

## THE GENUS PENTACRINUS IN ALASKA

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In April, 1913, Dr. T. W. Stanton, of the United States Geological Survey, submitted to me for examination some crinoid remains collected by field parties of the survey in the extreme northern part of Alaska, near the Arctic Ocean. These proved to belong to the true *Pentacrinus* (*Extracrinus* of Austin, de Loriol, and P. H. Carpenter) of the lower Jurassic of England and continental Europe, and of the type of *P. subangularis* Miller, from the Lias of Boll, Metzgingen, Holzmaden, and other localities in Wurtemberg, Germany. I advised Doctor Stanton of this identification in a preliminary report, which was published.<sup>1</sup> The occurrence was of much interest as the first discovery of *Pentacrinus*, with the exception of isolated stem segments, yet made in American rocks, and because these specimens gave evidence of an unexpectedly wide distribution of one of the typical species. A detailed account of the material was deferred in the hope of obtaining more complete specimens from one of the localities, as it was then expected that Mr. Leffingwell might visit the region again. Nothing further has been accomplished, however, and it has been thought advisable to proceed with what we have.

The material in hand comes from two localities. The first is on a small island called Black Island, in Canning River, opposite Mount Copleston, longitude 146° 20' W., latitude 69° 30' N.; it is about 100 miles above the mouth of the river where it debouches into the Arctic Ocean near Flaxman Point. Here a single specimen was secured, consisting of a small slab containing crinoid remains brought from the island by a native. It was derived from a formation composed of about 4,000 feet of shale called the Kingak shale, correlated by Mr. Leffingwell as of lower Jurassic age.<sup>2</sup> The specimen consists of part of a set of arms of a large individual, probably associated with numerous others, in a preservation so exquisite as to induce a strong desire to secure further treasures from the locality. Although won-

<sup>1</sup> Professional Paper 109, U. S. Geol. Surv., 1919, The Canning River Region, Northern Alaska, by Ernest de K. Leffingwell, p. 119.

<sup>2</sup> *Idem*, p. 119.

derful specimens of the species to which this probably belongs have been obtained in various European localities—one of the finest being on exhibition in the hall of Invertebrate Paleontology in the United States National Museum, having complete arms 15 inches long, and 5 feet of stem attached—none of them exhibit such perfection in fine structural details as this, especially in the sharp definition of the pinnules, as shown by the figure herewith. The condition of this specimen indicates that it was part of a considerable colony, in which a large number of these crinoids were imbedded together, as is the case at some of the European localities.

The second locality is about 125 miles east of the first, near the international boundary line, on a tributary to Overthrust Creek, 13 $\frac{1}{4}$  miles above its mouth, and about 8 miles west of the one hundred and forty-first meridian. A. G. Maddren, while engaged in geological investigations along the Canada-Alaska boundary during 1911 and 1912, found at this locality a crinoid bed composed of fragments of the same *Pentacrinus* as the Black Island specimen, in a formation largely made up of black shales which are probably the equivalent of the Kingak shale.<sup>3</sup> These remains consist of numerous column and arm fragments of large size, rather closely packed together, indicating a bed of considerable extent, in which, however, the specimens lack the fine preservation of that of locality 1. The matrix is highly ferruginous, with much oxidation at the surface by which the structural details are destroyed, except in some of the column fragments, which have the joint-faces well preserved, showing the petaloid sectors characteristic of the genus.

There is a general similarity in size and appearance of the parts recovered from the two localities, which indicates the probability of their being of the same species. They are larger than the corresponding parts of specimens as usually found at Lyme-Regis in Dorsetshire, England, but not of greater size than that of many specimens from the Wurtemberg localities.

Among Mesozoic crinoids no genus has attracted more attention, both in the literature and in the rocks, than *Pentacrinus* of the lower Jurassic. From what has been learned in recent years, it probably had a wider distribution than any other. In view of this fact, and of the evidence as disclosed by the material now before us of its great abundance in a region where it was least expected, I have thought it well, for the benefit of those who may not have convenient access to the publications, to give a brief summary of the leading facts relative to the genus. The chief descriptive matter may be found in the works of J. S. Miller, Quenstedt, de Loriol, and P. H. Carpenter; but for a comprehensive and lucid exposition of the genus and the

<sup>3</sup>Leffingwell, same reference, p. 120.

complications relative to it, the reader should consult Bather's paper on "Pentacrinus, a Name and a History."<sup>4</sup>

The name is involved in considerable confusion, and students are apt to be misled by the manner of its use in the literature at certain periods. The two principal species were described by J. S. Miller in his Natural History of the Crinoidea. 1821, as *Pentacrinus briareus* (p. 56, pls. 1 and 2) from the lower Lias, and *P. subangularis* (p. 59, pls. 1 and 2) from the middle or upper Lias. It is evident from Miller's descriptions that he had as types specimens from the typical localities: *P. briareus* from Lyme-Regis, Dorsetshire, England, and *P. subangularis* from the black slate in Wurtemberg, Germany. He credits *subangularis* also to Lyme-Regis, and de Loriol refers a specimen from France to that species; while Quenstedt describes several varieties of *P. briareus* from Wurtemberg localities; but it is open to question whether the two forms are not chiefly confined in Europe to their respective localities and horizons. There is some confusion in the descriptions as to horizon; *subangularis* is credited to both the middle and upper Lias, and *briareus* to upper and lower.

These two most common species in the Lias of England and Germany are extremely abundant, often composing entire strata, in which their remains are beautifully preserved, furnishing most striking specimens, which are to be seen in nearly all museums.

The name *Pentacrinus* as employed by Miller included two types: 1, in which the radials project downward over the proximal columnals, and the arms are heterotomous; and 2, in which the radials do not so project, and the arms are dichotomous. The name was also applied to the earlier described stalked crinoids of the present seas, such as *P. caput-medusae*, *P. mulleri*, *P. wyville-thomsoni*, *P. decorus*, etc. Then the Austins in 1848 proposed to separate the species of type No. 1 under a new genus, *Extracrinus*, leaving only those of No. 2 under the original name. This course was followed by de Loriol<sup>5</sup> and by P. H. Carpenter in the *Challenger* Report on the Stalked Crinoids, and the names were applied by them accordingly.

Later on it was discovered that the *Pentacrinus briareus* of Miller, which had been illustrated under the name of the Briarean Pentacrinite by Parkinson in 1808<sup>6</sup> and of which Miller's name had been copied into treatises and textbooks generally,<sup>7</sup> was the identical species which had been described by Blumenbach in 1802 from a specimen from Dorsetshire as *Encrinites fossilis*, and as *Pentacrin-*

<sup>4</sup> Natural Science, vol. 12, 1898, p. 254.

<sup>5</sup> Crinoides de la France, vol. 2, 1868, p. 385.

<sup>6</sup> Org. Rems., vol. 2, p. 248.

<sup>7</sup> Dana's Manual of Geology, ed. 4, p. 778.

*ites fossilis* in 1804.<sup>8</sup> Under the rules of nomenclature this name had priority, and Miller's name would have to be discarded in its favor. Not only so, but as the name *Pentacrinus* had been attached to the (*briareus*) *fossilis* type, No. 1, long before the time of the Austins, it followed that their genus *Extracrinus* must also go into the discard, and all the species which had been ranked under it would now have to be listed as the true *Pentacrinus*.

Furthermore, it was found that the *Pentacrinus* type No. 2 was covered by the genus *Isocrinus* Agassiz, 1836 (von Meyer, 1837); so that the species of that type, which included all the Recent "*Pentacrinus*", would have to be written *Isocrinus*, leaving the species of type No. 1 as the true *Pentacrinus*, typified by Blumenbach's original species, *P. fossilis*.

All this history, of which I am giving but a brief abstract, will be found fully set forth with ample reference to the original sources, in Doctor Bather's paper already mentioned. Thus when in the literature the name *Pentacrinus* is encountered for an existing crinoid, or for a fossil species in the works of de Loriol, it means *Isocrinus*; and where the name "*Extracrinus*" occurs it should be read *Pentacrinus*. And for the classic name "*Pentacrinus briareus*" there should now be substituted *P. fossilis*. Quenstedt did not adopt the name "*Extracrinus*," but continued to use the original term for both forms.

With this explanation to obviate confusion over the names, we are in position to consider the questions relating to the particular forms of the genus suggested by the new material.

According to Quenstedt and de Loriol<sup>9</sup> the true *Pentacrinus* (type No. 1, above) is divisible into two groups, characterized by stem characters only, which with our present knowledge would be described as follows:

1. *P. (briareus) fossilis* (Blumenbach), 1802. Lower Lias, Dorsetshire, England.

Stem short, sharply pentagonal. Columnals alternating, but not strongly unequal. Internodals few, from 1 near the calyx, to 3 or 4 distally. Cirri large, very long, prismatic or flattened, in whorls of 5 to every nodal.

2. *P. subangulrais* Miller, 1821. Upper and middle Lias, Wurtemberg, Germany.

Stem very long, subpentangular or round. Columnals alternating, very unequal; internodals numerous, increasing from the calyx distalwards by doubling. Cirri few, small, short and round.

In a good specimen from Holzmaden in my collection the cirrus intervals increase from 3 ossicles (1 long and 2 short) beginning with the second large columnal near the calyx, to 7, 15, and 31 internodals at about the fifteenth internode, a distance of about 30

<sup>8</sup> Abh. Naturh. No. 70, pl. 70.

<sup>9</sup> Crin. de la France, vol. 2, p. 385.

em.; the increase is by interpolation of new internodals, which continues progressively further down along the stem, the interpolated columnals appearing at the surface in the form of short and thin lacunae, which gradually widen and coalesce until they become full columnals, and these increase in length until they approach the size of those adjoining them. So the next increase would be to add 32 young thin ossicles to the internode, making 63 in all at about the twenty-fourth internode.

Thus the progression would be about like this:

Internode 1 has 1 long, 2 short-----	3
Internodes 2-5 have 1 long, 2 short, 4 lacunae-----	7
Internodes 6-10 have 3 long, 4 short, 8 lacunae-----	15
Internodes 11-17 have 7 long, 8 short, 16 lacunae-----	31
Internodes 18-25 have 15 long, 16 short, 32 lacunae-----	63

Both groups are cited from Wurtemberg, but apparently only *P. fossilis* from England. De Loriol gives a list of the species in the two groups, and declares that as to those occurring outside of France they have not been described with sufficient exactness to enable him to recognize them. And the same may be said of most of those from France. In fact the literature is encumbered with the names of more than a hundred species of *Pentacrinus*, most of them without definition by which they can be recognized. They have been proposed chiefly upon isolated stem-ossicles, which differ much in contour and markings according to their position in the stem. Outside of the common species the characters are not well known, and nothing short of a thorough revision of all species based upon the type and associated material will afford the knowledge necessary for comparison.

The specimens from Alaska without doubt belong to the second, or *subangularis*, group. The round column, and strong alternation of columnals as they appear in figure 2 of our plate, establish this conclusively. Enough is visible in the lateral views of the few short stem fragments exposed to show that the internodal columnals merge in the form of lacunae, as shown by figure 4, and as further explained in my paper on *Pentacrinus rotiensis* from the East Indies.<sup>10</sup>

No cirri are observable on the parts preserved. The sculpture of the numerous joint-faces exposed on figure 2 is precisely of the type of the Wurtemberg specimens, as figured in the above-mentioned paper (pl. 1, figs. 3, 4, and herein, fig. 3). But there is to be seen a slight difference in the outline of the columnals, that of the latter being distinctly subpentagonal, while those of our specimens are almost uniformly round, a difference which may be due to different positions in the stem.

<sup>10</sup> Nederlandse Timor-Expeditie II. Jaarboek van het Mijnewesen, 45e Jaargang, 1916, Leiden, Holland. Published in 1918.

The set of arms shown in the Black Island specimen (fig. 1) are also clearly of the *subangularis* type. The brachials are slightly wedge-shaped, giving off a pinnule from the longer side of each, both on the main arms and the ramules, so that as seen from either margin the pinnules are borne alternately on every second brachial. Their form and proportions, as well as the exquisite delineation of details, are clearly brought out in the photograph. One notable item is the very large size of the first pinnular, which articulates with two brachials. Some of the pinnulars show notches or crenulations on the ventral edges.

In size there is not much difference between our specimens and the average of those from Wurtemberg. Compared with good-sized specimens from Holzmaden, as figured in Quenstedt,<sup>11</sup> we have the following details:

	Alaska	Wurtemberg
	<i>Mm.</i>	<i>Mm.</i>
Diameter of column.....	6-12	12, 13, 15
Width of arm in lower division.....	7	7
Number of brachials in interval between ramules.....	13-14	13

With the foregoing facts to go on, there would seem to be no good reason for separating the Alaskan form specifically from *subangularis*. Yet in order to allow for probable migrational changes not disclosed by our incomplete material, and for more convenient designation in the literature, I think best to give it a varietal name, *Pentacrinus subangularis*, var. *alaska*, which will have at least as good ground to stand on as any of the five varieties based on Wurtemberg specimens into which Quenstedt undertook to subdivide the species *P. briareus*, to say nothing of the doubt, before mentioned, whether the type of the (*briareus*) *fossilis* group occurs in that area.

Wishing to have the benefit of the fullest information before finally recording my own impression, I sent copies of my figures to Dr. F. A. Bather, requesting him to compare them with the specimens in the British Museum, and to favor me with his opinion. This he has very kindly done, and given me a report from which I quote the following extract:

LONDON, 25 May, 1923.

DEAR MR. SPRINGER: I have examined your photographs of *Pentacrinus* from Alaska with great care, comparing them with the published descriptions, and with the material in this museum from Dorset and Wurtemberg. The only difference I can see is that the few stem fragments visible from the side do not show such marked or regular alternation in the sizes of the columnals as do all the specimens in this museum. This may depend possibly on the region of the column from which they came, and in any case the evidence of the photograph is not very extensive. The photograph of the arms shows the

<sup>11</sup> Petref. Deutschl., vol. 4, pl. 101.

pinnules much better preserved than any specimens we have here. The ventral edges of some of the pinnulars show about four notches or crenulation. I am unable to detect these in any of our specimens, but the material is insufficient. I should certainly refer these specimens to *P. subangularis* in the broad sense. Quenstedt, you will remember, confessed that his attempts to divide up that species were not very satisfactory to him.

Perhaps the most interesting feature of the Alaskan discovery is its bearing upon the geographical distribution of this vigorous Jurassic crinoidal type, which now appears to have spread into almost all waters, and to have flourished in great profusion in regions remote from each other. Isolated stem-ossicles from Dakota and from Utah described as *Pentacrinus asteriscus* by Meek and Hayden,<sup>12</sup> and as *P. whitei* by W. B. Clark, show a still wider spread upon the American continent. And when we consider the further evidence now in hand of the existence of a closely related form in the East Indian archipelago, as given in my paper before cited, we are impressed with the cosmopolitan range of the genus, far exceeding that of any crinoid of the present ocean. It is a good illustration of the result of conditions prevailing in the Jurassic and Cretaceous periods of deep and clear seas, which were favorable to the development and spread of marine faunas over large areas with a minimum of checks and interference, in contrast to those of subsequent periods down to the present, in which owing to the great changes in land form affecting the conditions of marine life, and to increasing competition arising from the multiplication of forms, the tendency has been toward progressively greater restriction of faunal areas.

#### EXPLANATION OF PLATE

##### *Pentacrinus subangularis* var. *alaska*, new variety

FIG. 1. Part of a set of arms, with ramules and pinnules finely preserved. Natural size. U. S. National Museum. Black Island, Canning River.

2. A small slab filled with stem-fragments, many showing the joint-faces in detail, and some in side view showing the very unequal columnals with interpolated lacunae. Natural size. U. S. National Museum. Overthrust Creek, near international boundary.

Lower Jurassic, Kingak shale; northern Alaska.

##### *Pentacrinus subangularis* Miller

3. A typical joint-face, enlarged, for comparison of structures.  $\times 2$ . Author's collection.

Lower Jurassic. Upper Lias; Boll, Wurtemberg.

##### *Pentacrinus rotiensis* Springer

4. A stem-fragment containing a complete internode of seven pairs of internodals, to show the mode of growth of younger ossicles by interpolation in the form of small lacunae not yet meeting at the exterior to form a complete columnal. Collection Dr. G. A. F. Molengraaff, Delft, Holland.

Jurassic. Island of Roti, Dutch East Indies.

<sup>12</sup> Pal. Upper Missouri, 1865, p. 67, pl. 3, figs. 2, a-b.







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