, but sometimes 4, 5, or 6. I give a figure of the pair next to the last, being about brachials 79+80 of that arm. (Plate 4, fig. 1*a*.)

The type-specimens figured are deposited in the U. S. National Museum, where they will be available for comparison with the magnificent collection of recent crinoids now being accumulated there. For convenience of reference they are designated by the letters, *A*, *B*, etc., as indicated in the explanation of the plate.

EXPLANATION OF PLATE 4.

Isocrinus knighti, new species.

Fig. 1. Large specimen, *A;* with bifurcating arms complete and part of stem; cirri mostly lost.

1*a*. Syzygy at IIIBr 79+80 of same specimen.

2. Large specimen, *B;* with stem 140 mm., and part of arms. Some arms of another individual attached.

2*a*. Detail of stem at "*a*" of same specimen, showing interarticular pores, ×2.

2*b*. Detail of same at "*b;*" showing cirrus sockets, ×2.

3. Small specimen, *C;* with part of arms, some not bifurcating.

3*a*. Calyx and lower IIIBr of same specimen; showing form and proportions of basal and radial plates, ×2.

4. Small specimen, *D;* with part of arms, one with an axillary, and some apparently simple.

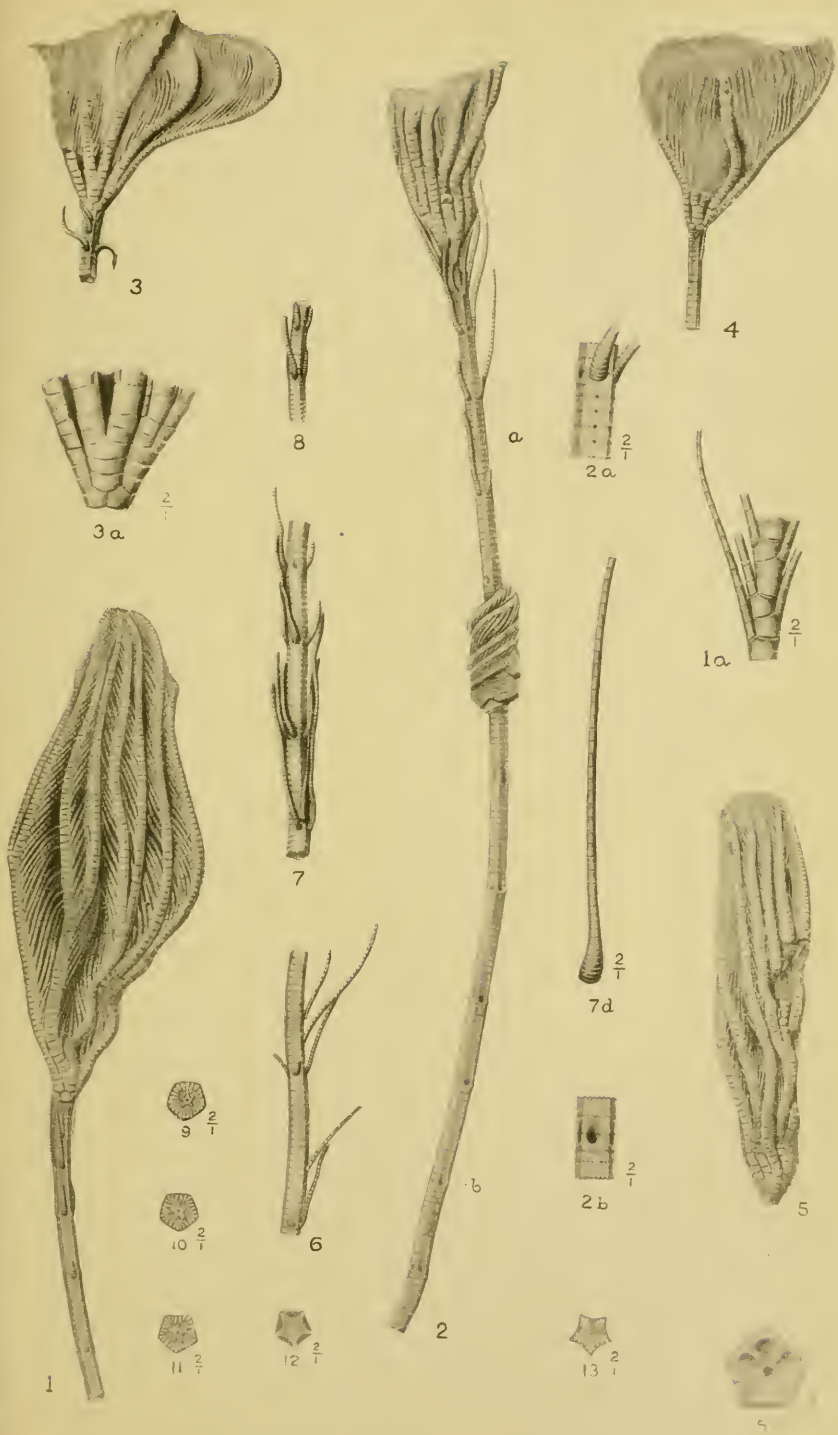
5. Small specimen, *E;* with two arms simple and one bifurcating at 23d IIIBr; stem detached, exposing infrabasals.

5*a*. Basal view of same specimen, showing infrabasals, ×4.

6–8. Portions of different stems, *F*, *G*, *H;* showing cirri.

7*a*. The longest cirrus on specimen *G*, ×2.

9–13. Weathered stem joints associated with the other specimens; 9, 10, 11 are mature internodals; 12 is the proximal face of a nodal incised by the cirrus sockets; 13 is a deeply stellate joint from the youngest part of the stem; all, ×2.



ISOCRINUS KNIGHTI SPRINGER