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No. 8

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HIS ROYAL HIGHNESS PRINCE ALBERT, K.G.

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A

MONOGRAPH ON RECENT AND FOSSIL CRINOIDEA,

WITH

FIGURES AND DESCRIPTIONS OF SOME RECENT AND FOSSIL ALLIED GENERA.

BY

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AND

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CIVIL AND MINING ENGINEER.

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CRINOIDEA.

Though the myriads of Lily-stars which formerly existed have almost wholly disappeared from the living creation, new forms of animals, somewhat analogous in their natures, have appeared to supply the place of the extinct Crinoideans: thus we find innumerable *Echini* and *Asteriæ* inhabiting localities, where, under a former condition of our planet, the Lily-stars waved their graceful rays in the pellucid waters of an ocean whose surface was never ruffled by the prow of the wandering bark, or its hidden depths explored by the searching eyes of the swarthy pearl fisher.

PRELIMINARY OBSERVATIONS.

The want of a complete work on that portion of the *Echinodermata*, known as the *Crinoidea*, has been frequently regretted by the scientific inquirer; for though much has been written on the subject, it has been presented to the world in such a scattered and desultory manner, that reference to many volumes is necessary to obtain even a superficial insight into the form and structure of the beautiful "Lilies of the Ocean."

Although considerable attention has been devoted to the subject, from the period when Sir Isaac Newton and other philosophers were interested in the inquiry as to the origin and nature of the fossil species, down to our own times, when extended observation has so increased our means of rightly explaining much that is interesting concerning the *Crinoidea*, yet we do not possess a single work, with the exception of Miller's, that is devoted entirely to the subject.

Subsequently to the appearance of Miller's Natural History of the Crinoidea, many new genera and species have been discovered, and more perfect specimens of those which were then known obtained. So fortunate have we been in our researches, that we have, unaided by other observers, discovered and collected a greater number of new species than had been heretofore obtained, from the earliest period to the date at which Miller wrote. These, added to the acquisitions of other collectors, have so extended our knowledge of these animals, that it is presumed a work, including all the known species, will prove highly interesting to the Zoologist, and of considerable importance to the Geologist, as elucidating many peculiarities of organic existence at the earliest geological epochs down to the present period, when but one or two living species of *Crinoidea* remain as the representatives of all the varied forms which inhabited the ancient seas.

Though we disclaim every intention of wishing to indulge in invidious allusions to

the labours of those who have preceded us in this field of inquiry, we cannot avoid arriving at the conviction that much prejudice has been indulged in, and much fanciful speculation resorted to, for the purpose of establishing favourite theories, and explaining structural peculiarities which the evidence of worn and imperfect specimens did not warrant.

These observations are considered necessary, as in the progress of our work deviations from many received opinions will present themselves. It may be naturally asked, on what grounds we claim exemption from the same liability to err as preceding writers. Our answer to such inquiry is, that owing to the fortunate discovery of numerous specimens, perfect as regards all their essential characters, we hope to be enabled to present much additional information on the subject, to clear up many doubtful points, and above all to remove many important errors which have been unfortunately received as established facts.

In another part of the work many instances of erroneous conclusions respecting the *Crinoidea* will be noticed, with a view of removing the obscurity in which the subject has been involved, and which has tended so much to retard the study of these beautiful fossil animals, the Lily-stars. It will not however be inappropriate to briefly notice in this, the first portion of our Monograph, some errors and speculations which have been indulged in by distinguished writers,—writers to whom science is greatly indebted, but who nevertheless, when treating on the *Crinoidea*, seem to have laid aside their usual acumen, and to have become involved in a labyrinth of conjecture and speculative reasoning quite opposed to a calm investigation of the subject.

Great praise is unquestionably due to Miller, for his indefatigable industry in reducing the confused knowledge respecting the *Encrinites* to something like a systematic arrangement; yet he had such strong prejudices in favour of certain views, that he appears to have overlooked important facts which militated against his cherished theories. He has in some cases taken parts of different animals and jumbled them together to found a single species on, or to illustrate a favourite point. This may have been caused by his great anxiety to render his figures as perfect as possible; and also may in part be attributed to the imperfect specimens he had access to. But whatever the cause, it is a system highly objectionable at all times, and when geometrically constructed fossils like the Lilies of the Ocean are the subjects, it leads to great and important errors.

One of Miller's favourite positions was the contractile power of the proboscis or oral tube in the *Actinocrinites*, the only genus in which he knew of the existence of this singular organ, and which he represents as capable of being withdrawn into the cup containing the viscera. This is in several instances a physical impossibility, and the following simple reason will prove it such; namely, that in some species the calcareous plates which envelope it, are of greater solid contents than the area into which Miller

imagined it could be withdrawn, and which was already occupied by the viscera of the animal.

Cuvier, in his *Le Règne Animal*, has adopted some of Miller's errors; while Blainville has, in addition to repeating similar misconceptions, fallen into some unaccountable mistakes respecting the Crinoidea. In his *Manuel D'Actinologie ou de Zoophytologie*, page 262, pl. xxv, fig. 1, he gives the drawing of a Pentacrinite as the *Encrine à panache*, *(Actinocrinites polydactylus)* with other errors equally unfortunate.

Goldfuss has, in his Petrefacta Germaniæ, represented several plates of the *Echinocrinus pomum* as belonging to the *Actinocrinites granulatus*, vide Pl. LIX. *fig.* 4, *a to f.* Thus founding a species in one genus, on the evidence of a few disjointed plates which clearly appertain to another. It is to be regretted that the practice of founding genera and species on imperfect and broken fragments has been so extensively adopted, that it will require more than ordinary labour to extricate the subject from the labyrinth in which it has become involved.

Von Buch, in a paper read before the Royal Academy of Sciences, of Berlin, March 16th, 1840, indulges in some novel speculations concerning genera from which *Crinoidea* originate. In this paper we find the following opinion advanced in the same eloquent language that characterises the whole document. "But before the ocean-lily had opened and expanded its arms, it moved on a short pedicle in the closed state in innumerable quantity, and only by frequent and highly varied attempts did this rupture and expansion succeed. These closed *Crinoidea* are still but little and imperfectly known; they deserve to be known, however, in every respect," &c.

The theory is ingenious, but we fear it will not bear the test of calm investigation, for, unfortunately for the hypothesis, we have *Platycrinites* and *Poteriocrinites* equally small with the minute species which it is supposed Von Buch alludes to, but which are nevertheless liberally furnished with exceeding long rays, and tentacula as numerous as their more gigantic congeners. If Von Buch's observations apply to the *Sphæronites*, how can the fact of their being destitute of rays accord with the opinion that it was "only by frequent and highly varied attempts" that the rupture and expansion of the arms succeeded; when these same *Sphæronites*, which are larger than the generality of species with highly developed rays, are wholly devoid of rays themselves?

This opinion of Von Buch's savours strongly of "the efforts of internal sentiment" of Lamarck, by which a continual transmutation of species is going on in the organic world, and by which the orang-outan has been transformed into the human species. The theory has been already ably refuted by Mr. Lyell in his Principles of Geology, we need therefore only express our dissent from the views advanced by Von Buch, as to the various species of *Crinoidea* ever having deviated from their original types.

We have some of these closed *Crinoidea*, but cannot discover the least grounds for supposing that they ever changed their form in the manner indicated by Von Buch.

The number and arrangement of the plates surrounding the body, differing so essentially from those of every other genera, preclude the idea that any transformation ever took place.

As the chief end and aim of science is truth, we trust we shall stand excused for thus adverting to the errors so prevalent with regard to the *Crinoidea*, and which it is necessary to notice in order to arrive at a right understanding of the subject.

Professor Owen, in the Edinburgh New Philosophical Journal, No. 65, July, 1842, in allusion to the probable solution of some interesting phenomena respecting various extinct species of animals, suggests the possibility that the atmosphere of our planet has undergone a material chemical change,—namely, from a dense fluid which contained much carbon, and but a small portion of oxygen as compared with the more invigorating and lighter medium which at present surrounds the earth.

Such a physical state of things would not only satisfactorily account for the gradual introduction of animals and plants approaching to the existing Fauna and Flora, but would explain some other physiological questions of great interest.

When investigating the lower fossiliferous rocks, we have frequently speculated on the probable physical conditions of the medium which enveloped our planet at the period of their deposition. If we adopt Professor Owen's ingenious and highly probable suggestion, and suppose the atmosphere, by its excess of carbon, to have been a dense heavy fluid, whose specific gravity was only a few degrees lighter than water, we have a clear exposition of the adaptation of the structure of molluscous animals, and the Ocean Lilies at remote geological epochs, to the peculiar physical conditions of an atmosphere whose force operated on the surface of the globe with a degree of energy much beyond the atmospheric pressure at the present time.

The *Encrinites*, which were spread over the bed of the ancient seas, were so completely protected by calcareous plates, that but a small portion of their softer substance was left exposed to a pressure which it may be conjectured it was unfitted to resist, and their forms were in every respect well calculated to meet the supposed atmospheric influence as exerted on the medium in which they lived.

The shells which inhabited the waters during the earlier ages of our planet, also indicate a physical adaptation to such a state of things as that hinted at by Mr. Owen, for they were either of a highly arched form, or else were furnished with internal spires, both modes of structure being well adapted to resist the crushing effects of an atmosphere, the pressure of which must have operated with considerable intensity at the lowest depths of the ocean; and which might well be supposed capable of injuring the fragile material which enveloped the mollusca, unless counteracted by some such wise provision as that which forces itself on our attention.

Sub-kingdom CENTRONLE, *(Pallas.)*

Section Echinodermata.

Body more or less protected by a shelly covering, composed of variously shaped calcareous plates imbedded in the substance, attached to the surface of the skin, or forming the indurated frame work of the animal. These pieces are formed by the deposition of earthy particles round certain central points, so that when fully developed, they observe a well-defined arrangement, which is easily traceable into certain distinct forms, each peculiar to its kind. This calcareous skeleton, though formed of numerous pieces, continues firmly united during the animal's life; but after death, in consequence of the liability of the investing membrane and connecting fibres to destruction, the bone-like plates and joints become incoherent. By the mode of structure pointed out, the increase of the animal, as regards the size and number of the plates, is duly provided for; and injuries of the plated envelope, from external violence, are readily repaired by the renewed deposition of calcareous matter.

All the known Echinodermes are marine, and are sustained by animal food.

Class 1. Pinnastella, or Crinoidea. *Pinnigrada, (Forbes.)*

Character of the class.—Viscera protected by an indurated skeleton formed of calcareous plates; mouth surrounded by pinnated rays composed of calcareous joints. Sometimes free, but more frequently permanently attached (dorsally) to other bodies by a jointed flexible column.

Order 1. Cionacineti.

Etym. ΚΙΩΝ *(cion)* a column, *and* ΑΚΙΝΗΤΟΣ *(acinetos)* fixed.

Fixed to extraneous objects by a jointed flexible column.

Family Platycrinidæ.

Contains the genera *Platycrinites*, *Cyathocrinites*, and *Caryocrinites*. As these genera have but few plates below the rays, they may be conveniently arranged into a natural group.

Genus 1. Platycrinites. *(Miller.)*

Etym. ΠΛΑΤΥΣ, *(Platus)* broad, with reference to the form of the perisomic plates.

Definition.—Dorso-central plate (pelvis) undivided and pentagonal, from which five, and in one or two instances six, broad perisomic plates proceed. The dorso-central plate is perforated centrally, to correspond with the opening in the column. Mouth in some species lateral, in others central, and frequently elongated into a proboscis of considerable length. Column composed of calcareous joints, either articulating by diverging striæ, or by transverse ridges. Base of attachment unknown, probably a hard calcareous secretion, with fibres by which the animal attached itself to the bed of the ocean.

Miller, in his Natural History of the Crinoidea, speaks positively as to the base of attachment, but it is believed that no satisfactory proof exists of this portion of the animal having ever been discovered.

The various species hitherto ascribed to the genus *Platycrinites*, arrange themselves naturally into three groups, the one characterised by the length, form, and position of the oral tube; the second by the structure of the valvate mouth; and the third by the mouth being placed laterally, or at some distance from the centre of the visceral cup.

We are therefore inclined to consider that it may hereafter be desirable to separate this genus into three divisions. Those species with central elongated oral tubes, forming one division, as the *P. lævis:* those with central valvate unobtrusive mouths, or mouths capable of being withdrawn into the visceral cup, a second, for which we would propose the generic name of *Centrocrinus:* and those species with mouths placed laterally, or not central, a third, which we would designate by the term *Pleurocrinus*.

The genus *Platycrinites* has, until recently, been considered as peculiar to the mountain limestone. Goldfuss has, however, mentioned two species as occurring in the Eifel;

and Mr. Phillips has described several species as yet more recently discovered in the Devonian rocks at Newton, and Plymouth.

Miller's reiterated assertion as to the dorso-central plate (pelvis) of this genus being tripartite, appears to be one of several instances of his adherence to error, after he possessed perfect evidence as to the unsoundness of his original opinion on the subject, for in his own collection several perfect specimens of dorso-central plates, whole and undivided, were to be found.

This error has been so unaccountably adhered to, that Mr. Phillips has, in his Palæozoic Fossils, (Devon and W. Somerset) Pl. 16, *fig.* 42, *page* 212, founded a new genus, *Adelocrinus*, on the imaginary peculiarity of an "undivided pelvis." Our cabinet contains numerous specimens of undivided dorso-central plates of *Platycrinites;* and it is far from improbable that the *Adelocrinus Hystrix* will eventually prove to be identical with *Platycrinites interscapularis.*

As we differ in opinion from all preceding writers on this subject, some further explanation is requisite, lest it might be supposed that we have arrived at a conclusion unsupported by satisfactory evidence.

Mr. Phillips, Cuvier, Goldfuss, and other writers, have all adopted Miller's error; and had we not fortunately discovered many undivided dorso-central plates, we should have probably been without convincing evidence of the mistake. We were first led to doubt the correctness of former observers by finding several dorso-central plates, which had been exposed to the wash of the sea, perfectly smooth and unbroken. These plates never exhibited the least indication of divisions, and a more extensive inquiry confirmed us in the opinion that no divisions had ever existed in them.

The circumstance that divided plates are frequently met with, may be explained by the fact that five internal furrows, or grooves, run from the central perforation in the plate to its outer edge. These furrows probably follow the direction in which the principal muscles played; why three of them should be deeper than the remaining two, is not so easily accounted for; but it is along these three deep furrows, where the plate is thinnest, and therefore most liable to fracture, that it invariably yields to pressure, or falls asunder by exposure to the atmosphere.

If a careful examination is made of the supposed divisions in the dorso-central plate, (pelvis) the edges will be found jagged and uneven, and quite dissimilar in appearance to the regular divisions between the other plates, clearly indicating that the separation is the effect of mechanical violence, and not that of organic structure. Sometimes the fictitious divisions run in a curved direction, in other specimens the fissures run obliquely to the axis of the columnar point of attachment, and in no two instances are the divisions found to correspond with each other, either in form or size.

In collecting many of these plates from the strata in *situ*, we have never met with a divided one. In decomposed rock it may be otherwise, but this cannot militate against

the undeniable fact that in all the more perfect specimens no division whatever is observable.

As it is more difficult to eradicate an error of long standing, than it is to establish a new fact, we have considered it necessary to offer this rather diffuse explanation.

1. Species. Platycrinites lævis. *(Miller.)*

Definition.—Dorso-central plate (pelvis) entire and pentagonal, with a central perforation communicating with the columnar canal. Perisomic plates five, broad, smooth, and somewhat orbicular on their lower edges, by which they fit into the undulations in the rim of the dorso-central plate. Towards their truncated summits, and about equidistant from the sides, are the horse-shoe shaped excavations for the attachment of the rays. The lower surfaces of these excavations are sloped at a high angle, to correspond with the attaching surfaces in the rays. Plates covering the abdominal cavity smooth. Proboscis, or oral tube, central and greatly elongated. Main rays five, subdivided twice, making twenty lesser rays, all dorsally rounded and closely tentaculated to their points. Column circular at and near the attachment to the dorso-central plate, but elliptical as it recedes from it, with circular auxiliary side arms.

Synonymes and References.

Parkinson's *Org. Rem. Vol. II. Pl.* 17. *fig.* 12.
Cumberland, *Trans. Geol. Soc. Vol. V. Pl.* 5. *fig.* 8.
Platycrinites lævis.—Miller, *Nat. Hist. Crinoidea, Pl. I. and II. page* 74.
—Schloth. *Nacht. II. tab.* 25. *fig.* 4. *a——h.*
—Bronn. *Pflanzenth. tab.* 3. *fig.* 9.
—Goldfuss, *Petrefacta Germaniæ, tab. LVIII. fig.* 2.
—Blainville, *Man. D'Actinologie, page* 262. *Paris ed.* 1834.
—Cuvier, *Le Règne Animal, Zoophytes, tab.* 7. *fig.* 3. *Paris ed.* 1837.

Localities and Formation.

Carboniferous limestone, Lancashire; Mendip Hills; Clevedon Bay; Frome; the Black Rock, on the Avon side, near Bristol; Bleadon, near Uphill, Somersetshire; Valley of the Maine, Kerry; vicinity of Dublin; Cork; Kildare; Hook Point, Wexford; Granagh Ferry, Kilkenny; Lough Macnean? &c.

The *P. lævis* appears to be more abundant in the lower and middle beds of the carboniferous limestone, than in the upper.

Description of the Calcareous Frame Work.

The dorso-central plate, *(Pelvis of Miller)*, Pl. 1. *fig.* 1. *n*, is convex externally, with the angles of the pentagon, which it forms, turned upwards, so that its figure becomes somewhat circular when viewed in connection with the plates which it supports. Externally, in the centre, is a circular depression finely striated in radii, for the attachment of the column. A central perforation preserves the communication between the column and body of the animal.

The Perisomic plates, *(Scapulæ, Miller)*, Pl. 1. *fig.* 1. *i*, *h*, are five in number, which adhere to each other by their lateral edges. Their lower edges are somewhat orbicular, and their whole contour rounded, so that the perfect animal, instead of presenting a conspicuous pentagonal appearance, as stated by Miller, is only slightly of that figure.

Abdominal plates.—The integument which extended over the abdominal cavity was strengthened and protected by numerous smooth, chiefly hexagonal, plates, from which proceeds the elongated proboscis, which is also covered with smooth plates of similar form.

Proboscis.—The figures 1. and 2. *e*, *l*, *p*, and *q*, Pl. 1. are highly interesting, as being faithful representations of that singular organ, the proboscis or oral tube, and which has never been noticed by previous observers as appertaining to this species. In some specimens the proboscis is fully two inches and a half in length, and rises from the centre of the plates covering the viscera. It is protected by continued series of smooth hexagonal plates from its base to the apex, where it is completely closed in with a few irregular shaped ones, so that the mouth must have been valvate. The oral tube possessed sufficient flexibility to have enabled the animal to move it in every direction, so that it was admirably adapted to take up any object, however minute, which the tentacula might have captured, and which was proper for the sustenance of the animal.

Rays, or Arms.—The five main rays, or arms as they have been frequently termed, are each composed of a single cunieform joint. Pl. 1. *fig.* 1. *h*. On the outer faces of this joint the two secondary rays (hands) articulate, each of these consists of two joints, the upper of which is cunieform. Pl. 1. *fig.* 1. *g*. *h*. From each of these upper joints of the secondary rays proceed two lesser rays, (Pl. 1. *fig.* 1. *a*, *e*, *g*, *h*.) which are composed

of single joints for a short distance above the points of bifurcation, which structure is succeeded by a double series of joints beautifully articulated into each other, the salient angles of one set entering into the retiring angles of the adjoining set. (Vide Pl. 1.) By this arrangement the greatest possible flexibility, combined with the requisite strength, was secured to the animal, which must have relied in a great measure on quickness of action and a delicate sense of touch for securing its food.

The inside of all the rays were sulcated throughout their whole length: in these sulci the muscles which imparted motion to the extremities played. An integument, plated with exceedingly minute plates, extended over and protected the softer parts contained in the sulci from injury. It is not improbable that cilia, almost imperceptible from their minuteness, were ranged along the lateral fimbriate web which fringed the pinnæ, whereby the animal, by their extreme sensibility, was enabled to detect minute objects in contact with the rays or tentacula.

The cuneiform joints of the rays were doubly sulcated, to allow a free passage to the muscles where the bifurcations take place. Pl. 1. *r*. The whole structure of the rays, the joints gradually diminishing in size to their extremities, with the inner plated integument, exhibit many beautiful contrivances to produce that degree of flexure which is so conspicuous in the rays of the *Crinoidea*.

There is reason to suppose that the joints of the rays were not wholly calcareous any more than the column, but that the indurated matter was arranged in a tubular manner throughout their substance.

The rays in this species are uniform in length.

The Tentacula.—From the outer side of each ray joint, Pl. 1. *s*. proceeds a single tentaculum, which is composed of numerous joints. These plumose appendages vary in full sized specimens, from half to three quarters of an inch in length, and gradually diminish in thickness to their extremities.

The tentacula become perceptibly closer to each other as they approach the extreme points of the rays; this is owing to the gradual diminution in the size of the ray joints themselves, each of which having a single tentaculum attached to it, they, as a matter of course, become more closely set towards the ends of the rays.

The tentacula are composed of numerous joints, whose inner surfaces are finely sulcated longitudinally. The softer substance filling the sulci, as in the rays, was probably protected by a plated integument, which effectually secured it from external injury.

The extremities were moved by the muscles which occupied the perforations and sulci, now seen in the indurated frame work of the animal, and not by a muscular integument which Miller assumed covered both the interior and exterior surfaces, "effecting by its contractile power the movement of the arms."

That the exterior surface was covered by a cortical envelope, or recticulated tissue, is

highly probable, for we see something analogous to it in recent allied forms; but that it possessed sufficient contractile power to effect the movement of the rays we consider as quite improbable.

The number of the rays, and closeness of the tentacula, serve as indices to denote whether the animal's staple articles of food were minute or otherwise. The ordinary objects of sustenance to those crinoids with few, but wide spreading rays, must have been of larger size than those creatures which supported the many rayed and closely tentaculated species. These latter, by their densely crowded plumose rays, were enabled to filter the element in which they lived, straining it as through a sieve, thus separating and retaining the minute marine animalcula, which generally abound in sea water, within the folds of their delicate tentacula; while the former captured and ordinarily fed upon such less minute species of animals as came within the sweep of their wide extended rays.

The form of the proboscis seems to confirm these views of their alimentation; and it may be considered as a general rule, though liable to occasional exceptions, that the size of the oral tube and the number of the rays bear a certain relation to each other. In those species which have numerous rays and closely set tentacula, the diameter of the oral tube is proportionally contracted; while in those with but few rays it is much enlarged. There is in reality a remarkable coincidence, in this respect, in those species which possess elongated mouths; and it is evident that the relation between the organs for securing the food, and the form and size of the mouth is all but constant.

Miller and Cuvier have represented the rays of this species as consisting of a double series of joints from their points of bifurcation. This is clearly erroneous, but the smallness of the specimen, from which the former took his figure, will perhaps account for his mistake. And the latter appears to have closely copied Miller's error.

Column.—The column of this species is composed of numerous joints, which are invariably circular at, and near the point of attachment to the body, but as it recedes from it, the joints gradually assume an elliptical form. This change in the structure of the column is highly interesting, for by it we imagine that, in conjunction with other points of structure, it furnishes a clue by which we can arrive at a knowledge of the manner in which the animal sought for and obtained its food.

Though Miller is not to be relied on, especially as regards the columns of the *Crinoidea*, his explanation of the remarkable change so generally observable in the *Platycrinites* is exceedingly ingenious, and in some measure correct, he is therefore justly entitled to the merit of being the first to remark on the singular modifications observable in the columns of this genus.

The upper or circular portion of the column is composed of larger and smaller

joints, which are also thicker and thinner alternately. The articulating facets of those joints which are circular are furrowed with diverging striæ, the elevated ridges of one joint fitting into corresponding depressions in those which adjoin it. This structure becomes gradually modified, and furnishes an instructive and interesting example of the manner in which nature, ever fertile in expedients, varies the ordinary structure of parts to meet the physical condition and wants in the economy of animals; for whenever circumstances require an altered mechanism, the amount of alteration necessary is immediately produced with a certainty equally admirable for beauty of appearance, as it is for its perfect adaptation to the purpose required.

It has been already observed that at and near the dorso-central plate, the mode of articulation between the columnar joints is carried on by numerous radii. At a short distance down the column this structure becomes modified, the joints, by almost insensible degrees, assume an elliptical form, and the diverging striæ gradually become less distinctly marked, while a transverse ridge is now for the first time faintly exhibited, dividing the surfaces of the joints into two equal parts. This elevated ridge becomes, at each succeeding joint, more and more strongly marked, while the marginal radii become gradually fainter and fainter until they totally disappear. In exact conformity with the change in the articulating facets of the joints, the outward form of the column becomes gradually modified to suit the altered mechanism. As the radii become less decidedly developed, the outward form of the joints gradually assume an elliptical shape, until at the precise point where the articulations between the joints are wholly secured by transverse ridges, the column becomes of a decidedly elliptical form, the radiating striæ entirely disappear, the joints are no longer unequal in diameter or thickness, but become uniform in size and structure.

The transverse ridges on the superior and inferior surfaces of one joint appear to have a tendency to assume an oblique direction to the ridges of the adjoining joints. This circumstance led Miller to suppose, that in a living state the superior and inferior surfaces of each joint, with their articulating ridges, were alone truly calcareous, and that a yielding muscular substance was interposed between them. After a very careful examination of many columns, we are unable to discover the least trace of such vascularity as Miller imagined to exist. That the columns were really vascular there can be no reasonable doubt, but they were so exactly in the opposite direction to that in which Miller believed them to be. He supposed the muscular or cartilaginous substance occupied a transverse space in each joint, instead of the numerous tubes which run parallel to the axis of the column.

We have reason to suppose that the column throughout its whole length was vascular, or rather that the animal deposited calcareous matter within itself to give stability to its pedicle, without destroying its flexibility. That, in fact, each joint of the column is composed of irregular calcareous tubes, so that a transverse section exhibits somewhat

the same appearance as the cellular tissue of plants when the stem is cut across. This mode of structure would render a large central columnar canal less necessary, and accordingly we find in the *Platycrinites*, and some other genera, only a minute perforation occupying the centre of the column. This circumstance, at one period, embarrassed the scientific inquirer, who was unable to discover the manner in which the functions could be carried on by means of so minute an aperture. But the microscope has revealed to us in the *Pentacrinites* a most beautiful and distinct tubular structure, and which we believe to be analogous in the *Platycrinites*.

We are now engaged in a series of investigations regarding the various columns, and on a future occasion hope to present a yet more satisfactory elucidation of the subject. The merit of discovery, as to the internal structure of the column of *Pentacrinites*, is, we believe, justly due to Dr. Carpenter, who, after much care and trouble, was enabled to produce some highly interesting and instructive specimens, distinctly showing the tubular arrangement in the column.

The muscular substance which occupied the columnar tubes probably ramified into exceedingly thin transverse fibrous cushions, which were interposed between the columnar joints, adding, by their contractile power, to the flexure of the column.

Miller asserts that the column at its attachment to the body is "of an almost round figure, and that the transverse ridge is here very faintly exhibited." Neither of these assertions is correct, for the column is perfectly circular at, and for some distance below its junction with the dorso-central plate; and there is not the slightest indication whatever of the transverse ridge near the point of adherence, as many joints with well defined diverging striæ occur before the central ridge becomes visible on the facets of the joints. Miller also considered the attachment between the column and body to have been slight in this species. There is, however, no evidence to warrant this opinion, for the union between the column and dorso-central plate is, to all appearance, as well secured, and its adherence as perfect as in others of the same family.

Auxiliary side Arms.—Distant about a third from the base of the column auxiliary side arms occur. These arms are long, flexible, and equal jointed, with a central perforation communicating with the column; they are generally situated at the ends of the longest diameters of the elliptical columnar joints. From this form of structure it follows as a necessary consequence, that when the elliptical joints assume an oblique direction to each other, the side arms are brought round in various directions, according to the degree of obliquity which each separate joint assumes in respect to those adjoining it, so as to present a radiated figure somewhat resembling the radii of a coach wheel.

The joints composing the auxiliary side arms articulate by a radiating striæ, as in the circular portion of the column.

We have already observed that the form of the column would probably furnish a clue

by which some knowledge of the manner in which many species of Crinoidea sought for and procured their food, might be arrived at. Bearing this in mind, and considering the peculiar construction of the column in the *Platycrinites*, where the elliptical joints possessed a tendency to assume an oblique direction with respect to each other, and which was undoubtedly a very common position, for many columns are found with the joints placed at various angles to each other, we have sufficient evidence to prove that the animal, during life, possessed the power of twisting its column to a very considerable extent.

Reflecting on the uses for which this exceedingly flexible column was designed, and the purposes to which it might be applied in the animal economy, we are led to believe that the peculiar form of the column of *Platycrinites* will furnish a satisfactory explanation of their manner of alimentation, and of the *Crinoidea* generally, when taken in conjunction with other striking points of structure.

It is supposed that when the animal was impelled by the natural desire to seek a supply of nourishment, and its net-like rays were spread in vain, that it then bent its column into the form of an arch, until its body was brought in contact with the objects on a level with its base, and the animal was thus enabled to secure any particle of nourishment within reach of its proboscis or tentacula.

In some such manner as this it is imagined the *Platycrinites* obtained a great portion of their food. Those with elongated oral tubes, if we are right in our conjectures, were enabled to search for and capture minute objects, such as the ova of mollusca, in the deep crannies and fissures at the bottom, which were no doubt then, as now, the receptacles of numerous colonies of embryo marine animals, and which must have furnished an abundant supply of food to the beautiful radiated creatures, whose numbers were so great, that during the greater portion of the period when the carboniferous strata were in the course of accumulation, the ocean bed was covered with them as with a forest; and though irruptions of matter inimical to crinoidal life were frequent during that period, and consigned thousands of them to a sudden destruction, yet did new generations speedily reappear to people the submerged surface, in place of those destroyed, that it is evident they were meant to perform an important part in the great and ALL WISE system of creation.

It is not improbable that some species of crinoids were enabled to capture, and feed on the small testaceous animals which came within range of their closing rays. In such cases the rays were admirably fitted to detain the captive mollusk, while the proboscis was extracting its substance or juices. Or minute molluscous animals may have been sucked in and gorged by the oral apparatus.

The *Platycrinites* appear to have associated together in considerable numbers, for we have found them in groups composed of twenty or thirty individuals; and though traces of other genera may occasionally be found associated with them, yet such accidental

admixture of species must be considered as exceptions to the general law by which each species was confined to the peculiar locality best suited to its habits, and in which it was destined to live. It is no doubt true that in some localities crinoidal remains are mixed promiscuously together; but when this is the case, they have been mostly washed into the position they occupy in the strata by the currents which prevailed at the period of their deposition, and which swept them from the spots on which they originally flourished. This is frequently evident from the absence of the more delicate organs of those animals which have been exposed to the action of water, as well as by the worn appearance of their less perishable parts.

The *P. lævis* must have been abundantly, though probably not generally, diffused in the seas of the carboniferous epoch, for its remains are numerous in the localities enumerated in a preceding page, more so perhaps in that portion of the mountain limestone formation which is so largely and beautifully developed in Ireland than at other points. When the same formation which presents such an extensive field for research in Russia shall have been carefully examined, it is not improbable that this and other species will be found equally abundant there as in the British Isles. Should this conjecture not prove correct, the horizontal range of the species must have been confined within rather narrow limits, as compared with the extent of the ancient sea of which it was a denizen.

Goldfuss and other continental writers have represented the *Platycrinites lævis* as occurring in the transition, or primary fossiliferous strata of Germany. The only evidence in support of this conclusion is that of a few fragmentary portions of elliptical columns. But as that form of column is not confined to a single species, these disjointed fragments are not sufficiently specific to warrant the conclusion that they appertain to the *P. lævis*. They may with greater probability be referred to the *P. depressus*, *P. ventricosus*, or some hitherto undescribed species.

No indication of the *P. lævis* has hitherto been discovered in the carboniferous strata of Yorkshire. Mr. Phillips has, however, in his Geology of that county, figured a *Platycrinite* as the *lævis*, but which is really a different species.

It has been impossible to determine whether the *P. lævis* possessed an anus or not, as the part where it would be naturally looked for, the plated integument above the rays, is generally so covered with the tentacula, that no satisfactory evidence on the point can be obtained.

Base of attachment.—Though this portion of the animal has never been discovered, there can be no doubt that all the species of Platycrinites were permanently fixed to the bed of the ocean. This we infer from the length and form of the column, which would have been a heavy encumbrance to an animal capable of locomotion. But if it was attached, then the greater the length of the column the more power it must have possessed of procuring its subsistence.

In the *Apiocrinites*, and some other genera, we have satisfactory and certain evidence of their having been attached to the bed of the ancient seas; therefore, from analogy in form, we may reasonably attribute the same peculiarity to other species wherein the organic structure presents characters sufficiently similar to warrant the conclusion.

Much confusion has prevailed respecting the P. lævis, owing to several writers on the *Crinoidea* having applied the specific name to specimens wholly and obviously specifically distinct from each other. The true *P. lævis* is, as its name implies, perfectly smooth, and may be known by the absence of all corrugating uneven surfaces, or granulæ, on any of the plates, either above or below the rays. When the proboscidial plates and rays are absent, then a difficulty may possibly arise as to its identity; but the term *lævis* has been applied to crinoids with large pointed abdominal plates, and lateral mouths, and which are quite dissimilar in the arrangement of the whole calcareous frame work above the rays.

Mr. Phillips has fallen into this error, in his excellent work, Geology of Yorkshire: but it is just to observe that he had himself some misgivings on the subject, for at page 204, we meet with the following remark: "It is very doubtful whether this be really the species of Miller: the articulations of the scapulæ do not quite agree." It might have been added, with perfect truth, that none of the plates quite agree with Miller's figure.

Miller, in his Natural History of the Crinoidea, enters into minute details relative to the columnar joints occasionally presenting various peculiar appearances, such as "slightly four cornered;" angles rounded, while along the middle of the exterior circumference the intermediate muscle is pressed out and forms a smooth rim, which is sometimes studded at intervals with tubercles occasionally elongated into a kind of pointed feelers, giving the joint some resemblance to the rowel of a spur.

All these apparently structural variations described by Miller are frequently met with, but they are merely the effects of weathering, and are not at all confined to the *Platycrinites*, for precisely the same peculiarities are as frequently seen in the columns of other genera, as in that to which Miller considered them peculiar.

The same observations will equally apply to the irregularities sometimes met with in the auxiliary side arms, and which Miller considered as indicating the muscularity of their exterior integument: but which are either attributable to the decomposition of the calcareous skeleton previous to its becoming imbedded in the matrix, or to its subsequent exposure to the atmosphere, after the beds had become elevated, and were gradually yielding to its corroding influence. These facts have been too frequently observed to admit of the least doubt on the subject, and which facts an observation of Miller's, in a great measure, tends to confirm. At page 77, Nat. Hist. of the Crinoidea, the following remark occurs: "On the surface of the same mass of partially decomposed limestone, I have met with very thin joints resembling those just described, only being very small and much longer."

It is quite evident that if the work of disintegration is going on in a rock, the contained fossils are mostly in a state of decomposition also, though the progress of decay is generally less rapid in the organic remains than in the rock in which they are imbedded. The almost certainty that decomposition takes place simultaneously in the matrix and its included fossils, though in different degrees, would have led a less sanguine observer than Miller to suspect the real cause of some of the variations in the form of the crinoidal fragments which he describes so minutely; but he had already embraced another view of the subject, that of the muscularity of the whole calcareous frame work, and consequently he appears to have rejected every kind of evidence which militated against this, his cherished theory.

Miller also mentions that on young undeveloped specimens tubercles are frequently seen. We have never been fortunate enough to meet with any of these undeveloped specimens which Miller and other writers delight to allude to, when describing minute imperfect specimens; for all those which have come under our observation, however diminutive they may be, are as perfect in every point of structure as their larger and full grown congeners.

Reference to our first plate will at once shew that the smaller specimens are not wanting in any essential organ, and that they do not differ in any particular, except size, from the larger individuals of the same species.

If the variations in form are not, as we suppose, mostly the effects of weathering, but are truly structural modifications, the difficulty still remains as to the species to which they may be properly referred; for they have never yet been found under circumstances sufficiently explicit to warrant the conclusion that they appertain exclusively to the *P. lævis.*

Internal and Membraneous Parts.

Though in fossil species no portion of the softer and more perishable parts of the animal remain, by which we can study its internal conformation, or the organization of its membraneous appendages, we can, by comparison with its living analogues and a careful examination of the preserved skeleton, arrive at an obscure knowledge of its muscular organs. Thus, from the form and arrangement of the tentacula, we consider them to have been furnished with membranes which became amplified into lateral fimbriate transparent webs, which both aided the animal in capturing its food, and enabled it to move with greater freedom within the limits of its circumscribed sphere of action. Numerous cirrhi were probably ranged along the inner surface of these membranes, adding, by their irritability, to the already highly diffused sense of touch which the animal possessed.

From the spheroidal form of the body and extent of the internal cavity, it is highly probable that the *P. lævis*, and others of the genus, possessed a liver; as also a long convoluted intestine terminating in a vent. The recent *Holopus* has a valvate anus; and we suppose the *Platycrinites*, which are so much larger, and certainly not inferior in organization, to have been furnished with a similar organ.

Whether aeration was carried on by means of aquiferous tubes, which brought the aerated water in contact with the nutritive fluid, it is difficult to determine, as a careful examination of several hundred specimens, has not enabled us to discover sufficiently clear indications of the existence of aquiferous passages to speak with confidence on the point. We have in the *Actinocrinites* discovered circular tubes communicating with the internal cavity, but their office is at present unknown.

An imperfect vascular system, with a cordal sinus, we have reason to suppose existed, as well as a distinct ovarial system.

There is also decided evidence of a fibrous muscular system, which imparted mobility to the remotest extremities.

The only slight indication of the preservation of any of the softer parts of the animal, is that of an exceedingly hard irregularly shaped substance, which, in several instances, has been observed lying across the indurated frame work of the animal, in such a manner as to give rise to the idea that the intestinal parts had oozed out of the visceral cup, and become incorporated with the calcareous sediment which entombed the specimen.

The obscure associated bodies alluded to, probably contained albumen, which became closely incorporated with carbonate of lime, and produced a substance even harder than the fossil itself. They may possibly be coprolitic matter, though they do not resemble in form the coprolites, so abundant in some beds of the carboniferous limestone. One of the extraneous bodies alluded to is visibly depicted in Pl. 1, *fig.* 2, *O*.

It is perhaps as well to remark here that the evidence on which several species of crinoids have been admitted into the genus Platycrinites by various authors, is not sufficiently conclusive to establish their claim to this distinction. We therefore propose to omit or suppress the following species, as not appertaining to the genus, namely, *P. microstylus*, *P. interscapularis*, *P. contractus*, *P. depressus*, and *P. ventricosus*.

As it is in justice due to those Authors who have endeavoured to establish species which we consider altogether questionable, to explain the grounds on which we have rejected so many species, we will briefly advert to the several reasons by which we have been guided when venturing to deviate from received opinions.

The *P. contractus*, (Gilbertson) Phillips, Geol. of Yorkshire, we consider as identical with the *P. lævis*, and we have therefore declined to continue it as a distinct species.

As to the *P. microstylus*, of which Mr. Phillips has not even given a figure in his

work, no opinion can be formed, as we have in vain searched our own cabinets and those of our friends, as well as the various museums accessible to us, without being fortunate enough to discover the least indication of the species.

The columnar joint which Mr. Phillips represents as that of a *Platycrinus*, in the Palæozoic Fossils, *Pl.* 58, *fig.* 39, is probably not of that genus, of which there is as yet no clear evidence to prove that it occurs in the Devonian Rocks.

We are also of opinion that the *P. depressus*, and *P. ventricosus*, of Goldfuss, and which he represents with tripartite dorso-central plates, do not in reality appertain to the genus *Platycrinites ;* nor is the figure given by that author, of the fragment which he terms *P. rugosus*, at all satisfactory evidence of its identity. Neither is the columnar joint which Goldfuss refers to the *P. lævis*, sufficiently specific in character to warrant the conclusion that it appertains to that species.

On a careful examination of some interesting specimens of *Crinoidea* from Newton Bushel, which Mr. Robert Alfred Austen has with great liberality and kindness placed in our hands, we are fully convinced that the so called *Platycrinites* found in the Devonian Rocks, do not belong to that genus. The *P. interscapularis*, (Phillips) for instance, and others with tripartite dorso-central plates, offer such decided characters that we are of opinion they should be removed from the *Platycrinites* and arranged in a new genus, for which we propose the name of *Hexacrinites.*

The true *Platycrinites* have an undivided dorso-central plate as observed at page 6. And it is probable that the genus is not found in any formation of greater antiquity than the carboniferous limestone.

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2. Species. Platycrinites spinosus. *(Austin.)*

Definition.—Visceral bulb globose, Dorso-central plate entire and pentagonal. Perisomic plates, (costals,) five ; Main rays five, subdivisions twenty, tentaculated to their extreme points. Abdominal plates hexagonal, each of which is lengthened in the centre into a spiny process. Oral tube much elongated, and its upper portion studded with thorn like projections. Column circular at its attachment to the body, but gradually becoming elliptical as it recedes from it. Base of attachment unascertained.

Synonymes and References.

Platycrinites Spinosus.—Messrs. Austin, *Ann. & Mag. Nat. Hist. No.* 63, *page* 109, *and No.* 69, *p.* 199.

Formation and Localities.

Carboniferous limestone.—Mendip Hills; Hook Point, County of Wexford.

The remains of this species are less abundantly diffused than those of the preceding one.

Description of the Calcareous Frame Work.

Dorso-central plate.—The dorso-central plate of this species resembles that of the *P. lævis*, but the articulated depression for the attachment of the column is smaller.

Perisomic plates.—These plates are thinner, and are slightly contracted towards their upper edges, so as to impart a more decidedly rotound contour to the body of the animal than has been observed in the typical species; and the excavations and openings communicating with the rays are neither so deep or so large.

Meso-plates—or plates situated between the rays, and which Miller termed inter-scapulars. In the present species these plates appear to be hexagonal with a central blunt tubercle on each. The Meso-plates are invariably larger in the *Platycrinites* than the plates lying between the rays and the base of the proboscis. They are, however, smaller in this species than in the *P. lævis*.

Abdominal plates—which cover the visceral cup between the base of the proboscis and basal joints of the rays, have each a central thorn-like process slightly curved, and frequently produced to a quarter of an inch in length. The exact office of these spines in the animal economy it is difficult to conjecture, unless they were to protect its most vulnerable parts from the assaults of the lesser marine predatory animals. They could not have been for the purpose of passing the food to the mouth as they were immoveable, and placed at too great a distance below the oral orifice to perform such an office.

Some slight variations are occasionally observed in the length of the spines on the abdominal plates.

Proboscis, or Oral Tube.—This organ furnishes very conspicuous characters in the present species. It is central and much elongated, the plates covering the upper portion are each armed with a long central immoveable spine, somewhat resembling in its slight curve the spur of a fowl. The plates surrounding the middle portion are smooth and hexagonal, gradually becoming, as they approach the base, tuberculated in their centres.

The only portion of the proboscis which could possibly have been contractile is that near its extreme point, where the plates are small and irregular in shape; but the power of contraction must have been exceedingly limited, even if the animal possessed the means of shortening the organ in the slightest degree whatever.

Though the proboscis of this, as well as that of the preceding species, possessed a sufficient degree of flexure to enable the animal to direct it on either side towards the points where the rays might have captured an object of nourishment, it is imagined that the tentacula passed it along in succession until it was securely deposited in the oral aperture, which was turned to receive the expected supply of food. That the degree of pliancy possessed by the proboscis was inconsiderable when compared with the wonderful degree of flexure in the rays, we consider evident, from the arrangement of the proboscidial plates; and we are borne out in this opinion by the fact, that of the numerous specimens of *Platycrinites* which we have discovered, with the oral tube beautifully developed, in no one instance have we found it much curved or contorted. In another genus it was evidently different, for we have obtained the oral organ much bent, and lying in a great variety of positions.

Rays.—The main rays are five in number, each composed of a single cuneiform joint, from which proceed the first bifurcations, consisting of two joints each; these are again succeeded by the second bifurcations, making the total number of rays twenty.

The same structural modifications are observed in the rays of this species as in the *P. lævis.*

The strongly formed basal joints with double excavations for the muscles, with their transverse ridges and marginal striæ, impart strength, with the required degree of flexure to the secondary rays, which present a similar mode of articulation to the basal joints. Between the upper cuneiform joints and the double series, are several wedge-shaped joints, similar to those described in the typical species.

It will be obvious, by studying the arrangement of the ray joints, that those constituting the lower portions must have possessed less flexure than the upper parts, where the double series admitted of a much greater degree of pliability. In this respect the rays somewhat resembled a nicely adjusted elastic fishing rod, moderately rigid at its base, but gradually becoming finer and more pliant towards the opposite extremity.

The rays of this species are finer and proportionally shorter than in the *P. lævis.*

Tentacula.—The delicate frame work of the tentacula has in many instances been so well preserved, that every joint is as clearly seen as if the animal was still alive. In this species they are equally numerous along the rays, and are otherwise similar to those of the typical species. They are perhaps rather finer, which in some instances makes them appear longer.

Column.—The column presents the same structural modifications as in the typical species.

Miller supposed that the alimentary canal extended down its whole length in the *Platycrinites*, but this idea has been long abandoned, as the narrow central opening could scarcely have admitted of such an arrangement.

It is impossible to define the length of the column, either in this or the other species of *Platycrinites*, as its natural termination has never yet been discovered. It was evidently of very considerable length, for we have seen them many inches in extent lying along the exposed surface of denuded limestone strata.

Auxiliary Side Arms.—These organs are long and delicate, and inserted in the column by articulating striæ, in the coniform excavations formed for their reception. We have seen auxiliary side arms of various species of *Platycrinites* several inches in length: their office was, we imagine, to aid the animal, by their motion, in sustaining itself in an upright position, as well as for the purpose of clasping extraneous objects, by which it was enabled, by retaining its hold, to remain in any desirable position at the bottom, and which was suited to its habits.

Base of Attachment.—This portion of the animal is unknown, but it was probably similar to that of other species of *Platycrinites*.

All the plates composing the calcareous skeleton were held together by ligamentous or muscular attachment. Those forming the lower portion of the visceral cup were immoveable, but the plated integument extending over the cavity, and lying between the rays and the base of the proboscis, was endowed with a slight, but exceedingly limited power of contraction or expansion.

The meso-plate, from its intermediate size, being smaller than the perisomic plates, and yet larger than those protecting the viscera, would have modified the too sudden change from the rigid portion of the cup, to that which was slightly moveable. The meso-plate also served to keep the bases of the rays asunder, so that however rapidly the extremities might have been moved, the shape of the abdominal cup remained unaltered.

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3. Species. Platycrinites mucronatus. *(Austin.)*

Definition.—Body globose; dorso-central plate saucer shaped and pentagonal; perisomic plates broad and smooth; plates arching over the visceral cavity, large, with central pointed tubercles. Mouth lateral; rays and column unascertained.

Synonymes and References.

Platycrinites lævis.—Phillips, *Geol. Yorkshire, Pl. III. fig.* 14, 15. *page* 204.
——————— mucronatus.—Messrs. Austin, *Ann. & Mag. Nat. Hist. No.* 63, *page* 109, *and No.* 69, *p.* 199. *Vol.* 10 & 11.

Formation and Localities.

Carboniferous limestone.—Bolland; and Mendip Hills?

This species appears to have been of rare occurrence, and extremely local as regards station. It has hitherto only been observed in the localities before named, and very few specimens have been obtained even there. We have traversed the denuded strata of mountain limestone, so frequently met with in Ireland, for many miles without finding the least indication of the species.

Description of the Calcareous Frame Work.

Dorso-central plate—pentagonal and saucer shaped, the depression for the attachment of the column large, but the perforation communicating with the columnar canal is small and circular. The radiating striæ for the articulation of the column neat, but well defined.

Perisomic plates.—These plates more closely approach to the hexagonal form, than to the nearly quadrilateral shape of the perisomic plates in the *P. lævis.* In the *mucronatus* they are extremely short, smooth, and deeply excavated on their upper edges for the attachment of the basal joints of the rays. The apertures of communication between the intestinal cavity and the rays are sufficiently large to have admitted powerful muscles for imparting motion to the extremities.

The Meso-plates—interscapulars of Miller, are five in number, and large as compared with those of other species, for no *Platycrinus* of equal size, has yet been observed to have them at all in proportion to the *mucronatus.* These plates occupy the spaces between the rays, and from their size were evidently intended to impart strength and stability to the base of the rays. The upper ends of those septagonal plates are truncated, on which the abdominal plates rest. Their lower ends are pointed, by which they fit into the retiring angles formed by the union of the perisomic plates.

The Abdominal, or coronal plates.—Immediately over each of the excavations, for the insertion of the rays, are three small smooth plates, the centre one of which is pentagonal, but the other two approach to the quadrangular form. These are succeeded by five large and two small capital plates, which crown and cover in the vertex. The largest of these plates is heptagonal, and its place is a little removed from the centre; the four accessaries or those next in size, are also mostly heptagonal, but irregularly so, and they sometimes even vary so much in form as to become hexagonal. These four plates fit on to an equal number of the edges of the larger and more central plate. On two other of its edges are the two lesser plates, which are irregular pentagons. The centre of each of these seven plates is sufficiently produced to form an elongated pointed tubercle.

The Mouth.—Between the two lesser plates is the lateral oral aperture, but the exact form of the mouth is unascertained, as the valves, or plated integument which protected it, have been removed from the specimen from which our figure is taken. From the form and arrangement of the plates around the oral aperture, it is evident that the mouth was incapable of extensive protrusion, and should more instructive specimens be obtained, this opinion we venture to believe will be found correct.

The Rays.—Number unknown. The excavations in the ray bearing plates are five in number, as in the former species, but they are larger, and from the great size of the meso-plates, the rays themselves were probably thicker than in the typical species.

The size of the meso-plates, we imagine always bear a certain relation to the size of the rays themselves. Thus in those species where the basal joints of the arms are massive, the meso-plates are of considerable size, but when the former are delicately formed, the latter are proportionally smaller. Reference to our second plate will better exemplify our meaning; and though in the absence of the rays themselves we can offer but negative evidence in support of these views, yet an extensive examination of other species adds to the probability that our conjectures are in the main correct.

The orifices for the passage of the muscles which moved the rays will be found much larger in the *P. mucronatus*, than in the *P. antheliontes*, as will the meso-plates of the former be found more than double the size of those of the latter species. This difference in structure we consider as indicative of a difference in the size of the rays; and in the absence of the rays themselves, it will be found a convenient criterion by which to form a comparative estimate of the size or number of the absent members.

The Tentacula.—Unknown.

The Column.—The imbedded portion of a column lying alongside the specimen

represented in our illustration in the second plate, in all probability appertains to the *mucronatus;* but as our rule is not in any case to refer an unattached fragment to a specimen, unless we are well assured by decided evidence that it really belonged to the individual to which we assign it, we hesitate in the present instance to refer the unattached fragment to any particular species.

THE BASE OF ATTACHMENT.—Unascertained.

The lateral mouth, and peculiar size and arrangement of the plates which cover the vertex of this species, are sufficient to constitute generic distinction; but as we are averse to multiply genera, already too numerous in some departments of natural science, we at present retain it in the long established genus *Platycrinites.* Did we consider it expedient to elevate it to generic distinction, we should take the *mucronatus* as the type of our proposed genus *Pleurocrinus.*

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4. Species. PLATYCRINITES ELONGATUS. *(Gilbertson.)*

Definition.—Dorso-central plate conical and pentagonal; perisomic plates either five or six, and much elongated as compared with others of the genus; proboscis or oral tube elongated, large, and central; column, rays and base of attachment unknown.

SYNONYMES AND REFERENCES.

Platycrinites elongatus.—Gilb.—Phill. *Geol. York. Pl. III. fig.* 24, 26.
—Messrs. Austin, *Ann. and Mag. Nat. Hist.* vol. 10, p. 109.

FORMATION AND LOCALITIES.

Carboniferous or mountain limestone, Woodspring, Somerset; Bolland; Hook Point, Wexford.

This species is not so numerous, or as extensively diffused as either the *P. lævis*, or the *spinosus.* Hitherto only a very limited number of specimens have been obtained from the mountain limestone of England, and we have only met with a single imperfect individual in the same formation in Ireland. This fact may be considered as another proof that the limits to the extension of species was as well defined in the earlier ages of our planet, as in our more recent seas.

Description of the Calcareous Frame Work.

The Dorso-central plate.—This plate differs from the dorso-central plate in the typical species in being conical instead of saucer shaped, so that the point of adhesion for the column is prominent in the *elongatus*, while it is more frequently depressed in the *lævis*. The central aperture communicating with the columnar canal small and circular.

Perisomic plates.—The number of these plates vary in different specimens. In some instances the body is surrounded by five, and in others by six; but in either case they are much elongated in comparison with other *Platycrinites*, and but slightly spreading towards their summits. Their form nearly approaches to that of lengthened parallelograms; and from their comparative length they present characters which easily distinguish the species from others of the genus. The excavations for the attachment of the rays are shallow, and do not extend to a third of the width of the plates. The lower edges by which they fit into the dorso-central plate are slightly rounded, and the whole visceral cup is less spherical than in most other known *Platycrinites*. All the plates are perfectly smooth.

Mr. Phillips, in his Geology of Yorkshire, mentions that this species has an "interscapular plate attached to the pelvis." However correct this remark may be as regards some specimens, the same peculiarity is not universal, for as many individuals are met with wanting the additional plate, as those which are found to possess it. Whether the presence or absence of the additional perisomic plate is of itself sufficient to constitute a specific difference, is a question which may be fairly entertained; but as we are opposed to the system of multiplying species, as well as genera, we continue to consider it more as an accidental variety than as a distinct species. In every other particular the specimens agree; the shape of all the plates, with the articulations for the rays and column presenting no distinctive differences on which to found a species.

The Meso-plates.—Unknown; but they were evidently small, as indicated by the form and arrangement of the perisomic plates, and the small excavations for the rays.

The Abdominal plates.—From the weathered and altered state of the abdominal plates in the only specimen in which we have met with this portion of the animal, we are unable to detail their structure; but they, in the aggregate, formed a cone, from the centre of which proceeds the proboscis or oral tube, as may be seen in the centre figure of our second plate. The interesting specimen from which our drawing was taken, is in

the cabinet of Mr. Wm. Morgan, by whose obliging kindness we were enabled to make the sketch.

The Proboscis, or Oral Tube.—The proboscis of this species is elongated in a somewhat less degree than in the typical species, but like that species it is central and incapable of being withdrawn into the intestinal cavity. It is covered to the vertex with rather irregularly shaped hexagonal plates, which completely conceal the oral orifice, so that the mouth must have been valvate, and incapable of contraction, as was probably the case with all those species whose oral apparatus was not surrounded by very minute plates. The proboscidial plates are smooth, and arranged spirally around the organ.

The Rays.—The number unknown; but from the smallness of the excavations for their attachment, they appear to have been delicate and few in number.

The Column.—This portion of the *elongatus* is as yet unascertained; but it was probably slender, as partly indicated by the smallness of the point of attachment in the dorso-central plate, though this is not always a just criterion by which to estimate the thickness of the column.

Base of Attachment.—Unknown.

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5. Species. Platycrinites antheliontes. *(Austin.)*

Etym. ΑΝΘΕΛΙΟΝ, *(anthelion)* a flower.

Definition.—Dorso-central plate pentagonal and somewhat saucer shaped; perisomic plates short and spreading; plates covering the vertex irregularly hexagonal. Mouth valvate and central; basal ray joints five, number of bifurcations unknown, but probably amounting to twenty. Column also unascertained.

Synonymes and References.

Platycrinites antheliontes.—Messrs. Austin. *Ann. and Mag. Nat. Hist. Nos.* 63 *and* 69, *pages* 109 *and* 199.

Formation and Localities.

Carboniferous limestone, Mendip Hills; Hook Point, Co. Wexford? and Yorkshire.

This species appears to have been of extremely local occurrence, as the only specimens hitherto obtained are from the Mendips and Yorkshire. We have an imperfect specimen from Ireland, which is probably identical with this species; but the characters are not sufficiently clear to enable us to determine with certainty as to its affinity. With this single exception, we have met with no indication of the species throughout the mountain limestone of Ireland.

Description of the Calcareous Frame Work.

The Dorso-central plate.—In this species the dorso-central plate is proportionably smaller than in the *mucronatus*. The depression for the adhesion of the column is small, and the articulating striæ finely marked. The opening into the columnar canal is also small.

The Perisomic plates—are short and spreading towards their upper edges. These plates are nearly hexagonal, as they are in almost all the known species with mouths but slightly produced. This peculiarity is strikingly evident when they are compared with the nearly quadrilateral perisomic plates of the typical species. Though the number of plates below the rays are the same in those species with elongated mouths, as in those whose mouths are unobtrusive, yet the difference in the shape of the perisomic plates, those of the former being quadrilateral, and those of the latter mostly hexagonal, frequently furnish good characters by which they may be easily distinguished from each other, even in the absence of all that portion of the animal above the rays, and which differs so materially in structure in different species.

The excavations for the insertion of the rays are not so deep in this species as in *P. lævis*, but each had a similar transverse ridge running across the bevelled edge of the excavation, with marginal striæ, as before observed in that species. One purpose of these ridges appears to have been to secure the rays in their assigned position, and to prevent the possibility of their slipping down from the bevelled edges on which they rested.

The perisomic plates are externally more convex than in the typical species, so that the contour of the animal is somewhat petaloidal.

The Abdominal plates—are irregularly hexagonal, frequently approaching to an oval figure. The integument which these plates protected was capable of a slight degree of extension or contraction at the will of the animal, so that when the extensor muscles were exerted, the abdominal portion became very slightly protuberant and the mouth prominent; but when the muscles were relaxed the part gradually subsided, and the valvate plates surrounding the mouth became closed, so that the oral aperture was no longer visible.

The extent to which the stomach and mouth could be protruded, is shewn in Pl. 2. *fig.* 3. *m.* The outline of the plates in the specimen from which our figure is taken is not very distinctly defined, owing perhaps to weathering, or not improbably to the action of acids used in the process of clearing the specimen.

The Meso-plates—are five in number, their shape polygonal, with their lower ends pointed so as to enable them to fit into the angles formed by the union of the perisomic plates. The upper portions of the meso-plates are fringed with seven or eight small abdominal plates, which in well preserved specimens present a very regular and beautiful appearance. In the *Platycrinites*, as before observed, the meso-plates will be found generally larger or smaller according to the depth of the excavations in the ray bearing plates.

The Maxillary plates.—Though we possess no evidence whatever to induce the belief that these animals were furnished with jaws, yet we find it convenient to use the term maxillary as applied to the plates which surround and close in the mouth of those species whose oral apparatus is not elongated into a tubular form. Thus the four central plates, as exhibited in figure 3. *l.* of our second plate, have been so termed in order to distinguish them from the surrounding plates, whose office was clearly subordinate to the maxillars. These four plates may be considered as so many valves, which the animal possessed the power of opening and closing at will. When they were closed the true oral aperture was so protected from external injury, that nothing but extreme violence could render it liable to annoyance.

The four maxillary plates which surround and close in the mouth of this species, bear some resemblance to a flower with four petals; from which circumstance it has derived its specific name.

The Rays.—We have not, unfortunately, met with any of this species to which the arms are attached beyond the basal joints, and the first series resting on them. The arrangement of these joints indicate that the rays were not numerous, probably not exceeding twenty. It is worthy of observation, that in all the species with mouths but slightly produced, and of which specimens have been obtained, no instance has occurred

in which the rays have been found attached, while in those with elongated tubular mouths they have been observed in all but a perfect state of preservation. The same remark applies equally to the *Actinocrinites* as it does to the *Platycrinites.*

The Column.—As no portion of the pedicle of this species has been discovered, it is impossible to offer an opinion on its structure, beyond observing that the articulating striæ on the dorso-central plate are such as to prove that the upper portion was circular. Whether the same changes of column were general in the animals with unobtrusive mouths as in the typical species, no satisfactory opinion can be formed, so in the absence of all evidence to shew the nature of the columnar structure, it would be premature to speculate on its probable form.

The Base of Attachment—unascertained.

Though we have in a previous page expressed our belief that this portion of the typical and other species remains undiscovered, we by no means intend to imply that the basal portions of columns of *Platycrinites*, with the calcareous fibres by which they attached themselves to the rocky bed of the ocean, have not been obtained, but merely to guard against the error of assigning the base of one animal to another, to which it may not properly belong.

Many fragments which exhibit the exuded calcareous matter, and which is sometimes prolonged into lengthened fibres of attachment, were referred by Miller to the *P. lævis;* but they are as likely to appertain to one species as another, for they have never been seen attached to a perfect specimen of any known species.

The striking difference in the structure of the valvate mouth of this species, when compared with the elongated oral tube of the *P. lævis*, is sufficiently characteristic to justify its removal from the genus in which we have placed it. But for our reluctance to add to the already superabundant nomenclature of science, we should not hesitate so to remove it into our proposed genus *Centrocrinus*, and to constitute it the typical species.

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6. Species. Platycrinites trigintidactylus. *(Austin.)*

Definition.—Body globose, dorso-central plate pentagonal and undivided, with a circular central perforation communicating with the columnar canal. Perisomic plates five, broad, smooth, and slightly orbicular on their lower edges. Mouth central and proboscidial. Basal ray joints five, subdivisions thirty. Column circular in its upper portion, but elliptical towards the base.

Synonymes and References.

Platycrinites trigintidactylus.—Messrs. Austin, *Ann. & Mag. Nat. Hist. Nos.* 63 *and* 69, *pages* 109 *and* 199.

Formation and Localities.

Carboniferous limestone.—Clevedon, Somerset; Black Rock, Avon side, Bristol; Hook Point, County of Wexford.

Description of the Calcareous Frame Work.

The Dorso-central plate.—Saucer shaped, with gentle undulations between the angles of the pentagon for the adhesion of the slightly orbicular edges of the perisomic plates.

The Perisomic plates—are broad and smooth, with the lower edges slightly orbicular, by which they fit into the shallow undulations in the edges of the dorso-central plate. The five perisomic plates are proportionally broader than has been observed in either the *lævis* or *spinosus*. It should be remarked that the edges of these plates, as well as those of the dorso-central plate, in all the species examined are finely striated for the purpose of adhesion. The perisomic plates are so deeply indented by the excavations for the basal joints of the rays, that the rays appear to spring from the centres of the plates, instead of resting on their upper edges as in the typical species. A transverse ridge crosses the bevelled edge of each excavation, as in the *lævis*, but there is in this species a faint indication of a perforation below the aperture, through which the muscles of the rays passed.

The Abdominal plates.—These plates are smooth, and apparently hexagonal.

The Proboscis.—From the centre of the abdominal plates rises the elongated oral tube, which is protected by numerous hexagonal plates. This organ is less produced, and the proboscidial plates smaller than in the typical species.

The oral aperture is quite covered over with irregular shaped plates, which may be considered in the light of so many valves, though not strictly such. The mouth was evidently so formed, that when closed the plated integument passed completely over it.

But when opened the integument was withdrawn on each side, leaving the orifice uncovered.

The Rays.—On each of the perisomic ray-bearing plates the cuneiform joint of the ray articulates. On the sloping faces of these basal ray joints rest two other joints, from which the first divisions proceed. These are succeeded by an equal number of cuneiform joints, which send off from their outer slopes the first tentaculated rays; their inner faces have each two joints resting on them, the upper of which are cuneiform. Each of these joints support two other tentaculated rays. It will be seen by this formula that the final divisions of the rays amount to thirty. The rays are arranged around the abdominal bulb in five groups, six in each group. They are thicker in proportion to the size of the animal, than in the typical species. But they terminate in a similar manner, in delicate fine joints.

The figure 1. *a*, Pl. 3, will shew that the progressive increase in the size of the rays commenced at the base, and gradually extended upwards. On reference to the plate it will be seen that the growth of the lower joints, in the younger specimen, was already considerable before the secondary series exhibited equal signs of increased developement. This specimen also proves that, in the earlier stages of growth, the number of rays were as constant as in the more matured animal. Of this we shall hereafter produce abundant proofs in other genera.

The Tentacula.—The tentacula are equally numerous in this, as they are in the typical species.

The Column.—The column is circular at and near the dorso-central plate, but becomes elliptical as it recedes from that point. It is somewhat thicker than in the typical species, but it presents precisely the same modifications of structure; therefore to enlarge upon it would only be a repetition of all that was advanced when describing the *lævis*.

The Auxiliary Side Arms—are similar to those of the typical species.

The Base of Attachment—unascertained, but probably composed of indurated fibrous root-like organs, by which it was moored to the rocky bed of the ocean.

From the *P. trigintidactylus* possessing the same number of rays as the *rugosus*, it may possibly be mistaken for that animal, though the latter presents characters sufficiently distinct, if they are attended to, to prevent error. The rugged tumid plates of the *rugosus* are alone sufficiently specific, for we altogether dismiss Miller's theoretical opinions as to the elevations on the plates proving the muscularity of the calcareous

skeleton. Miller founded his opinion on the belief that according to the various positions of the rays, the muscles became developed in corresponding degrees. It so happens however that we have specimens with the rays perfectly closed, others with them partly so, and others with the rays spread to their full extent, and no alteration whatever is observable on the surface, on either those species with smooth plates, or on those with highly ornamented exteriors.

On referring to our illustrations, the very great difference in the form of the perisomic plates in the two species will at once be manifest. Another decided specific difference in the *P. trigintidactylus* is its central elongated oral tube; whereas the mouth of the *rugosus* is not proboscidial, though Miller asserts that it is.

We have obtained numerous specimens of the *P. trigintidactylus* in strata of the mountain limestone, where but few indications of the *rugosus* exists. The *P. trigintidactylus* attained a larger growth than the typical species. We have collected specimens superior in size to the beautiful and well preserved specimen, the figure of which is given in our third plate. It was only equalled or surpassed in size by the *P. gigas*.

Miller in his second plate of *Actinocrinites*, page 98, CRINOIDEA, gives the figure (7) of what he terms the proboscis of *Actinocrinites triacontadactylus*. The smoothness of these proboscidial plates, in contrast with some pointed abdominal plates which he had met with, gave him an opportunity of further indulging in his favorite theory as to the muscularity of the calcareous frame work of these animals. At page 102 he adduces the specimen referred to as proof in support of his views. Unfortunately for his hypothesis the specimen does not belong to the genus *Actinocrinus* at all. It is in fact the oral tube of a *Platycrinus*, that of *Platycrinus trigintidactylus*.

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6. Species. PLATYCRINUS GRANULATUS. *(Miller.)*

Pl. III. fig. 2, i. to o.

Definition.—Abdominal bulb globose. Dorso-central plate pentagonal and entire, and centrally striated for the articulation of the column, with a circular perforation communicating with the columnar canal. Perisomic plates five, beautifully embellished with granulæ, as are all the other plates. Mouth central and elongated. Rays thirty-five. Column slender.

Synonymes and References.

Platycrinites granulatus.—Mill. *Nat. His. Crinoidea*, p. 82.
Phillips. *Geol. of Yorkshire, Pl. III. fig.* 16.
Messrs. Austin, *Ann. & Mag. Nat. His.* vol. 10, No. 63, p. 109.
Witry. *Auc mem., de l'Ac. de Brux. III. Pl.* 3, *f.* 5, *et.* 6.
Muenst. *Beitr. zur. Petr. I.* p. 5.
Koninck. *t. F. fig.* 2, *a, b*, p. 43.
M. Edw. *ap. Lamarck II.* p. 666.
Encrinites granulatus.—Schloth. *Nachtr. z. Petref. III.* p. 94. *Pl.* 26, *f.* 3, *a, b, c.*
Platycrinites granulosus.—Blain. *Man. d'Act.* p. 292.

Formation and Localities.

Carboniferous or mountain limestone.—Bolland; Mendip Hills; Leigh Downs, and the Black Rock, near Bristol; Hook point, Wexford; Granagh Ferry, Kilkenny; and Tournay.

Notwithstanding the various localities in which the Granulatus has occasionlly been found, the species was of rare occurrence, if the absence of its remains in a fossil state may be considered as a proof of its scarcity.

Description of the Calcareous Frame Work.

The Dorso-central Plate.—In this species the dorso-central plate is ornamented with highly raised granulæ, which give it a very elegant appearance. Five rows of granulæ range with great regularity from the columnar point of attachment, to each of the five angles of the plate; each pair of rows forming two sides of an acute triangle, the edges of the plate completing the figures. Other well defined lines of smaller granulæ run in the same direction and stud the intermediate spaces.

The Perisomic Plates—Are five, broad, and slightly spreading towards their upper edges; the excavations for the insertion of the rays are slight, several lines of granulæ radiate from the base of each ray, on the superior edges of the perisomic plates, and gradually expand until they terminate at the lower and outward angles of the plates, where they meet the lines of granulæ on the dorso-cental plate. The intervening spaces are ornamented with rows of smaller granulæ as before observed in the dorso-central plate

The lines of the larger granulæ when viewed from the base of the rays, and in the direction of the column, present well defined lozenge-shaped figures, which are extremely neat and beautiful.

The Meso-Plates.—These plates do not extend below the basal joints of the rays. They are irregularly lozenge shaped, and the lines of granulæ with which they are ornamented conform to the outward form of the plates.

The Abdominal Plates—Irregularly hexagonal, and studded with granulæ.

The Proboscis—Is central and elongated, and the plates which envelope the tube, are granulated in the same manner as the abdominal plates.

The Rays.—In this species the rays amount to thirty five, and differ from the other *Platycrini* in being single jointed throughout their whole length. This peculiarity may be considered by some observers as sufficient to remove the *granulatus* from the genus in which we have retained it. But as the rays are so very seldom found attached to any of the fossil *Crinoidea*, we regard them as very questionable characters to found genera on, and we therefore consider we are furthering the true ends of science by restraining the number of genera, instead of extending them. If imperfect specimens of the *granulatus* are examined an apparent irregularity in the number of rays may be observed, but which irregularity does not in reality exist. It is necessary to notice this as some writers have supposed that no dependance can be placed on the number of the rays in the different species of *Crinoidea*, so that any excess or deficiency in the reputed number which may happen to occur in a broken or imperfect specimen, is at once placed to the account of nature, who is accused of indulging in all sorts of fanciful unmeaning vagaries and uncertainties. Nothing can be more fallacious than this mode of getting over a difficulty, for the doctrine which teaches that Nature sometimes errs, but Philosophy never, may be a convenient mode of disposing of a question which the latter is unable to solve. But the doctrine is not sound, nor will it bear the test of examination. Occasional irregularities may, and no doubt do occur, but they are comparatively so few that they can scarcely be taken into account. In proof of this we can confidently assert, that out of upwards of four hundred specimens of the superior portions of *Crinoidea* which we have collected from the strata in which they occur, we have not met with more than four or five irregularities occasioned either by deficiency or excess.

As in the generality of animals of this genus the rays are arranged in five groups, but each group is in this species composed of seven divisions, as follows. A single basal cunciform joint articulates by radiating striæ on to the excavation in each of the perisomic ray bearing plates. This is succeeded by the first divisions, each of which is

composed of two joints, which proceed from the outer slopes of the basal joint. Other divisions take place, those on the right hand series of each group amounting in all to four, and those on the left hand to three, making in the aggregate thirty five. The manner in which this arrangement is carried out will be best seen on reference to our third plate.

Had two less perfect specimens been examined, it would possibly so happen that in one instance, the right hand portion of one group, consisting of four rays, might remain attached, while on the other, the left hand portion with only three rays would be preserved. In this case an observer would be inclined to attribute the irregularity to deficiency or excess, when in fact it is as equally the result of a well defined law of nature as any of those well known contrivances by which the CREATOR modifies and completes his works; and which is evidently not the result of chance, but of design.

The rays are composed of single series of wedge shaped joints, and are rather short in comparison with other species of *Platycrini*. Each joint is ornamented with a tubercle on its dorsal surface which imparts an elegant appearance to the rays.

THE TENTACULA—In consequence of the rays being composed of single joints, each of which is furnished with only a single tentaculum, they are less numerous in this spcies than in others of the genus, and are further remarkable for the manner in which the joints of the tentacula increase in size at, and near their points of articulation. The tentacula extend to the lower joints of the rays.

THE COLUMN—Unascertained, but the point of attachment is circular and small.

BASE OF ATTACHMENT.—Unknown.

This species never attained to a large size, but when its highly ornamented coat of mail is considered with the beautiful though peculiar arrangement of its rays, and the general symmetry of its form, we must pronounce it to be the most elegant of a group of animals, which have in all ages been much admired for their complicated frame work and beauty of design.

As size is not at all times neccessarily associated with elegance and grace, the *granulatus* must be considered, if not the sovereign of the Lilies of the Ocean, at least the Queen of the *Platycrini*.

Milne Edwards, and L. De Koninck, consider the *P. granulatus*, and the *P. ellipticus* of Phillips, as one and the same species. We had also arrived at the same conclusion, even before we were acquainted with the opinions of those Authors. The raised borders mentioned by Mr. Phillips, appear to be merely formed by confluent lines of granulæ.

8. Species. Platycrinus Striatus. (*Miller.*)

Pl. III. fig. 3, *p to. u.*

Definition.—Dorso-central plate pentagonal, with a projecting rim for the attachment of the column. The five perisomic plates are narrower than in the typical species. Rays twenty. Column similar to others of the genus. All the plates which envelope the abdominal bulb are finely striated.

Synonymes and References.

Platycrinites striatus.—Miller. *Nat. Hist. of the Crinoidea*, p. 82.
Messrs. Austin. *Ann. & Mag. Nat. Hist.* vol. 10, No. 63. p.109.
Blain. *Man. d'Act.* p. 262.
Platycrinus striatus.—Koninck. *t. F. fig.* 3, *a, b,* p. 44.
Encrinites striatus.—Schloth. *Nacht. III.* p. 94, *Pl.* 26, *fig.* 4, *a, b, c.*
Platycrinites striatus.—M. Edw. *ap. Lamk.* 2, p. 666.

Formation and Localities.

Carboniferous or Mountain Limestone.—The Black Rock, and Leigh Downs, Avon side, Bristol; Broadfield Down; and Hook Point, Wexford.

This species was probably extremely local, as its remains are not so widely diffused, or so abundant as some of the other species of *Platycrini.*

Description of the Calcareous Frame Work.

The Dorso-central Plate—Is hemispherico-conical, with a small projecting circle of attachment for the slender column. The five most conspicuous elevated ridges which ornament the plate, radiate from the columnar point of attachment to the five points of the pentagon, numerous fine striæ follow the same direction, and many other delicate ridges run parallel to the border.

The Perisomic Plates.—The striæ on these plates radiate from the excavations for the rays, which are exceedingly small, to the lateral and inferior edges; other faintly marked striæ cross the former in a circular direction producing a slight reticulated appearance on the plates.

The Meso-Plates.—The exact shape of these plates is unknown; the lower portion is however angular and finely striated.

The Abdominal Plates.—Unknown.

The Mouth—Unascertained; apparently central.

The Rays—Agree in number and mode of articulation with the typical species, but they are more delicate and longer in proportion to the size of the animal.

The Tentacula—Are longer and closer than in the lævis.

The Column.—The column of this species was unknown to Miller, but we have been so fortunate as to find several specimens with portions of it attached to the dorso-central plate. It is subject to the same modifications of structure as the column of the typical species.

The Base of Attachment—Is unascertained. If the last described species is entitled from its highly ornamented exterior to rank as the Queen of the *Platycrini*, the striatus equally demands our admiration for its delicate form and structure, in which it equals or surpasses all others of the genus yet discovered. The peculiar length and fineness of the tentacula, with the great delicacy of the rays make it an object of particular interest to the admirers of graceful forms. The *striatus* is the smallest and most delicate species of *Platycrinus* at present known, as evinced by the size of its embedded remains. Of all the specimens hitherto discovered, that which is represented in our third plate, figure 3. p. is supposed to be the largest and most perfect.

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9. Species. Platycrinus Gigas. *(Gilbertson.)*

Pl. IV. fig. 1, *a, b, c.*

Definition.—Dorso-central plate pentagonal and broad; perisomic plates smooth and wide; meso-plates rather unequal in size; abdominal plates large, with a central tubercle on each; mouth central, and very slightly produced. Rays and column unknown.

Synonymes and References.

Platycrinus gigas.—Phill. *Geol. York. Pl. III. fig.* 22 *and* 23.
Aust. *Ann. & Mag. Nat. Hist.* vol. 10, p. 109.

Formation and Localities.

Carboniferous limestone.—Bolland; and the Mendip Hills.

This species is not very extensively diffused through the limestone strata in which it occurs, as but few specimens have hitherto been obtained; and those few are so imperfect that we are unable to offer any description of the rays, column or the more delicate organs which form such interesting features in the *Crinoidea* when obtained in a more perfect state of preservation.

The *gigas* appears to have attained to a considerable size, and though we have met with specimens of the *P. trigintidactylus* fully as large, yet the characters are so clearly dissimilar that no mistake can occur when comparing the two species. The large abdominal plates, and the slightly obtrusive mouth of the former, are alone sufficient to distinguish it from the latter, with its elongated oral tube; besides the difference in the form of the perisomic plates, and the excavations for the rays, are quite characteristic.

Description of the Calcareous Frame Work.

The Dorso-central Plates—Are somewhat contracted at the columnar point of attachment; which is small when compared with other species of *Platycrini*. The undulations for the reception of the perisomic plates are slightly orbicular.

The Perisomic Plates—Are broad, and the excavations for the rays large, but not deep, as in the *P. trigintidactylus*. These and the dorso-central plate are quite smooth.

The Meso-Plates—Are large and hexagonal, with a small tubercle in the centre of each.

The Abdominal Plates—Large, with a central tubercle.

The Mouth.—Central, and not proboscidial.

The Column and rays unknown.

10. Species. Platycrinus Rugosus. (*Miller.*)

Pl. IV. fig. 2. d, to k.

Definition.—Dorso-central plate pentagonal and massive; perisomic plates tumid; abdominal plates irregularly hexagonal; mouth unobtrusive. Rays thirty; column round at its attachment to the body, but elliptical as it recedes from it. All the plates are boldly tuberculated.

Synonymes and References.

Pentacrinites.—*Cumberland Trans. Geol. Soc.* vol. 5, *Pl. IV. fig.* 4 *and* 5.
Platycrinites rugosus.—Mill. *Crinoidea*, p. 79.
Phill. *Geol. York. Pl. II. fig.* 20, p. 204.
Aust. *Ann. & Mag. Nat. Hist.* vol. 10, p. 109.
Portlock. *Geol. Rep.* 1843.
Blainv. *Man. D' Actin. Pl. XXIX. fig.* 4.

Formation and Localities.

Carboniferous limestone.—Whitewell in Bolland; Caldy Island, on the south coast of Wales; the Mendip Hills; Lancashire; Leigh Downs, near Clifton; Black Rock, Avon side; and Hook Point, Wexford.

Description of the Calcareous Frame Work.

The Dorso-central Plate—Is in this species generally very flat and thick, with a few elongated tubercles irregularly arranged on its surface. Miller has fallen into the same error with respect to the dorso-central plate of this *Platycrinus* as he has with others of the genus.—The furrows or grooves alluded to at page 7. are deeper in the dorso-central plate of this species than in others of the genus.

The Perisomic Plates—Are thick and tuberculated; in some specimens the tubercles are arranged with considerable regularity, in others they are scattered without much regard to form. The excavations for the attachment of the rays are deep but rather narrow. The structures of these and the dorso-central plate are sulcated.

THE MESO-PLATES—Are not well defined in the generality of specimens. They are hexagonal with a central tubercle on each.

THE ABDOMINAL PLATES—Are irregularly hexagonal with one or more tubercles on each.

THE MOUTH—Is unobtrusive. Though Miller asserts that the integument over the abdominal cavity was "capable of elongating itself in the centre into a proboscis, analogous to that in *Actinocrinites*." This is quite erroneous for in all those species which have large, or even moderately sized abdominal plates, the mouth is invariably incapable of elongation to the extent Miller supposed it to be. In species where the abdominal plates exceed certain limits as to size, the mouth is either sub-central or lateral. It is evident from the structure of the adjacent parts that such must always be the case.

THE RAYS—Amount to thirty, and are furnished with plumose tentacula similar to those of others belonging to the genus.

THE COLUMN—Is more massive than in other species of *Platicrini*, but subject to the same modifications as observed in the typical species. Small tubercles sometimes occur on the extreme ends of the elliptical columnar joints.

THE AUXILIARY SIDE ARMS—Appear to have been small, and placed at irregular intervals along the column.

BASE OF ATTACHMENT—Unascertained.

There are greater variations in form observed in this species than in any other of the *Platycrini*. None of the specimens however depart sufficiently in character from the best defined, to constitute specific difference.

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11. Species. PLATYCRINUS TUBERCULATUS. *(Miller.)*

Pl. IV. fig. 3, m, to y.

Definition.—Dorso-central plate pentagonal and tumid; perisomic plates short, with the articulations for the rays rather low; abdominal plates conical in their centres; mouth lateral, and unobtrusive; rays and column unknown.

Synonymes and References.

Platycrinites tuberculatus.—Miller's *Crinoidea*, p. 81.
Phill. *Geol. York. Pl. III. fig.* 17, p. 204.

Formation and Localities.

Carboniferous Limestone.—Bolland, and the Mendips.

The dorso-central plate has generally a very prominent tubercle at each of its angles, but in some instances a greater number than five occur on the plate. Tubercles also occur on the perisomic plates, chiefly near their lower edges, but this arrangement is not constant. The abdominal plates are mostly conical in their centres. The mouth is placed laterally and exactly on a line with the excavations for the rays. It was evidently not proboscidial. The structure of the column and the number of rays are unknown. The base of attachment is also unascertained.

Doubts have been entertained as to whether the *tuberculatus* and the *rugosus* are not identical; but this opinion is not founded on satisfactory evidence.

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12. Species. Platycrinus laciniatus. (*Gilb.*)

Pl. V. fig. 1, *a, b, c.*

Definition.—Dorso-central plate more conical than in the typical species; perisomic plates with small excavations for the rays; all the plates are tuberculated, with calcareous strings crossing the sutures. Rays and column unknown.

Synonymes and References.

Platycrinus laciniatus.—Phill. *Geo. of York. Pl. III. fig.* 18.
Aust. *Ann. & Mag. Nat. Hist.* vol. 10, p. 109.

Formation and Localities.

Carboniferous limestone.—Bolland; and Mendips.

The lengthened tubercles on this species mostly range with considerable regularity along the plates, chiefly radiating in lines from the columnar point of adherence, to the outer margin of the plate; and from the base of the rays to the lateral edges of the perisomic plates. The calcareous strings which cross the sutures are unique and characteristic of the *laciniatus;* the same peculiarity of structure never having been observed in others of the genus. These calcareous ligatures serve to connect the plates more firmly together, and they may be considered as so many prolongations of the fine striæ on the edges of the plates, observed in other *Platycrini.*

The mouth appears to have been central, but from the imperfect specimens hitherto obtained it is impossible to decide on its true position.—The rays, column and base of attachment are unknown.

The contour of this species approaches to that of the *striatus,* which circumstance has caused some doubt as to the propriety of retaining it as a separate species. These objections we consider as not well founded, as each of the specimens present characters quite sufficient to constitute specific difference. The fine striæ on the plates of one species are quite dissimilar to the tubercles on the other: and though the delicate lines on the plates of the *striatus* are occasionally broken, they never assume the form of distinct and prominent tubercles, like those on the *tuberculatus.* The manner in which the sutures unite, is also perfectly distinct in each species.

Malformed Platycrinus.

Pl. V. fig. 3, *a, b.*

The figure 3, *a,* and *b,* Pl. V. represents a curious specimen of *Platycrinus,* with the doso-central plate so concealed by the disproportioned column, that it is difficult to determine whether the lower edges of the perisomic plates rest on the superior columnar joint, or on the hidden dorso-central plate.

The thickness of the column as compared with the size of the body in this specimen is strikingly conspicious. Other occasional peculiarities of structure are met with in the *Platycrini,* but as they present characters more remarkable for the oddity of their appearance, than for the instruction they afford, we abstain from dwelling further on the subject.

We shall conclude our observation on the genus *Platycrinus* by offering a few brief remarks on some of those fossils which have been admitted into the genus on what appears to be questionable evidence. Foremost among the *Platycrini* which we have rejected, stands Miller's *P. pentangularis.* The figures which he has given at page 81. of his Crinoidea are compounded of various specimens ingeniously arranged in the manner of a Chinese puzzle to suit the Author's ideas on the subject.

One of the bodies figured as the *Platycrinus pentangularis* is in fact that of a *Pentremite;* the ambulacral rows of which Miller considered as excavations in the scapulars for the attachment of arms. One figure he has represented with rays and a column. This may possibly be our *Dichocrinus fusiformis,* but Miller has placed the body on the column of a *Poteriocrinus.*

Notwithstanding these errors the *P. pentangularis* was still considered as a well founded species, and was said to occur in the Devonian system of rocks. Mr. Phillips in the Supplement to the Palæozoic Fossils has represented a specimen which he refers to this species, but which from its imperfect state of preservation he was unable to decide on with that degree of certainty so desirable in cases of this nature. "I believe," observes Mr. Phillips, "that it is really an elongate species, congeneric with *Platycrinus interscapularis.*

In the same work the following observation occurs—"The genus *Platycrinus* has up to this date never been mentioned as occuring in any other than the mountain limestone strata of Britain; though on the continent of Europe it may be more widely diffused." From this quotation it will appear that the genus *Platycrinus* was always considered as peculiar to the mountain limestone, an opinion to which we are still inclined to adhere, unless the obscure fossil from the Devonian Rocks, which Mr. Phillips has named *Adelocrinus Hystrix Pl.* 16. *fig.* 42. Palæozoic Fossils, should hereafter prove to belong to that genus.

The figures given by Continental writers, of *Platycrini* from formations more ancient than the mountain limestone are all represented with divided dorso-central plates; therefore we have no hesitation in still expressing our doubts as to the correctness of retaining them in the genus *Platycrinus.*

The impression of an oval columnar joint with a transverse raised ridge, which was seen by Mr. Phillips at Pilton, cannot decide the question as to the existence of *Platycrini* in the Devonian system of rocks, as the oval column is not exclusively characteristic of that genus. The oval column occurs in the chalk, where that of the *Apiocrinus ellipticus* is found nearly approaching in form to that of the *Platycrini.* The same form of column may likewise bel ng to the *Hexacrini,* therefore until specimens are discovered with the columns attached, we consider it the safest course to abstain from referring them to any particular genera or species.

Genus II. DICHOCRINUS. (*Munster*)

Definition.—Dorso-central plate hexagonal and bipartite; perisomic plates six, five of which bear the rays. Column and base of attachment unknown.

We had long suspected that a crinoid intermediate in character between the so called *Platycrini* of the Devonian strata and the true *Platycrini* of the mountain limestone would be discovered, and accordingly on a careful examination of numerous specimens we have met with sufficient evidence to prove that such intermediate form does occur in the carboniferous limestone. This interesting fact exhibits in a very striking manner the beautiful gradations in organic structure from Crinoids with a tripartite hexagonal dorso-central plate, on which rest six perisomic plates, to a bipartite dorso-central plate, to which six perisomic plates adhere, and finally to the true *Platycrinus* with its undivided pentagonal dorso-central plate bearing but five perisomic plates.

We had made these observations before we were acquainted with the fact, that Count Munster had already arrived at the same conclusion.

Miller in his work on the Crinoidea, at page 114. has given the figure of a bipartite dorso-central hexagonal plate, but which he considered a monstrosity. With this idea he made the following observation. "I consider this as a monstrous variety of *Platycrinites lævis,* analogus to those irregularities of nature which occasionally render the column of the *Pentacrini* tetragonal and hexagonal," &c.

The dorso-central plate here alluded to by Miller, may be referred to the genus *Dichocrinus,* and it will probably be found that all those crinoids with six perisomic plates, which occur in the carboniferous limestone, have a bipartite dorso-central plate and are consequently not *Platycrini* but *Dichocrini.*

The six plated specimens heretofore considered as the *P. elongatus* by Mr. Phillips, and referred to in a former number of our monograph as such, will properly appertain to this new genus of Count Munster.

Species 1. Dichocrinus radiatus. (*Munster.*)

Pl. V. fig. 5. *a, b, c, d.*

Definition.—Dorso-central plate bipartite, hexagonal and moderately conical; perisomic plates six, five of which bear the rays. All the plates are smooth. Column and rays unknown.

Synonymes and References.

Platycrinus elongatus. (*interscapular variety*).—Phill. *Geol. York. Pl. III. fig.* 26.
Platycrinites lævis. (*variety*).—Mill. *Crinoid.* p. 114. *fig.* 4. 5.
Dichocrinus radiatus.— Munst. *Brit. zur. Petref.* 1. p. 2. *Pl. I. fig.* 3, *a, b, c, d.*
Kon. *Descr. des Ani. Foss. t. E. fig.* 6, *a, b, c, d.*

Formation and Localities.

Carboniferous limestone.—Bolland; Black Rock, banks of the Avon, Bristol; Mendips; and Belgium.

M. L. De Koninck gives the figure of another species of *Dichocrinus,* which he terms *Septosus,* but of which he appears doubtful, as to its appertaining to the genus. The specimens hitherto obtained are not such as to justify us in considering this species as established, we therefore omit it.

M. Koninck states that the columnar canal is pentagonal, in this genus, and the plates in the *D. radiatus* granulated. The latter is probably the effects of weathering. If not, M. Koninck's must be a different species to that which we have referred to his *D. radiatus.*

Though M. Koninck considers it necessary to change the name of Mr. Gilbertson's *P. elongatus* (Phill. Geo. York.) to that of *Dichocrinus,* we are confident the species established by the last named Author is a good one, and therefore to be retained, for there is an elongated crinoid with an undivided dorso-central plate, and with five perisomics resting on it. This is represented in our second plate *fig.* 2, *g, h.*

The difficulty has occurred through uniting those specimens with six perisomic plates, and a bipartite dorso-central plate, with those which are clearly *Platicrini.*

2. Species. DICHOCRINUS FUSIFORMIS. (*Austin.*)

Pl. V. fig. 6, *a, b, c, d.*

Definition.—Dorso-central plate bipartite, hexagonal and acutely conical; perisomic plates six, much elongated, and the superior edges of five of them excavated for the attachment of the rays. All the plates are smooth. Column unascertained.

SYNONYMES AND REFERENCES.

Platycrinites pentangularis?—Mill. *Crin.* p. 81, *fig.* 1.

FORMATION AND LOCALITIES.

Mountain limestone.—Yorkshire; and Mendips.

The rays in this species appear to be ten in number, arranged in pairs. A single basal ray joint articulates into each of the excavations in the five ray bearing plates. On these basal joints several wedge-shaped articulations rest. These are succeeded by the bifurcated rays, which are compossd of a single series of joints to their extreme points.

Genus III. HEXACRINUS. (*Austin.*)

Definition—Dorso-central plate tripartite and hexagonal; perisomic plates six, five of which bear the rays; mouth sub-central and unobtrusive.

Mr. Phillips has admitted these very interesting fossils from the Devonian strata into the genus *Platycrinus*, on the supposition that the dorso-central plate of that genus was tripartite, an error which has been removed by the fortunate discovery of numerous specimens in such a state of preservation as to preclude the possibility of further doubt on the subject.

The only point on which the two genera agree is that of possesing but a single series of perisomic plates, and which bear the rays. In every other respect they are generically distinct.

Animals of the genus *Hexacrinus* though rather numerous during the accumulation of the Devonian deposits, do not appear to have existed in the succeeding epoch, for as yet not a single specimen of the *Hexacrinus* has been observed in the carboniferous limestone. Nor has the genus been discovered in the Silurian deposits.

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1. Species. HEXACRINUS MELO. (*Austin.*)

Pl. VI. fig. 1. *a, b, c, d, e.*

Definition—General figure globose, but somewhat elongated towards the columnar point of adherence.—Dorso-central plate tripartite, hexagonal and conical; on each face of the hexagon rests a perisomic plate. These six plates are tumid on each side the orbicular surface; the five which bear the rays are larger than the non ray bearing plate. All the sutures are sulcated, and the plates studded with granulæ though without much symmetry as regards their arrangement, the granulæ are generally most numerous on the upper parts of the perisomic plates, and on the lower angles of the dorso-central plates. The abdominal plates are large with a central prominence on each: one larger than the rest crowns the summit. These plates are also granulated. Mouth sub-central and unobtrusive. Column and number of rays unascertained—the latter consist of five groups as in the *Platycrini.*

Synonymes and References.

Platycrinus interscapularis.—Phill. *Palæozoic Fossils, Pl.* 14, *fig.* 39.
Aust. *Ann. & Mag. Nat. Hist.* vol. 10, p. 109.

Formation and Localities.

Devonian strata.—South Devon; Newton, and Plymouth.

We have taken this species as the type of our proposed genus *Hexacrinus*, because it has been obtained in a fine state of preservation, and therefore furnishes clear evidence of its character, and title to this distinction.

The five perisomic plates which bear the rays are excavated at their upper edges to admit the basal ray joints, in a similar manner to those of the *Platycrini*. The sixth or non-bearing perisomic plate, is irregularly hexagonal. All the plates are somewhat thinner in proportion to their size than is commonly observed in the *Platycrini*.

It is to be regretted that no specimen belonging to this genus, with any considerable portion of the rays attached, has hitherto been discovered.

Among the various portions of columns met with in the Devonian system of rocks, we cannot with safety refer any one of them to heretofore known species; and though Mr. Phillips has named several from their supposed resemblance to those belonging to certain genera, we consider it the safest course and less liable to create confusion and error, to leave these fragmentary specimens unappropriated, until more certain evidence is obtained as to the genera and species to which they properly appertain. In order however that their form may be known, we have represented several of them in our seventh plate.

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2. Species. Hexacrinus depressus. (*Austin.*)

Pl. VI. fig. 2, *a, b, c, d, e.*

Definition—Dorso-central plate tripartite and hexagonal; perisomic plates six, five of which bear the rays as in the typical species; abdominal plates covering the apex depressed instead of forming a dome, as in the first species; small granulæ are thickly dispersed over the whole exterior of the plates. Mouth sub-central and unobtrusive; rays and column unknown.

Formation and Localities.

Devonian strata—South Devon, Newton, and Plymouth.

The plates of this species are very closely fitted to each other, and the non-ray-bearing plate differs considerably in shape from the typical species. The meso plates between the rays, bend abruptly over the abdominal cup, and with the abdominal plates form a depressed covering to the vertex.

This species attained to a considerable size, and is even larger than the first species.

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3. Species. Hexacrinus macrotatus. (*Austin.*)

Pl. VI. fig. 3, *a, b, c, d.*

Definition—Dorso-central plate tripartite ; perisomic plates six, and elongated; abdominal plates, number of rays and column unknown.

Synonymes and References.

Platycrinus tuberculatus.—Phill. *Supp. Pal. Foss.* t. 60, *fig.* 39*.

Formation and Localities.

Devonian system.—South Devon, Newton, and Plymouth.

Mr. Austen's specimens, from which our figures of this and the two preceding species are taken, so clearly exhibit the arrangement of the plates, that it is quite improbable that any *Platycrinus*, a genus to which all these specimens have been heretofore referred, will ever be found with a divided hexagonal dorso-central plate, or with six perisomic plates around the body.

4. Species. HEXACRINUS? PENTANGULARIS. (*Austin.*)

Pl. VII, fig. 1, *a, b, c, i.*

Definition.—Dorso-central plate tripartite?; perisomic plates six, five of which bear the rays. These latter plates are prominent near the excavations for the attachment of the rays, which imparts to the calcareous skeleton a decided pentagonal contour. All these plates are smooth and thin.

SYNONYMES AND REFERENCES.

Platycrinus pentangularis.—Phill. *Pal. Foss. Pl.* 60, *f.* 29* *f.* 39**, p. 240.

FORMATION AND LOCALITIES.

Devonian System.—Newton Bushell, Devon.

The specimen from which our figures are taken does not shew the divisions in the dorso-central plate, which is broken and otherwise imperfect, nor does it exhibit the arrangement and divisions of the perisomic plates as distinctly as we could wish; but notwithstanding we consider the evidence is in favor of its belonging to the genus *Hexacrinus*, and against its being a *Platycrinus*.

The excavations for the rays are shallow; but shallow as they are, the lower ray joints do not fill up the lunulate depressions. On each thin lower articulation is a cuneiform joint, which is also exceedingly thin, with a central perforation. From this point, the rays bifurcate, the succeeding joints being oval, and articulating by marginal striæ. These joints are perforated to correspond with the passage through the cuneiform joints below them, and they also appear to be sulcated on their inner sides.

When enumerating the genera comprised in the family *Platycrinidæ*, the genus *Hexacrinus* was omitted, as it was not then established. This was owing to our erroneously supposing the different species since removed to the new genus, were properly retained among the *Platycrini*.

Among the fossils from the Devonian rocks in Mr. Austen's collection, are two apparently undivided hexagonal dorso-central plates. These specimens have been acted on by some physical agent, probably infiltered water, which has in part decomposed and re-arranged the particles in such a manner as to obliterate all trace of the divisions,

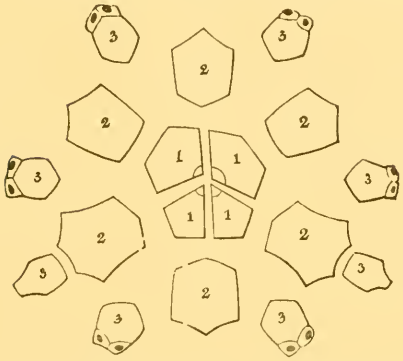
which we are convinced at one period existed. We have therefore no hesitation in referring both the plates to the genus *Hexacrinus*.

A similar obliteration of the divisions in the dorso-central plate of the *Cyathocrinus geometricus* has also been observed in specimens from the same system of rocks.

Several fragments of columns have been obtained from the same localities as the four species of *Hexacrini* figured in plates 6 and 7, but we have been unable to determine to what species they may be referred. Portions of four of these columns are represented in plate 7.

Genus IV. CARIOCRINUS. (*Say.*)

Etym. ΚΑΡΙΣ (*Caris,*) The Sea Onion?



Definition.—Dorso-central plate quadrupartite (1.); first series of perisomic plates, six (2.); second series, eight (3.); on which the upper series, or ray-bearing plates rest.

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1. Species. CARIOCRINUS ORNATUS. (*Say.*)

Pl. VII. fig. 3, *a* to *m*.

Definition.—Dorso-central plate quadrupartite; first series of perisomic plates, six; second series eight, six of which are more regularly hexagonal than the other two, whose upper edges are straight and prolonged above the superior angles of those on either side of them. On the upper sloping edges of the six, with the salient angles pointing upwards, rest a series of small plates which bear the rays.

SYNONYMES AND REFERENCES.

Caryoorinus ornatus.—Say. *Journ. Ac. of Nat. Science, Philadelphia, Vol.* 4, *No.* 9.
Zool. Journ. Vol. 2, p. 311, *t.* 11, *fig.* 2.

Formation and Localities.

Niagara shale.—Lockport, N. America.

Description of the Calcareous Skeleton.

The Dorso-central Plate is quadripartite, the two smaller divisions being irregularly quadrangular, and the two other, or larger ones, pentagonal. The inner angles, where they meet in a central point, are minutely truncated to form the opening into the columnar canal, and there is an elevated circular ridge, striated within, for the insertion of the column ; elevated lines of granulæ run from the centre to the terminal angles, and other rows conform to the shape of the plate, while a few are sometimes met with, which do not appear to follow any definite arrangement.

The Perisomic Plates.—The first series, resting on the dorso-central base, consists of six large plates somewhat conical in their centres, two of which are pentagonal, two hexagonal, and the remaining two heptagonal. Each of these plates has several lines of granulæ, which in some specimens are confluent, and appear as ridges, radiating from a convex point near their centres. These lines of granulæ vary in number according to the number of angles in each plate, the pentagonal plates having five, the hexagonal six, and the heptagonal seven, so that a row of granulæ runs from a central point, to each terminal angle of the plate, and there meets with similar lines from the adjacent plates, of either the first or second series. Other lines of smaller granulæ conform to the shape of the plate. Most of the larger granulæ are perforated, and communicate obliquely with the internal cavity which contained the digestive organs. The exact office in the animal functions these pores were destined to perform, it is difficult to determine ; they might have been for the extrusion of suckers, as in the recent echini, or for the purpose of respiration.

The arrangement of the granules is such as to add strength as well as to ornament the plates, which are further strengthened by a number of elevated radiating ridges on their interior surfaces.

Mr. Say describes the first series of plates (costals) as consisting of four pentagonal, and two hexagonal ; they are however as represented in the dissected skeleton we have given with the generic definition. The angles are sometimes not very decidedly defined, but they are generally sufficiently acute to determine their number with certainty.

The perfect manner in which these variously shaped plates fit against each other is exceedingly interesting, and the varied lines of granules which intersect them in so many directions add greatly to the beauty of the ornamented exterior.

The second series of plates are eight, all more or less hexagonal; six of these have each two small plates resting on their upper edges, making twelve in the aggregate; the remaining two of the second series are prolonged, and arch over between the rays till they meet the abdominal plates on the vertex. All the second series of plates have lines of perforated and smaller granulæ, which observe the same arrangement as the first in respect to running in the direction of the angles of the plates, and the smaller granules also following their outward contour.

The second series of plates bend considerably inward, and thus leave a much smaller space on the vertex than is more generally the case with crinoids.

The Ray-bearing Plates—ten in number, are small and not very regular in shape, they are closely attached to the upper edges of the second series, and appear scarcely larger than the rays themselves. Mr. Say describes the second series of plates as bearing the rays, but we have been enabled to trace the divisions between their upper edges, and the true ray-bearing plates quite distinctly in well-preserved specimens.

Including the ten ray-bearing plates the third series consists of twelve, two of which are excavated in such a manner as to form the inferior portion of the oral aperture.

The Abdominal Plates amount to ten or twelve, or even more, six of which, occupying the centre, are larger than the others; most of them are irregular hexagons, though the two central plates are more frequently heptagonal, and cover the space between the mouth and anus, which latter is a narrow elongated valvate opening situated exactly opposite the oral orifice, and a little within the larger group of rays.

Each plate has from one to five or more tubercles on its surface.

Mr. Say represents the *Cariocrinus ornatus* as having but eight "capital plates;" his specimens must therefore have been badly developed, or he has surely made some mistake in counting them.

The Mouth is small, and placed a little within the line of the rays. It appears to have been valvate and protrusive, but not proboscidiform.

The Rays.—The primary rays are ten arranged in three sets, those on either side the mouth consist of three rays each, and the largest group of four is placed on the side

farthest from the mouth. Whether the rays bifurcated or were single none of the specimens hitherto developed offer any illustration whatever.

Figure 3, *e*, table 7, represents a portion of a crinoid's ray, composed of five bands of joints, which was obtained from the Lockport shale, along with the bodies and columns of *Cariocrini*. It may, therefore, probably belong to that animal. Its structure is very similar to the rays of *Sagenocrinus*, the only known crinoid which departs so widely from the usual structure and arrangement observed in the rays of the *Crinoidea*, (Pinastella,) and where the rays are composed of more than two series of joints, and instead of being sulcated or channelled, have each a central canal for the passage of the muscles, and fleshy substance of the animal.

Mr. Say describes the *Cariocrinus ornatus* as possessing only six rays, but Mr. Lyell's specimens from which our figures are taken, clearly shew ten points of attachment for arms.

The Column is circular, and perforated by a small round tubular canal. It is composed of sets of three thin and smaller joints, alternating between every two thicker and larger ones. This arrangement may be modified according to the position the several parts occupy in relation to the body and base, but most of the portions of columns we have met with have the ossicula piled one on the other as we have described. In some specimens the larger joints are studded at intervals around the circumference with tubercles, similar to those frequently seen in other columns, but which are probably merely the effects of weathering.

The Auxiliary Side Arms.—At intervals along the column occur circular side arms, the joints of which articulate by elevated radii.

The base of attachment appears to be formed by branches around the column.

Mr. Say describes a second species of *Cariocrinus*, the *loricatus*, which Dr. Bigsby found in the same locality as the *C. ornatus*, but as only one specimen has been developed, and the specific definition is not very satisfactory, it may probably be only an occasional variety of the *ornatus* We have come to this conclusion from the circumstance that of the various specimens we have examined, only one species is to be found, and also from the fact that Mr. Say has described the perisomic plates (costals and scapulars) of the *ornatus* erroneously. Therefore, when he says of the *loricatus*, "Costals five pentagonal, and one hexagonal. Resembles the preceding, but there is only one hexagonal costal plate, and one interscapular plate;" we are led to believe that the plates of the specimens described from were not so well defined as to ensure correctness in the description. Or

there may possibly be certain irregularities of form which we have not been fortunate enough to discover.

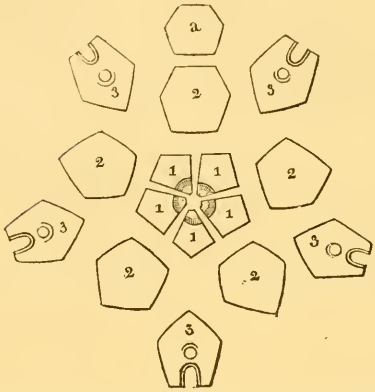
We are indebted to the obliging kindness of Mr. Lyell for the opportunity he has afforded us of examining and drawing the crinoids which he brought from America, among which are the beautiful specimens of *Cariocrinus* represented in plate 7, with the exception of figure 3, *c*, which is in the museum of the Bristol Institution.

Though the American formations do not appear to be so rich in the variety of crinoidal forms as the European, yet several specimens of great beauty have already been developed, and when the geology of that fine country has been more extensively examined by scientific explorers, we may hope to meet with many new kinds. All those we have seen from America differ from any known European species, and the genus *Cariocrinus* appears to be peculiar to the new continent.

These remarks chiefly apply to the number of species, not to the paucity of individuals, for some American strata, as exemplified by Mr. Lyell's specimens, are almost wholly, as in some European rocks, composed of crinodial remains.

Genus V. CYATHOCRINUS. *(Miller.)*

Etym. ΚΥΑΘΟΣ *(Cyathos,)* a Cup.



Definition.—Dorso-central plate quinque-partite, (1); on which rest the first series of perisomic plates, five in number (2); second series six, five of which bear the rays (3); with one intermediate or non-ray-bearing plate (a).

The ray-bearing plates in the figure of the dissected skeleton are those of the *C. geometricus,* and are more elongated above the ray articulations than in the typical species.

All the species of *Cyathocrinus* are of small size, and none of them appear to have been abundant in the localities in which they are found.

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1. Species. CYATHOCRINUS PLANUS. *(Miller.)*

Pl. VII. fig. 4, *a, b, c, d, e.*

Definition.—Dorso-central plate quinque-partite, forming a saucer-shaped concavity, on the edges of which rest the first series of perisomic plates five, four of which are pentagonal, and one hexagonal; second series six, five of which bear the rays. The non-ray-bearing plate is hexagonal, and invariably occurs on the hexagonal plate of the first series.

Synonymes and References.

Cyathocrinus planus.—Mill. *Crin.* p. 86, *fig.* 29, 30.
Bronn. *Let. Geogn. t.* 4, *f.* 6.
Cyathocrinus distortus.—Phill. *Geol. York.* 2, *t.* 3, *f.* 34.

Formation and Localities.

Carboniferous or mountain limestone.—Black Rock, banks of the Avon, Bristol; Barry Island, coast of South Wales; Castleton, Derby; Hook Point, Wexford; Lilleshall, Salop?

Magnesian beds of the mountain limestone, Clevedon Bay; and Woodspring.

Magnesian limestone.—Humbleton?

There has been much confusion respecting the localities where the *C. planus* occurs; this is owing to several very different crinoids having been referred to this species. We believe that none of the genus occur in formations newer than the carboniferous limestone, or of greater age than the Devonian.

Description of the Calcareous Skeleton.

The Dorso-central Plate of the *C. planus* is quinque-partite and shallow, with a circular? perforation in the centre, communicating with the columnar canal.—Exteriorly and centrally, is a slight depression, striated for the reception of the superior columnar joint.

The Perisomic Plates.—The first series consists of five, four of which are pentagonal, but inclining to a subhexagonal form; the fifth plate is hexagonal, though sometimes rounded at its lower edge.

The whole first series of plates are prominent in their centres, which imparts an appearance of fulness to the body.

The second series consist of six plates, five of which bear the rays. The non-ray-bearing plate is hexagonal, and rests on the truncated upper edge of the hexagonal plate of the first series.

The Ray-bearing Plates are perforated low down from their upper edges, for the passage of the muscles of the rays. A deep groove runs from each perforation to the summit of each plate, which is prolonged considerably beyond the point of attachment

for the rays, and in-arched so as to partially cover in the vertex. This is particularly conspicuous in *C. geometricus*, and appears to be very common in crinoids of this genus. All the plates of the *planus* are smooth.

Miller, at pages 86 and 87, represents the "scapulæ" (ray-bearing plates) as "of a form similar to those of *Poteriocrinus*." This is incorrect, as no plates can well differ more widely.

The Abdominal Plates.—In consequence of the inarching of the ray-bearing plates, three or four plates are sufficient to cover in the vertex. These plates are irregular in shape, and the central one is frequently the smallest of the group.

The Mouth is lateral, prominent and protected by irregular-shaped calcareous plates, which are also arranged round the base of the oral aperture. Two or three of these plates, which are somewhat larger than the others, are built up on the non-ray-bearing plate of the second series.

It is strange that Miller should have seen a specimen with the mouth protruded, and yet have omitted to ascertain its nature. In noticing the abdominal plates at page 87, he observes, "In a specimen in the Ashmolean collection at Oxford this integument is swollen out, and gives the specimen a singular appearance." But it seems he was not aware that this protruberance was the true mouth.

The Rays are single-jointed and bifurcate several times. The primary or main rays are five, each composed of three single joints, above which Mr. Morgan's specimen, represented in plate 7, figure 4, *a*, shews two other bifurcations; but whether the rays were further subdivided, none of the specimens we have seen enable us to decide. The number of digitations in this, and other crinoids may generally be relied on, though the number of joints in each digit is not always constant, sometimes varying in different specimens, or even in the same individual.

The rays were no doubt tentaculated, although none of the specimens shew the tentacula. The primary rays of all the known *Cyathocrini*, amounted to five, but the number of digitations probably varied in different species.

The Column of the *C. planus* is circular, and the ossicula of its upper portion are rounded inwards so as to make them less prominent at the points of articulation than in their centres. The striæ on the facets of the joints are chiefly marginal, the central portions being smooth and often slightly depressed. The tubular canal running through the column is circular. Miller has represented the upper portion as "quinquangularis;" but as he has evidently mistaken the column of *Poteriocrinus* for that of the *Cyathocrinus planus*, both in his figures and text, we consider him wholly in error on this occasion.

The lower portion of the column figure 4, *b*, has a tuberculated appearance around the prominent circumference of each joint, but this is probably produced by external causes.

We have been unable to detect the slightest appearance of auxiliary side arms on the column of this species although Miller asserts they were of considerable length. The figures 26, and 27, at page 86 of his Crinoidea, are not the side arms of any species of *Cyathocrinus*, 26, being a small column, and 27, the column and side arms of a *Poteriocrinus*.

The base of attachment unascertained.

Miller's principal figure of this species cannot be depended on, as he appears to have taken the rays of the *Taxocrinus longidactylus* and placed them on the body of the *C. planus*

This *Taxocrinus* is figured in the Transactions of the Geological Society, vol. 5, pl. 3, fig. 1, and which has often been referred to the *C. planus*.

The specimen from which our enlarged figure 4, *a*, plate 7, is taken was found and developed by Mr. William Morgan, of Clifton, Hotwells, to whose kindness we are indebted for an opportunity of adding it to our illustrations.

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2. Species. CYATHOCRINUS GEOMETRICUS. (*Goldfuss.*)

Pl. VII. fig. 5, a, b, c, d, e.

Definition.—Dorso-central plate quinque-partite, first series of perisomic plates five, second series six, five of which bear the rays.

SYNONYMES AND REFERENCES.

Cyathocrinites geometricus.—Goldf. *Pet.* p. 189, *t.* 58, *f.* 5.
Phill. *Pal. Foss. Suppl. Pl.* 60, *f.* 41.*

FORMATION AND LOCALITIES.

Devonian strata—Newton, South Devon; and Eifel.

THE DORSO-CENTRAL, and first series of perisomic plates of the *C. geometricus* are raised conically in their centres, from which strongly-marked ridges radiate in sets of four or five, the lines becoming sharper as they approach the margins of the plates, and till they unite at the sutures with those of the contiguous ones; the ridges of one plate exactly fitting against the radiations from the plates adjoining it.

The second series of perisomic plates consist of six, five of which bear the rays, these latter plates are perforated near their centres, and grooved above for the passage and

attachment of the muscles and ligaments, the grooves extending from the perforation to the upper margin of the plates. Above the perforations the plates inarch, as in the typical species, until they almost cover in the vertex, which above the ray-bearing plates was probably protected by a coriaceous integument closely studded with small calcareous plates.

All the second series of plates have similar elevated striæ to the first.

The intermediate or non-ray-bearing plate occurs, as is generally the case in the *Cyathocrini*, over the hexagonal plate of the first series, and supports the plates at the base of the oral aperture.

The passage through the dorso-central plate into the columnar canal appears circular in all the specimens we have examined, and we consider the passage through the column to be round also.

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3. Species. Cyathocrinus? pinnatus. (*Goldfuss.*)

Pl. VII fig. 6, *a, b.*

Definition.—Number and arrangement of the perisomic plates unknown; rays closely tentaculated; column furnished with branching auxiliary side arms.

Synonymes and References.

Cyathocrinites pinnatus.—Goldfuss. *Pet. G. t.* 58 *fig.* 7.
Cyathocrinus pinnatus.—Phill. *Pal. Foss. t.* 16, *f.* 45, p. 31.

Formation and Localities.

Devonian strata.—Staunton?; Mudstone Bay?; Eifel.

We much doubt the propriety of retaining the *pinnatus* among the *Cyathocrini*, for the rays and columns which Goldfuss has figured as typical of the species, may belong to two very different crinoids, as they have never been seen attached to a body. All the specimens attributed to this species which we have examined are imperfect and unsatisfactory, we have therefore in this instance broke through our rule of only illustrating from the specimens themselves, and taken our figures from Goldfuss, without being answerable for their correctness.

Goldfuss has been most unfortunate in his synonymes, having referred to Miller's *Actinocrinus moniliformis*, page 114 figures, 9, 12, & 13, as appertaining to the pinnatus; and although Miller was incorrect in placing the specimen referred to among the *Actinocrini*, it is certainly not the column of a *Cyathocrinus*. Goldfuss also gives figures of the same form of column and refers them to the pinnatus.

Miller's figure 9, is a column lying across the rays of another specimen, and which Goldfuss appears to have mistaken for the side arms attached to it.

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4. Species. Cyathocrinus calcaratus. (*Phillips.*)

Pl. VIII. fig. 2, *a*, *b*, *c*.

Definition.—Dorso-central plate quinque-partite and pentangular; first series of perisomic plates five, second series six, five of which bear the rays.

Synonymes and References.

Cyathocrinus calcaratus.—Phill. *Geol. York.* 2. *t.* 3 *fig.* 35.

Formation and Localities.

Mountain or Carboniferous limestone.—Bolland.

The first series of perisomic plates are so much produced in their centres in this species, as to become almost conical.

The *C. calcaratus* was not extensively diffused in the carboniferous seas, so that its remains are rarely met with in the deposits of that epoch, and even those few specimens which have been developed are so imperfect that we know nothing of the number and arrangement of its rays, or the structure of its column.

The dorso-central plate is conical in this species, but depressed in the typical.

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5. Species. Cyathocrinus bursa. (*Phillips.*)

Pl. VII. fig. 7, *a*.

Definition.—Dorso-central plate quinque-partite, and somewhat depressed in the centre for the articulation of the column; first series of perisomic plates five, all very tumid in their centres; second series six, five of which bear the rays.

Synonymes and References.

Cyathocrinus bursa.—Phill. *Geol. York.* 2. *t.* 3. *f.* 29.

Formation and Localities.

Mountain limestone—Yorkshire.

The *C. bursa* is small, and like the last species, was of rare occurrence in the carboniferous ocean; but we may yet hope to obtain more instructive specimens than that from which our figure is taken, which shews nothing of the rays or column.

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6. Species. Cyathocrinus conicus. (*Phillips.*)

Pl. VIII. fig. 1, *a*, *b*.

Definition.—The dorso-central plate is quinque-partite; first series of perisomic plates five; second series six, five of which bear the rays.

Synonymes and References.

Cyathocrinus conicus.—Phill. *Geol. York. t. III. fig.* 27.

Formation and Localities.

Mountain limestone—Bolland; Ireland.

The Dorso-central Plate, and all the perisomics of the *C. conicus*, are narrower, less raised in their centres, and longer than in any of the other known *Cyathocrini;* these peculiarities give it much the air of a *Poteriocrinus* for which it may easily be mistaken unless attention is paid to the number and arrangement of the plates.

All the plates appear to be finely granulose.

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7. Species. Cyathocrinus mammillaris. (*Phillips.*)

Pl. 7. *fig.* 8, *a*, *b*.

Definition.—Dorso-central plate quinque partite; first series of perisomic plates five, all tumid in their centres; second series six, five of which bear the rays.

Synonymes and References.

Cyathocrinus mammillaris *Phill. Geol. York. Pl.* 3. *f.* 2.

Formation and Localities.

Mountain limestone, Bolland; Mendips.

All the plates in this species are finely granulated, or delicately striated as in figure 8, *l*, and the excavations for the articulations of the rays are rather large.

All the rays of the *Cyathocrini* which we have examined, appear to be, as far as their imperfect preservation shews, composed of single series of joints.

In the *C. conicus* the aperture through the dorso-central plates communicating with the columnar canal is pentagonal.

Observations on the Genus Cyathocrinus.

Of the numerous genera into which the Crinoidea has been divided by different Authors none has fallen into greater confusion than the Cyathocrinus. This is chiefly owing to the system which has been to extensively followed, of giving specific names to imperfect fragments of columns, which fragments, though varying in structure, may not unfrequently be only different portions of the same column.

It must be remembered that almost every column presents very different modifications in form and structure according to its position with respect to its base of attachment.—As a prevailing, though perhaps not constant rule, it may be observed that the inferior portion of a column is most frequently composed of joints of equal thickness, while the middle parts present a different modification, and the superior portion departs still further in structure from the lower part. Thus a column may furnish materials for at least three species, if every isolated fragment is to receive a specific name. Nor can the central perforation always furnish good evidence of species, for it is sometimes pentagonal in one part and circular in another. The alteration in structure caused by the periodical growth of the column, may also prove another source of error.

It is remarkable how seldom the columns which are found associated in the same strata with the bodies of crinoids, have been referred to the species with which they are

imbedded. Though this might lead to error, it is surely preferable to multiplying species on insufficient evidence.

These remarks are equally applicable to most other genera, as well as to the genus *Cyathocrinus.*

So great has been the confusion in this genus that of the twenty four or twenty five species described by various Authors, we consider only seven of them to have been established on a proper basis.

Of the four species of crinoids figured and described by Miller as *Cyathocrini,* only one belongs to the genus. His *C. Tuberculatus* has been included in our genus *Euryalecrinus,* his *C. rugosus* has been removed to the genus *Crotalocrinus,* and we have also found it necessary to transfer his *C. quinquangularis* to another genus.

The *Cyathocrinus macrocheirus* of Mr. Griffiths Carboniferous Limestone of Ireland is clearly not a *Cyathocrinus* but it is a *Poteriocrinus.*

The *C. mequidactylus* of the same author is merely a small specimen of the *C. Planus,* all its specific characters perfectly agreeing with those of that crinoid.

Another species, the *C. distans,* which Professor Phillips has figured in the Palœozoic Fossils, Pl. 59. Figure 49* is merely a fragment consisting of two columnar joints.—This specimen may possibly appertain to the *C. geometricus,* or it may be a portion of an auxiliary side arm, or a column of some one or other of the *Hexacrini,* for as yet we have no knowledge as to the form and structure of the the columns of that genus. The same remarks will apply to the *C. megastylus;* the *C, ellipticus;* the *C. variabilis;* and the *C. nodulosus,* of the same Author.

The appearance presented by the specimen which Professor Phillips has named *C. nodulosus,* is perhaps the effects of weathering, for we have seen the side arms of an *Actinocrinus* assume the same tuberculated exterior, even in situations where others associated with them have remained unaltered.

The very imperfect fossil for which Miller proposed the name of *Cyathocrinus abbreviatus* in the appendix to his work, is so doubtful in character that we have omitted it altogether, it may appertain to the *C. planus,* or some other known species of *Cyathocrinus*

The *C. ornatus* of Phillips' Geology of Yorkshire appears to be the *Platycrinus striatus* of Miller. And not one of the so called *Cyathocrini* of Murchison's Silurian System properly belong to the genus.

The *C. Pentagonus* of Goldfuss, will probably be found to belong to some species of *Pentacrinus,* to the columns of which it bears a close resemblance.

It has already been observed that the genus *Cyathocrinus* is not found in the Silurian rocks, for the encrinites of that system are distinct in species and mostly if not entirely in general from those of the Devonian and Carboniferous groups. In the Devonian rocks the genus *Cyathocrinus* first appeared on the stage of life, but the species inhabiting

In consequence of an error at page 67, it is requested that that page may be cancelled, and the accompanying leaf substituted for the corresponding pages sent with No 5.

J. A.

the Devonian seas became extinct before the mountain limestone deposits began to accumulate, so that, with one or two exceptions at most, each system of ancient rocks has its own peculiar species of Crinoids, none of which occur in deposits newer than the group in which it first appeared.

Sir Roderick Murchison, at page 206 of his work on Russia and the Ural Mountains, makes the following observation relative to the occurrence of one species of *Cyathocrinus* in the Permian strata.

"The Crinoidea are extremely scarce, and of seventy to seventy five species which inhabited the carboniferous seas, one only, the *Cyathocrinus planus* (Miller) lived during the Permian epoch. Even this solitary species is extremely rare and we are as yet unacquainted with it in Russia."

Sir Roderick does not state the evidence on which the opinion as to the *Cyathocrinus planus* occurring in the Permian system is founded. It is true that Prof. Sedgwick in the transactions of the Geological Society, vol. 3, second series, page 126, states that portions of columns of two species of Crinoidea are found in great abundance in the quarries of Magnesian limestone near Humbleton; and also that specimens from Humbleton and Tynemouth had been examined by Mr. Miller, and were referred by him to the *C. Planus*.

It is almost needless to repeat that, considerable difficulty and doubt must of necessity prevail in referring portions of columns to particular species unless the structure of the whole column from its base to the apex is well known, or the particular portion described as belonging to an ascertained species has been seen attached to the Crinoid to which it is referred. It is therefore far from certain that the *C. Planus* lived during the Permian epoch.

2. Family. POTERIOCRINIDÆ.

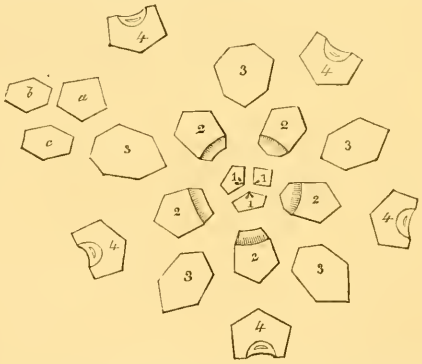
This family contains several genera, among which are the *Poteriocrinus* and *Synbathocrinus*.

The plates surrounding the digestive organs of all the *Poteriocrinidæ* are more or less tumid, and adhere to each other by broad surfaces of attachment. In some species the calcareous skeleton is prolonged internally so as to materially reduce the size of the internal cavity.

As we shortly intend to propose a more comprehensive arrangement of the Crinoidea than the one previously adopted, the exact limits of this family will be more particularly defined in a future page.

Genus 1. POTERIOCRINUS. (*Miller.*)

Etym. ΠΟΤΗΡΙΟΝ. (*Potherion*) a drinking cup, from the supposed resemblance the armless body bears to a common conical wine glass. All the known species of *Poteriocrinus* occur only in the mountain limestone formation.



Definition.—Dorso-central plate tripartite? 1; first series of perisomic plates, five, (2;) second series, five (3;) third series or ray-bearing plates, five, (4,) with two or three intermediate plates, *a*, *b*, *c*,

the Devonian seas became extinct before the mountain limestone deposits began to accumulate, so that, with one or two exceptions at most, each system of ancient rocks has its own peculiar species of crinoids, none of which occur in deposits either older or newer than the group in which it first appeared.

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It is almost needless to repeat that considerable difficulty and doubt must of necessity prevail in referring portions of columns to particular species unless the structure of the whole column from its base to the apex is well known, or has been seen attached to the body of the crinoid, it is therefore far from certain that the *C. planus* lived during the Permian epoch.

2. Family. POTERIOCRINIDÆ.

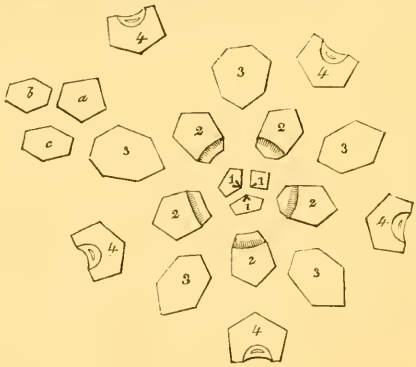
The genera in this natural group are less numerous than in the preceding. It comprises *Poteriocrinus, Taxocrinus, and Synbathocrinus.*

The different species composing this, and the preceding family are found in a fossil state but none have hitherto been discovered in the recent seas.

The lower series of plates surrounding the bodies of the *Poteriocrinidæ* appear to rest on, and articulate on to the superior columnar joints, which latter also articulates by radiating striæ to the concealed dorso central plates.

Genus 1. POTERIOCRINUS. (*Miller.*)

Etym. ΠΟΤΗΡΙΟΝ *(Potherion)* a drinking cup, from the supposed resemblance the armless body bears to a common conical wine glass. All the known species of *Poteriocrinus* occur only in the mountain limestone formation.



Definition.—Dorso-central plate tripartite? 1; first series of perisomic plates, five, (2;) second series, five (3;) third series, or ray-bearing plates, five, (4,) with two or three intermediate plates, *a, b, c.*

There has been much uncertainty as to whether the dorso-central plate of *Poteriocrinus* is tripartite, or quinquepartite, and even yet some doubt may remain on the subject, though the general evidence is in favour of its tripartite arrangement. Miller in his work on the crinoidea has represented that which is probably the first series of perisomic plates, as the dorso-central plate (pelvis). But it is just to remark that he did so with considerable hesitation, owing to the difficulty he experienced in obtaining specimens shewing the connexion between the plates of the body and the first columnar joint,

Professor Phillips represents the dorso-central plate as tripartite, in which opinion after a careful examination of many specimens we are inclined to coincide.

1. Species. Poteriocrinus Crassus. (*Miller.*)

Pl. VIII. fig. 3, *a to. m. and Pl. IX. fig.* 1.

Definition.—Dorso-central plate tripartite?; first series of perisomic plates, five; ray-bearing plates five; intermediate lateral plates two, or three; mouth centrical, much elongated and tubular,

Synonymes and References.

Poteriocrinites crassus.—Mill. *Nat. Hist. Crin.* p. 68.
Encrinites crassus.—Schloth. *Nacht. t.* 25. *f.* 2.
Poteriocrinites crassus.—Blainv. *Man. d' Act.*
M. Edw. *ap. Lamk.* 11, *p.* 664.
Munst. *Beitr zur Petref.*
M de Koninck. *Descrip. des Ani. Foss. Pl. F, fig.* 4.
Flem. *Brit. Anim. p.* 495
Woodward, *Cat. of For. foss.*
Cumberl. *Tran. of the Geol. Soc. of London, Vol.* 5. *pl.* 3. *f.* 2. *page* 90. (1*st series*)

Formation and Localities.

Carboniferous limestone, Yorkshire; banks of the Avon, Bristol; Hook Point, Wexford; Arran; and Tournay.

Magnesian beds of the carboniferous limestone, Clevedon Bay, Somersetshire.

Dr. Woodward has stated that this species occurs in Syria.

Description of the Calcareous Skeleton.

The Dorso-central Plate of the *Poteriocrinus crassus* is so much concealed by the lower edges of the perisomic plates, and the upper columnar joint that it is impossible to examine it in the best preserved specimen; for unfortunately in this case the more perfect the specimen the less chance there is of ascertaining its structnre, as regards the manner of its attachment to the column.

The Perisomic Plates.—The first or lower series which surround the dorso-central plate, and partly rest on the superior columnar joint consists of five pentagonal or irregular hexagonal plates. These plates bend under at an acute angle, and rest by a striated border on to the superior columnar joint.

The second series is also composed of five plates, but two of these are heptagonal, and three hexagonal, with their lower prominent points inserted into the retiring angles formed by the union of the first series; the third series or ray bearing plates consist also of five, and as one of the second series is irregular in shape, a corresponding irregularity occurs in one of the ray bearing plates to meet the anomalous modification.

At one point of the circumference, and between two of the ray bearing plates, are two or three irregularly shaped plates which cause a wider interval between the rays at the point where they occur, than has been observed between the other rays. Various conjectures have arisen as to the use of these intermediate plates in the animal's economy. As it is probable that the encrinites derived a portionof their food from the bottom, it is obvious that if this open space was turned downwards the mouth, whether proboscidiform or otherwise, would have a freer scope to search for objects of sustenance on the sea bottom than if its base was completely surrounded with rays. This peculiar form may therefore have been designed to enable the animal to obtain its food with greater facility.

All the perisomic plates are granulated, either from the effect of weathering, or of the original structure.

The Oral Tube, or Proboscis.—One striking feature in the *Poteriocrini*, is the absence of those plates which we have termed abdominal, and which Miller called pectoral plates.

Instead of the vertex being covered in by these plates, as in some other genera, the proboscidiform oral tube in this, appears to occupy the entire space included within the circle formed by the primary rays, and its immense size and length in comparison

with the attenuated body below the rays, form one of the most interesting characters not only of the species, but of the genus.

In the *P. crassus* the oral tube attained the length of four or five inches, and two inches and a half in circumference, and it appears to have been well fitted to gorge prey of larger size than most other crinoids.

The oral tube has been frequently found detached from the body, and free from the matrix in which it had been imbedded, on the shores of the Bristol Channel, at Clevedon, where it is mostly worn by the abrading action of the salt water, but still retaining sufficient evidence of its structure to enable us to indentify it with certainty as belonging to the *P. crassus*.

In its detached state it has often been mistaken for a gigantic fossil leech, or worm. —Figure 1. Plate 9, is from a specimen in the collection of Miss Rich who liberally granted us the use of the crimoids in her cabinet.

The Rays.—The primary rays are five, each composed of several joints or ossicula. Each ray articulates by grooves and ridges on the basal surface of its lower joint, which grooves and ridges fit into corresponding elevations and depressions on the upper edge of the ray bearing plate. The ridges are perforated for the passage of the muscles which held the rays in their assigned position, and at the same time imparted motion to them.

The first bifurcations increase the number of rays to ten, the second amount to twenty, but the specimens examined do not exhibit further divisions.

The rays are deeply sulcated inwardly for the passage of the muscles, which were protected by an integument covered with minute plates.

All the rays, the minor digitations, as well as the primary rays, are composed of single series of joints, consequently as each joints only bears a single tentacula, the latter are less numerous and wider apart than in those crinoids whose rays are composed of a double series of joints.

The rays of the *P. crassus* are long and of great strength when compared with the body.

The Column.—The column is circular and composed of numerous thin joints, which articulate by the radiating striæ on each of their facets. Towards the upper portion of the column the joints gradually decrease in thickness, and as gradually enlarge in diameter until they form a surface equal in size to the lower portion of the crinoid's body.

The central canal running through the column is pentagonal in its upper portion, and circular as it approaches the base. It also becomes larger as it recedes from the body.

Miller represents the columnar canal as circular, while Professor Phillips on the contrary represents it to be pentagonal. This difference of opinion calls to mind the dispute between the two travellers as to the real color of the chameleon, wherein both were right, and both were wrong. Our explanation of the matter as now given will not, we hope, "make confusion worse confounded."

The striæ on the facets of the columnar joints do not all radiate from the centre of the column, as if they did, those at the central axis would be too much crowded; therefore to prevent this defect, which would destroy the proper adhesion of the joints, the striæ converging from the centre become rather wide apart at the margin. The marginal spaces thus left are occupied by short striæ arranged in such a manner as to make the longer striæ appear forked.

Miller was the first to observe the injuries which the columns of this species so frequently suffered. The effects of most of these mishaps as presented to our notice, is a gradual swelling out into an unsightly protuberance of several consecutive joints, with a considerable concavity on one side. This concavity has evidently been produced by the violent extraction or severance of an auxiliary side arm from the column; and the crinoid in its endeavours to repair the injury and strengthen the wounded part, has by a rapid and more profuse secretion of calcareous matter enlarged the joints, above and below the severed member, and at the same time closed in the orifice which communicated with the columnar canal.

The Auxilary Side Arms.—These jointed appendages occur at intervals around the lower portion of the column as in others of the genus.

The columnar articulations being thin, each side arm requires several consecutive joints to form a sufficient surface for its attachment.

The base of attachment though unknown, was probably that most usually observed, namely an irregular shaped mass of calcareous matter, deposited around the base of the column, and on the rock to which it was attached with several root like processes which imparted greater stability to the tall column.

The *P. Crassus* is the largest crinoid known of the genus, among which considerable irregularities occur. Sometimes the rays are attached by strong ridges the whole width of the ray bearing plates to the body, at others the ray bearing plates are partially excavated to receive the basal ray joint, and few large specimens are found without traces of mutilations or injuries of various kinds.

On considering the causes which could produce such frequent bereavement of members among the *Poteriocrini*, we are naturally led to seek for the solution of the question by

inquiring as to the description of enemies they had to contend with, and by what dangers they were surrounded in the tranquil depths of the carboniferous seas, where they might be supposed to have lived in peaceful security for the full term of life assigned them by nature. Such however was not the case, for certain predaceous fish, if we can judge by the coprolitic matter so abundant in some beds of mountain. limestone, devoured them and other genera with the same *gusto* as a hungry cod of our own seas does their living analogues, the starfish and sea-urchins, and with the same selfish disregard to their symmetrical forms and ornamented exteriors.

As the boundless extent and fathomless depths of the ocean are, and always have been, since the first creation of carnivorous beings, a continual scene of rapine, the Lily-stars in their turn captured and fed on such creatures as they were able to master, among which, certain mollusca appear to have been the favourite aliment of the *Poteriocrini*. Of these we consider the spined Producta and its ova to have been the chief support, for wherever the remains of the *Poteriocrinus* occur, there the *Productas* are found associated with them, in the same manner as the recent sea urchins and starfishes are observed on the Mactra and oyster beds.

The Poteriocrinus was well able with its long and powerful arms to seize on any luckless mollusk that crawled within its circumscribed sphere of action, tethered as it was to the bed of the ocean; and if it also possessed the power of injecting any acrid fluid into the gaping shell, as the starfishes are supposed by some to be capable of secreting, then the destruction of its prey would be certain.

To get at the mollusk the Poteriocrinus must have arched round its column like a swan's neck, until the long oral tube and rays reached the bottom where the shell fish rested in fancied security, when folding it in its pliant but powerful rays, the captive was borne from its rocky bed by the crinoid resuming its upright position, where it could regale on the imprisoned mollusk at leisure: or it might have finished its meal whilst in its curved state.

In these predatory explorations an insidious side arm might have been occasionally either accidentally or otherwise introduced into the shell of the producta and detained by its closing valves as security against further aggression, when in its efforts to regain its freedom the struggling crinoid may have torn its entrapped member from the column, leaving an indelible mark of the wound as evidence of its rapacity, or prying propensities. Or the smaller rapacious fish may have seized on and torn away the tempting looking bait.

The latter suggestion is the least probable of the two, as it is known that the side arms of recent crinoids can resist a considerable strain, or cling with great tenacity to any object they infold in their grasp.

Though the *Poteriocrinus* is chiefly met with in company with the Productas, other

crinoids have been found with univalves inclosed within their rays in such a position as to leave but little doubt that a sudden death had overtaken them in the midst of their repast.

Many species of Crinoidea, as some of the *Actinocrini*, with their long flexible narrow pointed oral tubes most probably fed on the corals which abounded in the early seas of our planet. In the proboscis of the *Actinocrinus polydactylus*, and some other species we find an instrument well suited for searching among the coral branches, and extracting the soft fleshy zoophytes from their calcareous cells.

Miller's figure 1. page 68, and our figure Pl. 8, 3 c,are drawn from the same specimen; the difference in the figures may be accounted for by the fact that Miller attempted a restoration, and we have endeavoured to convey a faithful portrait of the original. This specimen is now in the museum of the Bristol Institution.

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2. Species. Poteriocrinus isacobus. (*Austin.*)

Pl. 8, *fig.* 4 *a, and b.*

Definition.—The dorso-central and perisomic plates, appear to agree in number with the typical species. Primary and secondary rays are each composed of a single elongate joint; minor digitations formed of several.

Synonymes and References.

Poteriocrinus minimus.—Austin, *Ann. Nat. Hist. Vol.* 10, *p.* 108.
isacobus.—Austin, *Vol.* 11, *p.* 195.

Formation and Localities.

Mountain limestone.—Mendip hills; Black Rock, Avon side, Bristol; Hook Point, Wexford.

This diminutive species of *Poteriocrinus* is another example of the diversified structures among crinoids of the ancient seas, for here we find the rays constructed differently from those of all other known species; and while they convince us by their form, they were less flexible than in any crinoid we have previously described, they assure us that the

objects of its sustenance were less minute in comparison with itself than its pigmy proportions might otherwise lead us to suppose, for it is quite certain that among animals the organs for securing the food and the size and strength of the objects to be captured invariably bear a relative proportion to each other.

The primary, and secondary rays of the *Poteriocrinus isacobus*, are each composed of a single joint, whose length is very considerable when compared with the thickness.—Inwardly they are deeply and widely grooved, so that when the inner side is presented to the eye they appear somewhat like sections of small bones. The minor rays are composed of several joints, but these are much longer than usual in erinoids even of a large size.

The final divisions of the rays, as far as we have been able to ascertain, amount to twenty, and this to all appearance is the full number.

The tentacula are few and far between.

The beautiful little specimen from which our illustrations are taken was found in the mountain limestone of Ireland, and is now in the cabinet of the Authors.

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3. Species. Poteriocrinus rostratus. *(Austin.)*

Pl. 9. *fig.* 2 *a, to* 2 *f.*

Definition.—The plates surrounding the body agree in number and arrangement with those of the typical species, but they are smaller and less massive. All the perisomic plates are smooth. Mouth proboscidiform and centrical.

Synonymes and References.

Poteriocrinus rostratus.—Austin, *Ann. Nat. Hist. Vol.* 10, 11. *p.* 108, *and* 196.
gracilis.—Griff. *Carb. lime of Ireland. Pl.* 2, *Fig.* 11. *to* 14.

Formation and Localities.

Mountain limestone.—Hook Point, Wexford; Banks of the Avon, Bristol.
Magnesian beds of Mountain limestone.—Clevedon, Somersetshire.

The *P. rostratus* is smaller than the typical species, and the plates inclosing the digestive organs are also much thinner; the structure of the oral tube is likewise different. In the typical species the plates which encircle the proboscis are closely striated or ridged transversely, while in the *rostratus* some of the ridges cross the plates horizontally, and others obliquely so as to impart a reticulated appearance to the organ.

The proboscis is composed of several vertical bands of plates which extend upwards from the base of the rays to the height, in a full grown specimen of two or three inches, and terminates in several spiniform points.

The tooth like plates at the apex of the oral tube are arranged in a manner which would have enabled the animal to use them either as instruments for picking up and holding the objects of its sustenance, or for the purpose of reducing them to a size, shape and consistency fitted for gorging. The pointed plates of the oral tube, may in some measure be compared to the dental apparatus, or Aristotle's lantern as it is sometimes termed, of the recent sea urchins. And the structure of this organ is another proof if proofs were wanting. that the office of the lily-stars was, as is that of the recent *echini* and *asteriæ*, to check the too great increase and keep within bounds certain creatures by feeding on them or their ova, while in turn the crinoids were doomed to support, in part, animals more perfect in organization than themselves.

We have developed several specimens of this Poteriocrinus in different states of preservation, three of which with a considerable portion of the rays and columns attached. Two of the number also shew the lower portion of the oral tube sufficiently defined to prove its identity with the more perfect though detached specimen of proboscis represented in plate 9. figure 2. d.

This beautiful species of *Poteriocrinus* was first discovered by the Authors in the mountain limestone of Ireland, since which they have ascertained its occurrence in the same formation on the banks of the Avon, Bristol; as also in the magnesian beds of the mountain limestone at Clevedon, where Miss A. Rich was so fortunate as to develope the beautiful column which forms so striking an object among our illustrations.

In this specimen the body appears to have been bent round and across the column a short distance below the summit, so that it hung down in the manner of a drooping flower. Unfortunately only a part of the body has been preserved, but the impression made by it is deeply indented on the surface of the rock in which it was imbedded.

The auxiliary side arms are in this instance so perfectly preserved, that they are unbroken to their extreme points, and the manner in which they increased in number is clearly exemplified by the smaller arms in their early stage of growth emanating from the column, above the larger and more perfect claspers below.

As the side arms seldom occur above the lower third portion of the column, it follows as a natural consequence that when new joints are formed by which its length is increased,

additional side arms are also produced, and thus the exact relation between the claspers and the length of the column is constantly maintained.

In order that the objects which came within the folds of the side arms might be more firmly retained, each joint has on its upper side, or that side which is next towards the column when the clasper is in a vertical position, an overlapping edge with a narrow raised ridge which runs parallel to the articulations, and by which means it could the more firmly maintain its hold of any extraneous object it might have grasped. Vide Pl. 9. fig. 2, g.

The rays are long, and composed of single series of wedge shaped joints, each of which is furnished with a lateral tentacula.

The primary rays are five, and the smaller divisions apparently amount to ten. These latter are deeply sulcated as in the typical species.

We are indebted to the kindness of Miss Rich for the opportunity afforded us of adding figures 1, and 2, a, plate 9. to our illustrations. The specimens from which figures pl. 9. 2, b, to 2 f. are taken, were developed by the Authors from the mountain limestone of Ireland.

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4. Species. Poteriocrinus granulosus. (*Phillips.*)

Pl. 9. fig. 2 a, to 2 f.

Definition.—Body hemispherical; ray bearing articulations extending the whole breadth of the plate; column large. Number of rays unknown.

Synonymes and References.

Poteriocrinus granulosus.—Phill. *Geol of York. Pl.* 4, *fig.* 2. *&c. page* 205.
Cap encrinite.— Parkinson's *Org. Rem. Vol.* 2. *Pl.* 15, *f.* 9, p. 194.
Parkin. *Outl. Orycto. Pl.* 9, *f.* 4.

Formations and Localities.

Mountain limestone.—Derbyshire; Yorkshire; Belmore Mountain, near Enniskillen; Hook point, Wexford; Mendips; and in the vicinity of Kirkaldy.

All the plates of the adult animals of this species appear to be covered with fine granulæ, but the younger specimens have only faint indications of a granulated surface. Each division of the dorso-central plate has a deep notch on its lower terminal angle, the combined effect of this, when the plates are in their proper positions, is to produce a pentapetalous aperture into the cavity containing the digestive organs, as represented in plate 9, fig. 3 e.

The column is circular, large and long, with a pentagonal shaped canal running through its upper portion, and gradually becoming circular as it descends towards the base.

This species of Poteriocrinus in its short tumid plates, its broad surface of articulation for the rays, and contracted cavity for the digestive organs, bears some analogy to the *Apiocrinus ellipticus* of the chalk, and the *A. elongatus* of the oolite.

Much of the Mountain limestone of Derbyshire is almost wholly composed of the broken and disjointed columns of this species of Poteriocrinus, and yet amidst these countless fragments of columns only a few bodies have been discovered. The probable conjecture as to the cause of this deficiency of the bodies of this animal, which we know must have existed, for every column supported a body containing the digestive organs, is, that the predaceous fishes of the period, preyed on the superior portions and rejected the other parts, and by this means a gradual accumulation of columnar fragments took place, while the plated bodies were crushed by the bony palates of their destroyers. This is the more probable as detached plates are as rarely found as complete bodies, and which must have been scattered through the matrix, had the animals been left to the natural and gradual progress of decay.

The ornamental marble from Derbyshire, and mostly known by the name of Encrinital Marble, owes its chief beauty to the symmetrical columns of this species of Poteriocrinus.

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5. Species. POTERIOCRINUS PLICATUS. *(Austin.)*

Pl. 9. *fig.* 4 *a*, *to* 4 *f*.

Definition.—The arrangement of the plates surrounding the digestive organs agree with the typical species, but they are much wider in proportion to their height; angles of the plates depressed, so as to form series of lozenge shaped and triangular indentations around the body; ray articulations semicircular and occupying about a third of the ray bearing plates; column large but thin jointed.

Synonymes and References.

Poteriocrinus plicatus.—Messrs. Austin. *An. & Mag. Nat. Hist. Vol.* 10, *page* 108, *& Vol.* 11. *page* 196.
crassus.—L. de Kon. *Anim. Foss. Belg. Pl.F. fig* 4. *a & b.*

Formation and Localities.

Mountain limestone.—Mendip hills; Black Rock, Avon Banks, Bristol; altered beds of mountain limestone, Clevedon Bay.

This species appears to be but sparingly diffused through the mountain limestone, having been met with in only a few localities, and even there in very limited numbers The crenulated lip like expansions on the articulating edges of the plates as represented in our ninth plate, fig. 4 e, are interesting points of structure.

The figures which M. L. de Koninck has given in his valuable work on the Belgic carboniferous fossils, of the external and internal form of a ray bearing plate, but which, probably misled by Miller's restored figure, he has erroneously referred to the *Poteriocrinus crassus*, bears close resemblance in its wavy folds to the form of the ray bearing plates of this species.

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6. Species. Poteriocrinus radiatus. (*Austin.*)

Pl. 10. *fig.* 1 *a*, 1 *b.*

Definition.—Body conical, the plates ornamented with several bands of well defined ridges which traverse the plates and cross the sutures. These elevated radiations unite with each other and form several series of triangles around the body. Mouth centrical and proboscidiform; rays bifurcated; column slender.

Synonymes and References.

Poteriocrinus radiatus.—Messrs. Austin, *Ann. & Mag. Nat. Hist. Vol.* 10, 11, *page* 108 *and* 196.

Formation and Localities.

Carboniferous limestone.—Yorkshire; Hook Point, Wexford; Portville?

The *radiatus* is smaller than the *conicus*, and differs from it in having highly raised radiating lines on the plates, which form a series of concentric triangles around the body. The ray bearing plates are excavated in their centres for the attachment of the rays, these excavations being narrow, the five primary rays which fit into them are less massive than in most other species of *Poteriocrinus*. The rays are long, taper, and bifurcating several times, the total number probably amounted to eighty. They are composed of single series of joints as are all of the genus, but the articulations are shorter than in most other species. Each joint has a single tentacula attached, but none of the crinoids with single jointed rays can have the close set plumose tentacula which adds so much to the beauty of those with the more complicated double jointed arms.

The extraordinary length of the rays, measuring as they do in a small specimen upwards of four inches in length, together with the great distance between the bifurcations distinguishes this species from most of its congeners.

The proboscis is centrical, and the organ as is common to the genus is extremely large and long as compared with the size of the body. It is covered with small hexagonal plates, the mouth as in other species being situated at the apex. The column is similar in structure to that of the P. rostratus.

This species was discovered by the Authors in the Carboniferous limestone of Ireland.

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7. Species. Poteriocrinus Quinquangularis. (*Austin.*)

Pl. 10, *fig.* 2 *a*, 2 *b*, 2 *c*, 2 *d*, 2 *e*.

Definition.—Dorso-central plates more attenuated than in the typical species. Mouth proboscidiform and centrical; main rays five, with one or more subdivisions; column enlarged and quinquangular near its attachment to the body and gradually becoming circular as it recedes from it.

Synonymes and References.

Poteriocrinus quinquangularis.—Messrs. Austin, *Ann. and Mag. Nat. Hist. Vol.* 10, *p.* 108, *Vol.* 11, *p.* 196.

Formation and Localities.

Mountain Limestone.—Black Rock, Avon Side, Bristol; Hook Point, Wexford; Clevedon Bay.

A group of this small species of Poteriocrinus, was discovered by the Authors, a few years since in the mountain limestone of Ireland. At a subsequent period they found it in the same formation in the vicinity of Bristol. It is a small neat species with a remarkably elegant column, which is quinquangular in its upper part, and circular towards the base, and composed of small thin joints, alternating with larger and thicker ones. Auxiliary side arms occur at certain intervals on the lower part of the column, where it becomes less pentagonal than at the summit. These side arms emanate from between the angles of the larger joints, never on the angles themselves. Sometimes there is a minute tubercle on each of the angles of the columnar joints, which adds considerably to the beauty of the column.

The body is slender and much attenuated at its attachment to the column. The proboscis is large and centrical, the mouth being situated at the apex. The surface of the oral tube is striated transversely in bands, the striæ of one band of plates uniting at the sutures, with those on the adjoining plates.

The divisional rays appear to amount to ten, the first and only apparent bifurcations occurring at about the fifth articulation from the ray bearing plates. These plates are excavated in their centres for the attachment of the rays, which are slender as compared with most other species of *Poteriocrinus*.

8. Species. POTERIOCRINUS CONICUS. (*Phillips.*)
Pl. 10, *fig.* 3 *a*, 3 *b*, 3 *c*.

Definition.—Body conical, approaching in form to the *P. rostratus*, but the plates are rather more tumid, and the first series are not quite so much elongated; the articulations for the rays extend across the whole width of the plates. Nothing is known of the number and structure of its rays.

SYNONYMES AND REFERENCES.

Poteriocrinus conicus.—Phill. *Geol. York.* 2. *t*, 4. *fig.* 3.
Port. *Geol. Rep. t.* 16. *f.* 12.
L. de Kon. *Des. des. anim. foss. Pl. F. f.* 3. *p.* 47.
Mil. Edw. *ap. Lamk. p.* 664.

FORMATION AND LOCALITIES.

Mountain Limestone.—Bolland, Yorkshire; Black Rock, Avon Side, Bristol; Ireland and Tournay.

The *P. Conicus* was first discovered in the mountain limestone of Yorkshire, by Mr. Gilbertson, since which we have obtained a well preserved specimen from the Black Rock, Bristol; but unfortunately the specimens obtained from both localities have neither the rays or column attached.

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9. Species. POTERIOCRINUS LATIFRONS. (*Austin.*)
Pl. 10. *fig.* 4.

Definition.—Body conical; rays articulating by the whole breadth of the ray bearing plates; primary rays five, secondary ten, final subdivisions twenty; column slender.

Formations and Localities.

The Mountain limestone, Mendip Hills, Somersetshire.

The *P. latifrons* is a very minute species the body scarcely ever exceeding the size of half a pea; but although the body is so exceedingly small, the rays are comparatively large and long. The primary or main rays are each composed of a single elongated cuneiform joint; on the outer slopes of these joints are two longer but thinner rays composed of several joints, generally from eight to ten; the rays again subdivide making the total divisional rays amount to twenty.

The rays in this species are proportionately thicker than in the *P. tenuis.*

This new species is extremely rare, and no scientific record with which we are acquainted has noticed its existence. Its occurrence as far as our observations extend is limited to the Mendips.

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10. Species. Poteriocrinus tenuis. (*Miller.*)
Pl. 10. *fig.* 5, *a*, 5, *b.*

Definition.—Body attenuated; mouth proboscidiform and centrical; main rays five, each composed of a single elongated joint, and articulating by the whole width of the narrow ray bearing plate; two thinner rays proceed from the sloping angles of the main rays, making the total number of divisions ten; column long.

Synonymes and References.

Poteriocrinus tenuis.— Mill. *N. Hist. Crin. p.* 71.
Schloth. *t.* 25. *fig.* 3.
A new and peculiar species of Encrinus.—Cumb. *Trans. Geol. Soc. Vol.* 5. *Pl.* 23.*f.* 1.
p. 380. 1*st. series.*

Formation and Localities.

Mountain Limestone.—Mendip Hills ; Black Rock, Avon Side, Bristol; Barry Island.

In the 5th vol. of the Transactions of the Geol. Soc. of London, at page 380, Mr. Cumberland, asserts that he has found portions of the arms of this species in the Severn Lias. We conceive this to be a mistake as to identity, for the genus had undoubtedly become extinct before the age of the Lias.

The upper part of the column of this species, is composed of alternate thick and thin joints, but which probably become nearly equal in size, at a short distance from the body, a form of structure, very frequently observed in the crinoids hitherto examined.

The number and arrangement of the rays of the *P. tenuis*, correspond with those of the *P. rostratus*, but the joints of which they are composed, are comparatively much longer.

The *P. tenuis* is a small and delicate species, few individuals ever having attained the size of Miller's figure at page 71, of his work on the Crinoidea.

Miller has unfortunately represented the main rays, (hands) as articulating into small excavations on the ray bearing plates, when in fact they are as wide at the points of articulation as the plates themselves, which are not excavated, but ridged the whole width as in most of the genus. He also represents the first joints of the secondary rays (fingers) as "adhering near the base, laterally to each other." Instead of which they fit on to the sloping edges of the cuneiform summits of the primary rays. This is evident in the specimen from which our figures are taken, and also in another well preserved specimen in our cabinet.

The figure of this species in plate 10. is imbedded with the intermediate plates between the rays at the open point of the circumference, and at the base of the proboscis, outward. It was not however considered necessary to give a second figure in a different position as the plates surrounding the body agree in number and arrangement with others of the genus.

Mr. Cumberland, who has given a figure of this species, in the Transactions of the Geological Society of London, under the title of "a new and peculiar species of Encrinus," suggests the probability of the proboscis, which has been bent round and turned outwards through the rays, above the intermediate plates, at its base, being an extraneous body. After comparing this supposed extraneous body as represented in Pl. 10, fig. 5,

with the enormous oral tube of the *P. crassus*, Pl. 9, fig. 1, its size will not deter the Palæontologist from assigning it to its proper place in the crinoid's calcareous skeleton

The ray joints are long and slender as compared with the *P. latifrons*. They are deeply sulcated on their inner surfaces; each joint, as is common to most of the crinoidea, giving support to a single tentaculum, these therefore from the joints being long, were not numerous.

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11. Species. Poteriocrinus impressus. (*Phillips.*)
Pl. 10, *fig.* 6.

Definition.—Body conical; articulations for the rays not extending quite across the plates; rays articulating by double parallel ridges, and a minute central perforation. Column and rays unknown.

Synonymes and References.

Poteriocrinus impressus.—Phill. *Geol. Yorks. Pl.* 4. *fig.* 1.

Formation and Localities.

Mountain Limestone.—Whitewell; Bristol; Arran; Ireland.

Our information respecting this crinoid, is exceedingly meagre, nothing being known of its rays, or column, or structure of the mouth.

This species of *Poteriocrinus* was first discovered by the late Mr. Gilbertson, and described by Prof. Phillips, in his work on the Geology of Yorkshire. Mr. Gilbertson's specimens are now deposited in the British Museum, having been purchased by the Trustees of that Institution.

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12. Species. Poteriocrinus dactyloides. (*Austin.*)
Pl. 10. *fig.* 7. *and Pl.* 11. *fig.* 1 *a*, 1 *b*.

Definition.—Body attenuated; rays five, deeply sulcated and articulating by the whole breadth of the plates; column thin jointed and but slightly enlarging in diameter at and near its attachment to the body.

Synonymes and References.

Poteriocrinus dactyloides.—Austin, *Ann. & Mag. Nat. Hist. Vol.* 10. *p.* 108. & *Vol.* 11. *p.* 197.

Formation and Localities.

Mountain Limestone.—Hook Point, at the entrance of Waterford Haven.

The *P. Dactyloides* is a small species, none of the specimens yet developed exceeding in size that from which figure 1 a, plate 11 was drawn. In the arrangement of its rays it very slightly approaches to the *Synbathocrinus.*

The rays are undivided and long in proportion to the size of the body. Their number and arrangement in small specimens have some faint resemblance to a long bony human hand, which circumstance has suggested the specific name.

The proboscis is large and its plates crossed by elevated striæ.

The upper portion of the column is composed of thin joints, every fourth articulation being somewhat thicker than the intervening ones. The lower portion is probably equal jointed as in most of the genus.

We have obtained several specimens of the *P. dactyloides,* from the mountain limestone of Ireland, but its occurrence in other mountain limestone districts, has not been clearly ascertained. The rarity of the species, may perhaps be attributed to the fragmentary state in which it generally occurs, rather than to the confined limits of its former existance.

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13. Species. Poteriocrinus pentagonus. *(Austin.)*
Pl. 11. *fig.* 2 *a*, 2 *b*, 2 *c*, 2 *d*, 2 *e*, 2 *f*.

Definition.—Lateral plates much shorter than in the typical species; mouth centrical and elongated into a proboscidiform tube; rays articulating to the body, by the whole breadth of the ray bearing plates, total number of rays twelve; tentacula numerous; column long, and composed of numerous thin joints.

Synonymes and References.

Cladocrinites pentagonus.—Austin, *Ann. & Mag. Nat Hist. Vol.* 11. *p.* 198.

Formation and Locality.

Altered beds of mountain limestone, Clevedon Bay, Somersetshire.

The basal and succeeding ray joints of this species of *Poteriocrinus* articulate by such broad surfaces as to appear like a third or fourth series of perisomic plates resting on the pentagonal ray bearing plates. The second or upper joint, of each of the primary rays is pentagonal, and equally broad at its attachment, as that on which it rests. The salient angles of these pentagonal pieces point upwards, so that their upper and outer sloping edges give support to the lesser rays. No further bifurcation takes place in the three out of the five groups of rays, but each of the remaining two, which are placed one on each side of the open space formed by the introduction of the inter-radial plates, as represented in plate 11, fiig. 2 b & 2 c, have an additional bifurcation, as if designed to guard the interval thus left, and to complete the circle, when the rays and tentacula, were spread out in quest of prey. On reference to the figures before alluded to, it will be seen that the open space caused by the introduction of the inter-radial plates, produces a corresponding interval in the net like circumference of the rays, when spread around, through which the minute creatures, which in all probability, formed in part the food of this crinoid, would have escaped, had it not been for the increase in the number of rays, at the exact point where some such contrivance was necessary to complete the apparatus for securing its prey.

Although we have not observed, in any other species of crinoid a similar partial increase in the number of rays, placed as it were to guard the passage made by the interval where the inter-radial plates occur, it is probable that additional rays do exist in several other species, in which there is a wider interval between the rays at one part of the circumference, than in the other four.

We have dwelt rather much on this subject, because a more interesting fact, or one that goes further to establish the manner in which a seeming irregularity of structure may be made subservient to a perfect adaptation of a means to an end, is not to be found, even among the beautiful and once abounding race of animals, which constitute the object of our present inquiry.

The oral tube, Pl. 11. figure 2 e, appears to be formed of five vertical bands of plates, but the pieces are not marked with elevated striæ, as in most other species of *Poterio-*

crinus. The specimen, from which our figure is taken, has been flattened by pressure but it is sufficiently perfect, to prove that the proboscis was of large size.

Figure 2 c, Pl. 11. represents a specimen with the plates, which cause the open space at the base of the rays, so frequently referred to, and which all the animals belonging to this genus possess. The arrangement of these plates, is particularly worthy of observation, because a *Poteriocrinus* when viewed on opposite sides, appears so totally different, that an unpractised observer, might consider two specimens of the same species as appertaining to animals, of even different genera.

The root or base of attachment, is formed of several root like processes combined with irregular secretions of solid calcareous matter.

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14 Species. Poteriocrinus longidactylus. (*Austin.*)
Pl. 11, *figure* 3, *a.*

Definition.—Body small and conical; main rays five, long, and articulating by the whole breadth of the plates, final divisions apparently forty; column long and enlarging near its attachment to the body.

Synonymes and References.

——————————Cumb. *Trans. Geol. Soc. Vol.* 5. *Pl.* 3. *Fig.* 1. *p.* 90.
Cyathocrinus planus.—Mant. *Wond. of Geol.* 3*rd. Ed. Pl.* 119.

Formation and Locality.

Altered beds of the mountain limestone.—Clevedon Bay, Somersetshire.

The column of this species near the summit, is composed of alternate thicker and thinner joints, which gradually become changed into joints of equal thickness. The columnar canal is obscurely pentagonal, but owing to abrasion or some other cause, the specimen from which figure 3 a, Pl. 11, is taken, does not distinctly show the true form of the column. This specimen has a body only three eights of an inch in diameter, and a quarter of an inch in height. The rays are three inches in length, or twelve times as long as the height of the body, and eight times as much as its diameter, so that when the rays were spread out to their full extent, the circle formed by them was upwards of six

inches in diameter. This crinoid therefore, with a body apparently so disproportionate to the length of its rays, could form by their expansion a net-like apparatus around it to a circumference of nearly twenty inches, or upwards of half a yard.

This *Poteriocrinus* has been the cause of much perplexity to Palæontologists. It was first figured by Mr. Cumberland in the Transactions of the Geological Society, but without any specific name being attached to it. Miller appears to have borrowed its fine set of rays to graft on to his restored figure of the *Cyathocrinus planus*. Dr.Mantell has also figured it under the same name in his instructive work, "The Wonders of Geology;" and we were at one time in doubt as to its true character, but on a careful examination and comparison with a very great number of specimens, we have arrived at the conclusion, that it is a true *Poteriocrinus*, and as such we do not hesitate to place it in that genus. It should never have been confounded with the *C. planus*, or mistaken for any other species of *Cyathocrinus*, because no crinoid belonging to that genus has the rays attached by the whole breadth of the ray bearing plates as they do in the fossil which has caused so many errors as to the true position it should occupy among the Crinoidea.

If the fossil which Mr.McCoy has named *Cyathocrinus macrocheirus*, be really identical with the *P. longidactylus* as we suspect it is, then the column is clearly pentagonal. But whether we are correct in our conjecture or otherwise, it is certain that the fossil in question cannot be a *Cyathocrinus*, because, as before observed, in none of that genus do the rays articulate in the manner represented in Mr. McCoy's figure.

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15. Species. Poteriocrinus abbreviatus. *(Austin.)*
Pl. 11. *fig.* 4 *a.*

Definition.—The dorso-central plates agree in number and arrangement with the typical species, but they are comparatively much shorter; rays twenty? column circular, and at the summit composed of alternate thick and thin joints.

Synonymes and References.

Cladocrinites brevidactylus.—Messrs. Aust. *Ann. & Mag. N. Hist. vol.* 11, *p.* 198

Formation and Locality.

The Mountain limestone, Hook Point, Wexford.

In this species the lateral plates enclosing the digestive organs are much abbreviated, and appear of considerable thickness. The rays, which are comparatively more massive than in any other species of *Poteriocrinus*, articulate by the whole breadth of the radial plates. Each of the five lower arms consists of two joints, the upper one being cuneiform; at this point these branch off into a pair, which generally consist of eight or nine joints, but the number is not invariably constant, the upper one being also cuneiform whatever the number may be. Here a second bifurcation takes place, the rays as is usual, diminishing in thickness at every successive division. Their total number is at least twenty; but the specimens hitherto developed do not exhibit further divisions.

The specimen from which our figure of this species is taken, was discovered by the Authors in an outlier of the mountain limestone, known as the Hook Point, a rather remarkable narrow tongue of land which stretches out from the Wexford coast, and partly across the mouth of Waterford Haven.

In the 5th Vol. of the Transactions of the Geological Society, plate 4, the several figures numbered respectively, 4, 5, 6, and 7, appear to relate to animals belonging to the genus *Poteriocrinus*, but the details as regards the arrangement of the plates forming the calcareous skeleton, are not sufficiently clear to enable us to determine the species to which they belong.

The auxiliary side arms or claspers belonging to crinoids of the genera *Poteriocrinus* and *Actinocrinus*, are arranged differently to those of *Extracrinus* and *Pentacrinus*. In the *Extracrinus Briareus*, almost every one of the larger joints has its claspers, but in the true *Pentacrinus* they only occur around the column at regular and distant intervals, the intervening joints being destitute of lateral appendages. In the two first named genera, the side arms occur only on the lower third portion of the column, and are so arranged, that one or more lines passed spirally round the column, will bisect the point of attachment of every side arm on it.

In general outward appearance, some species of *Poteriocrinus* bear a slight resemblance to animals of the genus *Cyathocrinus*, but when the calcareous skeleton is examined with proper attention, differences sufficiently obvious, will present themselves to notice, and prevent all chance of confusing the animals of one genus, with those of the other.

The group of inter-radial plates at one point of the circumference, and which appear designed to connect the proboscidiform oral tube more completely with the body, than if the rays were equally close all round, and the base of the proboscis had only the inner edges of the ray-bearing plates to rest on, is alone sufficiently characteristic of the *Poteriocrini*, as a single hexagonal inter-radial plate, resting on the upper edge of the hexagonal piece of the first series of perisomic plates, and forming the interspace, is a distinctive mark of the *Cyathocrini*, which have mouths protrusive but not proboscidiform. The difference in the dorso-central plates, and the manner in which the rays articulate as previously noticed, are also distinguishing characters, which cannot easily be mistaken.

The irregularities before adverted to, as occurring in some of the older specimens of *Poteriocrini*, more particularly in Mr. Morgan's specimen, Pl. 8. Fig. 3a, and b, are clearly the result of injuries, not of original structure. The irregularities in the rays, and other malformations are mostly found in specimens which exhibit signs of age, and which so often appear to have suffered injuries of various kinds; but the younger animals are mostly free from deformity, and possess the same symmetrical forms, as those of other genera.

In some species of *Poteriocrinus* we can trace characters which seem to connect them remotely with several other genera. The *P. granulosus* in the thickness of its lateral plates, and contracted cavity for the digestive organs, shews its distant affinity to the genus *Apiocrinus*; and the *P. Latifrons* when the rays are closed around the oral tube suggests a comparison with the *Encrinus moniliformis*.

It should have been observed that in noticing the different columns, the arrangement of the ossicula as seen in the most perfect specimens, has been the chief evidence on which our descriptions are founded, but at the same time we are aware that the very thin alternate joints near the summit are frequently the new and imperfect joints, interposed between the older and more perfect articulations.

When the number of species is considered, as well as the relation they bear to other groups, together with their variations in form and structure, the *Poteriocrinus* becomes one of the most important genera, among the numerous and varied forms of the Crinoidea.

The gradual development of new species, exhibits in an interesting manner the constant accession to our knowledge of these invertebrate animals, which formed so important a part among organic beings ere the higher organized animals held undisputed dominion over land and sea. Mr. Miller in his work on the Crinoidea, describes but

two species of *Poteriocrinus*; Professor Philips by his researches increased the number of known species to five; and our own more recent inquiries have brought to light fifteen well defined and interesting species, varying in size from the smallest radiated echinoderm to the somewhat uncouth and massive *P. crassus*.

The different species of *Poteriocrinus* do not appear to have been so abundantly diffused throughout the carboniferous seas as some other genera, but in one particular portion of the ancient sea bottom which was favourable to their mode of life, the bed of the ocean must have been as thickly covered with them as a well-stocked garden is with plants. This ancient sea bed now forms part of the romantic scenery of Derbyshire, and it is remarkable that the *P. granulosus* is the chief, if not the only species found there; but this single species must have existed in such enormous profusion as to form by its remains extensive and massive beds in which the broken and disjointed columns are the principal, or rather the only constituent, and which indicate the vast extent of time required for their accumulation.

The specimens represented in Pl. 9, fig. 1, 2 a, 4 a, 4 b, and 4 c, are in the cabinet of Miss Rich, who has been indefatigable in collecting fossil cronoidea.

Genus 2. Synbathocrinus. (*Phillips.*)

Definition.—Dorso-central plate undivided, (1); on which rest five broad lateral plates, (2).

Professor Phillips was the first to notice this curious crinoid and to found on it his genus *Synbathocrinus.* Hitherto only one species has been discovered, but this single species unites in itself characters which make it an intermediate and connecting link between several other genera. In its pentagonal undivided dorso-central plate, and broad lateral plates it is homologous with the *Platycrini;* the structure of its rays and their mode of articulation to the ray bearing plates, connect it with the *Poteriocrini;* while in its contracted internal cavity for the digestive organs, and tumid plates, we see its remote approach to the *Apiocrini.*

1. Species. Synbathocrinus conicus. (*Phillips.*)

Pl. 11, *Fig.* 5 *a*, 5*b*, 5 *c*, 5 *d*, *and* 5 *e*.

Definition.—Dorso-central plate *pentagonal;* perisomic or lateral plates five; rays five; column unknown.

Synonymes and References.

Synbathocrinus conicus.—Phill. *Geol. of York. pl.* 4, *f.* 12, *and* 13.
—Aust. *Ann. Nat. Hist. vol.* 10, *p.* 108.

Formation and Localities.

The Mountain limestone, Bolland; Barry Island, in the Bristol Channel; Hook Point, Wexford.

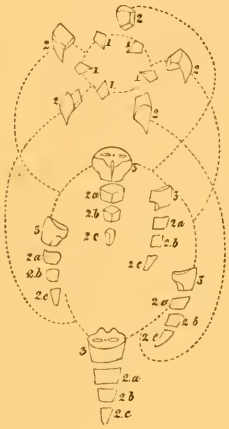
The dorso-central plate of the *S. conicus* resembles that of a *Platycrinus*, as do also the perisomic plates, which consist of one series only, as is common to that genus, but the manner in which the rays articulate is totally different in the two genera. In the *Platycrini*, as may be seen on reference to our illustrations, they invariably articulate by a lunate excavation in the radial plates, but in the *Synbathocrinus* they are attached by the whole breadth of the plates. The structure of the rays, which are long, differs but slightly from that of several species of *Poteriocrinus*.

The small interradials which we have termed meso plates, and which are so characteristic of the Platycrines are wholly wanting in this genus; nor would the form of the lateral plates admit of the introduction of meso plates. In the *Platycrini* the marginal angles at the summit of the plates are cut off, forming an angular notch between every two plates for the introduction of the meso plates. In *Synbathocrinus* the lateral plates have no retiring angles in which meso plates could possibly be inserted.

Only a few specimens of this small but interesting fossil have been discovered. Mr. Gilbertson, we believe, developed two or three specimens without rays or columns, from the carboniferous limestone of Yorkshire; Mr. Morgan was so fortunate as to discover at Barry Island, the specimen from which fig. 5 b, pl. 11, was drawn, and the Earl of Enniskillen has since obtained from the Hook Point limestone, the specimen represented in Pl. 11, fig. 5 a. This specimen has been deposited in the Bristol Scientific Institution.

It is a remarkable circumstance that of all the varied forms in which the Crinoidea have appeared during different geological epochs the number of pieces forming the dorso-central plate has never exceeded five. All the gradations from one to five prevail, but that number has never been exceeded. In this, and the genus *Platycrinus*, we see it whole and undivided, in the Dichocrines it is composed of two pieces, in the Hexacrines the number three prevails, in *Cariocrinus* and *Tetramerocrinus* four is the dominant number, in *Cyathocrinus* and some other genera it is composed of five pieces, but at this point further subdivision ceases.

Genus 3. EXTRACRINUS. (*Austin.*)



Definition.—Dorso-central plate composed of five pieces, (1); first series of lateral plates, (2); second series five, (3). In mature and perfect specimens these latter are jointed and prolonged downwards below the dorso-central pieces as represented in the diagram, 2 a, 2 b, and 2 c; mouth centrical; column pentagonal.

We have applied the term *Extracrinus* to designate this genus, deriving the term in part from *Extra,* beyond, or without. The name is meant to refer to the second series of perisomic pieces, which, in consequence of their singular development, extend downwards much below the margins of the dorso-central plates. This peculiar form of ossicula seems to be exclusively confined to the crinoids which we propose to separate from the genus *Pentacrinus,* as they differ in many essential particulars from the type of that genus.

It is to be regretted that Mr. Miller in his arrangement of the Crinoidea has taken the *Pentacrinus Caput Medusæ* for the typical species, while at the same time his generic plate represents the dissected skeleton of quite a different crinoid. In the hope to remedy this intermingling of genera we propose to retain Miller's genus *Pentacrinus,* and to continue the *P. caput Medusæ* as the type of the genus, including in it all those species of crinoids that answer to the generic standard, and which have inhabited the seas during various geological epochs commencing with the liassic deposits, and descending with various specific modifications to the seas of our own time.

Miller derived the generic name *Pentacrinus* from the pentagonal shape of the column, a form of structure not peculiar to the crinoids of the lias, or more recent formations, though generally very characteristic of them. There is one character however which distinguishes the pentagonal columns found in the lias and more modern strata from the pentagonal columns of the crinoids which existed in the carboniferous seas, namely, the former invariably articulate by pentagonal crenated star-like forms, while the articulating surfaces of the latter are furrowed by linear striæ radiating from a central axis.

So little inclined have we been to multiply genera or species unless when circumstances imperatively demanded it, that we have already published in our Monograph a plate with a beautiful group of crinoids under the title of *Pentacrinus Briareus*, and which at the time of the publication we hoped might still be considered as appertaining to that genus, but on comparing these fossil species with the recent *Pentacrinus* it was found incompatible with any kind of systematic arrangement to continue in one and the same genus animals differing so materially from each other as the *Pentacrinus Caput Medusæ*, and the *Extracrinus Briareus*. In the latter the body is of considerable size, enlarging within the rays into a capacious abdominal pouch, but in the true *Pentacrinus* it is extremely diminutive, and the second series of perisomic pieces are never jointed, or much produced beyond the margin of the dorso-central plates as they are in the *Extracrinus*, which has in consequence of these additional ossicula several more pieces in the frame work of the body than the *Pentacrinus Caput Medusæ*.

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1. Species. EXTRACRINUS BRIAREUS. (*Miller spec.*)

Pl. 12, *Fig.* 1 *a, to r.—also the first plate.*

Definition.—Dorso-central plate composed of five pieces; large series of lateral pieces apparently five, but as each of these is jointed they amount to fifteen or twenty according to age, with five small wedge-shaped pieces inserted alternately with the larger ones, which latter are prolonged below the margins of the dorso-central plate; mouth centrical and slightly protrusive, but not proboscidiform; rays numerous and closely set with tentacula; column long, and furnished with numerous auxiliary side arms.

We have accorded to the late Mr. Miller the merit of establishing this species, for although Mr. Parkinson and others had previously described it under the name of the Briarean Pentacrinite, they had not attempted to place it in its true position among crinoids, or to establish a systematic arrangement, by which alone the nature of animals and their relative affinities can be properly understood.

Synonomes and References.

Briarean pentacrinite.—Park. *Org. Rem. tab.* 17, *fig.* 15.—tab. 18. f. 1, 3.
—Knorr. *Recueil. de Mon. Suppl. tab.* 11. f. 6.
—Blumenb. *Abbild. Nat. Geg.* 70, *Pl.* 1, *f. a and b.*
Pentacrinites Britannicus.—Schloth, *Petref. p.* 328, *Nachtr.* 11, *p.* 105, *tab.* 30, *f.* 1. *a, to c.*
Pentacrinites Briareus.—Mill. *Nat. Hist. Crin. Pl.* 1 *and* 2, *pages* 56 *and* 57.
————————.—Goldf. *Pet. Germ. Pl.* 51, *fig.* 3 *a, m. p.* 168.
————————.—Buckl. *Bridg. Wat. Treat. Vol.* 1. *fig.* 434, & *Vol.* 2 *p.* 52 & 53.
————————.—Aust. *Ann. and Mag. Nat. Hist. Vol.* 10, *p.* 109.

Formation and Localities.

The lias at Lyme Regis; Charmouth; Watchet; Horfield; Keynsham; Boll, Wurtemburg.—Cornbrash, a sub-ordinate member of the oolitic system, at Kingscote Turnpike.

This species appeared at an early period of the lias, and attained to its greatest diffusion before the liassic deposits terminated, its numbers then rapidly diminished until it finally became extinct during the deposition of the lower oolite.

Henry Sheppard, Esq. was the first to point out its existence in the Cornbrash.

Description of the Calcareous Skeleton.

The Dorso-central Plate, is small and composed of five pieces, it is so completely concealed by the surrounding pieces that it can only be seen by looking into the interior

of the abdominal pouch. Opposite to the divisions between these plates, are five small but solid pointed pieces, whose points pass outward, and rest on the salient angle of the pentagonal column; abutting against and alternating with these smaller pieces are the five jointed lateral pieces, which are also pointed, but in this case the points pass further down and fit into the retiring angles of the column, but without being attached to it. By this arrangement, a strong pentagonal foundation was formed for the support of the numerous rays, and this elaborate structure was further strengthened by a number of retractile fibres, or muscles, which also imparted mobility to the rays; five of these muscles, more powerful than the rest, originated opposite to the centre of each of the five larger perisomic pieces, which are inwardly notched for the partial reception of these muscles, five smaller muscles passed upwards at the junctions of the larger pieces, and were consequently attached to the prominent sides of the five lesser perisomic pieces. Five still smaller muscles originated at the outer angles of the lines of junction between the five dorso-central pieces, altogether forming a complicated and wonderful combination of calcareous matter and muscular fibre, which must have possessed great strength and power of resistance to external forces. Reference to Pl. 12, c, d, e, will convey a more perfect idea of the arrangemet of this portion of the animal than the most laboured verbal description.

Miller and other palæontologists appear to have been unacquainted with the arrangement of the pieces forming the dorso-central plate and lower portion of the body of this crinoid, for they have erroneously represented the five smaller lateral pieces as the pelvis, and omitted to notice the five plates which form the true pelvis, but which are concealed by the lateral pieces.

These inaccuracies were no doubt caused by the difficulty of obtaining specimens illustrative of the organism of this portion of the animal, for externally there is nothing to indicate the presence of the small dorso-central pieces, and even up to the present period very few specimens have been obtained sufficiently well preserved to exhibit the great beauty of this contrivance, which at once combined strength with the required amount of mobility.

The Perisomic or Lateral Pieces.—The first series consist of five pieces; in the second series there are also five pieces, but as these are sub-divided in the adult animal they frequently amount to twenty, a fact we believe hitherto unobserved. Each of these consist of three pieces, (or in the older specimens of four), not soldered together, but articulating by radiating striæ and contractile fibres, which rendered them capable of flexion to a considerable degree, the lower one tapering to a point. These pieces are prolonged externally downwards, the two lower joints extending over several of the columnar joints, but to which they are in no way attached.

Miller, who does not appear to have been aware of the jointed structure of these pieces, imagined they served as buttresses to strengthen the column at its summit where it was most muscular and yielding, and therefore required some such support to enable it to sustain the great weight of the body and rays with their thousands of tentacula. This was in all probability one of the ends designed by this peculiar contrivance, but had these pieces been rigid as Miller and other naturalists supposed they were, they would have imparted strength and stability to the column near its attachment to the body, while at the same time they would have destroyed in some degree its flexibility. This defect was completely obviated by the beautiful and unique contrivance of making these pieces jointed and flexible, so that they could yield to the lateral movement of the column on either side and at the same time act as moveable abutments, adjusting themselves to any required position, and effecting their object far more perfectly than if it were possible for them to have been of an unyielding nature, without interfering with the flexibility of the column. In Pl. 12, Figures c, and d, will be found a correct representation of the manner in which these joints articulate to each other, their proper adhesion being secured by marginal striæ arranged around an oval surface of attachment, with intervening muscular fibres. The specimens represented in Pl. 12, fig. 1, a, were selected for the purpose of illustrating the structure of this portion of the animal, and as this part is frequently obscured by the overlying auxiliary side arms, we consider it a fortunate circumstance that our figures will serve to elucidate a fact of some importance to the zoologist as well as to the palæontologist.

It is probable that in the earlier stages of growth and before the different parts had arrived at maturity these pieces were not jointed as in the adult animal.

The Rays.—A single ray of two joints emanates from each of the five radial or larger perisomic pieces, the rays then branch off into a pair. At about the seventh joint, they again subdivide and form two leading branches, from the inner lateral edges of which many minor rays proceed, but the distance between each of these is not regular, somtimes as many as fifteen joints intervene, while in others only ten occur. The cuneiform joints from whence the minor rays proceed are not equally divided into two sloping surfaces of articulation as in the lower bifurcations, but the inner slope which supports the lesser ray is smaller than the outer one, which scarcely differs from the ordinary articulating surface of the leading branches. All the ray joints are more or less wedge shaped, the thickest part invariably occupying a lateral position, but so placed that a thick and thin part alternate with each other. On the widest side of each joint, but inclining inwards, there is a small rounded projection perforated in its centre for the attachment of a tentaculum, as represented in Pl. 12, fig. g. The cuneiform joints at the

points of bifurcation, and a few of the terminal joints of each ray being devoid of tentacula, are alone free from these projecting supports.

Parkinson, though unacquainted with the structure of the dorso-central plate of this species, was quite correct in his description of the manner in which the rays rest on the upper surfaces of the larger series of perisomic plates, and which he has termed the scapulæ; while Miller improperly represents the two joints of each main ray as a portion of the body itself.

The minor subdivisions of the rays varied considerably in number according to age the smaller specimens having only five or six lateral branches emanating in each leading ray, while in the adult animal they amounted to eighteen or nineteen, so that if we multiply the lesser number by twenty, which is the number of the leading branches, it follows that a full grown *Extracrinus Briareus* has the surprising number of three hundred and sixty rays, which give support to several thousand tentacula, each furnished with appropriate muscles, all of which during life were capable of motion according to the convenience, safety, and wants of the animal. Several terminal joints of each ray, as represented in Pl. 12, fig. 2. l. are furnished with a small hook like process, which resemble in form the feet of a caterpillar, and which there can be no doubt were for the purpose of prehension, and in order that these organs might perform their office, that of securing food and conveying it to the mouth, without obstruction from the crowding of parts which might possibly interfere with each other, the joints on which these hooks occur are destitute of tentacula.

The rays are long and tapering, and possessed the power of moving in every direction. so that when they were spread arround with the tentacula filling the intervals between them, they formed a complete net like apparatus through which nothing could pass without coming in contact with some one or other of these delicate organs.

In some specimens each ray has on its lateral margin several small tubercles, which vary in form on almost every joint.

The Tentacula.—With the exception of the cuneiform joints and the few that are furnished with hooks at the extremities, each ray joint gives support to a jointed tentaculum. These gradually become finer and shorter in accordance with the decrease in the size of the ray joints towards their terminal points.

In Dr. Buckland's Bridgewater Treatise, Pl. 53, fig. 17, a magnified extremity of a tentaculum, represents the two last joints as forming a delicate pair of pincers, we have not been so fortunate as to detect these pincers in any of the tentacula, which we have examined, but we have constantly found them at the extremities of the rays.

That portion of the body lying between the column and the first ray articulations appears exceedingly diminutive, but when considered in relation to the whole of the

pouch containing the digestive organs it is found to be of considerable size. In the specimen represented in Pl. 12, fig. 1, b, the plated integument inclosing the capacious abdominal pouch has been so beautifully preserved during the process of petrifaction that it retains the exact form it possessed in life, and we see it resting between the rays somewhat in the manner of a ball when poised on the cup made to receive it.

This specimen was originally in the collection of Mr. J. Johnson, but it is now in the possession of the Rev. — Jackson. The plated integument has been likewise well preserved in one of the group represented in our first plate; a dark cross indicates the figure.

The Mouth.—In the centre of the plated integument before described is the mouth, which was slightly protrusive but not proboscidiform. It was well fitted for sucking in soft fleshy prey, and being surrounded by the rays,it was easy for them or the tentacula to pass objects of sustenance from every part of the circumference to the oral orifice.

The Column.—The column is pentagonal and deeply sinuated between the salient angles. The upper portion is composed of ossicula alternately thicker and thinner, with a still thinner joint interposed between every two of the larger articulations. The intervening thin joints are the rudimentary new ones, which are always introduced at the upper portion of the column. In this manner the column became lengthened, and as new joints were developed at the summit, others towards the base attained their full size, so that as one articulation arrived at maturity, a new one was introduced to keep up the required degree of flexure, and thus to compensate for, or restore the loss of flexibility which would otherwise have taken place through the conversion of a thin and probably yielding joint into a full sized and comparatively rigid one.

Towards the base the columnar articulations gradually become more equal in size, until at length the approximation is all but complete, and all the joints are nearly of the same form and structure. In Pl. 12, and the explanatory observations, this subject will be found more particularly detailed. The lower joints are ornamented with rows of tubercles which run transversely to the axis of the column.

Near the summit the larger columnar joints are slightly rounded at their articulating rims, and the articulating surface is alternately convex and concave, while the smaller and thinner joints are partially compressed, but the angles to which the stellular or floriform crenulations extend are doubly convex, that is, bulged out both above and below. The small joints fit admirably into the depressions in the larger joints, while the convex surfaces of the latter occupy the depressions in the smaller ones, so that by each surface of articulation being alternately convex and concave an amount of strength was secured which would defy all chance of dislocation by ordinary and

probable means. Thus by the mutual disposition and mutual accommodation of uneven surfaces the column in its most flexible part was as well secured from injury as if each of the joints had been dovetailed into those above and below it, while at the same time its perfect flexure was provided for.

The articulating facets of the joints undergo various modifications in accordance with the change in the disposition of the different parts of the column, but each surface of articulation is furnished with five double series of crenated star-shaped radii, which are more or less expanded according to the position they occupy in the column. These beautiful crenated stellular markings were admirably adapted to impart both strength and flexibility to the tall column, the office of which was to move laterally in every direction to enable the animal to search for its food, by altering its position as far as its attached state rendered it necessary or possible. The aperture through the centre of all these ossicula formed a continuous canal from the base to the summit of the column, and which Miller considered was for the passage of an alimentary canal. Be this as it may, the perforation is extremely minute, and appears to be of equal size throughout the column, which there is reason to suppose was several feet in length.

The Auxiliary Side Arms, or Claspers.—These delicate lateral appendages to the column, are so numerous that in a full grown specimen they amount to a thousand or fifteen hundred. At and near the summit of the column every thick joint forms a point of attachment for several of them, but they are not articulated with their longest diameters coincident with the axis of the column, as represented by Miller. The articulating bases are arranged alternately right and left at an angle of about 45° from the true columnar axis, as represented in Pl. 12, fig. i. By this contrivance they are less crowded than if the articulations were perpendicular to the column. The joints composing the lower part of the side arms are thin elliptical, or depressed, ovate bodies, approaching to lozenge shape, and which are often carinated at each end of their longest diameters. At a short distance from the point of attachment they gradually decrease in size and become more rotund in form until they terminate in an obtuse point.

Lower down the column the side arms are less numerous than at the summit, so that this crinoid was furnished with claspers in an inverse ratio to most other genera. In the Poteriocrines and Actinocrines the side arms increase in number towards the base of attachment, the upper portion of the column being destitute of them; but in this species of *Extracrinus* the exact reverse of this is observed, the lower part of the column being most free from them, while towards the summit they are so closely set as to completely conceal all but the prominent angles of the pentagonal column, or even these portions are not always clearly perceptible when the side arms are closely folded in a compact fasciculus around the column. They always emanate from the

retiring angles of the column, and their great flexibility enabled them to expand on every side and assist to poise the body of the animal in equilibrio, to move laterally, or to hold fast to extraneous objects and thus remain unmoved by the current, or as Dr. Buckland has observed, " they would close and fold themselves along the column in a position which would expose the least possible surface to the element, and together with the column and arms, would yield to the direction of the current."

The manner in which the side arms are arranged around the column is well exhibited in some of the figures represented in the beautiful group which constitutes our first plate of illustrations, and in Pl. 12, fig. 1, a.

THE ROOT OR BASE OF ATTACHMENT.—Dr. Buckland in his Bridgewater Treatise advances the idea that the root of the *Briarean Extracrinus* was slight and capable of being withdrawn from its attachment. This suggestion, which we are neither prepared to oppose or confirm, is founded on the circumstance that none of those solid secretions by which the *Apiocrines* are known to have been attached to the sea bottom, have yet been discovered in relation with the *Briareus*. This it is true is but negative evidence as to the Extracrinus having possessed the power of locomotion, nor do we attach much weight to it, as the same difficulty exists in regard to some of the carboniferous limestone crinoids, whose base of attachment remains still undiscovered, but that they were permanently fixed to the bed of the ocean by an indurated base cannot be doubted.

The fact that great numbers of these fossil animals are frequently found in contact with masses of drifted wood which has been partially converted into jet gives strength to the supposition that the *Extracrinus Briareus* often attached itself to floating pieces of wood in the same manner as the living *Anatifera* is attached to drift timber in the recent seas. It is also probable that the Briareus was often attached to the bottom in situations where it was sufficiently firm, and the water clear and tranquil.

The facts which give countenance to the opinion that the *Extracrini* were frequently attached to floating timber are chiefly derived from the position the fossils occupy in relation to a thin seam of lignite in the lias marl, between Lyme and Charmouth. Dr. Buckland's observations on this part of our subject are so much to the purpose that we are induced to transfer them to our pages.

" Throughout nearly its whole extent, Miss Anning has constantly observed in this lignite the following curious appearances :—The lower surface *only* is covered by a stratum, entirely composed of Pentacrinites, and varying from one to three inches in thickness ; they lie nearly in a horizontal position, with the foot stalks uppermost, next to the lignite. The greater number of these Pentacrinites are preserved in such high perfection, that they must have been buried in the clay that now invests them before decomposition of their bodies had taken place. It is not uncommon to find large slabs

several feet long, whose *lower* surface only presents the arms and fingers of these fossil animals, expanded like plants in a Hortus Siccus; whilst the *upper* surface exhibits only a congeries of stems in contact with the under surface of the lignite. The greater number of these stems are usually parallel to one another, as if drifted in the same direction by the current in which they last floated.

The mode in which these animal remains are thus collected immediately *beneath* the lignite, and never on its *upper* surface seems to shew that the creatures had attached themselves, in large groups, (like modern barnacles), to the masses of floating wood, which, together with them, where suddenly buried in the mud, whose accumulation gave origin to the marl, wherein this curious compound stratum of animal and vegetable remains is imbedded. Fragments of petrified wood occur also in the lias, having large groups of mytili, in the position that is usually assumed by recent mytili, attached to floating wood."—*Bridgewater Treatise*, vol. 1, page 437.

As the waters of the sea during the deposition of a considerable portion of the lias, were subject to frequent irruptions of mud which rendered them turbid, and the sea bottom incoherent marl, conditions not generally favourable to the Pinnastella, as from the soft nature of much of the sedimentary matter the bottom was not sufficiently firm for their permanent attachment, the valuable suggestions of Dr. Buckland become of considerable importance as affording a probable solution of the most frequent mode of existence of the Extracrinus Briareus.

The fossil Crinoids imbedded in the lias are frequently covered with a delicate film of iron pyrites, which gives them the appearance of bronze figures. This metalliferous coating has been apparently deposited by a natural process of electrotyping, originating in the currents of terrestrial magnetism which traverse the earth's crust.

It has been computed that a single specimen of Extracrinus Briareus contained in its indurated skeleton no less than one hundred and fifty thousand ossicula, each of which is equivalent to a little bone. Our own calculation extends the number much beyond that previously made by Dr. Buckland in his Bridgewater Treatise; and Dr. Mantell, in the "Wonders of Geology," as the following details will shew.

Omitting the plates which cover the dome-like integument over the abdominal pouch, and which are very numerous as may be seen on reference to Pl.12, fig. 1, b, as also the minute plates which studded the integuments over the sulci along the rays, as well as taking a lower estimate than even the facts warranted of the number of joints both in the rays, and side arms, and likewise making the column shorter than it really must have been in the mature animal, the total number of ossicula or calcareous joints composing the skeleton or indurated frame work cannot be less than seven hundred and forty one thousand, seven hundred and ten; and as each

joint is perforated for the passage of muscles or elastic fibres, there must have been a regular system of muscles which ramified to the remotest extremities, and gave motion to the wonderful frame work, so that the number of muscles in a single adult *Extracrinus Briareus* must have been but little short of one million and a half.

The number of joints or ossicula may be apportioned to the several parts as under.—

Pieces composing the dorso-central plate	5
1st series of lateral pieces	5
2nd series of ditto, (jointed)	20
5 Main rays, of 2 joints each	10
5 pair of Secondary rays, (arms), each of seven articulations	70
Twenty leading rays, each consisting of 200 ossicula	4,000
Three hundred and sixty lateral rays, each consisting of at least 100 joints... ...	36,000
Tentacula.—One preceding from each of the forty thousand joints of the main secondary and lateral or lesser rays	400,700
Column.—Number of ossicula, at least	900
Side Arms.—Taking the average number of ossicula in each side arm, at 100 ...	300,000
Total	741,710

In this calculation the column has only been considered as being thirty three inches in length, although there can be little doubt that it was frequently more than double that number of inches; and the side arms are taken as though composed of only one hundred joints each, whereas many of them contain upwards of one hundred and twenty four ossicula. The number of joints in the tentacula are also considerably greater than we have founded our calculation on. Each according to its position has from fifteen to twenty four ossicula. We have only multiplied them by ten.

It will be seen by our making these deductions that there has been no desire on our part to indulge in exaggeration when dissecting these wonderfully constructed animals, but that we have been more inclined to diminish than to exceed the due limits. At the same time we are convinced that were it possible to count every joint and plate in a full grown *Extracrinus Briareus*, the total amount would exceed a million.

We have been diffuse in describing this species, not only on account of the errors which we conceive many palæontologists have fallen into respecting its structure, but because it is the earliest known crinoid in which the beautiful stellular crenated markings appear on the facets of the columnar joints, a form of structure common to the crinoids of the lias and subsequent formations down to those inhabiting the recent seas.

From the occurence of animal exuviæ in which the ossicula of the *E. Briareus* form a considerable portion, it is evident that the predaceous fishes of the liassic seas committed great havoc among the lily-stars of that period. The letter A in our first plate, representing a beautiful group of *E. Briareus* is annexed to the coprolitic matter.

The group in the plate referred to, is there erroneously denominated Pentacrinus Briareus, instead of Extracrinus Briareus.

As a proof of the fidelity with which our illustrations are executed, it may be observed that the late Mr. James Johnson, to whom this very interesting group of crinoids originally belonged, carefully compared the lithographic illustration with the original, without, we believe, discovering a single error or omission. The specimen referred to is now in the British Museum.

According to Dugdale, the family of Shuckborough derive a symbol in their coat of arms from the columnar articulations of the Extracrini. In his Antiquities of Warwickshire he says—"This family do bear in their arms, *Sable, a chevron betwixt three Mullets;* relating, as 'tis observable, to those little stones called *Astroites*, which are very like a mullet, and are frequently found in the plowed fields hereabouts."

This circumstance may have given rise to the opinion that the heraldic symbol of the mullet was originally derived from the star-like forms observed on the columnar joints of these fossil bodies, but the heraldic mullet has been, we think, with greater propriety, considered as representing a spur-rowel.

The columnar articulations have been termed *Asteriæ*, or Star-stones. *Asteriæ Columnares*, or Columnar Star-stones. They were also formerly called *Stellariæ*, or *Lapides Stellares*, and in Germany they are popularly termed *Sternstienes*. They are also locally known in different parts of England by a host of trivial names, such as Castles and Apostles, Lassington Stones, &c.

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2. Species. EXTRACRINUS LEPIDOTUS. *(Austin.)*
Pl. 13. *figures* 1 *a, to* 1 *k.*

Definition.—Dorso-central plate quinquepartite; first series of lateral perisomic pieces five; second series five, prolonged below the dorso-central plate, and apparently jointed as in the typical species; column composed of alternate thick and thin articulations, and furnished with numerous delicate round side arms.

Synonymes and References.

Briarean Pentacrinite.—Parkins. *Org. Rem. Vol.* 2, *Pl.* 18. *fig*, 2, *p.* 252.
—Knorr. *Recueil de Mon. suppl. t.* 11 *c.*
Pentacrinites subangularis.—Mill. *Nat. Hist. Crin. Pl.* 1, *p.* 59.
—Goldf. *Pet. Germ. Pl.* 52, *fig.* 1, *a, to n, p.* 171.

Formation and Localities.

The lias at Chedwick, or Chedcock, near Bridport; Lyme, Dorsetshire; and Boll, Wurtemburg.

A few specimens only of this beautiful species of Extracrinus have hitherto been developed, consequently its geological range may be considered as confined within narrow limits as compared with the preceding species. It seems to have first appeared on the stage of life towards the close of the liassic period, and to have become extinct at the physical change which gave rise to the succeeding or oolite group of rocks.

The specimen from which our illustration is taken was long in the cabinet of the late Mr. James Johnson, and is now in the possession of the Rev. D. Williams, of Bleadon. Another fine specimen now adorns the collection in the British Museum. Some finely preserved portions of columns are also deposited in the Museum of the Bristol Institution. The upper surface of one slab twelve inches by nine or ten, is a complete congeries of the columns of this species, and shews that in some few instances these animals were as thickly associated together as the more generally diffused E. Briareus. On the under side of this slab is the column represented in Pl. 13, fig. 1, i.

The arrangement of the calcareous pieces forming the body of this species of Extracrinus bear a general resemblance to that of the E. Briareus. The prolonged lateral pieces are in most specimens jointed, while in others they rather appear as if soldered together, but in either case they extend some distance below the dorso-central plate.

The main, or primary rays are five, of two joints each, but somewhat shorter than in the typical species. At each of the upper or cuneiform joints they branch off into a pair making ten, these again subdivide, and as the leading rays of each group occupy the outer flanks, the lateral or lesser rays emanating from the leaders occupy the central spaces.

The rays in adult animals amounted to nearly the same number as in the typical species, but the tentacula are attached in a different manner. In the E. Briareus they articulate on to projections designed for their support, but in this species they fit into notches, or shallow depressions in the ray joints. The tentacula are closely set to the end of the rays. The ray joints are not so rotund as in the E. Briareus, and their mode of articulation is somewhat different, as may be seen on reference to Pl. 13, figures g, h.

The plated integument which covers the abdominal pouch closely resemble that of the typical species, but in the E. lepidotus there was also a plated membrane extending between each group of the lower rays. The plates which protected this integument are in some specimens still found in the same position they occupied during the life of the animal, and impart a very beautiful appearance to the fossil skeleton. The membrane alluded to was attached laterally to the secondary rays, and was capabable of considerable extension, and in consequence of its pliancy did not interfere with the movement of the rays. The plates are highly polished, and are arranged in a regular definite form, and bear some resemblance to scales, from which circumstance we derived the specific name. From the manner in which the plates covering this portion of the membrane adhere laterally to the lower portion of the rays, it is evident that the outer sides of the leading rays to which they are attached, are devoid of tentacula, as their points of adhesion are occupied by the scale-like plates, which are arranged in regular series in a circular form around hexagonal, or heptagonal central pieces, and which arrangement produces a beautiful floriform appearance.

The column is formed of alternate thick and thin joints, which externally are less pentagonal than in the E. Briareus, but the pentapetalous crenated markings on the articulating surfaces of the joints are nearly as pentangular as those on the articulations of that species.

Near the upper part of the column a majority of the thicker articulations are each furnished with five round auxiliary side arms. These claspers are not placed in a line directly over each other as in the preceding species, but they are disposed alternately right and left in the retiring angles of the column, and thus form a double series. Several consecutive joints above each point of attachment of the side arms are grooved or furrowed perpendicularly to the axis of the column, so as to form a narrow channel in which the delicate claspers might lie when the animal desired to present the least possible resistance to the passing current. The manner in which the claspers are inserted into and articulate to the column is represented in the enlarged portion of a column, Pl. 13. fig. 1, e.

We have not in this instance retained Miller's specific name because several species of true Pentacrinus possess the same external form of column, therefore since the discovery

of these more recent specimens, the name subangularis ceased to be characteristic of one species only.

Both Miller, and Goldfuss have erroneously represented the two joints of each of the five primary rays of this, and the preceding species, as the second costals and scapulæ, and in consequence of this error, the primary or main rays are improperly represented by them as ten in number instead of five. Parkinson has in both cases very properly represented the primary rays as corresponding in number with the ray bearing pieces (scapulæ).

Genus 4. Pentacrinus. *(Miller.)*

Definition.—Dorso-central plate resembling an enlarged and thickened columnar joint, (1), perisomic or lateral pieces five, (2), on which the first ray joints articulate. Column generally pentagonal; auxiliary side arms circular, and occurring at intervals along the column in circles of five.

The six pieces as represented in the generic illustration are all that constitute the body of this animal below the rays. The organs of digestion are enclosed within a membraneous pouch encircled by the rays.

In describing this genus we have found it impossible to adopt the formula laid down by Miller, because he has, in the recent species as well as in the fossils which we have placed in the preceding genus, fallen into errors which are now quite obvious, and although we may not be quite correct in our definition, for strange to say that owing to the desiccated membrane which invests and covers the dorso-central plate within the abdominal pouch adhering to, and concealing that portion of the calcareous skeleton, the structure of the recent species as exhibited in those specimens of the P. Caput Medusæ hitherto brought to Europe, is not so well known to us as its fossil analogues, yet we are enabled to point out the erroneous conclusions arrived at by Miller, and reiterated by several succeeding naturalists.

The dorso-central plate which Miller describes as "a pelvis of five joints," appears to resemble an enlarged and thickened columnar joint, without divisions. The salient angles of this piece are so placed as to appear between the retiring angles formed by the junction of the perisomic pieces where they unite laterally to each other. If the dorso-central plate is divided, the divisions are not perceptible, or it must be extremely small and altogether concealed as in the preceding genus, but of this we know nothing, as all the fossil specimens of Pentacrinus as well as the recent species appear to differ entirely in this respect from the Extracrini.

1. Species. Pentacrinus Caput Medusæ. *(Miller.)*
Pl. 14, *Fig.* 1 *a, to f.*

Definition.—Dorso-central plate resembling an enlarged and thickened supra-columnar joint? on the prominent angles of which, the retiring angles formed by the junction of the five lateral perisomic pieces rest; mouth centrical and slightly protrusive, but incapable of being elongated into a proboscidiform tube; basal rays five, which at the second joint bifurcate, these again subdivide, until the final subdivisions amount to one hundred and twenty; column formed of alternate thick and thin pentangular joints, from which radiate at intervals five auxiliary side arms.

Synonymes and References.

Encrinus Caput Medusæ.—Lamarck.
Isis Asteria.—Linneus. Whitehurst.—*Inquiry into the original State and Formation of the Earth, Pl.* vii. *fig.* 2.
—Parkinson's *Organic Remains, Vol.* 2. *Pl.* xix. *fig.* 1.
—*Memoires de l' Academie de Sciences de l' An.* 1755.
Pentacrinus Caput Medusæ.—Miller, *Nat. Hist. Crin. Pl. fig. p.* 48.
————————————.—Buckl. *B. Treat. Vol.* 2, *Pl.* 52, *f.* 1, *p.* 432.
Parra. Hist. Nat. Havannæ, page 191, *t.* 70.
Ocken's *Zoolog*—&c. &c.

Localities.

The sea bottom off the islands of Barbadoes, Martinique, and Nevis; and probably at certain depths throughout the Caribbean sea.

The two specimens of this crinoid now in the Bristol Institution, were taken in the Caribbean sea, off Barbadoes; and Mr. Stutchbury informs us that he has reason to believe they were taken by the fishermen at a depth of from fifty to eighty fathoms, in clear water with a rocky bottom. The side arms, and probably the rays, encircled the fishing lines and clung with such tenacity that on the fishermen drawing up their lines the columns became fractured, so that the upper portions of the animals were taken into

the boats, and the lower parts left attached to the rocky bed of the sea, thus in a great measure proving they were fixed by an indurated base of calcareous matter.

It is extremely doubtful whether the P. Caput Medusæ has ever been found in a fossil state, the specimens of columns found in the lias near Bristol, Keynsham, Hengrove, &c., and generally referred to this species may probably belong to some other Pentacrinus. If it does occur in a fossil state we should expect to find it in the newer tertiary rocks, but none of the specimens hitherto obtained from any of the tertiary beds can with safety be referred to this species.

The dorso-central plate appears to be formed of an enlarged columnar joint. This may possibly be divided into five wedge shaped pieces as stated by Miller, but if so the divisions are not manifest in any of the specimens we have examined.

In the five sinuosities or retiring angles of the dorso-central plate, the five perisomic lateral pieces are placed. These pieces are truncated at their upper edges, where they partly slope inwards towards the columnar canal. They have two slight ridges with perforations for the articulation of the primary rays. These lateral pieces are exteriorly lunated, and their lower ends extend downwards to a level with the lower edge of the dorso-central plate, but they do not overlap the column as in the preceding genus, *(Extracrinus.)*

On the five lateral pieces the same number of primary or main rays of two joints each articulate,but the number of joints is not uniformly constant. The first joints of these rays were considered by Miller as the second costals, but his own description of them is almost conclusive evidence of his error respecting them. It is as follows,—" The figure of these joints is that of a horse-shoe, having in the interior an excavated truncated termination. The exterior surface is semicircular, and *their lateral edges do not adhere to each other, but are united by the integument covering the abdominal cavity.*" This description is quite correct in one sense, but not in another, for the fact of the pieces not adhering to each other is strong evidence that he is wrong, for in all the crinoids we have examined the pieces composing the body invariably adhere to each other laterally, and it is difficult to concieve why Miller should have deviated from a rule, which may be considered as universal. Parkinson, who, in this respect is equally correct in his description of this species as he is in describing the E. Briareus, considers these pieces as portions of the rays. The second joints of the primary rays, (the scapula of Miller) have each a central ridge extending from the exterior edge of the joint to the interior, thus forming two sloping surfaces, like the slanting roof of a house, for the adhesion of the secondary rays which here branch off into a pair. On each of these sloping sides is a perforated ridge, which runs in an oblique direction from the inner edge of the joint towards its outer circumference where it unites with the corresponding ridge on the opposite slope. These

pieces are also connected laterally by the intervening plated membrane.

The ten secondary rays are each composed of several joints generally varying from three to four, five or six, but the number is not constant even in the same specimen. Miller, with much apparent justness, considered these irregularities as designed for a desired end, namely—That as the cuneiform articulations never afford support to a tentaculum the vacuity occasioned by their absence would render their net-like expansion less complete, unless some compensating contrivance was resorted to. This end is accomplished by the number of joints below the bifurcations varying in the different rays, so that a tentaculated articulation in one ray is placed opposite to a plain cuneiform joint of the adjoining ray, and by this means the vacancy can if required be swept by the tentaculum opposite to it.

Other bifurcations take place until the total number of the lesser rays appear to amount to one hundred and twenty; but it is difficult to estimate their number correctly, as the specimens brought to Europe are generally more or less imperfect, for owing to the shrinking or destruction of the connecting ligaments the ray articulations become separated, and in endeavouring to repair the injury, attention is not always directed to original structure.

It has been supposed that the sexual organs of crinoids are placed in the arms, but this question is still involved in much obscurity, and we are of opinion that in some genera the ovarial organs will be found to occupy a position in the dorsal side of the cup; while in others they may be ventral, or situated where the rays are given off, or as is now believed, in the rays themselves. Our knowledge on this subject even among existing echinoderms is far from complete, and when we attempt an anatomical investigation of animals whose existence was so remote, our difficulties increase a hundredfold, for the numerous and varied forms of extinct crinoids may have been modelled, not upon one, but upon several laws of organic developement.—Even in the recent *P. Caput Medusæ* we believe the ovarial orifice has not been discovered, and we freely admit that it has baffled all our researches.

Miller, at page 54 of his work on the Crinoidea, mentions that the specimen he examined, had suffered considerable mutilation previously to its removal from the sea bottom, and that by its power of reproduction, two secondary rays, with their minor divisions had been constructed to supply the place of the lost ones. This we are informed is a mistake, and that the supposed reproduction was merely a restoration with gum, some of the intervening joints having being lost in its transit from the West Indies.

By these remarks we do not intend to question the correctness of the opinion as to the power of reproduction possessed by these animals, for we have undoubted examples

of such reproduced members in the genera Platycrinus, Poteriocrinus, Actinocrinus, &c.; and it is beyond dispute that animals low in the scale of organic life possess powers of reproduction which are unknown among those of superior organization. This may be considered as a compensating power to the lower animals, whose liability to injury must be greater, owing to their habits and conditions of life exposing them to dangers which the more perfectly endowed creatures evade through superior intelligence or instinct.

The power of reproduction possessed by crinoids is paralleled in crustaceans. Crabs and lobsters it is well known can reproduce both claws and legs; the lobes of star-fishes also when broken off by casual mischance or dismembered by their own contortions are readily reproduced.

The rays are thickly set with round and jointed tentacula.

The pouch containing the organs of digestion is protected and covered in with a plated integument, in the centre of which is the mouth. The construction of this organ renders it incapable of being elongated into a proboscis, but the lips of the orifice can doubtless be protruded to a small extent for the purpose of taking up, or sucking in the food designed for its support. This portion of the animal is but imperfectly known as in the few specimens which enrich the European museums the integument is so shrivelled or even destroyed that a satisfactory examination is rendered impossible. Besides being strengthened and protected by small angular plates, the tentacula on the lower rays in some measure guard this part from the aggressions of the smaller predaceous animals.

The ventral portion of the pentacrinus probably predominates over the dorsal side as it does in the Extracrinus, but of this we have no positive evidence.

The column is pentangular and composed of alternate thick and thin joints, with a small central perforation throughout its whole length, and communicating with the cup in which the digestive organs are situated, in the same manner as in other crinoids. The way in which the column is lengthened by the introduction of new joints is clearly visible in the recent species, and agrees with the description given under the head of Extracrinus Briareus. The secretion of calcareous matter first commences round the central canal, then by a regular and continual deposit the process of enlargement still proceeds until the new joint has acquired a size and thickness consistent with the position it is designed to occupy in the column. By the renewal of this operation from time to time, the column becomes lengthened, and as the new joints are interposed, others of an older growth towards the base become thicker and more indurated.

As the columns of the specimens hitherto brought to Europe are broken off in such a manner as to preclude the possibility of correctly ascertaining the exact form of the

articulating surface of the joints, Mr. Miller had recourse to certain columns found in the lias, and which he referred to this species, but which we consider incorrect, for assuredly none of the fossil specimens can be properly considered as identical with the recent pentacrinus.

The AUXILIARY SIDE ARMS or CLASPERS occur in circles of five, at intervals along the column, the intervening spaces varying in extent, but irregularly increasing from the summit to the base, that is, assuming the same arrangement, obtains in its lower portion as we find it in that part which we have had opportunities of examining.

The columnar joints from which the claspers proceed have in each retiring angle a slight depression occasioned by the absence of the thin contracted membrance which is said to envelope the column of the living animal. These are the points of adhesion for the claspers, which are not so deeply inserted, or grafted into the column as they are in the Poteriocrines and some other genera of still greater antiquity. The claspers being perforated and placed in the deep sinuosities between the angles of the column, are, from their proximity to the central canal readily supplied with the secretions necessary for their support. This arrangement is equivalent to that noticed in some of the older crinoids, the same end however being obtained by different means, but in both cases the claspers are brought within a given distance of the central axis, an arrangement perhaps necessary in order to facilitate the supply of calcareous matter for the construction of the joints, as well as of vivifying juices to maintain the part in full vigour.

The newly formed claspers are, near the body of the animal, exceedingly small, and occur at very brief intervals around the column. Those which are fully developed consist of about forty joints each, which are shorter near the column than they are towards their terminal points. The claspers are circular or nearly so, and are capable of motion in every direction, either laterally or perpendicularly to the axis of the column.

There can be no reasonable doubt as to the P. Caput Medusæ being in its living state permanently attached to the bed of the ocean by an indurated base, all the specimens hitherto obtained having been evidently broken off by mechanical violence, the columns presenting at the fractured parts proof that considerable efforts had been exerted to separate them from the lower portions, which still remained adhering to the sea bottom. Some years since, Mr. J. Tobin, who had an opportunity of examining a specimen which had just been drawn up from the sea, made the following observation respecting it—" It was brought to me so fresh out of the sea that at the bottom, where it plainly appeared to have been broken off from the rock to which it was fixed, the blood" (the fluid which passes through the columnar canal,) " was actually oozing from the

vertebræ. This specimen I endeavoured to preserve, but it was totally destroyed by the ants, who eat every cartilage, so that it fell to pieces."

From the plated integument which extends along the inner sides of the rays and tentacula, some idea may be formed of the immense number of calcareous plates which constitute the indurated skeleton of this animal. According to a calculation made by the late Mr. Miller, and there is no reason to doubt the correctness of this calculation, it requires about *two hundred* plates to cover the membrane which protects the channel inside each tentaculum, so that many thousand pieces are required for this purpose alone.

The whole external surface of the specimens brought to Europe are devoid of the membraneous covering which is reported to envelope the living animal, and they appear in their preserved state of a delicate straw colour, and so highly polished as to resemble fine enamel.

The muscular or fleshy substance intervening between the joints of the column, the claspers, and the rays must be of inconsiderable thickness, but of wonderful tenacity or it could not hold the joints so firmly together as to admit of the column being fractured obliquely through several consecutive joints, instead of its yielding in the natural divisions when the force which tore it from the ocean bed was applied to it.

It should be observed that throughout the indurated frame work of these curiously constructed creatures we constantly find the membraneous matter closely intermingled with the calcareous secretions which give stability to the whole structure.

One of the specimens in the Bristol Institution may be considered as a variety of this species. The column is not so deeply sinuated between the prominent angles as in the specimen described, and there is some indication of the rays being more numerous. If this latter point should be hereafter clearly established it will entitle it to specific distinction.

Of all the abounding forms of the Lily-stars that once spread their waving rays in the ancient seas, the *P. Caput Maducæ* is the chief existing representative, and therefore on that account the more interesting to the naturalist, who can trace back the genus, species by species, to its first appearance in the seas where the lias formed the bed of an ocean which flowed over a great part of the then submerged Europe; and when, judging from analogy, the temperature of the sea in the latitude of England was similar to that of the waters which now flow around the shores of Barbadoes.

2 Species. Pentacrinus Johnsonii. (*Austin.*)

Plate 15, *Fig.* 1 *a*, to *c*.

Description.—The plates composing the body of this species agree in number and position with the generic definition. The rays are long and taper, and apparently forty, or upwards, in number. The column is long and slender, the claspers circular, and placed in series of five round the column, with considerable intervals, between each series.

Synonymes and References.

Pentacrinites Johnsonii.—Aust. *Ann. Nat. Hist. vol.* 10, *p.* 109.
—Morris, *Cat. Brit. Foss., page* 56.
gracilis.—Charlesworth, *Lond. Geol. Journ. No.* 2, *Pl.* 9, *page* 96.

Localities.

The Inferior Oolite? Bridport, Dorsetshire; and in the Lias, at Staithes, near Whitby, Yorkshire.

The exact relation of the stratum at Bridport in which this *Pentacrinus* occurs, has not, we believe, been satisfactorily determined. Some Geologists consider it as occurring in the lowest bed of the Inferior Oolite, while others refer it to the upper bed of the Lias.

This beautiful *Pentacrinus* is remarkable for its slender and graceful form, every part exhibiting the greatest neatness and delicacy of structure. The body is small, the rays long and taper and closely set with delicately fine tentacula. The five main or primary rays bifurcate at the second or third joint from the ray-bearing pieces. At a considerable distance from the first bifurcations they again branch out into pairs. A third subdivision takes place still higher up, and there is some indication of even a fourth bifurcation, but none of the specimens yet obtained prove this fact sufficiently distinct to warrant us in deciding the point with certainty.

The rays, if we estimate each of them as branching thrice, amount to forty, but if the final subdivisions are four, the total number will be eighty. No other *Pentacrinus* has such delicate slender arms as this elegant and well-preserved species. The rays, as

in all of the genus, are composed of a single series of wedge-shaped pieces, the thickest ends of which alternately occupy a lateral position ; to the thickest ends of each of these ray-joints a jointed tentaculum of extreme fineness is attached.

The column is long and slender, the joints of which it is composed being thin and generally uniform in size, except those near the body, where the new joints are thinner than those below the first series of auxiliary side arms.

The claspers, like the column, are long and slender, they occur at wider intervals and are longer than those of the typical species ; they are circular and composed of thin joints, and emanate from the re-entering angles of the column.

With this species of *Pentacrinus*, the Ophiura Egertoni was frequently associated, for we find their remains occupying the same strata, and so intermingled that it is probable the same physical catastrophe which prostrated the graceful lily-stars overwhelmed the Ophiura in a common destruction.

The specimens from which our figures are drawn were selected from among a group of forty bodies of these animals, together with two Asteriæ, and numerous portions of columns all embedded in one slab of stone eighteen inches in length by twelve inches in width. This highly interesting group of crinoids was obtained at Bridport by that indefatigable collector the late Mr. James Johnson, of Clifton, Hotwells, at whose death, when his valuable collection was sold, and the treasures which it had taken a long life to accumulate were dispersed throughout the civilized world, it became the property of the British Museum, the most appropriate depository for such a splendid relic of an ancient period in the Earth's history.

We have dedicated this Pentacrinus to Mr. Johnson as an acknowledgement of his perseverance in collecting palæontological specimens, and of his liberality in throwing open his museum to the scientific enquirer; and now that his labours have ceased, we hope it will remain as a tribute to the momory of one of the most successful collectors of fossils of our own times.

The P. Johnsonii, though sufficiently abundant in some few localities of limited area does not appear to have been very widely diflused, nor does its occurrence among the fauna of a former period denote a prolonged geological existence. The slab of stone containing so many individuals, and now in the British Museum, to which we before adverted, contains by far the most perfect specimens hitherto discovered. Another valuable group, but less perfect is in the Museum of the Bristol Institution. These, with three or four other specimens of this *Pentacrinus* are all that have yet been discovered and go far, to prove that the purpose for which it was introduced on our planet was but of brief duration.

3. Species. PENTACRINUS TUBERCULATUS. (*Miller.*)

Plate 15, *Figure* 2 *a*, to 2 *c*.

Description.—The body of this crinoid answers to the generic definition as given in a previous page. It differs from all other known species of *Pentacrinus* in the comparative massiveness of its column, and claspers. These lateral appendages occur in series of five, with considerable intervals between each series.

SYNONYMES AND REFERENCES.

—Park. *Org.Rem., vol.* 2, *Plate* 17, *fig.*2, *and Plate* 19, *fig.* 2
—Whitehurst's *Inq. into the Orig. state of the Earth, Pl* 7, *fig* 1, *and* 2.
Pentacrinites tuberculatus.—Mill. *Nat. Hist. of the Crinoidea, page* 64.
.—Morris, *Cat. Brit. Foss. page* 56.

FORMATION AND LOCALITIES.

The Lias at Pyrton Passage, Gloucestershire.

Miller, at page 64 of his work on the Crinoidea states that the *P. tuberculatus* is found in a bed of rubbly lias, near the top of that group of rocks, which bed ranges through a large portion of the inland counties—namely, Rutland, Leicestershire, Northamptonshire, also through a portion of Gloucestershire.

It will be seen on reference to figure 2 c, Plate 15, that the dorso-central plate of this species is merely an enlarged and thickened columnar joint, without any indication of divisions, a structure apparently common to all the Pentacrines, and which so clearly distinguishes them from the more elaborately formed Extracrines.

The rays of the *P. tuberculatus* are thick and bifurcated, but the total number of divisions is unknown. If however the figure 2, Pl. 19, vol. 2, Parkinson's Organic Remains refers to this species, the final or terminal rays are eighty. The figure here alluded to appeared originally, we believe, in the 52d vol. of the Philosophical Transactions.

This species in its strong rays and broad tentacula presents a complete contrast to the more delicately formed *P. Johnsonii,* in which all the parts are extremely neat and slender, while every portion of the tuberculatus is indicative of strength. From this it may be inferred that the food of the one was minute and unresisting, while that which sustained the other was capable of exercising some degree of activity in eluding the tenacious grasp of its destroyer.

The jointed tentacula fit into curved notches or depressions in the sides of the ray joints.

It is somewhat remarkable that nearly all the columns of this species are found in a curved position, indicating that during life they must have possessed a considerable degree of muscularity. The joints being thinner, though of greater diameter than those of the *P. Caput Medusæ,* will partly account for this, for in consequence of their tenuity the intervening muscles must have been more numerous, and consequently on the death of the animal the irregular shrinking of the fibres may have caused the peculiarity alluded to, aided perhaps by the rupture on one side of the muscular tunic which enveloped the external surface of the column. By the gradual contraction of this part it would at length become rent and thereby allow the integument on the opposite side to contract more freely, so that it would have drawn the column by degrees into a curve, while the ruptured portion would offer no resistance to its assuming the form in which we now constantly find it.

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4. Species. Pentacrinus Millerii.

Plate 16, *Figure* 1 *a*, to 1 *f.*

Description.—Body small, forming a pentagon; rays long and bifurcating; column pentagonal and slender, and furnished with circular claspers.

Synonymes and References.

Pentacrinites scalaris.—Goldf. *t.* 52, *f.* 3, *t.* 60, *f.* 10.
—Park. *Org. Rem. vol.* 2, *Plate* 13.
—Mill. *Nat. Hist. Crin. page* 61.
—Morris, *Cat. Brit. Fossils, p.* 56.
—Knorr, *suppl.* 7, *g. n,* 205, *figure* 4—8.

Formation and Localities.

The Oolite at Lansdown, near Bath ; at Dundry, near Bristol ; and at Farley Castle, in the Forest marble, a subordinate member of the Lower Oolite. And, according to Dr. Goldfuss, in the marly beds of the Jura formation at Baireuth, Boll, &c.

This Pentacrinus when divested of its column, and lying with its rays fully expanded, bears some faint resemblance to an Ophiura with branching arms, but when closely examined, the comparison no longer holds good, for all the characteristics of a true Pentacrinus at once become obvious.

The body below the rays is small, and the lateral perisomic pieces fit closely into the dorso-central plate, which resembles an enlarged columnar joint, with a star formed depression on its articulating surface for the attachment of the column. See fig. 1 c, Pl. 16.

The five primary rays are short, and consist of two joints each, they then branch off into a pair, each of which again bifurcate at some distance from the first divisions. Other bifurcations take place until the final subdivisions amount to eighty or a hundred, or even more.

It should be observed that the rays of the *Pentacrini* divide in a different manner to the *Extracrini*. In the latter it will be seen on reference to fig. 1 a, Pl. 12, that after the second bifurcations, the leading rays send out lateral offsets from one side only, the lateral branches being thinner than the rays from which they proceed. In the true Pentacrines the arrangement is different, for where each ray divides, it branches into a pair of equal magnitude as regards each other, but of diminished size as compared with the primary rays, and whenever the bifurcations are repeated till the third or fourth subdivisions, it is always by a simple division of the ray into two smaller ones, both being exactly equal in thickness. The rays in consequence of this arrangement bear some resemblance to crinoids of the genus *Poteriocrinus*, and it has so happened that detached fragments have been erroneously considered as belonging to the last named genus.

The Pentacrines in the arrangement of the rays seem to constitute a link between the Poteriocrines and Extracrines, the Pentacrinus *Caput Medusæ*, more particularly approaching to the structure of the last named crinoids, and the *P. tuberculatus*, closely resembling that of the Poteriocrines.

The long and delicate tentacula are, owing to the shortness of the ray joints from which they proceed, closely set; they are also composed of short joints, and taper to a fine point.

The pentangular column is long and slender, and apparently equal jointed throughout its whole length, excepting where the newly formed joints near the summit were continually in progress during the periodical growth of the animal.

The articulating facets of the columnar joints differ from those of the other Pentacrines. The crenulated floriform ridges in the Millerii occupy the entire margin, following the sinuosities of the column with unerring regularity, but they are not prolonged so far inwardly towards the central axis as in the other species. Beautiful as are all the columns of the Pentacrines, none excel this in the admirable arrangement of the striæ, which strengthened and at the same time allowed the column to move laterally in every direction.

The claspers are round, long, and delicately fine. They occur in series of five each, but at shorter intervals than in the typical species.

Miller appears to have been aware of the occurrence of this *Pentacrinus*, in the Inferior Oolite of Dundry, but from the fragmentary state in which it had been obtained when he wrote his Natural History, he was unabled to ascertain its specific characters. Since he terminated his researches, several well preserved specimens have been procured, figures of which will found in Pl. 16.

This crinoid has long been known in our museums as the *P. Milleri*. Dr. Goldfuss has figured and described it under the name of *P. scalaris*, but as it has been dedicated to Miller, its first discoverer, by the sanction of most British Palæontologists, we have retained the specific name which has been so long familiar to us.

The *P. Millerii* is only known in the British Isles as a characteristic fossil of the Lower Oolite, but Goldfuss has noticed its occurrence in the marly beds of the Jura formation, which beds the Doctor considers as equivalents of the Oxford Clay of British Geologists. These marly beds occur at Baireuth, Banz, Amberg, and Boll.

If these beds are the true equivalents of the Oxford Clay, this *Pentacrinus* must have continued to exist to the eastward of Britain some time after it became extinct in the West.

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5. Species. Pentacrinus subbasaltiformis. *(Miller.)*

Plate 16, *Figure* 2.

The column of this species is less angular than that of the *P. basaltiformis*, and the radiating floriform markings on the articulating surfaces of the joints somewhat different and less strongly marked.

The only portion known of this Pentacrinus is the column, therefore its more general characters still remain concealed among the entombed organic treasures of a bygone period.

SYNONYMES AND REFERENCES.

Pentacrinites subbasaltiformis—Miller, *Nat. Hist. Crin., p.* 140.
—Woodw. *Cat. Vol.* 2, *p.* 51.
—Wetherell, *in Geol., Trans. vol.* 5, *pl.* 8, *fig.* 3, *p.* 132.
—Morris, *Cat. Brit. Foss. p.* 56.

FORMATION AND LOCALITIES.

London Clay, White Conduit House, Islington ; Richmond, Hampstead, and Herne Bay have also been named as localities where it has been found.

Mr. James Sowerby found some fragments of the column of this species in the London Clay, at Islington ; and he informed Miller that similar fragments were occasionally met with at Richmond, and also that some species were obtained when sinking a well at Kensington.

Although the specific characters of this *Pentacrinus* are unknown, there can be no doubt of its being a distinct species, and forming one of those graduating links in the series of created beings, that connect the ancient extinct crinoids with the living echinoderms.

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4. Species. PENTACRINUS SOWERBII. *(Wetherell.)*

Plate 16, *Fig.* 3 *a, and* 3 *b.*

The only portion known of this species is the column, but which is sufficiently distinct in the arrangement of the ossiculæ, to entitle it to specific distinction.

The angles of the Pentagonal joints are even more rounded in this, than in the preceding species, and the general surface of the column is interrupted by the projection of the larger joints which occur at short intervals.

SYNONYMES AND REFERENCES.

Pentacrinus Sowerbii—Weth. *in Geol. Trans. vol.* 5. *Pl.* 8, *fig.* 4, *p.* 132.
—Morris, *Cat. Brit. Foss. p.* 56.

FORMATION AND LOCALITIES.

London Clay, near White Conduit House, Islington; Richmond, and Kensington.

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7. Species. PENTACRINUS PRATTII. *(Austin,)*

Plate 16, *Fig.* 4 *a*, *to* 4 *c*.

This is another instance of a species founded on the evidence of the column alone, a practice which is highly objectionable when the disjointed remains of different crinoids are found in profusion scattered through the same matrix, but which is perfectly safe when only the column occurs in a particular group of rocks, for it has now become almost certain that each formation has its characteristic crinoids, as it has its distinctive mollusca, and other organic bodies.

FORMATION AND LOCALITY.

The Tertiary beds at Bieritz, in the vicinity of Bayonne.

The column is massive, the joints of which are generally uniform in thickness, and the angles rounded in a similar manner to the *Extracrinus lepidotus*, but considerably more so than even in that crinoid, which was long considered as the least angular of all the floriform pentagonal columns. The spaces betweeen the crenated ridges on the articulating facets of the joints are deeply impressed, so that the tranverse fibrous cushions which were interposed between the articulations, added by their contractile power to the flexure of the column.

We know but little of the history of this species beyond the fact that Mr. Pratt brought several specimens of columns from the tertiary beds in the vicinity of Bayonne, but we are not aware that any other portion of the animal has been discovered, either detached from, or in connection with the column, nor do we know of even a single instance in which the body of a crinoid has been discovered in the Tertiary Rocks of this country, or of any other part of the globe.

8. Species. Pentacrinus Fittonii. *(Austin.)*

Pl. 16, *fig.* 5. *a, and* 5 *b.*

The remarks in preceding pages on the questionable propriety of founding species on detached fragments of crinoids are equally applicable to this, but at the same time we have no doubt the fragments discovered by Dr. Fitton in the Gault of Kent and Wiltshire are portions of a Pentacrinus, differing in many respects from established species, therefore we have no hesitation in dedicating it to its discoverer, and placing it among its congeners.

The column of this Pentacrinus is more acutely angular than the preceding species, and is altogether less massive. The articulating floriform ridges are also different. They are not so strongly marked, nor are the depressions on the face of the joints, for the attachment of the muscular integument so deeply impressed.

Synonymes and References.

—Dr. Fitton, *Geol. Trans. vol.* 4, *Pl.* 11, *fig.* 4, *p.* 114, 130, *and* 259.

Formation and Localities.

The Gault at Copt Point, near Folkstone ; and in the Vale of Wardour, Wiltshire. It is also said to occur in the Lower Green Sand, in the vicinity of Folkstone, Kent.

In Dr. Fitton's paper on the strata below the Chalk, we find the following observations respecting this *Pentacrinus.*

"The stem only has been found, it is various in size, the sides are concave, the angles rounded. Joints equal, the margins of their surfaces ornamented with short striæ.

Some specimens show the bases of lateral arms. It strongly resembles a species found in the Chalk ; (Mantell's Fossils of the South Downs, p. 183 ; Geol. of the South of England, p. 112); which is however much larger." *Geol. Trans. vol.* 4, *p.* 335.

The *Pentacrinus* found in the Chalk is without doubt a distinct species, but as no specimens have been discovered sufficiently perfect to furnish distinct specific characters on, we at present abstain from attempting a more detailed description of it.

In the stratigraphical table at page 352, vol. 4, of the Geol. Transactions, the *Pentacrinus Fitonii,* is referred with a double note of interrogation to the P. scalaris,—the Millerii of our monograph, from which it specifically differs.

9 Species. PENTACRINUS BASALTIFORMIS. *(Miller.)*

Plate 16, *Figure* 1 *a*, to 1 *e*.

A description of the neat column of this species is all that can be given at present, for although thousands of specimens of this portion of the animal have been found, no part of the body has yet been met with. No additional information has therefore been obtained since Miller first noticed its occurrence in the Lias, a fact which was previously known to Parkinson.

The column is composed of numerous ossiculæ, which are nearly of equal size and thickness throughout its whole length, always excepting the newly formed and immature joints, which are, according to the universal law as regards the growth of this part of crinoids, invariably introduced at, or near the summit. The articulating facets of the joints vary according to their distance from the body. In those occupying positions near the summit, the spaces between the oval, or floriform crenated ridges are wider than on those more remote from it. In other words, as the joints became by age more indurated and possessed increased powers of adhesion, the petal like markings gradually expanded until they obliterated the intervening space and occupied the whole attaching surface of the joints, and thus we frequently find them in a fossil state.

The column appears to have been of nearly uniform diameter from its base to its articulation with the body. Each joint is ornamented with minute tubercles which are symmetrically arranged, but varying in arrangement on their joints according to their remoteness from, or proximity to the body. These tubercles are sometimes arranged quadrangularly, at others they appear in the form of a double waved line, while, not unfrequently each group has a cruciform appearance. From this, and similar variations, Miller deduced his theory respecting the gradual deposition of the calcareous substance of the column, a conclusion which cannot well be doubted, although his ingenious attempt to illustrate his views by the presence or absence of tubercles may be fairly questioned.

Round auxiliary claspers occur at intervals along the column, in series of five each.

SYNONYMES AND REFERENCES.

Pentacrinite.—Park. *Org. Rem. vol.* 2, *Pl.* 13, *fig.* 54,

Pentacrinite basaltiformis.—Mill. *Nat. Hist. Crin. p.* 62.
—Morris, *Cat Brit. Foss. p.* 55.
—Goldf. *Pl.* 52, *fig.* 2 *a. to* 2 *g*, *p.* 172.

Formations and Localities.

In the Lias, at Lyme Regis, Dorsetshire; at Pyrton Passage, Gloucestershire; and at Magilligan, Ireland. ?

Dr. Goldfuss notices its occurrence in the marly beds of the Jura formation, which beds, he considers, correspond with the Oxford Clay of England. It is said to occur at Baireuth, Banz, Amberg and Boll.

It appears strange that while our acquisitions to palæontology have so much increased of late years, particularly as regards this class of animals, we should have been so long baffled in our researches after the body of the *P. basaltiformis*, a circumstance almost unparalleled in the whole course of investigation of the Crinoidea. Of the columns we find countless thousands, but not a single body has yet been discovered. In a marly bed of the lias at Lyme, the fragments of columns of this species are as thickly disseminated as the crystals of quartz and felspar are scattered through some granites, but no portion of the body is met with. In other instances columns of considerable length are seen, but no indication of the superior part of the animal presents itself.

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10. Species. Pentacrinus subsulcatus. *(Munster.)*

This species has been founded on a few small fragments of the column, and detached portions of the claspers. The column is obtusely pentagonal and equal jointed; the striæ on the articulating facets occupy the margin, and inwardly to the central canal, but with smooth interspaces of considerable size.

Enlarged representations of this crinoid are given by Goldfuss. Pl. 53, f. 4, p. 175.

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11. Species. Pentacrinus subteres. (*Munster.*)

The column is equal jointed, and but slightly pentagonal; the striæ are chiefly marginal, though five narrow bands of striæ diverge from the central canal, and meet those on the margin.

Figures representing this species from the Jurassic rocks are among the illustrations in Goldfuss, Pl. 53, fig. 5, p. 176.

Since this portion of our work was sent to the press, Mr. Stutchbury has been kind enough to direct our attention to some fragments of columns, evidently of a *Pentacrinus*,

from the Inferior Oolite at Leckhampton, near Cheltenham. These we consider as portions of an undescribed species which bears some resemblance to the *P. basaltiformis*, but yet possessed of sufficient characteristic marks to remove it from that species.

The chief distinctive features of the column of this species are its more decided stellular form than most others of the genus, the re-entering angles going far in towards the central axis, and the peculiarity observable in one part of every alternate joint at its inmost angle projecting beyond the intervening ones, while all the joints at the salient angles are level with the general surface. The crenated ridges on the facets of the joints are also but faintly indicated, and on some of the articulations they are wholly wanting.

The Rev. P. D. Brodie appears to have been the first to notice the occurrence of this *Pentacrinus* in the Roe stone, the local name given to a subordinate member of the Inferior Oolite, but he has not met with any portions of the body, so that all the knowledge we possess of this crinoid is derived from the fragments of columns collected by its discoverer.

It is to be hoped, now that attention has been directed to the subject, that the discovery of the body and rays of this *Pentacrinus* will reward the exertions of those who devote much time and labour in searching for the hidden treasures of by-gone ages.

Pentacrinus cingulatus. (*Munster.*)

As nothing but fragments of the column have been obtained in the Jurassic rocks, it is perhaps premature to speculate on the probability or improbability of this being a distinct species. Our own impression however is that these portions of columns may justly be referred to the *P. Millerii*, (*P. scalaris* of Goldf.)

Figures and description of specimens from the Jura-formation are inserted in Goldfuss' work, Pl. 53, fig. 1, p. 174.

Pentacrinus pentagonalis. (*Goldfuss.*)

The columnar fragments on which this species is founded, we consider as identical with the preceding. They are probably those of young immature individuals.

Figures and description of this *Pentacrinus* are given by Goldfuss, Pl. 53, fig. 2, p. 175. In the illustrations the figures are greatly enlarged.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Platycrinites lævis, *a* to *n*, exclusive of *k*.

a.—lateral aspect shewing the articulations of the ray joints.
b.—minute specimen exhibiting the change in the form of the column, rays, &c.
c.—portion of column shewing the bases of auxiliary side arms.
d.—column exhibiting the gradual change from circular, alternately larger and smaller joints, with radiating striæ on their upper and inferior articulating facets, to joints of equal thickness and elliptical form, with transverse ridges and without radiating striæ.
e.—lateral aspect showing the proboscis, rays, tentacula, part of the column attached, &c.
f.—meso-plate, interscapular of Miller.
g.—bifurcation of rays exhibiting the arrangement of their joints.
h.—perisomic plate with the base of rays attached.
i.—perisomic plate showing the excavation for the attachment of the ray joints.
l.—proboscis, or oral tube, exhibiting the beautiful arrangement of the proboscidial plates.
—enlarged view of the apex of the proboscis. The plates conceal the oral aperture.
m.—minute specimen, with rays and tentacula.
n.—dorso-central plate exhibiting the radii for the attachment of the column.

Fig. 2. Platycrinites spinosus, *o* to *s*, including *k*.

k.—lateral aspect exhibiting the spiniform abdominal plates, with the same magnified.
q.—lateral aspect showing the base of the proboscis, rays, tentacula, attachment of the column, &c.
p.—proboscis exhibiting the spur-like protuberances near the apex.
o.—lateral view of the abdominal bulb, and rays.
r.—cuneiform, and other ray joints, with their articulating facets.
s.—tentacula, with the manner in which the double series of ray joints fit into each other.

PLATE II.

Fig. 1. Platycrinites mucronatus, *a* to *f*.

a.—view of the apex exhibiting the abdominal plates with their central points, as also the cavity where the lateral mouth was situated.

b.—side view of the abdominal bulb shewing the excavation for the insertion of the ray joints. The pointed and smaller abdominal plates, with the meso-plate, are seen to advantage in this specimen.

c.—dorso-central aspect, with the mark of columnar attachment.

d.—upper portion of the column of P. mucronatus?

e.—pointed abdominal plate.

f.—meso-plate, interscapular of Miller.

Fig. 2. Platycrinites elongatus, *g*, *h*, *i*.

g.—lateral aspect.

h.—lateral aspect shewing the proboscis.

i.—enlarged view of a specimen with six perisomic plates.

Fig. 3. Platycrinites antheliontes, *k* to *r*.

k.—lateral view of the abdominal bulb exhibiting the basal joints of the rays.

l.—apex showing the abdominal plates, with the four maxillary plates surrounding the valvate mouth in the centre.

m.—lateral aspect exhibiting the utmost degree of elongation to which the mouth could be protruded. The beautiful arrangement of the abdominal plates round the polygonal meso-plate is in this figure distinctly seen.

n.—lower joints of the greater and lesser rays.

o.—dorso-central plate with central radii for the attachment of the column.

p.—dorso-central aspect.

q.—perisomic plate shewing the excavation for the articulation of the ray joint.

r.—polygonal meso-plate.

The specimens from which the figures in Pl. I. are taken, with the exception of fig. *m*, were collected by the authors from the carboniferous limestone of Ireland. Fig. *m* is drawn from the identical fossil which Miller took for the type of the genus, and which is represented as magnified thrice in his Nat. Hist. of the Crinoidea. Pl. 1. page 74. Miller added a portion of column from an unattached fragment.

The figures in Pl. II., with the exception of *g*, *h*, are drawn from specimens in the fine collection of the Bristol Literary and Philosophical Institution, the Curator of which, Mr. Stutchbury, has kindly furthered our researches. Fig. 2. *h*, was obtained at Woodspring, near Clevedon, Somersetshire, by Mr. Wm. Morgan, to whose kindness we are indebted for the opportunity of taking the illustration.

The *P. mucronatus* appears to be identical with the fossil which Mr. Phillips has figured as the *P. lævis* in the Geology of Yorkshire.

PLATE III.

Fig. 1. Platycrinites trigintidactylus, *a* to *h*.

1. *a*.—lateral aspect of a small specimen shewing the column, with side arm? body, tentaculated rays, and proboscis in the centre.
1. *b*.—large specimen exhibiting the full grown body, the tentaculated rays, and the upper portion of the column. This is nearly the largest size to which the species attained.
1. *c*.—specimen with the tentaculated rays attached, and the elongated oral tube, on which the hexagonal plates which envelope it are beautifully exhibited.

d.—perisomic ray-bearing plate, shewing the deeply formed excavation for the attachment of the rays.

e.—dorso-central plate.

g.—perisomic ray-bearing plate, with the divisions of the rays and their articulations.

h.—portion of a column. Though it is difficult or impossible to determine with certainty as to which species this column appertained, yet as it probably belonged to the present one, we have included it in our illustrations.

Fig. 2. Platycrinites granulatus, *i* to *o*.

2. *i*.—a beautifully preserved specimen, exhibiting the rays, tentacula, &c.

k.—lateral aspect of the specimen which Miller described from.

l.—specimen shewing the base of the oral apparatus.

m.—dorso-central plate.

n.—perisomic ray-bearing plate, exhibiting the excavation for the rays.

o.—shewing the manner in which the rays bifurcate.

Fig. 3. Platycrinites striatus, *p* to *u*.

3. *p*.—lateral aspect, exhibiting the rays, tentacula, &c.

r.—portion of the column, shewing the structural modifications.

s.—dorso-central plate, exhibiting the manner in which the striæ run.

t.—lateral aspect of the dorso-central plate.

u.—perisomic ray-bearing plate, with the small excavation for the ray joint.

The whole of the figures given in this plate are taken from specimens in the Author's Collections, with the exception of *h*, *k*, *l*, which are drawn from specimens in the Bristol Institution Museum.

PLATE IV.

Fig. 1. Platycrinites gigas, *a* to *c*.

1. *a.*—specimen shewing the perisomic ray-bearing plate, with the base of ray attached.
1. *b.*—lateral aspect of specimen, exhibiting the meso-plate with its central tubercle, the abdominal plates, &c.
1. *c.*—dorso-central aspect.

Fig. 2. Platycrinites rugosus.

2. *d.*—dorso-central aspect, also exhibiting the basal joints of the rays.
2. *e.*—lateral aspect of specimen, shewing the excavations for the rays.
2. *f.*—lateral aspect of a specimen, exhibiting portions of the rays, &c.
2. *g.*—lateral aspect of a variety of the *rugosus.*
2. *h.*—dorso-central aspect of the same variety.
2. *i.*—dorso-central aspect of another and smaller variety.
2. *k.*—lateral aspect of the last named variety.

Fig. 3. Platycrinites tuberculatus.

3. *m.*—lateral aspect, exhibiting the lateral oral orifice between the rays, &c.
3. *n.*—lateral aspect, shewing the excavations for the rays, tuberculated plates, &c.
3. *o.*—dorso-central aspect.
3. *p.*—dorso-central aspect of a smaller specimen.
3. *q.*—the apex of the same specimen.
3. *s.*—dorso-central view of a variety with smooth perisomic plates.
3. *t.*—meso-plate.
3. *u.*—small perisomic ray-bearing plate, exhibiting the excavation for the rays.

x.—fragment of a column, with the sockets for the articulation of the auxiliary side arms.

y.—portion of column. These two columnar fragments are supposed to appertain to the *rugosus.*

In this plate the drawings are all, with the exception of the columnar fragments *x* and *y*, taken from specimens in the possession of the Bristol Institution.

PLATE V.

Fig. 1. Platycrinus laciniatus. *a, b, c.*

a.—lateral view of specimen.
b.—dorso-central aspect.
c.—lateral view.

Fig. 2. Platycrinus mucronatus. *(variety)*

a.—lateral aspect of *P. mucronatus.*

Since the publication of our first Number, we have had opportunities of examining Mr. Gilbertson's collection, in which we have found this interesting variety of the *P. mucronatus.* Several figures of this species have already appeared in our second plate. *b, c, d.*—Three specimens of the same species in their young state, shewing the points on some of the abdominal plates prolonged into spines. It appears that when these points are as much developed on a portion of the plates as those represented in the figures, they are wholly wanting, or are merely rudimentary on the others. The situation of the lateral mouth is very plainly exhibited in figure *d.*

Fig. 3. Malformed Platycrinus. *a, b.*

a.—view of abdominal cavity.
b.—lateral aspect exhibiting the malformation, where the perisomic plates appear to rest on the column.

Fig. 4. Radical portion of a Platycrinus.

Fig. 5. Dichocrinus radiatus. *a, b, c, d.*

a.—lateral aspect of *D. radiatus.*
b.—dorso-central aspect, shewing the division.
c.—lateral view of a larger specimen exhibiting the non ray-bearing plate.
d.—the non ray-bearing plate.

Fig. 6. Dichocrinus fusiformis. *a, b, c, d.*

a.—enlarged lateral view.
b.—natural size of the same specimem with the rays attached.
c.—main ray and its bifurcations.
d.—magnified lateral aspect, exhibiting the non ray bearing plate, and the dorso-central division.

The specimens of *Dichocrinus* from which our figures are taken, are in the museum of the Bristol Literary and Scientific Institution.

PLATE VI.

Fig. 1. HEXACRINUS MELO. *a, b, c, d, e.*

a.—dorso-central aspect, shewing its tripartite arrangement.
b.—lateral aspect exhibiting the meso-plate between the rays, and the excavations for the attachment of the rays.
c.—lateral aspect, shewing the non ray bearing plate.
d.—non ray bearing plate.
e.—abdominal plates with the oral aperture, *y*.

Fig. 2. HEXACRINUS DEPRESSUS. *a, b, c, d, e.*

a.—dorso-central aspect, shewing its tripartite arrangement.
b.—lateral view of a smaller specimen.
c.—lateral aspect of another, and full sized specimen.
d.—lateral view shewing the manner in which the meso-plates bend over and unite with the abdominal plates.
e.—non ray bearing plate.

Fig. 3. HEXACRINUS MACROTATUS. *a, b, c, d.*

a.—lateral aspect shewing the non ray bearing plate.
b.—view of a smaller specmen.
c.—enlarged view of specimen.
d.—non ray bearing plate magnified.

All the specimens of *Hexacrini,* which are figured in plate VI. are in the collection of Mr. Robert A. C. Austen, of Merrow House, Guildford; to whose kindness and liberality we are indebted for an opportunity of making the drawings.

PLATE VII.

Fig. 1. Hexacrinus pentangularis. *a*, *b*, *c*, *i*.

a.—dorso-central aspect.
b.—lateral aspect exhibiting the lower portion of a primary ray.
c.—view of the cavity which contained the digestive organs.
i.—lower portion of a primary ray, and the intermediate plates.

Fig. 2. Various unappropriated columns. *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*.

a.—articulating surface of columnar joint.
b.—lateral view of the same column.
c.—portion of moniliform column.
d.—articulating facet.
e.—columnar articulation with pentapetalous canal.
f.—portion of the same column.
g.—facet of columnar joint.
h.—fragment of column.

Cariocrinus.

Fig. 3. Cariocrinus ornatus. *a*, to *m*.

a.—lateral aspect of a full-sized specimen.
b.—dorso-central aspect.
c.—lateral view of a smaller specimen.
d.—abdominal plates, shewing the oral and anal apertures.
e.—portion of a crinoid's ray, probably that of the *Cariocrinus*.
f.—enlarged view of the same specimen.
g.—articulating surface, shewing the divisions of the joints.
h.—column of *Cariocrinus ornatus?*
i.—articulating facet.
k.—inner surface of one of the hexagonal perisomic plates.
l.—external surface of ditto.—Both magnified.
m.—one of the second series of plates, with the small ray-bearing plates resting on it.

Cyathocrinus.

Fig. 4. Cyathocrinus planus. *a*, to *e*.

a.—lateral aspect shewing the meso plate, the arrangement of the rays, &c.
b.—lateral aspect of a different specimen.—In the Author's cabinet.
c.—lateral view of a larger specimen.—In the Bristol Institution.
d.—dorso-central aspect of the same.
e.—view of a specimen which shews the protrusive mouth, &c.

Fig. 5. Cyathocrinus geometricus. *a, b, c, d, e.*

a.—lateral aspect.

b.—view of the vertex.—Mr. Austen's specimen.

c.—dorso-central view.

d.—ray-bearing plate.

e.—perisomic plate of the first series.

Fig. 6. Cyathocrinus? pinnatus. *a, b.*

a.—rays, tentacula, &c.

b.—column and bifurcating side arms.

Fig. 7. Cyathocrinus bursa. *a.*

a.—dorso-central aspect.

Fig. 8. Cyathocrinus mammillaris. *a, b.*

a.—lateral aspect.

b.—lateral aspect of a smaller specimen.

PLATE VIII.

Fig. 1. Cyathocrinus conicus. *a, b.*

a.—lateral aspect.

b.—lateral view, shewing the meso plate between the rays.

Fig. 2. Cyathocrinus calcaratus. *a, b, c,*

a.—dorso-central aspect.

b.—lateral aspect shewing the meso plate.

c.—lateral view of a smaller specimen, exhibiting the excavation for the rays.

Poteriocrinus.

Fig. 3. Poteriocrinus crassus, *a,* to *m.*

a.—lateral aspect shewing the column, rays, &c.

b.—the same specimen reversed, shewing the base of the oral tube.

c.—specimen on which Miller founded the genus.

d.—specimen exhibiting the bifurcation of the rays and a portion of the oral tube.

e.—small specimen shewing the arrangement of the intermediate plates.

f.—exhibiting the manner in which the rays bifurcate.

g.—articulating facet of columnar joint.

h.—portion of injured column, exhibiting marks of reparation.

i.—enlarged columnar joints, similar to the preceding.

k.—columnar joint, with large canal.

m.—columnar disk.

PLATE IX.

Fig. 1. Poteriocrinus crassus.

1.—lateral view, shewing a large portion of the proboscis, &c.

Fig. 2. Poteriocrinus rostratus. *a, b, c, d, e, f, g.*

2, *a.*—column and auxiliary side arms.—2, *g.*—side arm.
2, *b.*—lateral view of a small specimen, exhibiting the column, rays, and tentacula.
2, *c.*—small specimen shewing the proboscis.
2, *d.*—proboscis with some of the pointed plates at the apex.
2, *e.*—portion of the same enlarged.
2, *f.*—lateral view of the body of an adult specimen.

Fig. 3. Poteriocrinus granulosus. *a, b, c, d, e, f.*

3, *a.*—lateral view shewing the intermediate plates at the base of the proboscis.
3, *b*—view of the internal cavity, and the ray-bearing articulations.
3, *c.*—shewing the columnar articulations on the dorso-central plates.
3, *d.*—inverted lateral aspect exhibiting the arrangement of the plates, &c.
3, *e.*—dorso-central view, shewing the pentapetalous opening into the internal cavity, and communicating with the columnar canal.
3, *f.*—portion of a column.
3, *g.*—part of a column imbedded in the matrix.

Fig. 4. Poteriocrinus plicatus. *a, b, c, d, e, f.*

4, *a.*—lateral view, shewing a portion of the column, &c.
4, *b.*—view of the internal cavity, shewing the sinuated edges of the ray-bearing plates, as also the ray articulations.
4, *c.*—lateral aspect, exhibiting the arrangement of the plates.
4, *d.*—ray-bearing plate, shewing the manner in which the plates articulate at the sutures.
4, *e.*—articulating surface of a ray-bearing plate, shewing the wreath-like crenulations around it.
4, *f.*—enlarged view of a portion of the same.

PLATE X.

Fig. 1. Poteriocrinus radiatus. *a, b.*

1, *a.*—lateral view, exhibiting a large portion of the proboscis, bifurcations of the rays, and a part of the column.
1, *b.*—lateral aspect, shewing the arrangement of the plates, and the radiating ridges on them.

Fig. 2. Poteriocrinus quinquangularis. *a, b, c, d, e.*

2, *a.*—lateral view of two specimens, shewing the arrangement of the plates.

2, *b.*—lateral aspect, exhibiting the intermediate plates, and the pentagonal articulation of the column.

2, *c.*—lateral aspect, shewing the rays and a portion of the proboscis.

2, *d.*—enlarged figure of the same specimen.

2, *e.*—a portion of the column with a side arm attached.

Fig. 3. Poteriocrinus conicus. *a, b, c.*

3, *a.*—foreshortened lateral view, shewing the arrangement of the plates, and the radii for the attachment of the column.

3, *b.*—vertical view of the same specimen, exhibiting the points of articulation for the rays.

3, *c.*—lateral view of a different specimen, shewing the intermediate plates.

Fig. 4. Poteriocrinus latifrons.

4.—lateral view, shewing the column, rays, &c.

Fig. 5. Poteriocrinus tenuis. *a, b.*

5, *a.*—lateral aspect, exhibiting the arrangement of the plates, with the proboscis, column and rays.

5, *b.*—enlarged view of the same specimen.

Fig. 6. Poteriocrinus impressus.

6.—lateral view, shewing the arrangement of the plates.

Fig. 7. Poteriocrinus dactyloides.

7.—lateral aspect, shewing the rays, &c.

All the figures in this plate, with the exception of Nos. 5 and 6, are taken from specimens in the cabinet of the Authors.—Figure 5, is drawn from a specimen in the collection of Mr. W. Morgan, to whose liberality we are indebted for this addition to our illustrations.

PLATE XI.

Fig. 1. Poteriocrinus dactyloides.

1 *a.*—lateral view, exhibiting the arrangement of the plates, the attachment of the rays, and column, and the base of the proboscis.

1 *b.*—portion of a ray with the tentacula attached.

Fig. 2. Poteriocrinus pentagonus.

2 *a.*—lateral aspect shewing the arrangement of the perisomic plates, the pinnated rays, and the column.

2 *b.*—This figure is introduced to show the manner in which the rays bifurcate, and the two additional branches, one on each side of the open space caused by the introduction of the inter-radial or non-bearing plates.

2 *c.*—lateral view exhibiting the inter-radial plates, and the additional bifurcations of the rays, and also the articulating facet of a columnar joint.

2 *d.*—lateral aspect of a specimen, shewing the tentacula.

2 *e.*—part of a proboscis which has been flattened out by pressure.

2 *f.*—base of attachment.

Fig. 3. Poteriocrinus longidactylus.

3 *a.*—lateral view showing the body, rays, tentacula, and column. This is drawn from Mr. Morgan's specimen.

Fig. 4. Poteriocrinus abbreviatus.

4 *a.*—lateral aspect shewing the arrangement of the perisomic plates, portions of the rays, and column.

Fig. 5. Synbathocrinus conicus.

5 *a.*—lateral view shewing the rays, &c.

5 *b.*—lateral aspect of a smaller specimen than the preceding.

5 *c.*—this specimen shews the arrangement of the lateral plates.

5 *d.*—represents the dorso-central plate, with the lateral plates attached to it.

5 *e.*—view into the internal cavity.

PLATE XII.

Fig. 1. Extracrinus Briareus.

1 *a.*—lateral aspect shewing the jointed, and intermediate lateral pieces, the rays, tentacula, &c.

1 *b.*—lateral view of a large specimen, in which are seen the abdominal pouch, the mouth, &c. In Dr. Buckland's Bridgewater Treatise there is a reduced figure of this specimen.

c.—jointed lateral and intermediate pieces shewing the manner in which the articulations are secured.

d.—specimen shewing the attachment of the column to the dorso-central plate, and a rudimentary new joint, with an enlarged view of the same.

e.—dorso-central aspect exhibiting the manner in which the first lateral pieces abut against the dorso-central plate.

f.—enlarged view of the articulating facet of a full grown joint.

g.—These figures represent the articulating facets of the ray joints at the second bifurcations, and the projections for the attachment of the tentacula.

h.—an auxiliary side arm.

i.—portion of a column shewing the points of articulation for the side arms.

k.—enlarged transverse view of a full grown columnar joint.

2 *l.*—terminal ray joints with the hook-like appendages, (enlarged.)

m.—portion of a ray with tentacula attached (enlarged.)

n.—enlarged view of the articulating facet of a columnar joint arrived at that stage of growth bordering on maturity.

o.—portion of a column exhibiting the full grown joints, with the smaller intervening articulations. The articulating facet of one of the thinner joints is shewn These latter are still less advanced in growth than figure *n*.

p.—portion of a column.

q.—portion of a column from a point more remote from the body than the preceding.

r.—the articulating facet of a columnar joint, with a rudimentary joint in the centre.

PLATE XIII.

Fig. 1. EXTRACRINUS LEPIDOTUS. *a*, to *k*.

1, *a*.—lateral view of a well preserved specimen, which exhibits the rays, and the plates which covered the plated membrane between the leading and principle rays.

1, *b*.—a portion of column, with the side arms attached, and shewing the manner in which they are inserted, right and left alternately.

1, *c*.—enlarged lateral view of the body, exhibiting the prolonged jointed lateral pieces, the way in which the rays are attached to them, with the scale-like plates which connect the lower portions of the rays to each other, and also a portion of the column. This figure is taken from the reverse or under side of the specimen figure 1, *d*.

1, *d*.—this figure exhibits nearly the same points as the preceding one, it is drawn in the position it occupies on the upper side of the slab, but the pieces connecting it with the rays, are displaced and broken.

1, *e*.—an enlarged view of a portion of the column, shewing the manner in which the claspers are inserted into the thickest joints.

1, *f*.—the articulating surface of a columnar joint.

1, *g*.—lower joints of the first divisions of the rays.

1, *h*.—cuneiform joint at the first bifurcation.

1, *i*.—portion of a column of the natural size.

1, *k*.—an enlarged view of a portion of the rays, with the intervening plates.

PLATE XIV.

Fig. 1. PENTACRINUS CAPUT MEDUSÆ. *a*, to *f*.

1, *a*.—lateral view of a beautiful specimen from the Caribbean sea, at present in the Bristol Institution. The drawing represents the lower portion of the body, the the rays, the tentacula, the column and auxiliary side arms or claspers. The figure is exactly half the natural size, and although some of the rays in the specimen have fallen asunder, (as shewn in the drawing,) owing to the difficulty of preserving the connecting integuments from decay, it is sufficiently perfect to exhibit all the essential parts of the animal, except the plated membrane, which covered the digestive organs.

1, *b.*—illustrates the manner in which the rays branch off. The body is enlarged in this figure for the purpose of shewing the salient angles of the dorso-central plate.

1, *c.*—enlarged view of the lower tentacula surrounding the pouch containing the organs of digestion.

1, *d.*—an enlarged view of a portion of the column.

1, *e.*—the articulating facet of a columnar joint. The crenulations do not appear on the surface of the joints in the recent species. This may be owing to the presence of the animal matter still remaining in a dried and shrivelled state, and concealing the hard calcareous substance of the column.

1, *f.*—enlarged view of a side arm, &c.

Specimens of the P. Caput Medusæ are, we believe, still preserved in the following Institutions—The British Museum; the Geological Society's Museum; the Museum of the College of Surgeons; the Hunterean Museum, at Glasgow; the Museum attached to the Bristol Institution; and one or two specimens in the Museums at Paris.

PLATE XV.

Fig. 1. Pentacrinus Johnsonii. *(Austin.)* *a*, to *c*.

1 *a*—lateral aspect of a well preserved specimen selected from a group of the *P. Johnsonii*, which lie embedded in various positions on the surface of the stone slab, together with numerous portions of columns.

The rays, tentacula, column, and claspers are all clearly exhibited in this figure, as well as the Ophiura lying across the column and among the rays.

1 *b*—lateral aspect of another individual drawn from the same group. In this figure the rays are not quite so much expanded as in the preceding one.

1 *c*—portion of a column with the delicate claspers attached to it, shewing the manner in which they are arranged in circles of five.

Fig. 2. Pentacrinus tuberculatus. *(Miller.)* *a*, to *c*.

2 *a*—portions of the rays and tentacula.

2 *b*—part of a column with a side arm attached.

2 *c*—upper portion of a column with the enlarged columnar joint at its summit, and which probably subserves the purpose of the dorso-central plate. Portions of the body and lower rays are also seen in this figure.

The specimens from which figures 2 a, and 2 c are drawn form part of the collection in the Bristol Philosophical Institution.

PLATE XVI.

Fig. 1. Pentacrinus Millerii. *a*, to *f*.

1 *a*—lateral view of a specimen which exhibits the lower part of the rays and tentacula, as also a portion of the column and claspers.

1 *b*—dorso-central aspect which shews some of the fine terminal rays, tentacula, &c.

1 *c*—dorso-central view of a different specimen.

1 *d*—portion of a column with the delicate claspers attached.

1 *e*—part of a column with the articulating surface of a columnar joint.

1 *f*—portion of a ray with the jointed tentacula.

Fig. 2. PENTACRINUS SUBBASALTIFORMIS. *(Miller.)*

2—part of a column.

Fig. 3. PENTACRINUS SOWERBII. (*Wetherell.*) *a*, and *b*.

3 *a*—portion of a column.
3 *b*—is also the fragment of a column.

Fig. 4. PENTACRINUS PRATTII. *(Austin.)* *a*, to *c*.

4 *a*—part of a column.
4 *b*—portion of a column, shewing the articulating facets of the joints.
4 *c*—is also part of a column.

Fig. 5. PENTACRINUS FITTONII. (*Austin.*) *a*, and *b*.

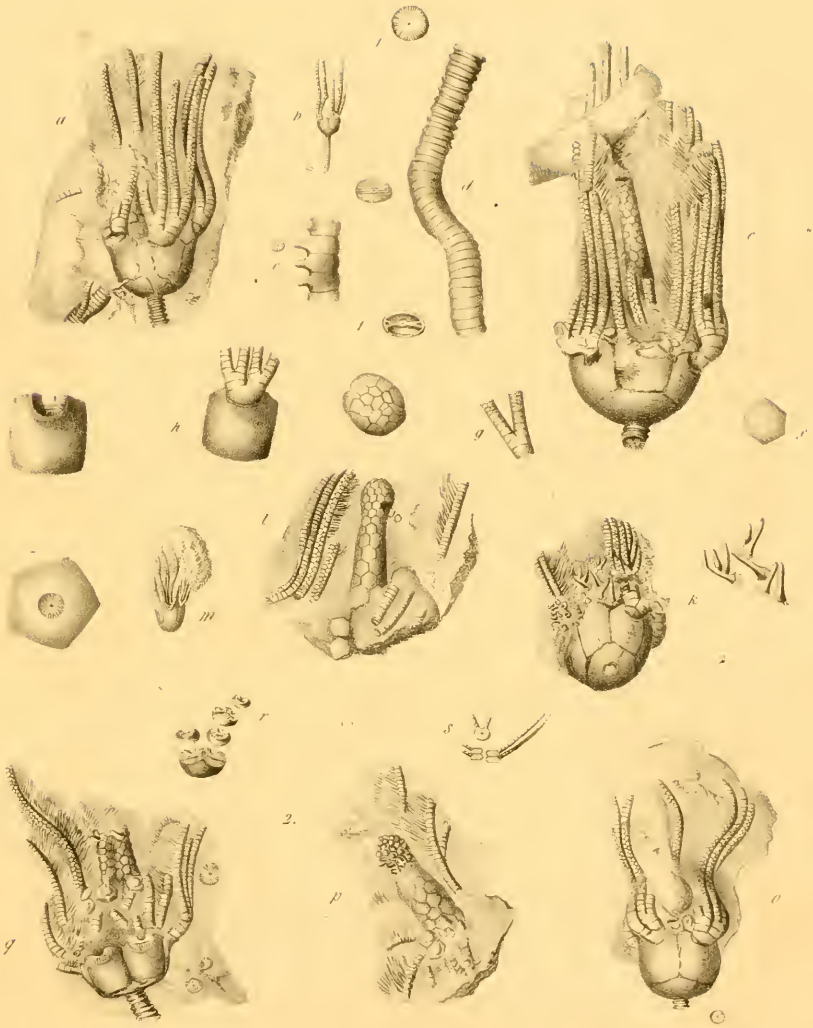
5 *a*—part of a small column.
5 *b*—portion of a larger specimen.

Fig. 6. PENTACRINUS BASALTIFORMIS. (*Miller.*) *a*, to *e*.

6 *a*—part of a column shewing the articulating point of attachment of a clasper.
6 *b*—portion of a larger column exhibiting the articulating facet of a columnar joint.
6 *c*—part of another column.
6 *d*—part of a column shewing the articulating surface of a joint.
6 *e*—portions of claspers.

PENTACRINITES BRIAREUS

(IN THE COLLECTION OF JAMES JOHNSON ESQ^R F.S.A)



1. Platycrinites laevis (Miller) 2. Platycrinites squamosus

Engraved by [illegible]

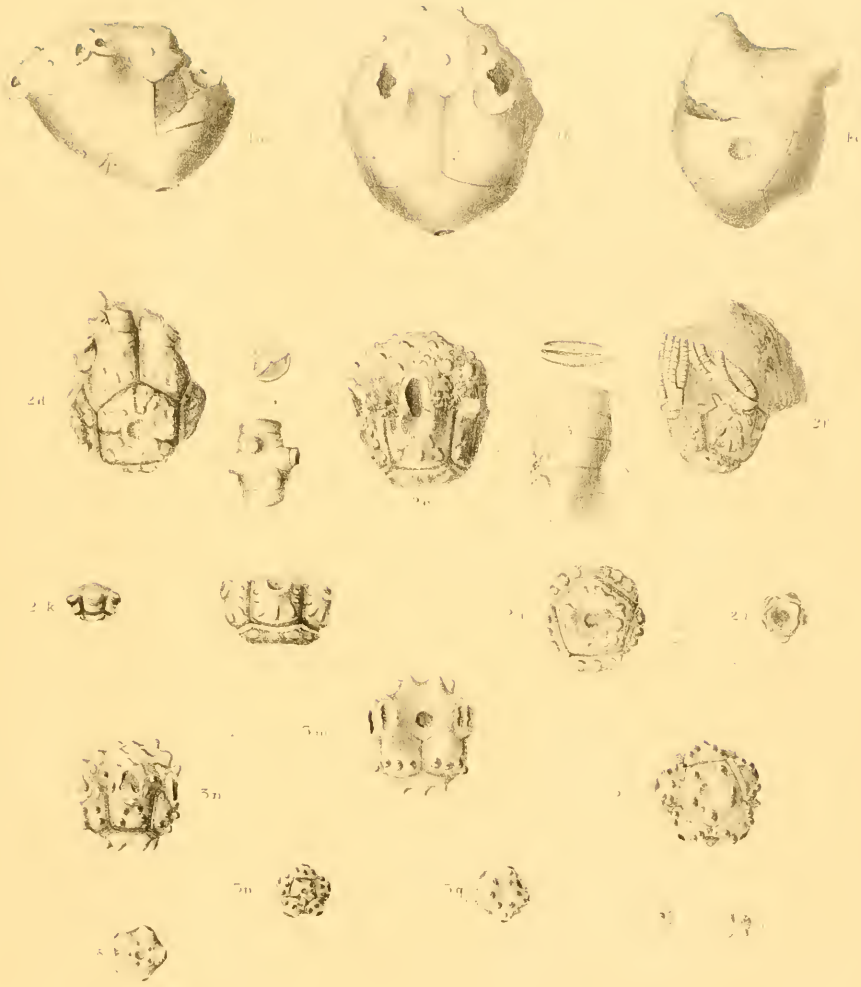
1. Palycrinites inversonatus

2. Platycrinites elongatus (Hall) 3. Platycrinites anthellionis

1 PLATYCRINITES [illegible]

2 PUGNEUMATUS (MILLER) 3 ? STRIATUS (AUCT.)

Drawn from Nature and on stone by Hard Ulrich junr.



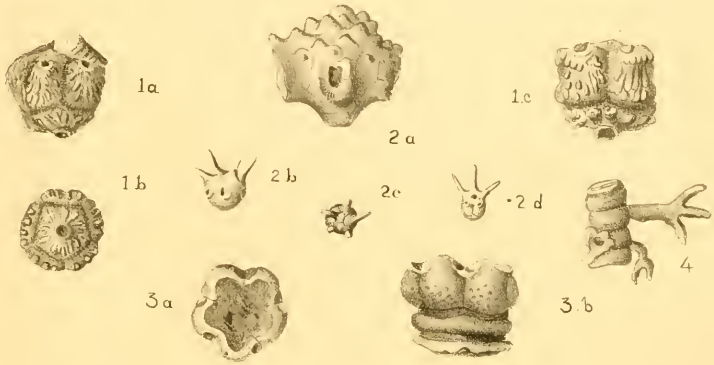
1. PLATYCRINITES [illegible] (GOLDFUSS)

2. P. [illegible] (MÜLLER) 3. P. TUBERCULATUS (MILL.)

Drawn from Nature and on Stone by Th.s Austin jun.

June 1843

GENUS PLATYCRINUS



GENUS DICHOCRINUS

FROM THE CARB. LIMESTONE

Fig. 1 PLATYCRINUS LASCINIATUS (GILB)

Fig. 2. P. MUCRONATUS (AUST) 3. MALFORMED PLATYCRINUS

Fig. 4 ROOT OF PLATYCRINUS 5. DICHOCRINUS RADIATUS (MUNST)

Fig. 6 D. FUSIFORMIS (AUST)

DRAWN from Nature & on stone by T. Austin junr

GENUS HEXACRINUS

Pl. 6.

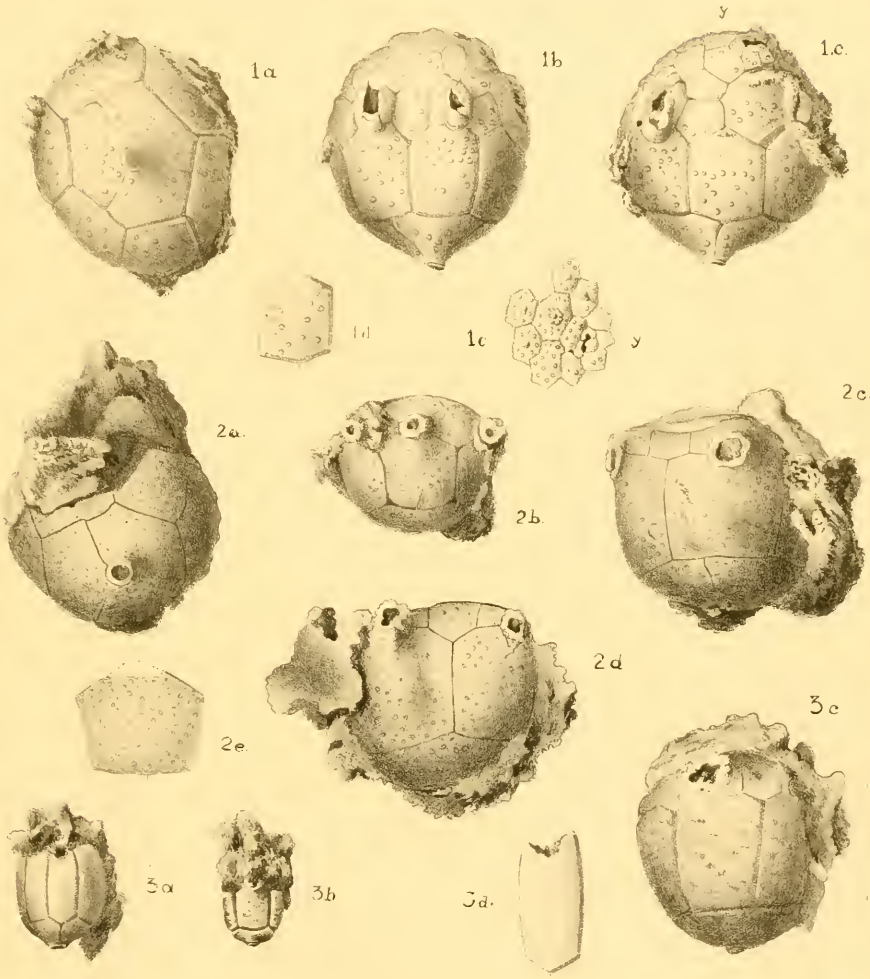
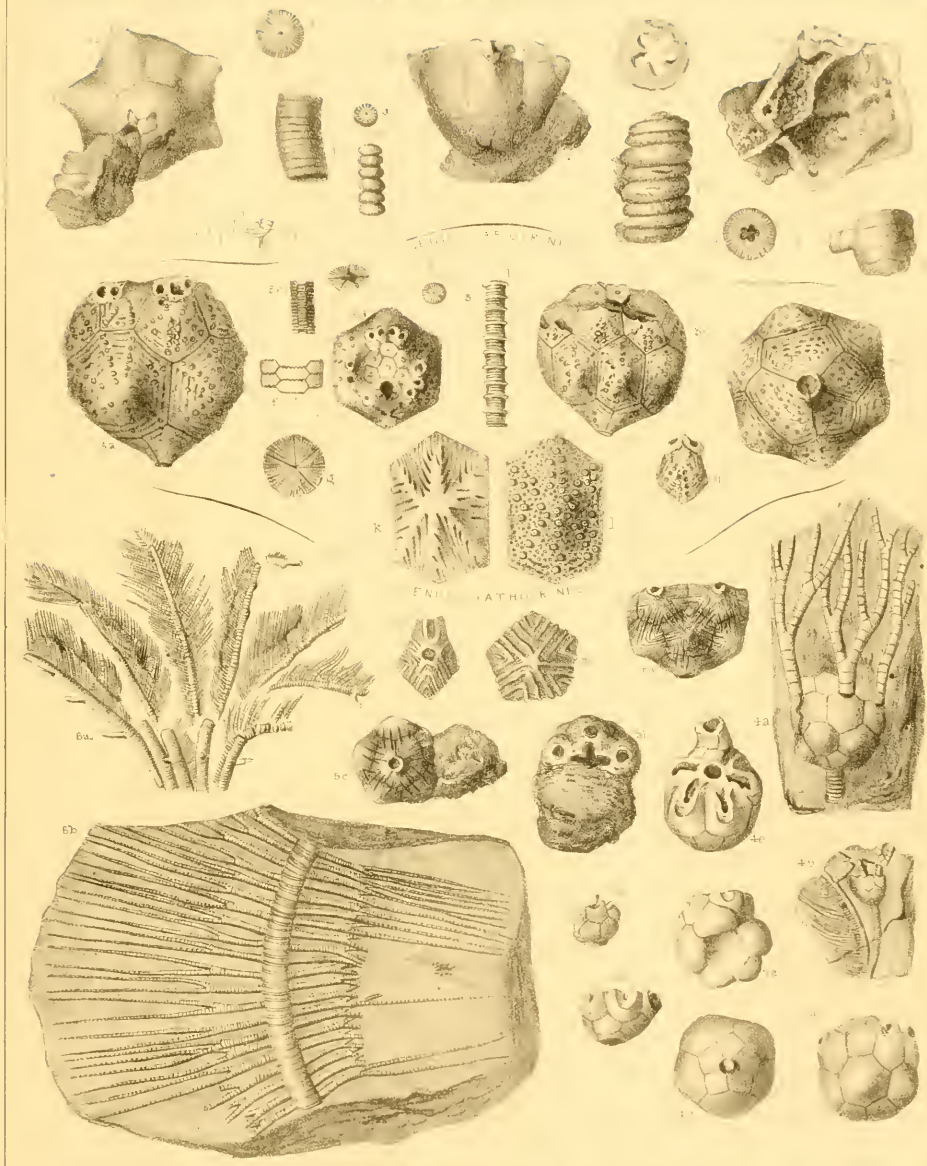


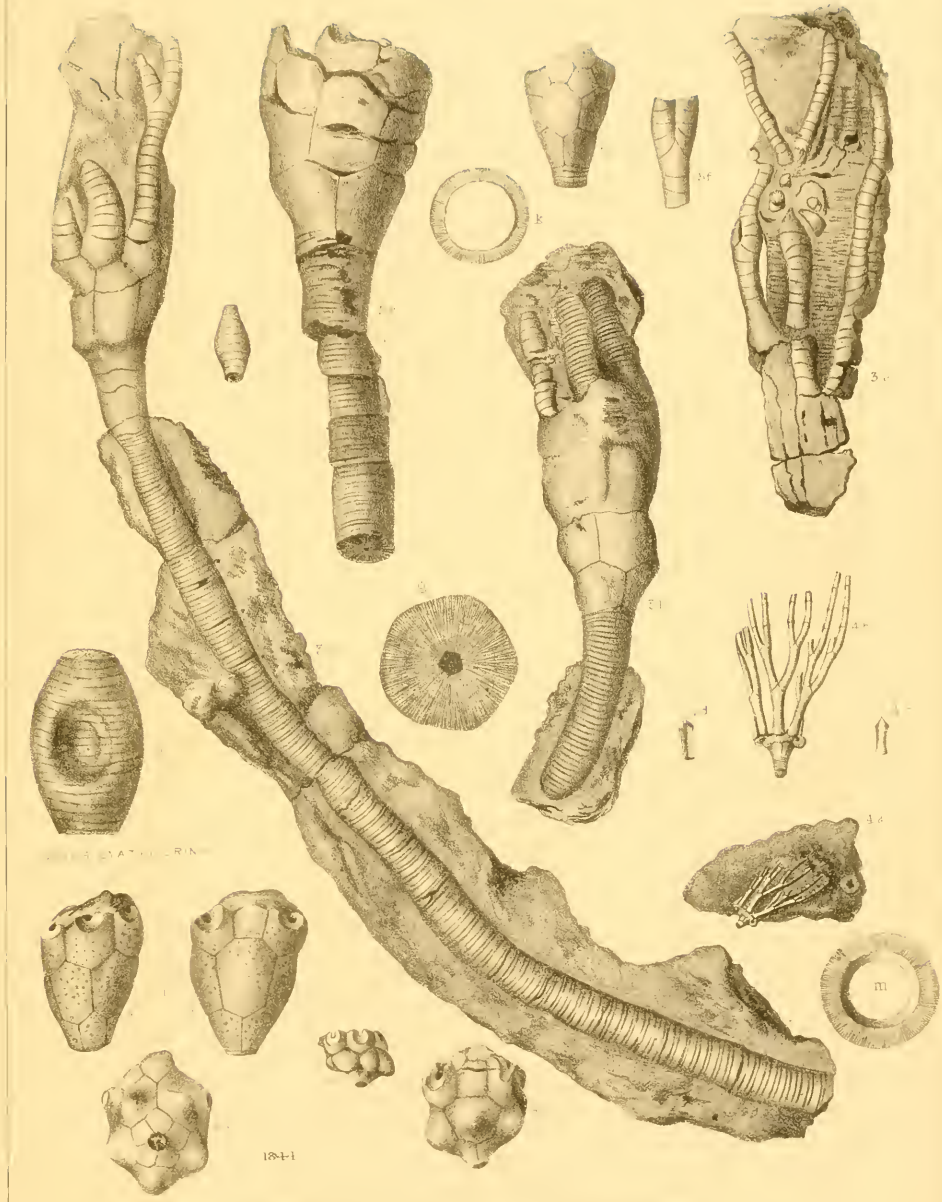
Fig. 1 Hexacrinus melo (Aust)

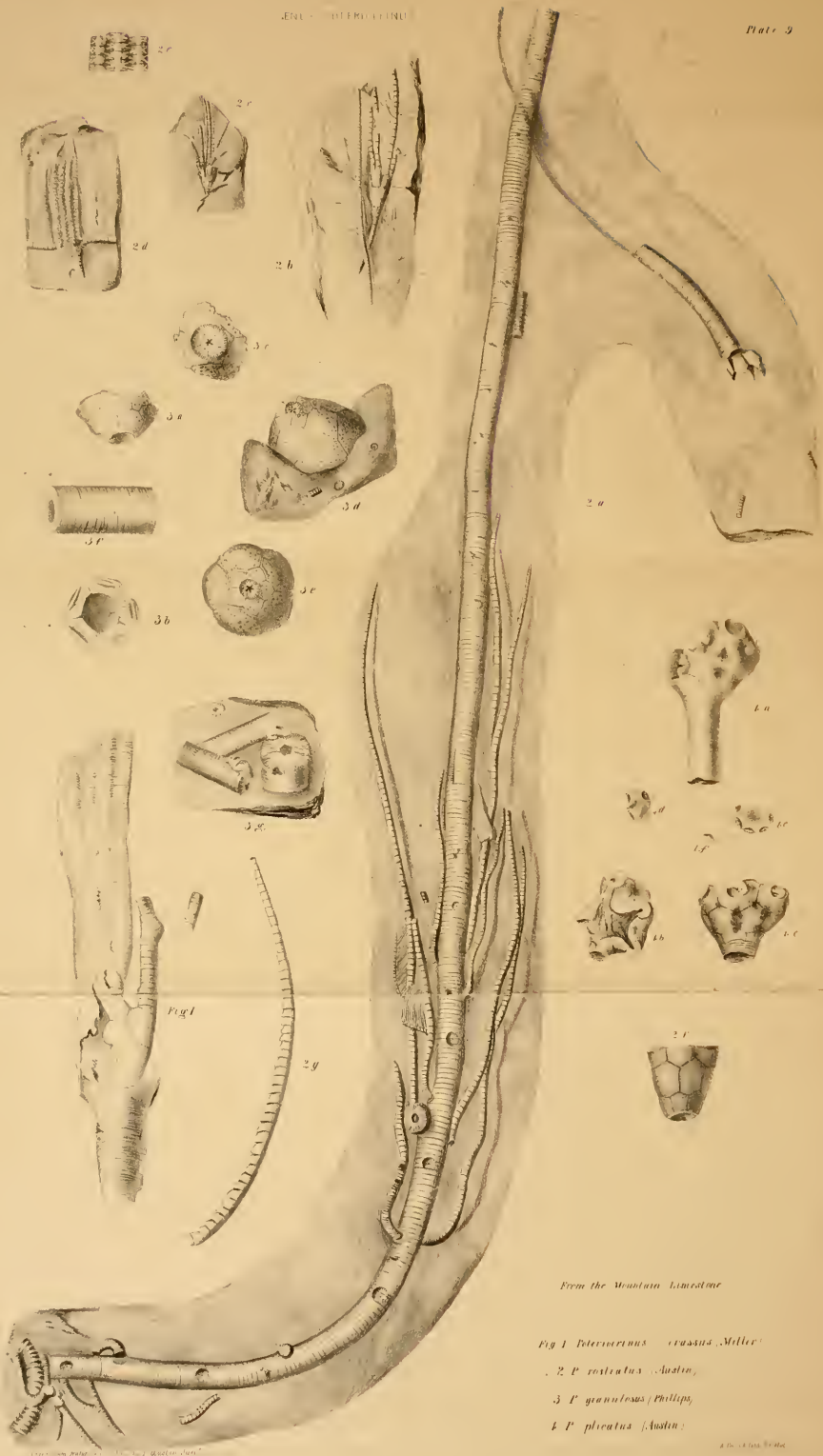
2. H. depressus (Aust) 3. H. macrotatus (Aust)

From the Devonian system Newton Bushel

Drawn from Nat. Sur. or stone by T. Austin




m



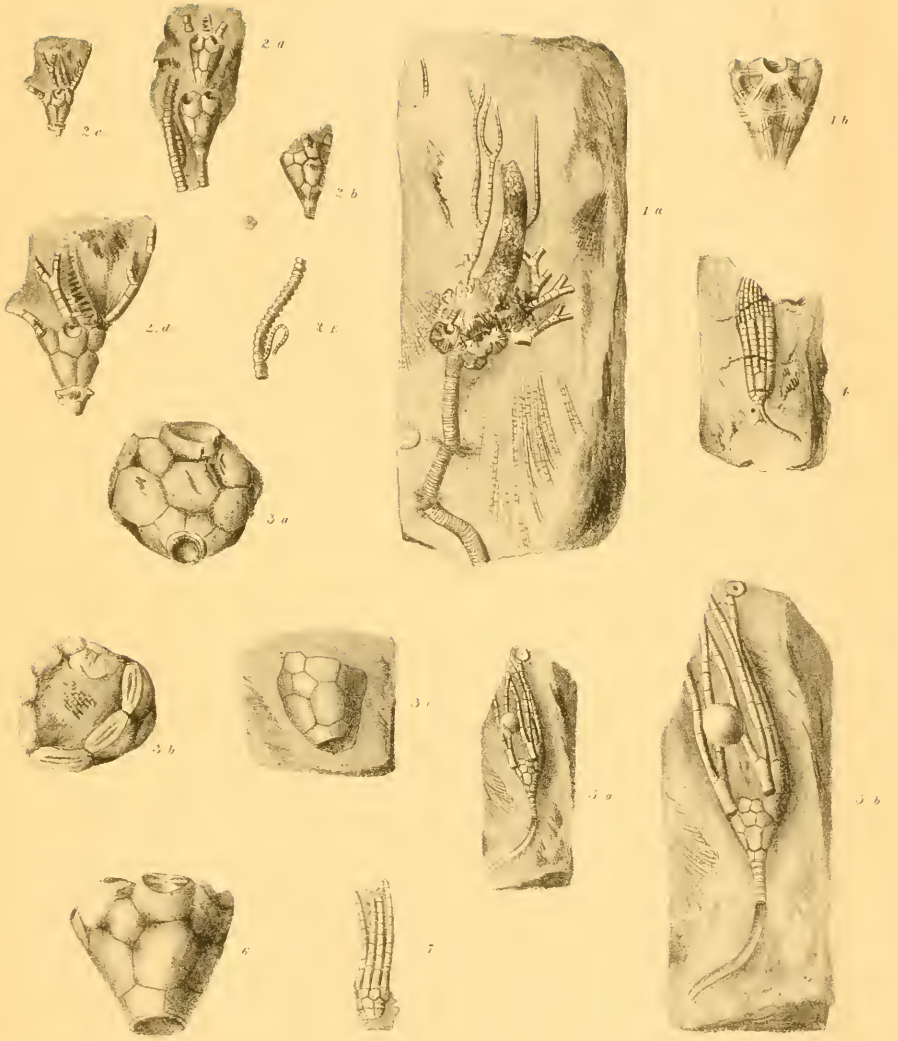
From the Mountain Limestone

Fig 1 Pterinopecten crassus (Miller)

2 P. rostratus (Austin)

3 P. granulosus (Phillips)

4 P. plicatus (Austin)



From the Mountain Limestone

Fig 1 Peterocrinus radiatus Austin

2 P quinquangularis (Austin) 3 P conicus (Phillips)

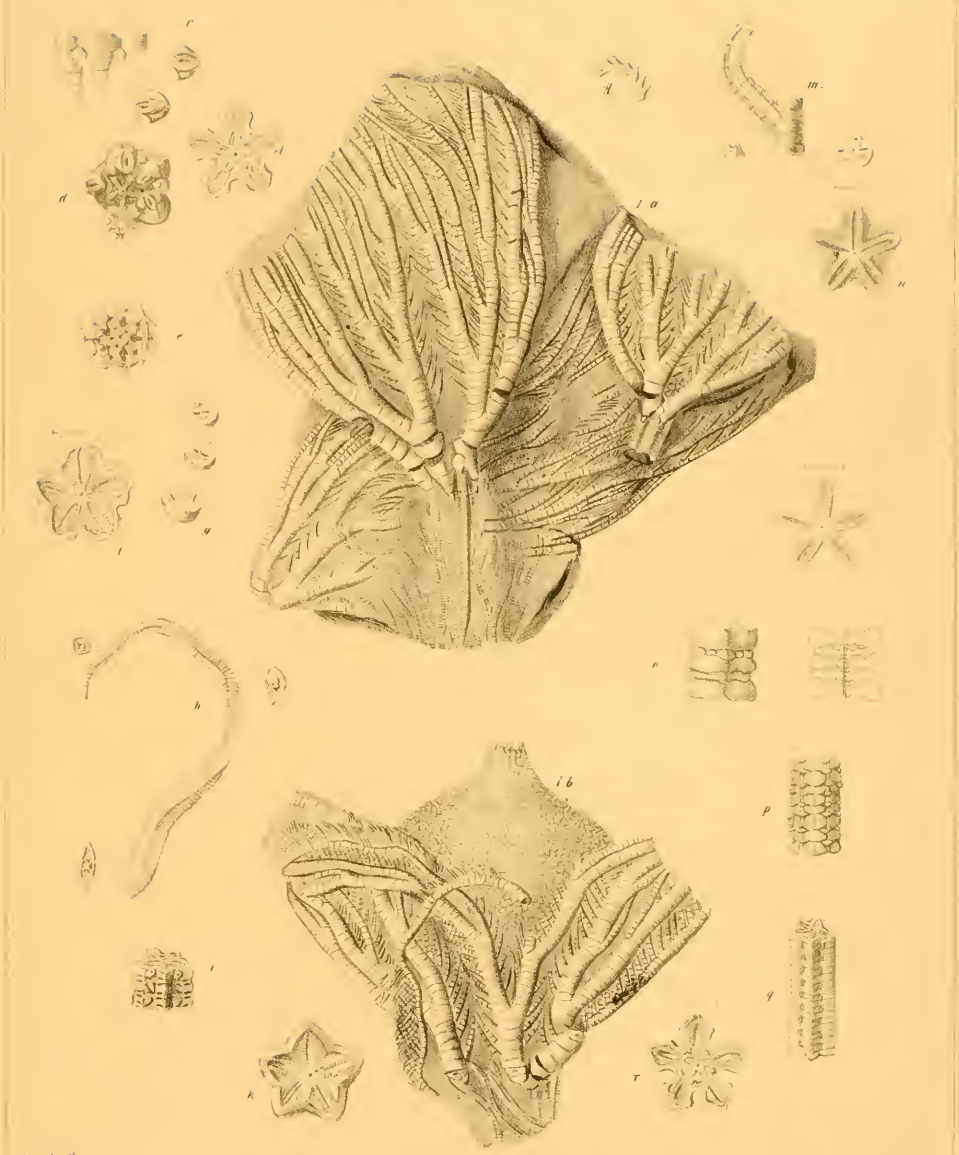
4 P latitrons (Austin) 5 P tenuis Miller

6 P impressus Phillips 7 P dactyloides (Austin)

Sept. 1st 1846

From the Carboniferous Limestone

1 Poterioerinus dactyloides Austin 2 Poterio pentagonus Austin
3 Poterio longi dactylus Austin 4 Poterio abbreviatus Austin
5 Synhathocrinus tenuicus Phillips



Sep. 1st 1841.

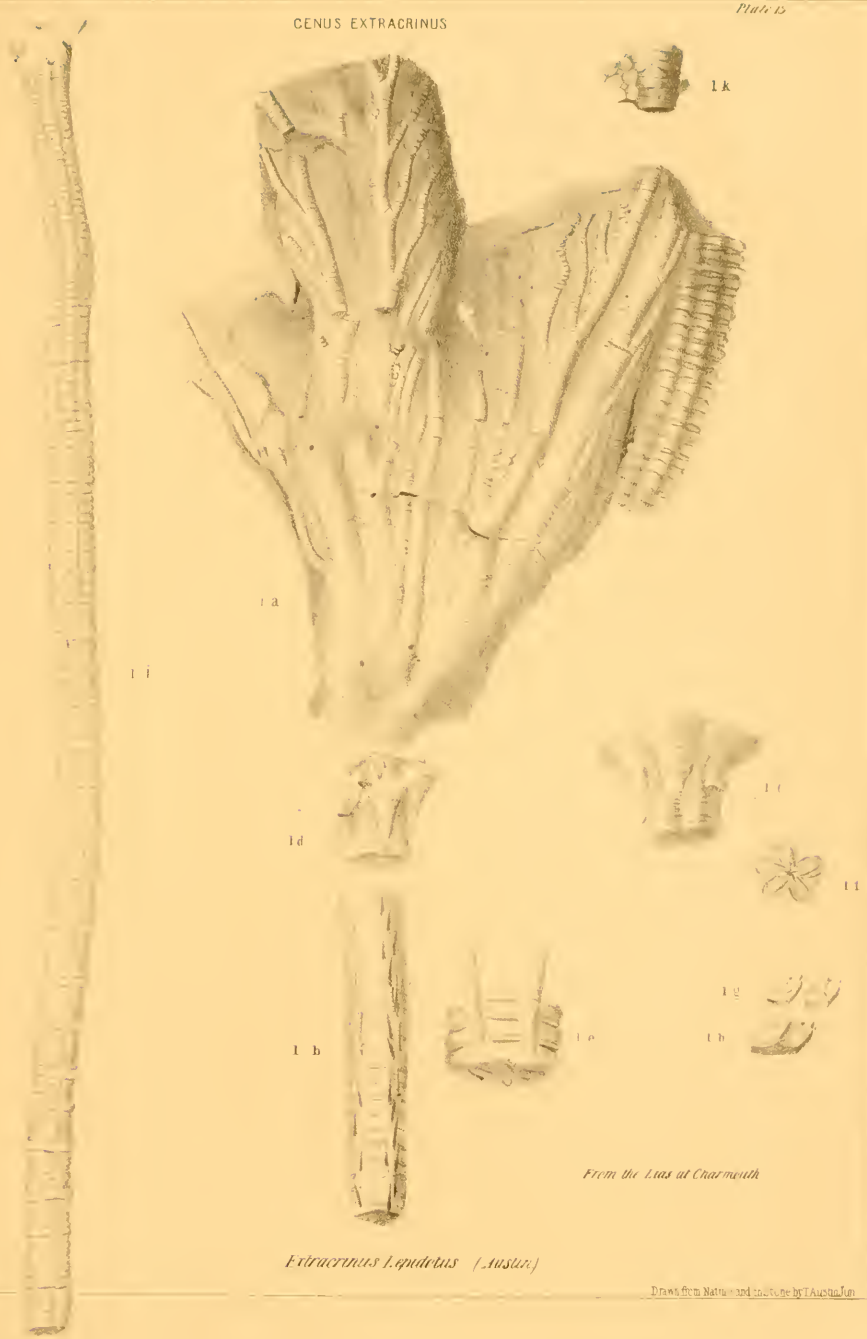
From the Lias

Eudocrinus Briareus (Miller)

Drawn from Nat. upon Stone by Arch. Fox

R. Ewart lith. Edinr.

CENUS EXTRACRINUS

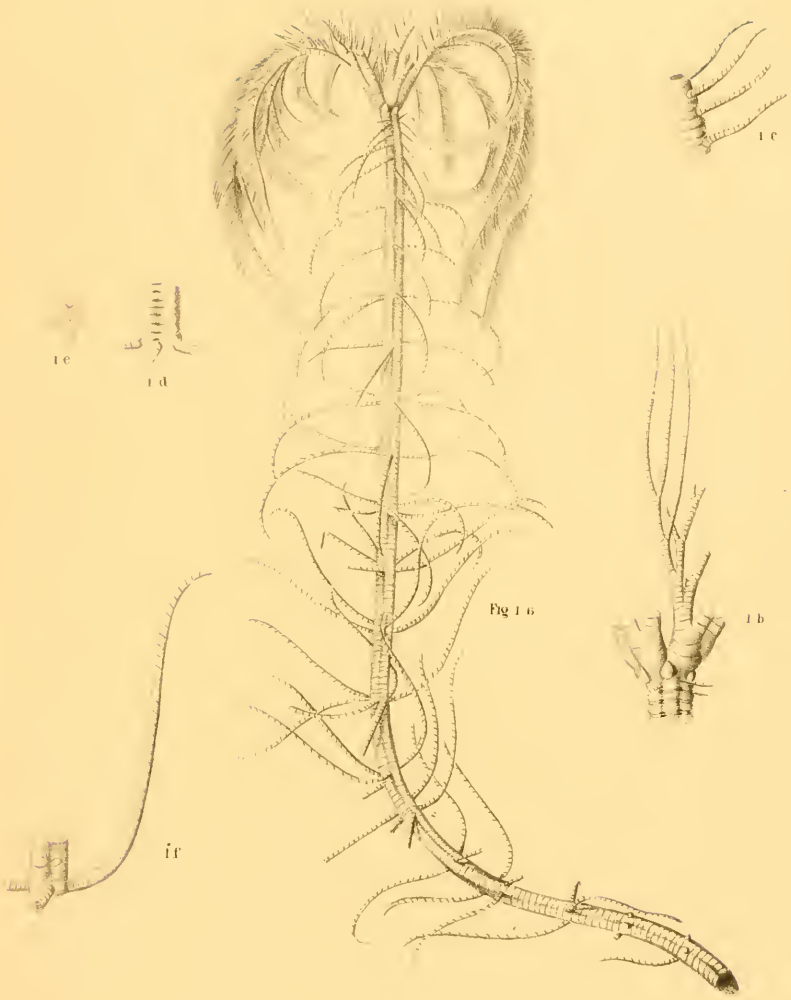


From the Lias at Charmouth

Extracrinus Lepidotus (Austin)

Drawn from Nature and on Stone by T Austin Jun

CENUS PENTACRINUS



Pentacrinus Caput Medusæ (Müller.)

Recent, Caribbean Sea

A Pocock lith Bristol

Drawn from Nature and on Stone by T Austen Junr

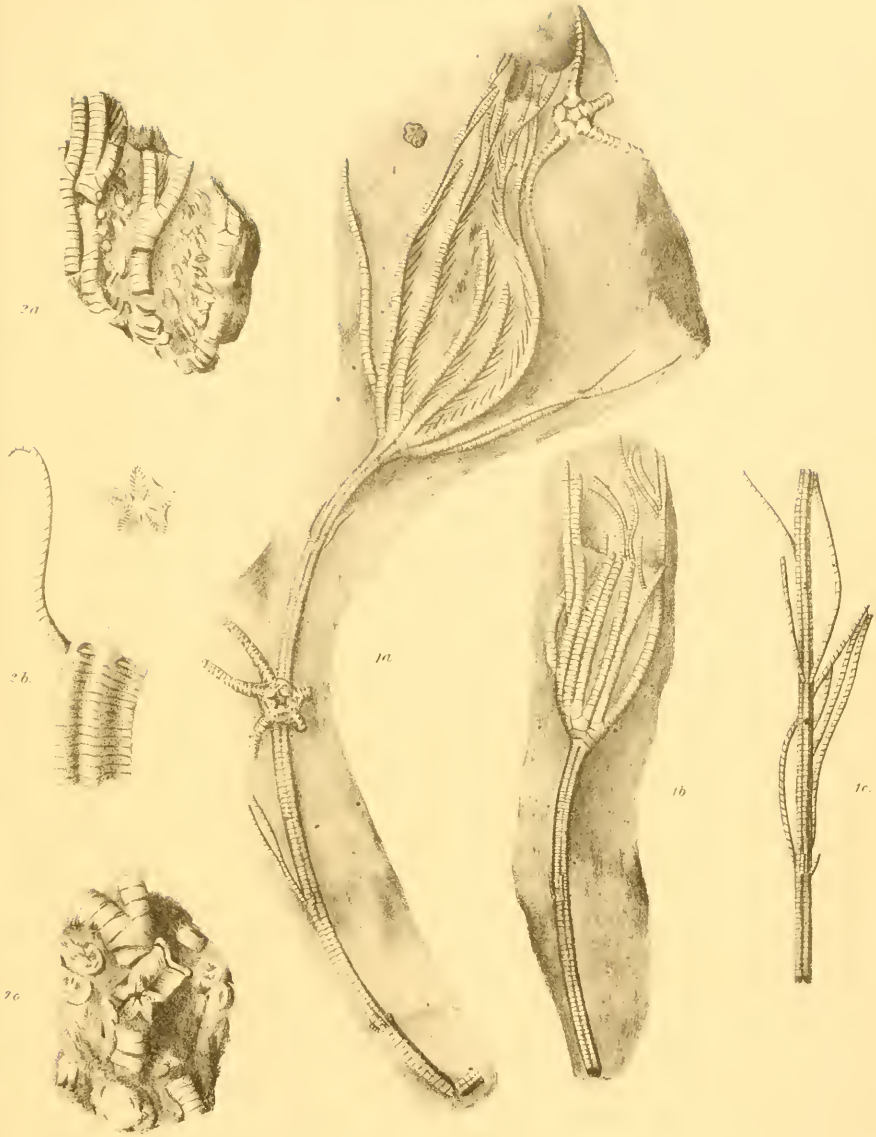
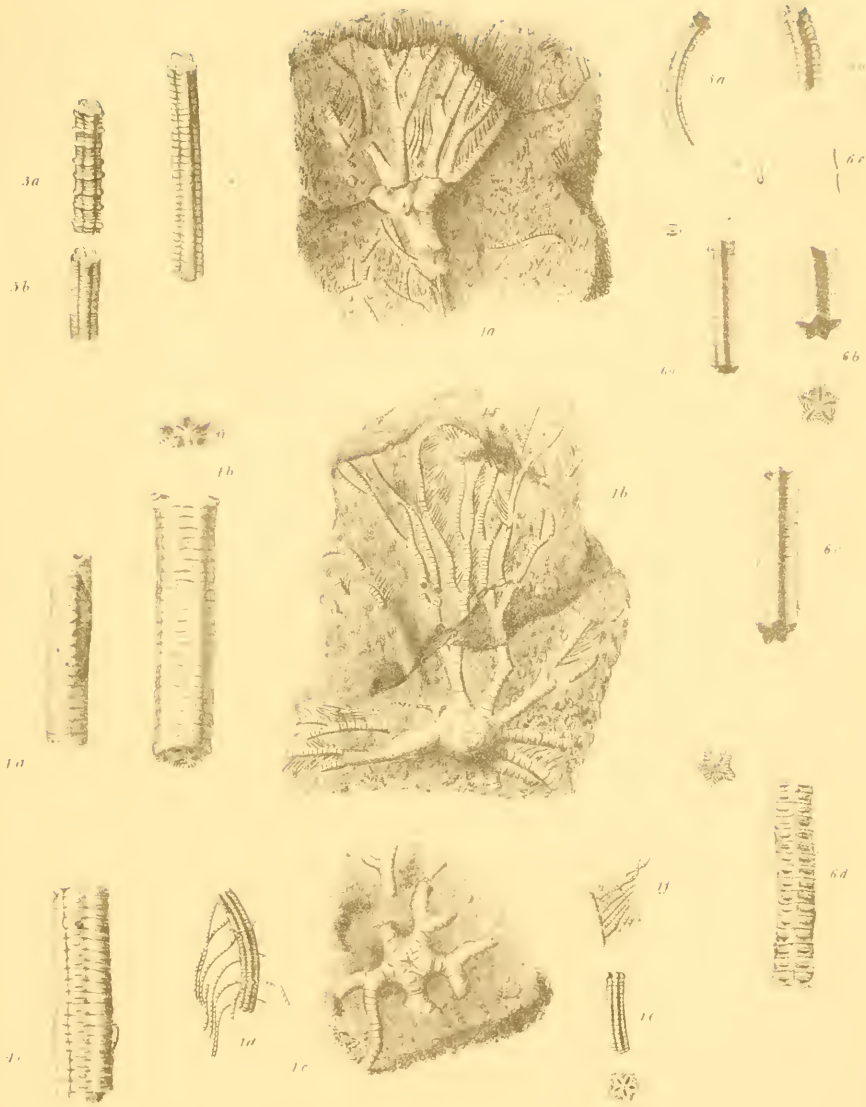


Fig 1. Pentacrinus Johnsonii Austin 2 P tuberculatus. Miller



Figs. 1 P. antaverinus Miller 2 P. subbasaltiformis (Miller)
Figs. 3 P. sowerbii Wilhelm 4 P. Prattii Austin
Figs. 5 P. Fittonii Austin 6 P. basaltiformis Miller

Date Due