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J. B. Woodworth.
Harv. Univ.

JOSEPH DINKEL DEL^T ET LITH.

PRINTED BY M & N HANHART

THE PERFECT SERIES OF THE BONES OF THE RIGHT FOOT OF THE MOA, OR EXTINCT COLOSSAL OSTRICH-LIKE BIRD OF NEW ZEALAND, FOUND IMBEDDED IN AN ERECT POSITION, WITH THE CORRESPONDING FOOT A YARD IN ADVANCE, IN A TURBARY DEPOSIT, AT WAIKOUAITI IN THE MIDDLE ISLAND, BY

WALTER MANTELL ESQ^RE OF WELLINGTON.

FIGURES. 1^a 2^a 3^a THE PLANTAR OR UNDER SURFACE OF THE FIRST, SECOND, & THIRD TOES. THE FIGURES ARE $\frac{1}{3}$ NATURAL SIZE LINEAR

THE ORIGINAL BIRD WAS ABOUT 10 FEET HIGH.

A

PICTORIAL ATLAS

OF

FOSSIL REMAINS,

CONSISTING OF COLOURED

ILLUSTRATIONS

SELECTED FROM

PARKINSON'S "ORGANIC REMAINS OF A FORMER WORLD,"

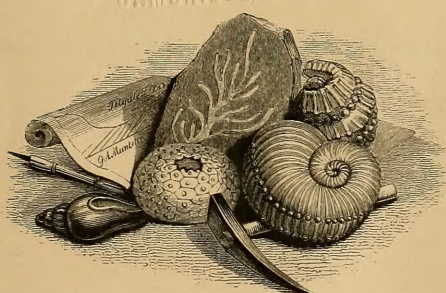
AND

ARTIS'S "ANTEDILUVIAN PHYTOLOGY."

WITH DESCRIPTIONS

BY GIDEON ALGERNON MANTELL, ESQ. LL.D. F.R.S.

VICE-PRESIDENT OF THE GEOLOGICAL SOCIETY,
FELLOW OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND, ETC.
AUTHOR OF "THE WONDERS OF GEOLOGY," ETC. ETC.



"All things in nature are engaged in writing their own history. The planet and the pebble are attended by their shadows—the rolling rock leaves its furrows on the mountain side—the river its channel in the soil—the animal its bones in the stratum—the fern and the leaf inscribe their modest epitaphs on the coal—the falling drop sculptures its story on the sand, or on the stone—not a footstep on the snow or on the ground but traces in characters more or less enduring the record of its progress."—*Emerson.*

With Seventy-four Plates,

CONTAINING NEARLY NINE HUNDRED FIGURES.

LONDON:

H. G. BOHN, YORK STREET, COVENT GARDEN.

1850.

LONDON:
R. CLAY, PRINTER, BREAD STREET HILL.

TO

THE VERY REVEREND

WILLIAM BUCKLAND, D.D. F.R.S.

Dean of Westminster,

&c. &c. &c.

THIS WORK IS INSCRIBED

AS AN EXPRESSION OF THE HIGH RESPECT AND AFFECTIONATE REGARD

OF ONE WHO HAS FOR MORE THAN THIRTY YEARS

ENJOYED THE HONOUR AND PRIVILEGE OF HIS CORRESPONDENCE

AND FRIENDSHIP.

CHESTER SQUARE, PIMLICO,
January 1850.

PREFACE.

In the hope of promoting the diffusion of a taste for the cultivation of a peculiarly interesting and attractive branch of Natural History, I have been induced, in compliance with the suggestion of the eminent publisher of this volume, to arrange in a connected series the Plates of the late Mr. Parkinson's "Organic Remains of a Former World," and of Mr. Artis's "Antediluvian Phytology," with descriptions of the specimens represented.

As I have been enabled, with the valuable assistance of my friend, John Morris, Esq. F.G.S., the author of "A Catalogue of British Fossils," to append, in almost every instance, the generic and specific names adopted by the most recent authorities, the volume will, I trust, not only prove interesting to the general reader, as a beautiful *Pictorial Atlas* of some of the most remarkable relics of the animals and plants of a "Former World," but also constitute a valuable book of reference in the library of the Geologist and Palæontologist, since it contains the names and localities of no inconsiderable number of species and genera.

For the guidance of the unscientific reader who may desire further information on any of the subjects treated of in the following pages, references are given to a few general works on Geology and Fossil Remains.

Chester Square, Pimlico,
August 1850.

TABLE OF CONTENTS.

Descriptions of the Plates.

FOSSIL REMAINS OF THE VEGETABLE KINGDOM.

(Plates I. to XXXIII. inclusive.)

FOSSIL REMAINS OF THE ANIMAL KINGDOM.

(Plates XXXIV. to LXXIV. inclusive.)

SUPPLEMENTARY NOTES.

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Lyell, Sir Charles, Travels in America, 1845, and 1849.

DESCRIPTION OF THE FRONTISPIECE.

THE MOA OF NEW ZEALAND.

THE Frontispiece represents the entire series of bones composing the right foot of the MOA (*Dinornis robustus*), found imbedded in an erect position, with the corresponding foot a yard in advance, in a turbary deposit, at Waikouaiti, in the Middle Island of New Zealand, in 1849. The figures are one-third less in linear dimensions than the originals.

Figures 1[a], 2[a], 3[a], show the palmar, or under surface of the respective toes, and exhibit the trochlear or articulating extremities of the phalangeal bones.

The ancient swamp or morass in which these matchless specimens were imbedded, is situated on the shore, in a little creek or bay near Island Point, at the mouth of the river Waikouaiti, and is covered by the sea except at the lowest tides. Many remains of the largest species of Moa have from time to time been obtained from this deposit; the bones sent to England by Dr. Mackellar, Mr. Percy Earle, and others, figured and described in the Zoological Transactions by Professor Owen, were from this locality.

The specimens figured were obtained by Mr. Walter Mantell, in 1849, when visiting Waikouaiti, as Government Commissioner for the settlement of Native claims. On the recession of the tide, the upper (or proximal) ends of the metatarsals were just visible above the surface: these were carefully dug up, and all the bones of the respective toes numbered, one by one, as they were extracted from the soil. In this state they were sent to me, and have subsequently been articulated under my direction, in their natural order of arrangement.[1]

The condition and position of the bones, and the nature of the deposit,—evidently an ancient morass, in which the New Zealand flax (*phormium tenax*) once grew luxuriantly,—remind us of the very similar circumstances in which the extinct gigantic Elks in Ireland, and the Mastodons in America, have occasionally been found engulfed in peat bogs and morasses; and, as my son emphatically observes, it is impossible to arrive at any other conclusion than that the Moa to which these feet belonged, had sunk down in the swamp, and perished on the spot. Vertebræ and other parts of a skeleton of a bird of the same proportions, were dug up near the feet.

As the specimens under examination are the first examples in which the entire series of the phalangeal and ungueal bones have been found in natural connexion with the metatarsals, I subjoin the admeasurements of the several parts, to render the peculiar construction of the feet in one species of the lost race of the colossal birds of New Zealand, more obvious to those who may feel interested in the subject.

TARSO-METATARSAL BONES.

	Inches.	Lines.
Length of the shaft from the distal end of the middle trochlea to the proximal extremity	17	0
Circumference of the proximal end	11	9
Transverse diameter, or width, of ditto	4	6
Antero-posterior diameter of ditto	2	6
Circumference of the middle of the shaft	6	3
Antero-posterior diameter of ditto	1	8
Transverse diameter of ditto	2	6
Width of the distal, or trochlear, end	6	3
Circumference of the trochlear end	15	6
Antero-posterior diameter of the middle trochlea	2	9

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[1] By the well-known eminent anatomical artist, Mr. Flower, of 22, Lambeth Terrace, Lambeth Road.

PHALANGEAL BONES.

		Inner Toe. (Fig. 1.) Inches.	Inner Toe. (Fig. 1.) Lines.	Middle Toe. (Fig. 2.) Inches.	Middle Toe. (Fig. 2.) Lines.	Outer Toe. (Fig. 3.) Inches.	Outer Toe. (Fig. 3.) Lines.
First, or proximal phalanx	Length	4	9	4	3	3	2
	Circumference of proximal end	6	6	6	9	5	9
Second phalangeal bone	Length	1	9	2	6	1	9
	Circumference of proximal end	3	0	5	3	4	9
Third phalangeal bone	Length	Ungueal. 3	0	1	9	1	0
	Circumference of proximal end	Ungueal. 4	0	4	6	4	6
Fourth phalangeal bone	Length	.	.	Ungueal. 3	0	0	11
	Circumference of proximal end	.	.	Ungueal. 4	2	4	0
Fifth ungueal bone	Length	.	.	.	.	2	6
	Circumference of proximal end	.	.	.	.	3	9

The total length of the toes is as follows:—inner digit, 9½ inch.; middle, 11½ inch.; outer, 9⅓ inch. The transverse diameter of the expanse of the foot, from the distal extremity of the inner toe (fig. 1a), to that of the outer one (fig. 3a), is 15½ inches. The length from the posterior part of the trochlear extremity of the metatarsal to the distal end of the ungueal of the middle toe (fig. 2a), is 13 inches. If to the actual dimensions of the bones be added the proportional thickness of the cartilaginous integuments, nails, &c., the length of the foot of the living bird may be estimated at about 16 inches, and the breadth at 17 or 18 inches.

From the great width and solidity of the metatarsals, and the form and corresponding size and strength of the phalangeals and ungueals, the ornithologist will perceive that the feet of the Moa must have constituted powerful instruments for scratching, digging, and uprooting the sub-terrestrial vegetable substances, which Professor Owen, with great probability, infers, formed the chief sustenance of the extinct colossal birds of New Zealand.

According to the relative proportions of the bones composing the hinder extremities of the gigantic species of Moa, the corresponding *tibia*, or leg-bone, of the feet above described, would be two feet nine inches in length, and the *femur*, or thigh bone, nine and a half inches; the total height of the bird was probably about ten feet.

Tibiæ, femora, and other bones of much larger proportions, (apparently of *Dinornis giganteus* and *D. ingens*,) were obtained from the same locality; some of these indicate birds of eleven or twelve feet in height; dimensions exceeding by one-third those of the largest known existing species of Struthionidæ—the Ostrich.[1]

Referring the reader to the additional account of the fossil birds of New Zealand given in a subsequent part of this volume (see *Supplementary Notes*, p. 173), I will conclude this notice with a few general remarks. From the numerous facts relating to the fossil remains of birds from our Antipodean colony, that have now been brought under the consideration of the naturalists and geologists of this country, we may safely conclude, that at a period geologically recent, but of immense antiquity in relation to the human inhabitants of those Islands, New Zealand was densely peopled by tribes of colossal struthious bipeds, of species and genera that have long since become extinct. I believe that ages ere the advent of the Maori tribes, the Moa and its kindred were the chief

[1] Even from this imperfect description (and further anatomical details would be irrelevant in the present work), the ornithologist cannot fail to observe the peculiar characters exhibited by these extremities of the remarkable family of birds, of which the diminutive Apteryx appears to be the only living representative. But the Apteryx differs most essentially in the structure of the cranium and mandibles, from the extinct types to which Professor Owen has given the names of Dinornis, Palapteryx, Aptornis, &c.

With regard to the construction of the feet it may be further remarked, that the length of the inner and outer toes is nearly equal, as in the Cassowary; but the middle toe, which in the Cassowary is one-third longer than the other digits, in the Moa scarcely exceeds in length by one-fifth, the inner and outer toes. The ungueal segments are very large, being equal to one-third the length of the toes. The phalangeals are relatively much shorter than in the Cassowary and Ostrich, and wider than in the former, and more arched than in either of these living struthious birds.

In the metatarsal the presence of the three elements whose fusion constitutes the bone, is strongly marked; there does not appear to be any certain indications of a posterior or hind toe, though Professor Owen imagines he has detected feeble traces of a fourth digit: in that case the bird to which my specimens belonged, would be termed *Palapteryx*. The crania found by Mr. Walter Mantell at Waingongoro, and figured and described by Professor Owen in the Zoological Transactions (Vol. III., Plates 52, 53, 54, 55), as Dinornis and Palapteryx, must have belonged to birds of comparatively small stature. The skull with the adze-like upper mandible, and the enormously-developed *basi-occipitals* and *basi-sphenoids* (*Dinornis*, of Professor Owen, Plate 52), was found associated with many vertebræ of the neck and back, and bones of the leg, of the same bird; and these my son states indicated a height of from six to seven feet. The skull and the rest of the skeleton were found imbedded in sand, and lying in their natural relative position; unfortunately, all these precious remains, except the cranium, were destroyed by a sudden rush of the natives to seize upon the exhumed relics! It therefore yet remains to discover the cranial type that characterized the colossal forms at present known only by other parts of the skeleton.

inhabitants of the country, and that from the period when those Islands were taken possession of by man, the race gradually diminished, and the colossal types were finally annihilated by human agency. That some of the largest species were contemporary with the Maories, there can now be no reasonable doubt. Apart from native traditions, and songs and tales in which allusions are made to the gigantic magnitude and flowing plumage of the Moa, the collocation of calcined and half roasted bones of the Dinornis, of dogs, and of the human species, in the ancient fire-heaps of the aborigines, and the unequivocal marks of the celt or axe of jade on some of the tibiæ,—the chips or cuts having evidently been made on the bones when recent,—afford incontrovertible proof that the last of the Moas, like the last of the Dodos, was annihilated by human agency.

From the remarkable size and strength of the thighs, legs, and feet of the Moas, it is clear that the hinder limbs must have constituted powerful locomotive organs; and when we consider the vast swarms of the largest species which existed at some remote period, it seems highly probable that this family of colossal birds,—a family unknown in any other part of the world,—was not originally confined within the narrow geographical limits of modern New Zealand, but ranged over a vast continent now submerged, and of which Phillip and Norfolk Islands, and Chatham and Auckland Islands, and those of New Zealand, are the culminating points.

But whatever may be the result of future discoveries as to the relative age of the bone-deposits, or the existence or extinction of any of the colossal species of Moa, or the former extension of the race over countries now submerged, one astounding fact must ever remain unassailable—the vast preponderance of the class Aves or Birds, that prevailed, and which still prevails, in the fauna of New Zealand, to the almost entire exclusion of mammalia and reptiles. Any palæontologist who saw only the collections sent over by my son, must have been astonished at their extent and variety. I may venture to affirm that such an assemblage of the fossil bones of birds was never before seen in Europe: nearly fifteen hundred specimens, collected from various parts of the country, with scarcely any intermixture of the remains of any other class;—it is a phenomenon as startling as the exclusively reptilian character of the fauna of the Wealden epoch. But the fauna of New Zealand, even at the present time, presents a character as ornithic and as anomalous as its ancient one; for while there are upwards of fifty or sixty genera of birds, there is but ONE indigenous mammalian quadruped known to naturalists—a species of rat! In this respect, therefore, as well as in its flora, in which ferns and other cellulosæ of peculiar types prevail to an extent unknown elsewhere, the country offers a striking example of that now acknowledged fact in natural history—a centre or focus of creation of certain organic types. And this law, with whose operation during the palæozoic and secondary ages modern geological researches have made us familiar, appears to have continued in unabated energy to the present moment.

From what has been advanced, it is manifest that the present geographical distribution of special groups of terrestrial animals and plants, displays as many anomalies in the relative predominance of the different classes and orders over certain areas, without relation to climatorial or other obvious physical conditions, as can be traced in the natural records of the earlier ages of the world. The conclusion therefore forces itself upon the mind, that throughout the vast periods of time to which our retrospective knowledge extends, the geological changes of the earth's surface, and the appearance and obliteration of species and genera, have been governed by the same physical and organic laws; and that notwithstanding the variable conditions of the land and the water, indicated by the sedimentary formations, there was at no period a greater discrepancy in the assemblages of certain types of the animal and vegetable kingdoms, than exists at present.

Of the nature of that law by which the extinction of a race of highly organized beings is determined, and whose effects through innumerable ages palæontology has in part revealed, we are as utterly ignorant as of that which governs the first appearance of the minutest living animalcule which the powers of the microscope enable us to descry; both are veiled in inscrutable mystery, the results only are within the scope of our finite comprehension.[1]

[1] See the concluding part of Lecture VIII. § 46, Wonders of Geology, vol. ii. p. 890.

INTRODUCTION.

The publication of Mr. Parkinson's "*Organic Remains of a former World*," at the commencement of the present century, must be regarded as a memorable event in the history of British Palæontology: it was the first attempt to give a familiar and scientific account of the fossil relics of animals and plants, accompanied by figures of the specimens described.

The three volumes[1] of which the work consisted, appeared at considerable intervals; the last was published in 1811. Although nearly forty years have since elapsed, and hundreds of geological works, of all kinds and degrees of merit, have subsequently been issued, Mr. Parkinson's Plates, owing to their fidelity and beauty, are still in such request, as to induce the proprietor, Mr. Bohn, now that the work is out of print, to publish them, with the descriptions and modern names of the fossils represented.

I have added a few explanatory remarks, and in the "Supplementary Notes," have given extended notices of some of the most interesting subjects, with the view of rendering the volume more intelligible and acceptable to the general reader.

In looking through the original work of Mr. Parkinson, the instructed observer will not fail to perceive the immense progress which the study of fossil animals and plants has made since the period of its first appearance in 1811. At that time, the terms Geology and Palæontology were unknown; all the sedimentary strata have since been accurately defined and arranged, and names assigned to the respective systems or formations; while the so-called *Diluvial Epoch*, which Mr. Parkinson, and even Baron Cuvier, considered as established by incontrovertible physical evidence, has been expunged from the chronology of geology. In Mr. Parkinson's volumes, no allusion will be found to that most remarkable era in the earth's history which modern researches have brought to light—*the Age of Reptiles;* the terms Ichthyosauri, Plesiosauri, Iguanodon, Megalosaurus—now familiar as household words—are not inscribed on their pages; all those marvellous beings of past ages have been discovered during the last forty years; in short, the remark of an eminent critic is as true as it is beautiful:—"Geology is a philosophy which never rests; its law is progress; a point which yesterday was invisible is its goal to-day, and will be its starting-post to-morrow."

I gladly avail myself of this opportunity to make a passing allusion to the excellent and accomplished author, Mr. Parkinson. I had the pleasure and privilege of his acquaintance in my youth, immediately after the publication of the third volume of his valuable work. Mr. Parkinson was rather below the middle stature, with an energetic, intelligent, and pleasing expression of countenance, and of mild and courteous manners; readily imparting information, either on his favourite science, or on professional subjects; for he was at that time actively engaged in medical practice in Hoxton Square, and was the author of several valuable medical

[1] Three volumes, in 4to.; price 10*l*. 10*s*.

treatises. He kindly showed and explained to me the principal objects in his cabinets, and pointed out every source of information on fossil remains; a department of natural knowledge at that time but little cultivated in England, but which peculiar circumstances had contributed to render the engrossing object of my young and ardent mind. In after years Mr. Parkinson warmly encouraged my attempts to elucidate the nature of the strata and organic remains of my native county, Sussex, a district which was then supposed to be destitute of geological interest; and he revised my drawings, and favoured me with his remarks on many subjects treated of in my first work—"*The Fossils of the South Downs.*"[1]

In 1822, Mr. Parkinson published "An Introduction to the Study of Fossil Organic Remains, especially of those found in the British Strata; intended to aid the Student in his Inquiries respecting the Nature of Fossils, and their Connexion with the Formation of the Earth;" 1 vol. 8vo. with ten plates, principally of the genera of fossil shells. He also contributed a few papers to the early volumes of the Geological Society of London, of which he was one of the original members. After Mr. Parkinson's death, his beautiful and choice collection was sold by auction, and its contents widely dispersed. The fine series of silicified zoophytes was purchased by Mr. Featherstonhaugh, and taken to America; and some years afterwards was destroyed by a fire which consumed the museum in which it was placed.

As illustrative of the pleasing style of Mr. Parkinson's work, I subjoin an abstract of the chapter, *On the Pleasure and Advantages of a Knowledge of Fossil Remains.* The epistolary style was adopted; and the first letter is supposed to be penned by a friend desirous of learning the nature of certain fossils he had observed on his journey to Oxford:—

"I have lived long enough to witness many sad disappointments to the fond dreams of happiness indulged by persons who, only intent on the acquisition of riches, had neglected to cultivate any intellectual or ennobling pursuit; so that on retiring from active life, they were unable to enjoy the leisure so dearly earned by years of anxiety and care, and either relapsed into a state of miserable ennui, or gave themselves up to the excitement of frivolous or vicious indulgences.

"Aware of the necessity of devoting the few leisure hours, which the duties of my calling left at my disposal, to some rational and amusing occupation, I have always cultivated, more or less assiduously, some branch of art or science, and thence acquired an enthusiastic admiration for the beauties of nature, and an insatiable curiosity to pry into the mysteries of the natural world. With this state of mind, I have at length resolved to avail myself of the means my little fortune affords me to indulge those feelings, and have, I trust, quitted the busy scenes of the world for ever.

"In pursuance of a plan long entertained of visiting the most interesting parts of our island, I left London last week, accompanied by my daughter, and our old friend, Frank Wilton, whose lively disposition and agreeable manners render him, as you well know, an excellent companion. But he has made himself most acceptable to us on another account;—his resolute scepticism with respect to the more rational, and his submissive credulity as to the popular and traditional explanations of such natural phenomena as are beyond his comprehension, are frequently productive of remarks so quaint and humorous, as to contribute in no small degree to our enjoyment.

"Ere our first day's journey was completed, I discovered how insufficient was the knowledge I possessed to enable me to form even a conjecture, as to the nature of the very first objects which particularly arrested our attention. We were within a few miles of Oxford, when

[1] Published in 1822.

Wilton, looking out of the carriage window, exclaimed, 'Bless me! never before did I see roads mended with such materials!' This, of course, drew my attention to what had so strongly excited his wonder; and I must confess that my astonishment was but little less than his own; for I beheld a labourer with a large hammer breaking to pieces a nearly circular ornamented stone, half as large as the fore-wheel of our carriage, and resembling in form a coiled-up serpent, or snake. We instantly stopped the chaise, and inquired of the man the name of the stone, and where it came from. 'This, Sir,' he replied, 'is a *snake-stone,* and comes from yonder quarry, where there are thousands of them.' Upon hearing this, we all alighted, and with surprise examined some of the unbroken stones, which, though evidently bearing the form of an unknown animal, were composed of solid rock. As we sauntered along, the carriage following us, we came to a neat building on the road-side, which a sign in the hedge opposite denoted to be a house of public entertainment. Hoping to gain more satisfactory information respecting the objects that had so much excited our curiosity, we entered this literally hedge ale-house, and on being shown into a neat room, the casement of which, surrounded by roses and honeysuckles in full bloom, opened into a garden redolent with fragrance and beauty, from the wild profusion of its flowers and shrubs, we determined to rest awhile, and partake of such refreshment as the cottage might afford. While these were preparing, Frank Wilton, whose restless curiosity leaves nothing unobserved, was examining the contents of the old oaken mantel-shelf, and suddenly cried out, 'Well! if the object of travelling is to behold novelties and wonders, surely this county will afford that gratification in the highest degree; for among the curious things on this mantel-piece, there is not one of which I have ever seen its like before.' The articles now passed under my examination, and with no better success; for I had never observed anything similar, nor could I form a rational conjecture respecting their nature.

"While thus engaged, our landlady made her appearance, and from her we learnt that this was her collection of curiosities, gathered from the neighbouring country; and she readily imparted to us all she knew of the subject. Taking up one of the stones, which resembled those we had seen on the road,—'This,' she said, 'is a petrified snake, with which this neighbourhood abounds. These were once fairies that inhabited these parts, and, for their crimes, were turned first into snakes, and then into stones. Here'—showing a stone of a conical form—'is one of the fairies' night-caps,[1] now also become stone.' 'Do, madam,' addressing Emma, 'pray observe this pattern; is it possible lace-work like this should ever have been worked by human hands? This—and this—are pieces of bones of giants, who lived here after the fairies were destroyed.' These bones, she informed us, were frequently dug up in several parts of the county, as well as innumerable *thunderbolts,*[2] some of which she also showed us, affirming that they were the very thunderbolts by which the giants were in their turn annihilated.

"We all listened attentively to this discourse, and on my smiling, when she withdrew, at the romantic account we had received, Wilton strenuously defended our good landlady's narration, and declared, he thought it was not without a fair share of probability. On the return of our hostess, I did not venture to express any doubt of the truth of her story, but merely requested to know if she was aware of there being anywhere a more extensive collection of similar curiosities. 'To be sure, Sir,' she replied, 'our University has a museum full of them; and if you be going through Oxford, it will be well worth your while to see it.'

"After taking refreshment, we left our kind and communicative hostess, but not with an intention of immediately visiting the Museum of the University. On the contrary, I felt that,

[1] A Cidaris, or turban-echinite; see Plate LIII.

[2] *Belemnites,* popularly termed "thunderbolts," Plate LIX.

without some previous knowledge of the objects to be examined, our curiosity would be only excited, not gratified; and I resolved to defer our visit to Oxford, until we had obtained the information necessary to insure us both pleasure and profit in the investigation of the relics of interest it contained.

"Thus, my dear friend, at the very outset of my long anticipated holidays, I have experienced considerable disappointment, and I confidently appeal to you to afford me the information I require; for I know that you have successfully cultivated the science which teaches the nature of these figured stones, or petrifactions, and possess a valuable collection of these most extraordinary objects. You now, therefore, have it in your power to add greatly to the delight and instruction I am anticipating from my travels, by giving me an insight into the origin and nature of the petrified remains which, I am told, are every where to be met with in the districts we are about to visit."

Of Mr. Artis's Work, I need only mention that it was intended, as its title expresses, to illustrate "*The Fossil Remains of Plants peculiar to the Coal Formations of Great Britain; selected for their novelty and interest from upwards of a Thousand Specimens in the possession of the Author;* by Edmund Tyrell Artis, Esq. F.S.A. F.G.S." It was published by Nichols & Son, 1838. The plates are well executed, and faithfully portray the original specimens.

Gallery of Organic Remains in the British Museum.

The collection of fossils in our national museum is now so varied and extensive, and so admirably arranged by its eminent Curator, Charles König, Esq., F.R.S., and his able assistants, Mr. Waterhouse and Mr. Woodward, that the intelligent reader whose interest may be awakened by the beautiful and curious objects figured and described in this volume, cannot fail to be highly gratified by inspecting leisurely the various organic remains from all parts of the world, that are there displayed.

I gladly avail myself of this opportunity gratefully to acknowledge the liberality and kindness I have at all times experienced from the Officers of the several departments of Natural History in the British Museum, in promoting my scientific researches, by affording me every facility to examine the vast stores of information placed under their guardianship.

DESCRIPTION OF THE PLATES.

PART I.

FOSSIL FLORA.

PLATES I. TO XXXIII. INCLUSIVE.

I

DESCRIPTION OF THE PLATES.

PLATE I.

(Plates I. to IX. inclusive are from Parkinson's Organic Remains.)

Fossil Woods and Leaves.

Fig. 1. Fossil coniferous wood, from a bed of clay at Blackwall. This wood is simply bituminized, and has undergone no other mineral transmutation; it is in the usual condition of wood in peat-bogs.

Fig. 2. A piece of bituminous wood, containing *Mellite*, or Honey-stone (*honigstein* of Werner), the yellow crystallized substance in the middle of the specimen. It is a fossil resin, allied to amber: from Thuringia.

Fig. 3. Carbonized coniferous wood, from the so-called "Bovey Coal" formation of Devonshire.

Fig. 4. A piece of calcareous wood, showing very distinctly the ligneous structure on the surface.

Fig. 5. Lignite, or carbonized wood, in clay; the cracks or fissures in the wood are filled up with white calcareous spar. Specimens of this kind are common in many argillaceous strata, as well as in limestone.

Fig. 6. A fragment of shale, covered with the imprints of the leaf-stalks that have been shed. It is a species of *Lepidodendron*. See description of Plate XXVI.

Fig. 7. This fossil vegetable is part of the stem of a tree; and possibly of a species of *Sigillaria*.

Fig. 8. Portion of a nodule of ironstone, enclosing some pinnules or leaflets of a beautiful fern (*Neuropteris*): from Coalbrook Dale, Shropshire.


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PLATE II.

Petrified Woods.

Fig. 1. Silicified bituminized wood; probably from New Holland.

Fig. 2. Silicified root of a coniferous tree, (*Rhizolithes*, of the early collectors,) "resembling in structure that of the larch."—*Mr. Parkinson.*

Fig. 3. A similar example of silicified bituminous wood, or root.

Fig. 4. Fossil coniferous wood, a longitudinal section.

Fig. 5. Another section of the same fossil wood.

Fig. 6. "Petrified larch-tree," from Mount Krappe in Hungary.

Fig. 7. Silicified bituminous wood.

Fig. 8. "Jasperized wood, resembling in structure that of the hazel."—*Mr. Parkinson.*

Fig. 9. Silicified coniferous wood; apparently a dried and withered mass, before it underwent petrifaction.

Fig. 10. Silicified wood, having a cavity lined with mammillated chalcedony; appearing as if the silex had percolated through the substance of the mass, and had slowly oozed into the hollow.

Fig. 11. Silicified bituminous wood. In this specimen the siliceous matter occurs in yellow semi-pellucid globules; the colour is supposed to have been derived from the bitumen.

The silicified woods delineated above, belong to the division which Mr. Parkinson denominated *opaline;* he conceived their peculiar characters to have resulted from an infiltration of fluid silex into the ligneous tissue, which, having previously undergone bituminization, was in a permeable state; hence originated the conchoidal fracture and peculiar resinous lustre which these specimens exhibit.

The specimen, fig. 7, Mr. Parkinson describes as corroborating the opinion that the ligneous tissues were converted into a bituminous substance, and subsequently impregnated with siliceous matter. "In that fossil there is a knot of wood which differs not the least in appearance from that in a recent piece, but it is perfectly impregnated with opaline silex. Is it possible that the change this knot has suffered could have been effected by an abstraction of the greater part or of the whole of its constituent molecules, and a substitution of particles of a different nature? Its hardness and closeness of texture oppose an insuperable bar to the supposition: whilst the mysteriousness of the change is entirely dispelled by admitting of the softening operation of bituminization, and consequent admission of silex in a fluid state."—*Mr. Parkinson.*


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PLATE III.

Petrified Stems and Leaves.

Fig. 1. A portion of the trunk of the fossil vegetable called *Stigmaria ficoides* (of M. Alex. Brongniart); it is the root of a tree common in the coal deposits; see *Supplementary Notes,* Art. *Stigmaria,* p. 198, for a description of the nature and mode of occurrence of these fossils.

Fig. 2. Impressions of dicotyledonous leaves in travertine; a modern calcareous deposit; from Campania.[1]

Fig. 3. Part of the stem of a reed-like plant (*Calamites dubius,* Brongniart); from the coal deposits of Yorkshire. See description of *Calamites.*

Fig. 4. Appears to be a fragment of the stem of a species of *Lepidodendron.*

Fig. 5. Fragment of the leaf of a Cycadeous plant, from the oolite of Stonesfield. (*Zamia pectinata.*)

Fig. 6. Portion of an ironstone nodule, split asunder, showing part of the terminal branch of a *Lepidodendron,* from Coalbrook Dale. See description of *Lepidodendron.*

Fig. 7. "A pebble that appears to have been partly enveloped in a leaf while in a soft state, which has produced the markings on its surface."—*Mr. Parkinson.*

Fig. 8. "Ligniform pitchstone;" fossil wood having a resinous transparency; supposed by Mr. Parkinson to have originated from an intermixture of silex and bitumen; the internal part is opalized.

Fig. 9. Fragment of calcareous coniferous wood from the Lias of Charmouth, Dorsetshire: the vegetable structure is well preserved.

[1] Medals of Creation, vol. i. p. 193.


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PLATE IV.

Fossil Fern Leaves.

Figs. 1, & 2. An ironstone nodule, split asunder, showing an inclosed fern-leaf (*Alethopteris lonchitidis*, of Sternberg); from the coal-beds of Newcastle.

Figs. 3, & 4. The corresponding parts of another nodule, containing a fern-leaf of a different kind (*Neuropteris*).

Fig. 5. A very beautiful fossil fern (*Cheilanthes microlobus*, of Göppert; *Sphenopteris*, of Brongniart); from the coal formation.

Fig. 6. A slab of coal-shale with fronds of ferns (*Alethopteris Serlii*, of Göppert); from Dunkerton.

Fig. 7. A beautiful fern (*Pecopteris*) in coal-shale; from Newcastle.


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PLATE V.

Fossil Ferns and Stems.

Fig. 1. A beautiful delicate plant, belonging to a family of which numerous species occur in the coal deposits; named, from the stellular form of the foliage, *Asterophyllites*.

Fig. 2. A fern in coal-shale, from Yorkshire. (*Sphenopteris trifoliata*, of *Artis.*)

Fig. 3. Another species of star-leaf plant (*Annularia brevifolia*), from the coal of Silesia.

Fig. 4. A dicotyledonous leaf in sandstone, in a beautiful state of preservation; from the tertiary strata of Œningen.

Fig. 5. A frond of a remarkable species of extinct fern (*Cyclopteris orbicularis*, of Brongniart); from the coal of Shropshire.

Fig. 6. An elegant fern (*Pecopteris*), from coal shale; Newcastle.

Fig. 7. A delicate plant (*Sphenophyllum erosum*, vel *dentatum*, of Sternberg), with wedge-shaped pinnules, from the coal formation.

Fig. 8. Portion of a stem, flattened by compression, of a species of *Sigillaria* (*Sigillaria tesselata*, of Brongniart). From the coal of Yorkshire.

Fig. 9. Fern (*Pecopteris oreopteridis*, of Brongniart); from the coal of South Wales.

Figs. 10, & 11. Two specimens of *Asterophyllites* in ironstone nodules, from Coalbrook Dale. The white appearance is occasioned by a deposition of hydrate of alumina.

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PLATE VI.

Fossil Fruits from Sheppey.

The greater number of the specimens here figured, are from the London clay of the Isle of Sheppey.[1]

These fossils are strongly impregnated with pyrites (sulphuret of iron), and are liable to decompose after exposure to the air for a few weeks or months, even when placed in closed cabinets; when first found they are remarkably beautiful. An excellent work on the fossil fruits of the Isle of Sheppey, was commenced by J. S. Bowerbank, Esq. F.R.S. of Highbury Grove; but which, it is much to be regretted, was discontinued after only three numbers were published.

Fig. 1. Portion of a branch of a tree, completely mineralized by pyrites; it is the "pyritous fossil wood" of Mr. Parkinson.

Figs. 2, & 3. Vegetable substances, too imperfect to determine.

Figs. 4, 8, 9, & 13. The berries of an extinct genus of plants, (named *Wetherellia*, by Mr. Bowerbank, in honour of Mr. Wetherell of Highgate,) which, from their appearance when split asunder, are called by the local collectors, "coffee berries." The natural affinities of these fossils are not determined.

Figs. 5, 6, & 7. The fruit or seed-vessel of a palm allied to the recent *Nipa*, a native of the Molucca Islands; the fossil is therefore named *Nipadites*.[2] See the next Plate.

Figs. 10, & 12. Fossil fruits of plants belonging to the Cucumber tribe (hence named *Cucumites*, by Mr. Bowerbank).[3]

Fig. 11. A transverse section of Fig. 16.

Figs. 14, 18, 24, & 26, are varieties of Cucumites.

Fig. 16. Calcareous wood from Oxfordshire.

Fig. 19. Wood mineralized by copper (Cupreous fossil-wood of Parkinson), from Souxson, in Siberia.

[1] For an account of the circumstances under which fossil fruits, &c. occur in that celebrated locality, see Medals of Creation, vol. ii.

[2] Medals of Creation, vol. i. p. 180.

[3] Plate xiii. of Mr. Bowerbank's work on the Fossil Fruits of the London Clay, contains numerous figures of Cucumites.

PLATE VI.—*continued.*

Fig. 18. Fossil fruit resembling the seed-vessels of plants of the genus *Cupania* (*Amomocarpum*, of Brongniart; *Cupanoides*, of Bowerbank); M. Brongniart considers the original to have been related to the Cardamoms (*Amomum*).

Fig. 21. Probably a species of Cupanoides.

Figs 20, & 22. Pericarp of a fruit; its affinities unknown.

Fig. 23. A piece of pyritous wood.

Fig. 25. A rolled specimen of *Nipadites*.

Figs. 24, & 26. Two fruits of plants of the Cucumber family (*Cucumites*).

Figs. 27, & 29. Specimens of the stems of a species of extinct Club-moss (*Lycopodites squamatus*); fossils of this kind are abundant in the pyritous clay of Sheppey.

Fig. 28. A fragment of silicified wood, rounded by attrition; from the gravel-pits at Hackney.

Figs. 15, & 17. I have purposely reserved the description of these fossils for this place, because notwithstanding their close resemblance to the aments or cones of a pine or larch, which led the earlier collectors to regard them as fruits, they do not belong to the vegetable but to the animal kingdom, being the hardened excrementitious contents (*Coprolites*) of the intestines of the fishes, with whose remains they are associated in the chalk.[1] The specimens figured are from Cherry Hinton, in Cambridgeshire; similar fossils occur in the Chalk and Chalk-marl of Sussex, Kent, &c.

[1] See Medals of Creation, vol. i. p. 432; and Dr. Buckland's Bridgwater Essays, vol. ii. pl. 15.

7

PLATE VII.

Fossil Fruits of Palms.

Figs. 1—5. Splendid specimens of one of the most remarkable of the fossil fruits that occur in the London clay of the Isle of Sheppey. The nut in its pericarp or husk is shown in fig. 1, the separate pericarp in fig. 2, and the nut itself in fig. 3. Figs. 4 and 5, represent another beautiful fossil of the same species.

These fossil fruits, which Mr. Parkinson considered as belonging to a species of Cocos, or Cocoa, and M. Brongniart referred to the Pandanus or Screw-pine, Mr. Bowerbank has demonstrated to be closely related to the recent *Nipa,* or Malucca Palm; a low shrub-like monocotyledonous plant, that inhabits marshy tracts near the mouths of great rivers, particularly where the waters are brackish.

Mr. Bowerbank has figured and described eleven species. The species represented in this plate is distinguished as *Nipadites Parkinsonis:* M. Brongniart had previously named it *Pandanocarpum Parkinsonis.*[1]

The following is Mr. Bowerbank's description of these fossils:—

"The fruits of which the group I propose to name *Nipadites* is composed, are known among the women and children by whom they are usually collected, by the name of '*petrified figs.*' The epicarp and endocarp are thin and membranous; the sarcocarp is thick and pulpy, composed of cellular tissue, through which run numerous bundles of vessels. The cells are about the $\frac{8}{100}$th part of an inch in diameter. Nearly in the centre of the pericarp is situated a large seed, which, when broken, is found to be more or less hollow. It is frequently not more than half a line in thickness; but in perfect specimens it presents the appearance of a closely granulated structure, in which small apertures containing carbonaceous matter occasionally occur. The seed in *Nipadites Parkinsonis,* consists of regular layers of cells radiating from a spot situated near the middle of the seed, and apparently enclosing a central embryo.

"If the habits of the plants which produced these fossil fruits were similar to those of the recent *Nipa,* it will account for their amazing abundance in the London Clay of the Isle of Sheppey; which formation, from the great variety of fossilized stems and branches, mixed up with *asteria, mollusca,* and *conchifera* of numerous marine and fresh-water genera, is strikingly characterized as having been the delta of an immense river, which probably flowed from near the Equator towards the spot where these interesting remains are now deposited."[2]

Figs. 6, 7, & 8. Specimens of a seed-vessel, or nut, of an unknown plant, often found in the strata of the coal measures. It is called *Trigonocarpum olivæforme,* from its general shape. From Leicestershire; it probably belongs to a plant of the Palm family.

[1] See an account of an "Excursion to the Isle of Sheppey," Medals of Creation, vol. ii. p. 897.

[2] History of the Fossil Fruits and Seeds of the London Clay. Van Voorst, London, 1840.


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PLATE VIII.

Petrified Stems and Woods.

Figs. 1—7, represent different sections and parts of some remarkably beautiful and interesting silicified stems of an extinct tribe of plants, related to the arborescent ferns, and which are found in considerable abundance at Chemnitz, near Hillersdorf, in Saxony. The name of *Psaronius* is given to the genus by M. Cotta.

Figs. 1, 2, 5, 7, are *P. helmintholithes;* figs. 3, 6, *P. asterolithes;* figs. 5, 6, 7, are enlarged figures of the transverse sections of some of the vessels forming the vascular tissue.

From the stellular figure produced by transverse sections of the vessels, this fossil wood has received the name of "*Staarenstein,*" or Starry-stone. In the time of Mr. Parkinson, the tubes now known to be the vessels of the vascular tissue, were supposed to have been produced by some boring or parasitical animals.

Fig. 4. Transverse section of a stem of calcareous wood from the Bath oolite.

Figs. 8, & 9. Calcareous fossil wood; the cylindrical cavities have been formed by the depredations of the ligniverous boring mollusk, the *Teredo,* and are now filled with translucent calcareous spar. This kind of fossil was called "*Lapis syringoides,*" by the early collectors.

Fig. 10. Silicified wood; the perforations are supposed to have been occasioned by the depredations of boring mollusca: the cavities are filled with a white pellucid chalcedony.

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PLATE IX.

Fossil Stems and Seed-vessels.

Fig. 1. The strobilus or cone of an extinct family of plants whose remains are very abundant in the coal strata, and which have largely contributed to the formation of the mineral fuel now become so indispensable to the necessities and luxuries of man. There are several kinds, and although there can be no doubt that they are the seed-vessels of the *Lepidodendra* with which they are associated, yet but few species are identified with their parent trees. The specimen figured is the *Lepidostrobus ornatus* of Lindley and Hutton. From the coal measures of Coalbrook Dale.

Fig. 2. One of the so-called "*Petrified Melons*" of Mount Carmel.

Figs. 3 & 4. An unknown fossil body; possibly a coral.

Fig. 5. A vertical section of one of the "*Petrified Melons*" from Mount Carmel. The fossil thus named by Mr. Parkinson appears to be merely a siliceous nodule, having a cavity lined with quartz crystals. There is, however, a legend rife among the barefooted friars of Mount Carmel, that has conferred a celebrity on these stones; it runs, that "on this spot was a garden well stocked with melons, and that the prophet Elias, who founded the monastery, once asking the gardener for one of his melons, he with churlish humour answered, they were not melons but stones: on which they were immediately changed into stones, and so remain to this day."

Figs. 6 & 7. Unknown vegetable fossils, highly metallic; fig. 6 appears to be a fragment of a cone.

Figs. 8 & 9, are nodules of pyrites, accidentally assuming the form of fungi; they are not fossils, but simply masses of inorganic mineral matter.

Fig. 10. Portion of the flattened stem of an extinct plant, from the coal measures of Yorkshire, whose affinities are uncertain; supposed to resemble the Yew-tree. It appears to be similar to the fossil named *Knorria taxina* by Messrs. Lindley and Hutton in the British Fossil Flora. In that beautiful work,—the continuation of which is much to be desired,—the genus *Knorria* comprises those fossil stems in which the projecting scars of the petioles are densely arranged in a spiral manner.[1]

[1] Medals of Creation, vol. i. p. 151.

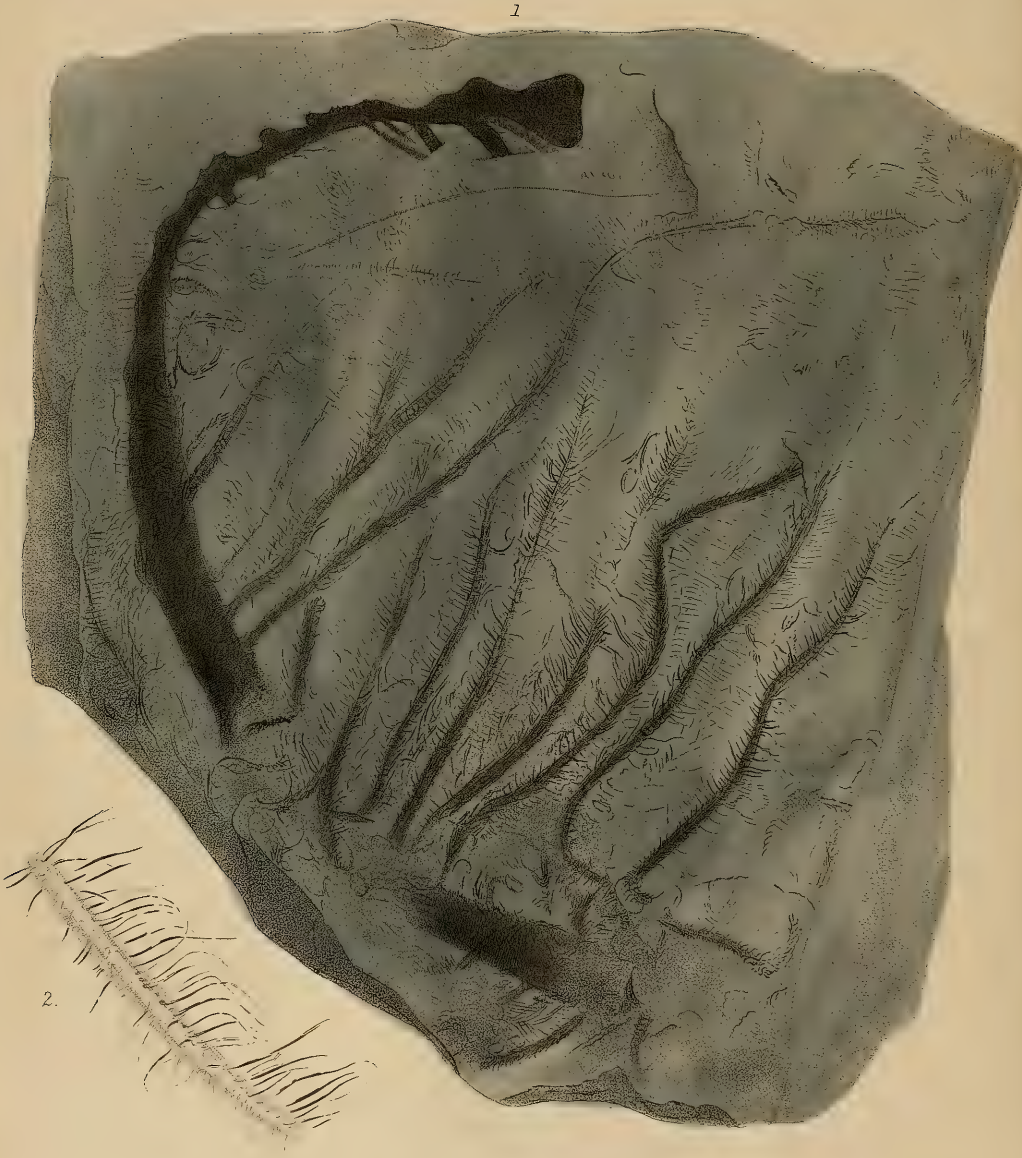
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PLATE X.

(Plates X. to XXXIV. inclusive, are from Artis's work on the Fossil Remains of Plants, from the coal formations of Great Britain.)

"Columnar Hydatica."

Under the name *Hydatica,* Mr. Artis has described two species of fossil plants, from the coal-mine near Wentworth, Yorkshire. The originals appear to have been aquatic plants, having a horizontal or creeping stem, sending up slender branches, which floated by their leaves on the surface of the water.

The generic characters are, " Stem, arborescent, jointed, branched; *leaves,* long, linear."

In the arrangements of Schlotheim and Brongniart, who consider only the construction of the leaves, these plants would belong to the genus *Poacites.*

The species figured is named *Hydatica columnaris,* or Columnar Hydatica. The stem is branched all the way up, and ends in a club-like head; the branches are numerous, simple, alternate, and covered with parallel hair-like leaves.

Fig. 1. The plant of the natural size, imbedded in coal-shale; fig. 2, a branch magnified, showing the two linear series in which the leaves are arranged.

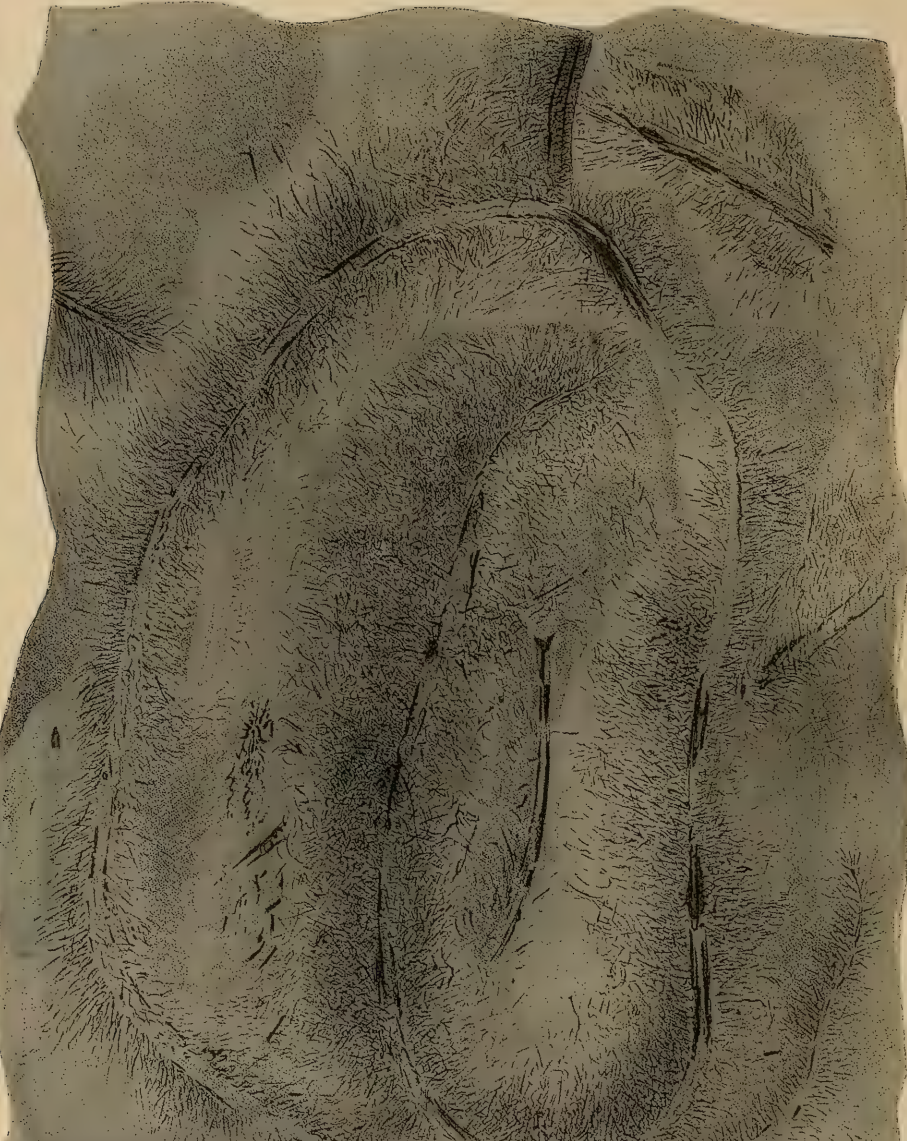
PLATE XI.

"PROSTRATE HYDATICA."

A SPLENDID specimen of another species of *Hydatica,* spread out on the surface of the coal-shale, as if expanded on the bosom of the lake in which it grew: the length of the original, a part of which only is figured in the plate, was eight feet, five inches.

This species is named by Mr. Artis, *Hydatica prostrata.* The stem is jointed, and slightly striated; the joints are formed with irregular sutures, whence arise tufts of linear leaves resembling those of our common grasses.

Fragments of this fossil plant are abundant in the roofs of several of the chambers whence the coal has been extracted, in Elsecar Colliery, Yorkshire.



J. Curtis Del. | Weddell Sc.

PLATE XII.

"Slender Myriophyllite."

The fossil here figured seems to approximate very closely to the Hydatica; but Mr. Artis describes the plant under the generic name of *Myriophyllites*;—*M. gracilis*. The stem is herbaceous and slender, terminating in a point; it is thickly covered with hair-like leaves.

It was found imbedded horizontally, in detached masses, separated from the great mass of vegetable matter which covers the coal, by an intervening layer of shale. It is rarely met with in the same bed with other vegetables, but generally in solitary and thin strata, taking a horizontal position; so that by riving the shale which contains these plants, numbers of them are disclosed on the same surface. In its general aspect this fossil vegetable resembles the trailing roots of some aquatic plants.

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PLATE XIII.

"BRANCHED CALAMITE."

LONG and large jointed stems, generally more or less flattened by compression, and bearing some resemblance to a cane or bamboo, are very abundant in the coal formations. Some of them attain many feet in length, and are of a corresponding magnitude in circumference. The original plants are supposed to have been related to the *Equisetaceæ,* or Mare's-tail, and not to the *Bambusiæ,* and other arborescent grasses. The stem is jointed, and longitudinally striated, having annular impressions at the articulations.

The present species (*Calamites ramosus*) has the stem arborescent and branched; the branches are cylindrical, striated, and inserted at the articulations of the trunk; the articulations of the branches are surrounded by a striated disk.

The stem has been found nine feet in length, and occurs both horizontally and vertically, in sandstone, in Leabrook Quarry, near Wentworth.

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PLATE XIV.

"DOUBTFUL CALAMITE."

THESE fossil stems are from the same sandstone quarry as the Calamite delineated in the previous plate.

They differ in some respects from the usual type of the genus, hence the specific name (*Calamites dubius*). The striæ are narrow, and have a fine groove running down the middle; the fifth or sixth articulation is surrounded by a double line of large globular indentations, one row belonging to each of the connected joints; these imprints have apparently been left by a zone of some organs which surrounded the articulations, and by its pressure left the indented frill, shown in the upper extremity of fig. 2.

These stems are generally found compressed, and from two to three feet in length. Their termination is unknown.

This species is figured by M. Ad. Brongniart in Hist. Veg. Foss. tab. 18, figs. 1—3.

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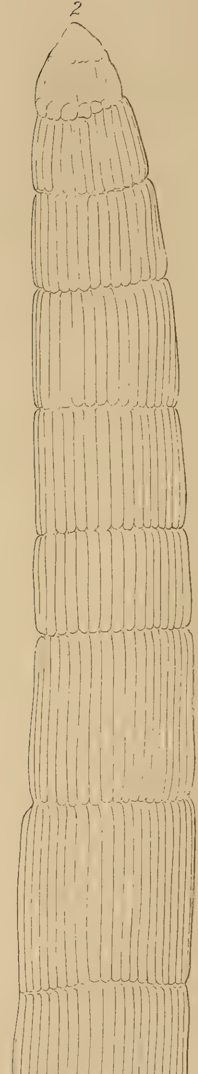

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W. Hall. fc.

PLATE XV.

"Pseudo-Bamboo Calamite."

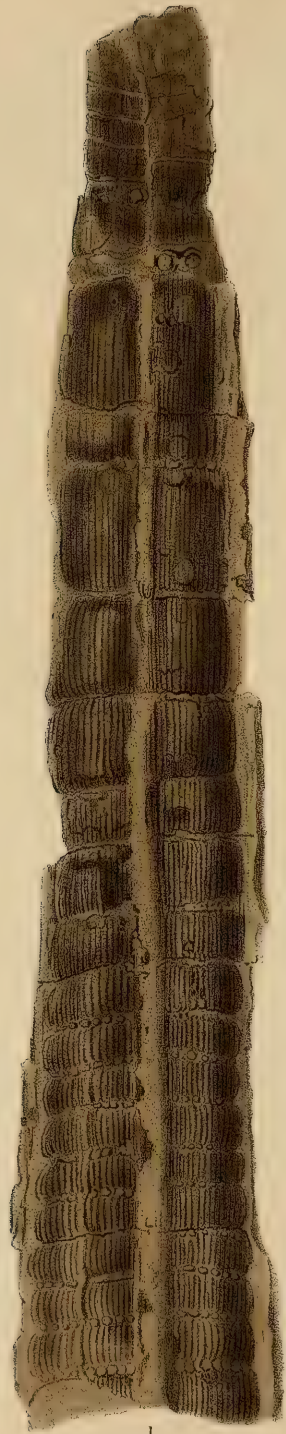
(*Calamites pseudo bambusia,* of Sternberg.
——— *Suckovii,* of Brongniart, Hist. Foss. Veg. tab. 14.)

"This fossil was found in the clay which fills the fissures of a very fine grit, called by the workmen 'Delf,' that forms a stratum from twenty to twenty-five feet thick, in the quarry at Leabrook, near Wentworth, in Yorkshire. Immediately under this stratum there is a thin bed of very good coal; and at a considerable depth below this bed, there is a second layer of coal, eight feet thick, which is covered in particular places with immense masses of fossil plants."

The species here figured very closely resembles the Bamboos. The stem is arborescent, and marked with parallel linear striæ, which are intercepted at the sutures; it is simple and cylindrical, and contracted at the articulations; it occurs five feet or more in length.

Fig. 1, represents part of the middle of a stem.

Fig. 2, shows the gradual upward diminution of the stem, and its pointed termination.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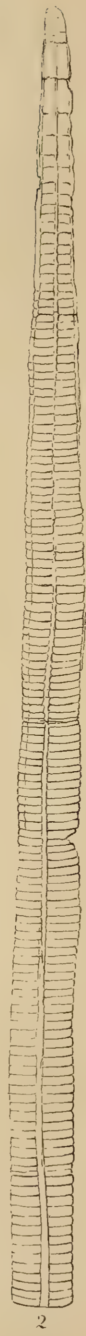
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PLATE XVI.

"SHORT-JOINTED CALAMITE."

(*Calamites approximatus*, Sternberg.
————, Brongniart, Hist. Veg. Foss. tab. 24.)

THIS species of Calamite is characterized by the shortness and number of the joints; these are intercepted by distinct articulations, and have small compressed tubercles, forming a studded row round the trunk. The articulations are about one-fifth the diameter of the stem apart. The tubercular studs, or warts, are probably the cicatrices of fallen leaves; they rise directly from the articulations, and not from the lower termination of the striæ, as in the species figured in the next plate.

The specimen was found imbedded horizontally in soft sandstone, at the bottom of the rock in Hober Quarry, near Wentworth.

FIG. 1, represents a portion of the upper part of the trunk, of the natural size, terminating at the top in a sharp compressed point.

FIG. 2. An outline on a reduced scale, to show the proportionate size of the stem.

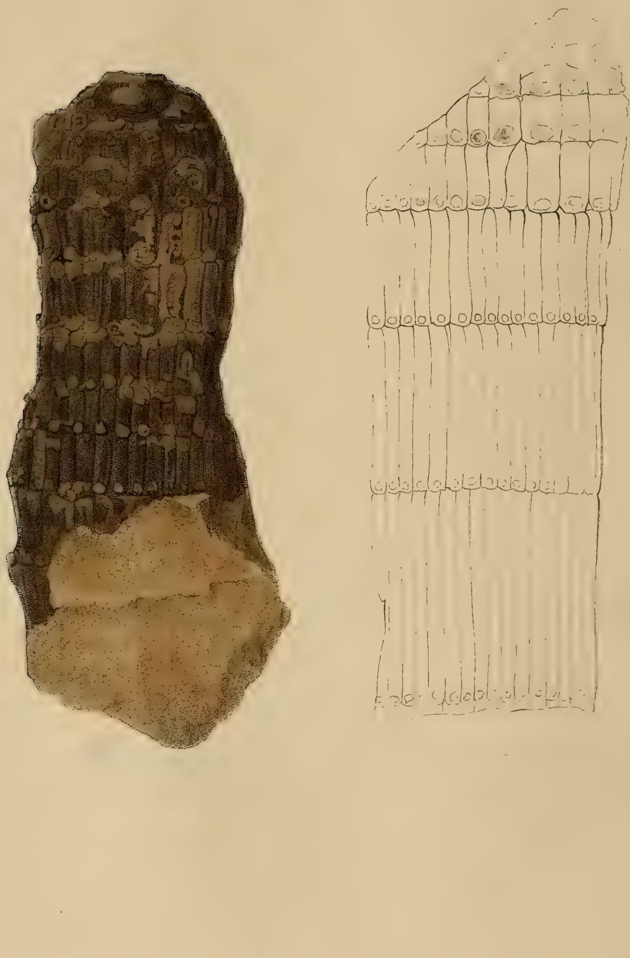

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PLATE XVII.

"Ornamented Calamite."

(*Calamites decoratus,* Artis.
————, of Brongniart, Hist. Veg. Foss. tab. 14, figs. 1—5.)

In this species of Calamite the joints are short, and decrease in length towards the summit, where they terminate in an enlarged rounded head. The striæ are ornamented with tubercles at the bottom, close to the articulation. The striæ are broader, and the tubercles larger, towards the summit.

The stem is sometimes found two feet long, and from two to four inches in diameter.

The situation of the tubercles at the lower extremity of the striæ, is a striking feature of this species; and the termination of the summit of the stem is remarkable for its obtuseness.

The specimen is from Leabrook Quarry, Yorkshire.

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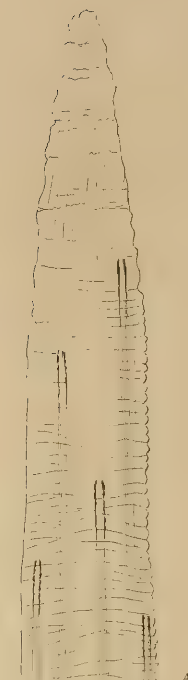

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PLATE XVIII.

"TRANSVERSE STERNBERGIA."

(*Sternbergia transversa,* of Artis.
Artesia————————, of Presl. Additions to Sternberg's *Flora der Vorwelt.*)

THE stems known by the name of *Sternbergia,* (from Count Sternberg, the author of the Fossil Flora,) appear to be related to the Yucca, or to the Pandanus or Screw-pine.

Mr. Artis observes, that they bear considerable analogy to the stems of the *Stapeliæ* of our gardens; but still, the external form, which is the only character visible, does not furnish sufficient ground for their being positively referred to that genus. The stem is marked longitudinally with double keels or ridges, which terminate at different heights spirally round the stem, and have small tubercles at their terminations. There are likewise slight annular depressions, mostly distinct, but in some places two or more unite.

The stem is straight, simple, and cylindrical, and is compressed towards the summit. It is sometimes found six feet in length, and from one to four inches in diameter. It is generally coated with a carbonized bark.

FIG. 1, shows a portion of the stem of the natural size.

FIG. 2. The upper extremity, in which the tubercular terminations of the double keels or ridges are seen at A, B.

Found associated with Calamites in the clay-bind of Leabrook Quarry.

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PLATE XIX.

"Fibrous Sigillaria."

(*Rhytidolepis fibrosa*, of Artis.)

Stems more or less flattened, with the external surface longitudinally furrowed, and uniformly ornamented with rows of deeply imprinted symmetrical figures, disposed with much regularity, are among the most abundant vegetable remains in the coal formation. These are named *Sigillariæ,* from the Latin word *sigillum,* signifying a *seal,* in allusion to the extreme regularity of the imprints on the surface. When found in an upright position, at right angles to the plane of the stratum, the original cylindrical form of the tree is commonly preserved; and many examples are now known of groups of erect Sigillariæ, with their roots extending into the surrounding clay or sandy loam; the roots proving to be the fossil bodies called *Stigmariæ,* which were formerly supposed to be a distinct family of aquatic plants.[1] The first discovery of this highly interesting and unexpected fact was made by Mr. Binney.[2]

The specimen figured was found in an erect position in the sandstone of a quarry at Rowmarsh, near Rotherham in Yorkshire.

The stem is simple, the furrows small and wavy, impressed with dots on the ridges. The cicatrices are ovate, subpentagonal, with the lower angles rounded, having a single gland near the lower extremity. The stem is three feet long, and four inches in diameter.

The transverse section, as seen in fig. 1, shows traces of a double concentric ring, as if produced by internal structure. Fig. 2, displays the equality of the stem throughout its entire length, and its abrupt termination. In fig. 3, is seen the cicatrix with its single gland, for the attachment of the petiole or leaf-stalk. Fig. 4, indicates the undulating line of the top of the ridge.

"The originals of these fossils are supposed by M. Ad. Brongniart to have constituted a peculiar family of coniferous plants, now extinct, which probably belonged to the great division of gymnospermous dicotyledons. In their external forms they somewhat resembled the Cacteæ or Euphorbiæ, but were more nearly related by their internal organization to the Zamiæ or Cycadeæ. The leaves and fruits of these trees are unknown, for no satisfactory connexion has been established between the stems, and the foliage and seed vessels with which they are sometimes collocated."[3]

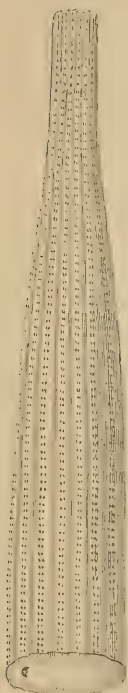
[1] Dr. Buckland's Bridgewater Essay, vol. i. p. 476. [2] See "Supplementary Notes, p. 198." [3] Medals of Creation, vol. i. p. 138.

1

A

B

C



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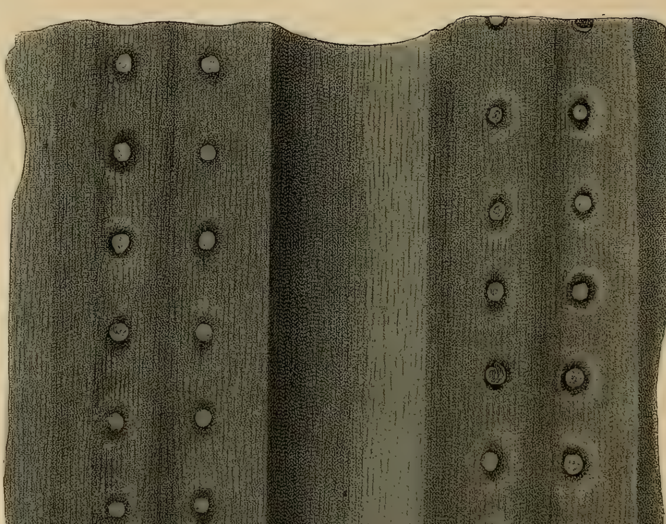

PLATE XX.

" Sigillaria."

(*Euphorbites vulgaris*, of Artis.)

This species is characterized by the remarkable fish-like form of the cicatrices left by the base of the leaf-stalks, and by the rapid tapering of the upper part of the stem, as shown in the reduced figure 1, which represents a specimen nine feet long, five feet in circumference at the base, and only twenty-one inches in circumference at the upper end.

The ridges, which at the superior extremity are simple and narrow, and parted only by a single line, become at the lower part of the stem wide and flat, and are separated by a groove of equal breadth, as seen in fig. 3, which is taken from B, fig. 1.

Fig. 2, represents a portion towards the upper end, at A, fig. 1; and exhibits the different appearance of the bark, and the under surface, when the cortical investment is removed; the imprints in each case differing very much in appearance.

The specimen from which the drawing was taken, was from a sandstone quarry near Altofts, in Yorkshire. In one of the abandoned chambers of the upper Elsecar coal-mine, seven trunks of this tree were suspended freely from the roof, the largest of which was eight feet in circumference.

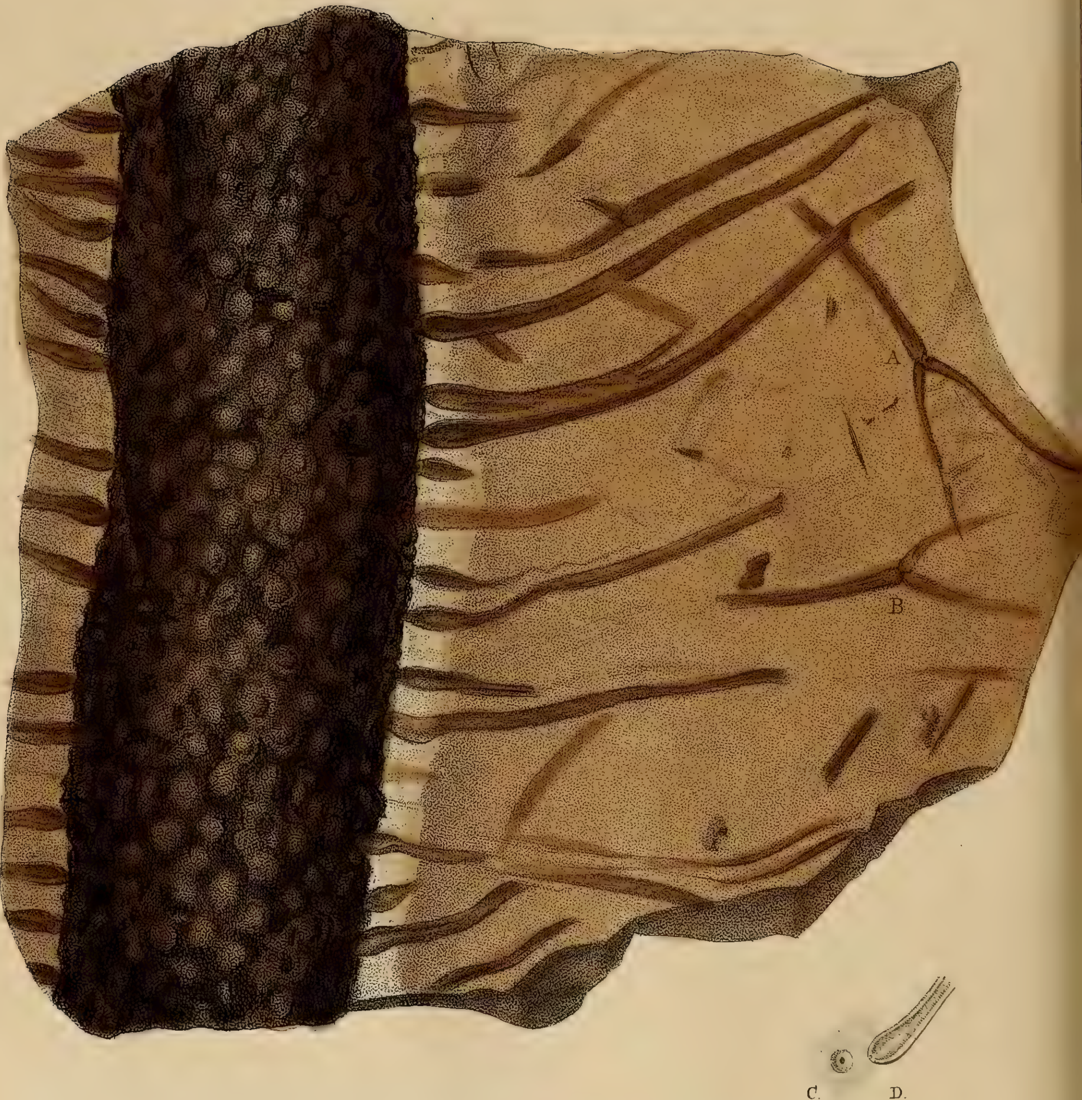

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PLATE XXI.

"Ficoid Stigmaria."

(*Stigmaria ficoides,* of M. Brongniart, Hist. Veg. Foss. tab. 17, figs. 5, 6. *Ficoidites furcatus,* of Mr. Artis.)

The fossil trunks or stems called *Stigmariæ,* or *Variolæ,* (from the pits or areolæ with which they are studded,) occur as abundantly in the coal formation as the *Sigillariæ,* of which tribe of plants unequivocal proof has at length been obtained that they are the roots. These bodies are more or less regularly cylindrical, and vary in length from a few inches to fifteen or twenty feet, the largest being several inches in diameter. Their surface is covered with numerous oval or circular depressions, in the middle of each of which there is a rounded papilla, or tubercle. These variolæ are disposed round the stem in quincunx order. When these roots are broken across, a small cylindrical core or pith is exposed, which extends in a longitudinal direction throughout the stem, like a medullary column. This central axis, which is often separable from the surrounding mass, is composed of bundles of vascular tissue disposed in a radiated manner, and separated from each other by medullary rays. This internal organization presents the same correspondence with that of the stems of Sigillariæ, as does the structure of the roots of a dicotyledonous tree with that of its branches and stems.

The Stigmariæ are almost invariably present in the bed called the "Under Clay," which underlies the coal, and when observed in this situation, long tapering sub-cylindrical fibres are found attached to the tubercles; and these processes or rootlets are often several feet in length. Their form and mode of attachment are shown at c, d; the rootlets terminate in bifurcations, as seen at a, b.

The specimen here figured is part of a root nearly six feet long, and three inches in diameter; some of the rootlets were two feet long. It is imbedded in shale; from Elsecar colliery.[1]

[1] A Stigmaria with rootlets, many feet in length, is placed over the doorway in the room devoted to fossil vegetables in the Gallery of Organic Remains in the British Museum.

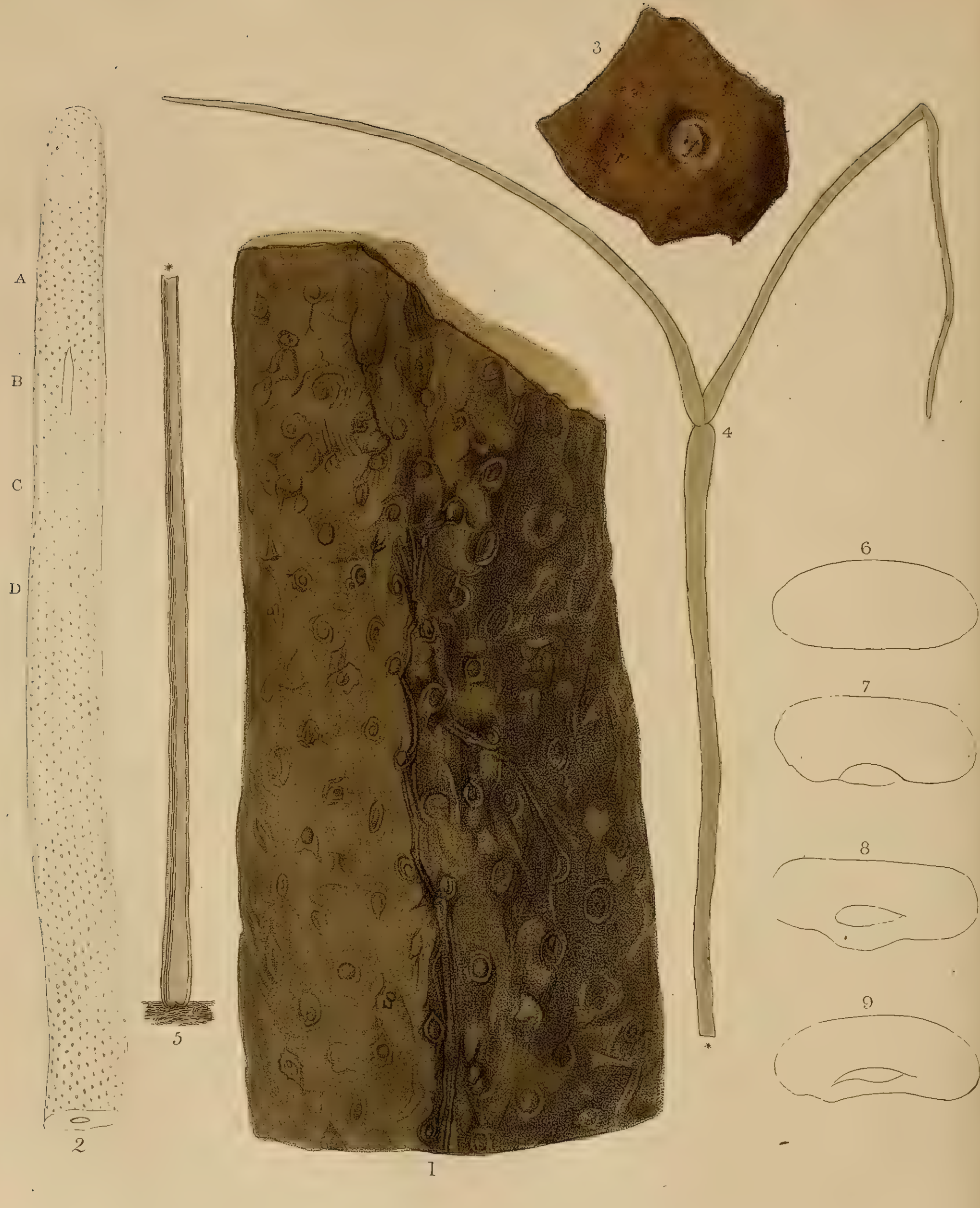

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PLATE XXII.

"Warty Stigmaria."

(*Stigmaria ficoides*, Brongniart.
Phytolithus verrucosus, Martin's Petrificata Derbiensia, Pl. II.
Ficoidites verrucosus, of Artis.)

In this species of Stigmaria the tubercles vary considerably in size, and give a verrucose, or warty, aspect to the surface. The specimen figured on a small scale, fig. 2, and a portion of the natural size, fig. 1, was between five and six feet in length, and four inches in diameter. A groove visible on the external surface indicates the inner axis, which by compression has been pressed from its natural central position; see fig. 2, A, B, C, D: figs. 6, 7, 8, 9, show in the corresponding transverse sections the position of this body.

The mode of attachment of the rootlets to the tubercle on the main root, is represented fig. 5. Fig. 3, exhibits the characters of the two kinds of variolæ, or tubercles.

When Dr. Buckland's Bridgewater Essay was published, the true nature of these fossil remains was unknown. It was supposed by Messrs. Lindley and Hutton, that the original was an aquatic plant, having a short dome-shaped trunk, from which radiated numerous long horizontal branches; and that when the plant was perfect, and the branches floating on the water, its appearance resembled that of an Asterias.[1] This dome-shaped trunk is now known to be merely the base of the stem of the tree. See *Supplementary Notes*, art. *Stigmaria*.

[1] Dr. Buckland's Bridgewater Essay, vol. ii. p. 95.

J. Curtis Del. Weddell Sc.

PLATE XXIII.

"GREAT STIGMARIA."

(*Stigmaria ficoides*, of Brongniart.
Ficoidites major, of Artis.)

THE fossil here represented is a fragment of a Stigmaria having larger tubercles than the species previously described. The tubercles are oval at the base, somewhat compressed, longitudinally furrowed at the top, with a pit in the furrow.

This root is from five to six inches in diameter; the axis is seen near the compressed side, in the transverse section at the bottom of the figure.

From a sandstone quarry, near Rotherham, Yorkshire.

The specimen figured by Mr. Parkinson, *ante*, Plate III. fig. 1, appears to be the fragment of a Stigmaria of this kind in ironstone: the internal axis is seen in the transverse section pressed from its natural position to near the outer surface.

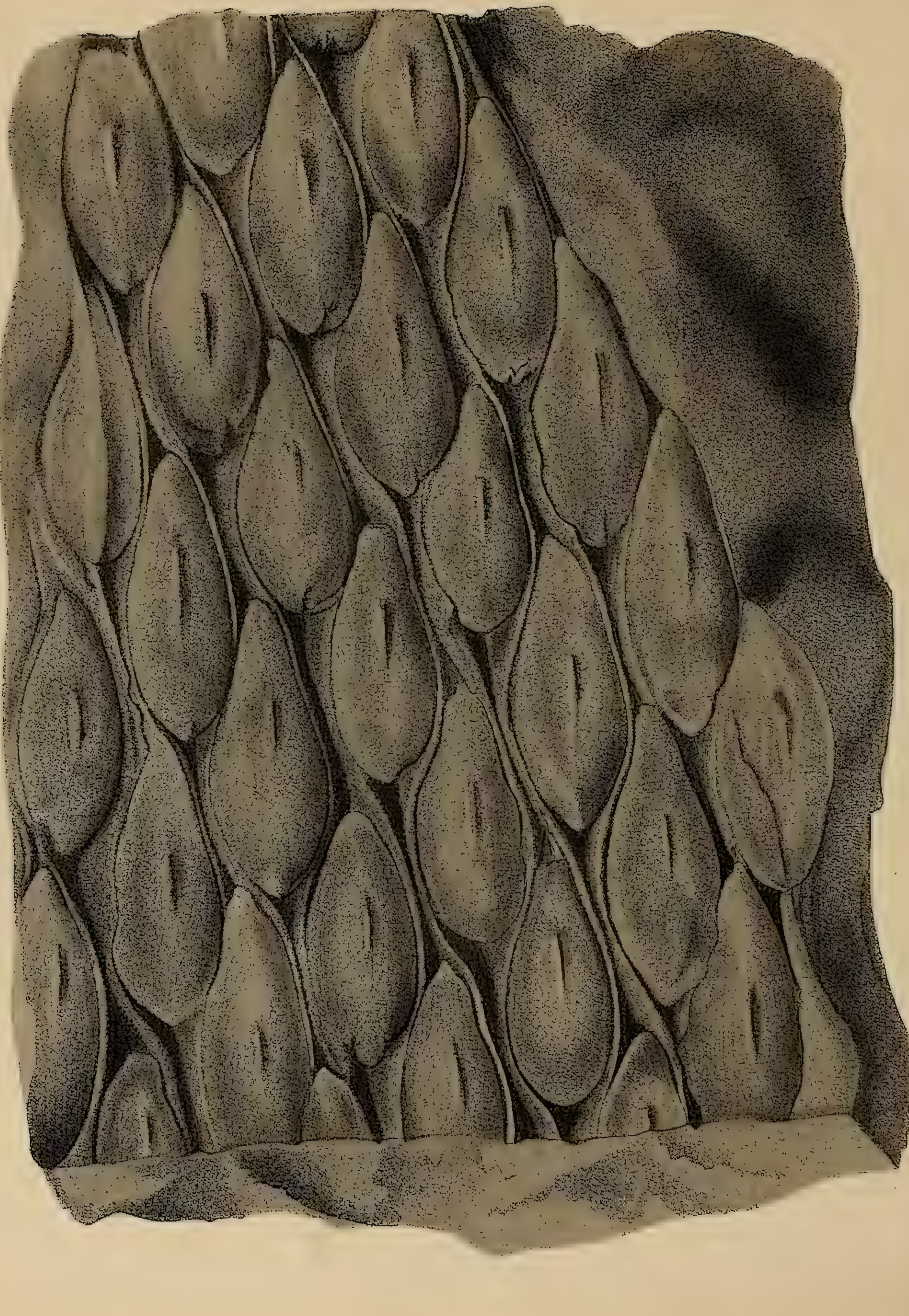

PLATE XXIV.

"CRESTED ASPIDIARIA."

(*Aspidiaria cristata,* of Presl.
Sigillaria appendiculata, Brongniart.
Aphyllum cristatum, Artis.)

THE fossil here represented is part of the stem of a tree nearly forty feet long, and two feet in diameter, found imbedded in sandstone at Banktop, Yorkshire.

The cicatrices of the petioles are obovate, and have a central oblong crest or ridge; the interstices form deep angular furrows.

The stems with this type of sculpturing, are supposed to belong to a group of extinct vegetables, which held an intermediate place between the Sigillariæ, previously described, and the Lepidodendra; together with the latter, and certain true Coniferæ and arborescent ferns, these trees appear to have constituted the principal forests of the Carboniferous epoch.

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PLATE XXV.

"Frondose Megaphyton."

(*Megaphyton distans,* of Lindley and Hutton's Fossil Flora of Great Britain.)

Very large stems not channelled, with regular cicatrices of great size, arranged longitudinally, occur in the sandstone and grits of the Carboniferous formation, and are supposed to belong to a tribe of extinct plants, more nearly allied to the arborescent ferns of our tropical climes, than to any other existing trees.

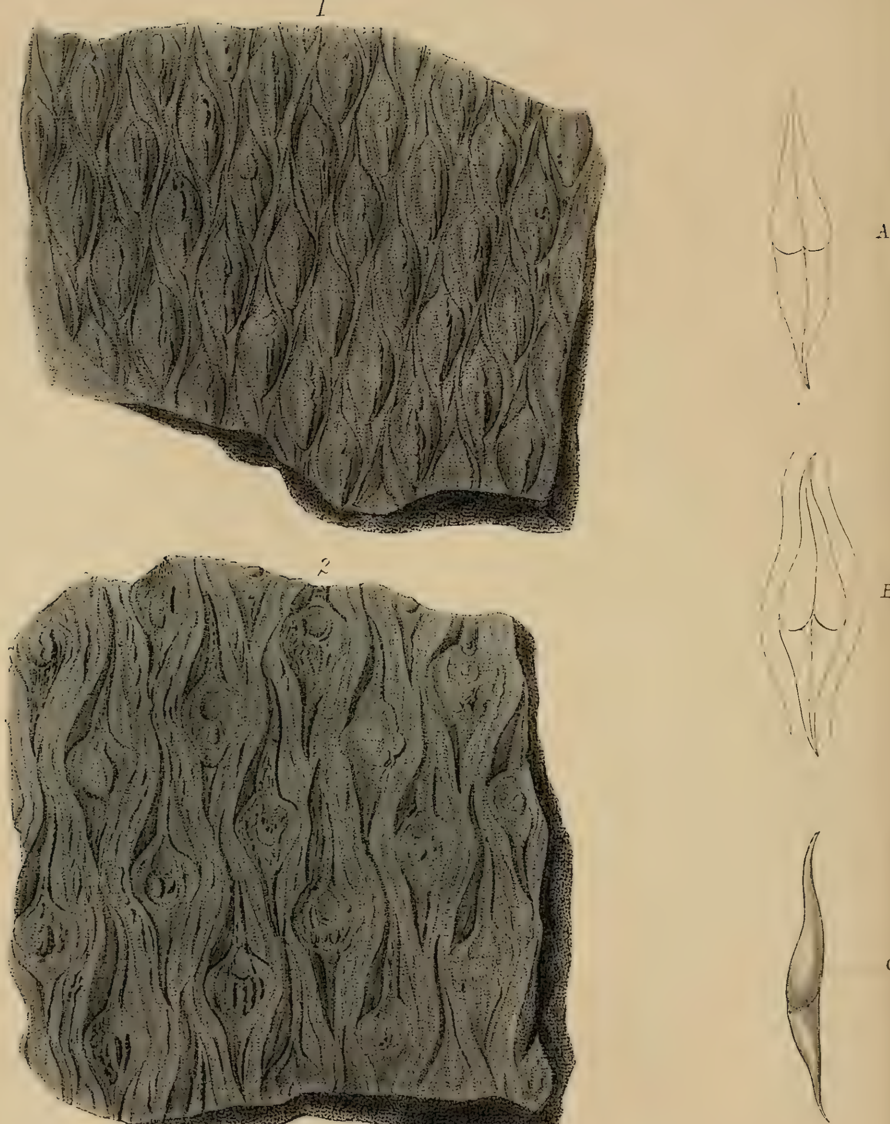
The specimen figured is part of a stem ten feet in length, from a quarry near Rowmarsh in Yorkshire.

This stem has a coarse fibrous surface, furrowed longitudinally; the cicatrices left by the shedding of the leaves are of a horseshoe shape with the points directed upwards.

This group of stems has been separated by writers on fossil botany into several genera, as *Bothrodendron, Ulodendron,* &c.[1] In some of these the scars are five inches in diameter.

There are many fine examples of these fossils in the British Museum.

[1] See Dr. Buckland's Bridgewater Essay, plate 56.



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Waddell Sc

PLATE XXVI.

" Lepidodendron, or Scaly-tree."

(*Aphyllum asperum*, Rough Aphyllum, of Artis.)

" The Lepidodendra (Scaly-trees) are a tribe of plants whose remains abound in the Coal formation, and rival in number and magnitude the Calamites and Sigillariæ previously described. The name is derived from the imbricated or scaly appearance of the surface, occasioned by the little angular scars left by the separation of the leaves. Some of these trees have been found almost entire, from their roots to the topmost branches. One specimen, forty feet high, and thirteen feet in diameter at the base, and divided towards the summit into fifteen or twenty branches, was discovered in the Jarrow coal-mine, near Newcastle.[1]

" The foliage of these trees consists of simple linear leaves, spirally arranged around the stem, and which appear to have been shed from the base of the tree with age. The markings produced by the attachment of the leaves are never obliterated, and the twigs and branches are generally found covered with foliage. The originals are supposed by M. Adolphe Brongniart, notwithstanding their gigantic size, to have been closely related to the Lycopodia, or Club-mosses."[2]

Associated with the stems of Lepidodendra, and oftentimes imbedded in masses of their foliage, and in some instances attached to the extremities of the branches, are numerous oblong or cylindrical scaly cones, garnished with leaves: an imperfect specimen is figured in Plate IX. fig. 1, and the vertical section of another in Plate III. fig. 6. These cones have received the name of *Lepidostrobi* (Scaly-cones), and are the seed-vessels or fruits of the Lepidodendra.[3]

These fossils often form the nuclei of the ironstone nodules from Coalbrook Dale, and are invested with a pure white hydrate of alumina; the leaflets, or more properly *bracteæ*, are often replaced by *galena*, or sulphuret of lead, giving rise to specimens of great beauty and interest, as examples of the electro-chemical changes which these fruits of the carboniferous forests have undergone.

The fossils figured in this Plate, are portions of a stem eleven feet in length, from near Hoyland, Yorkshire. Fig. 1, is from the upper part, and shows the carbonized scales attached; fig. 2, represents part of the lower end, in which the scales are decorticated, from the adhesion of the bark to the surrounding shale.

A. Shows the cicatrix, with its transverse gland that connects the scale, in the upper part of the trunk.

B. Exposes the interstice between the scales in the lower portion of the stem.

C. A section of the hollow cicatrix.

[1] Wonders of Geology, sixth edition, vol. ii. p. 722.
[2] Medals of Creation, p. 144.
[3] See Medals of Creation, p. 147, and lign. 31, p. 149.

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PLATE XXVII.

"Lychnophorite."

(*Lychnophorites superus*, of Artis.)

The fossil figured under the above name by Mr. Artis, is part of a large branch of a tree, the surface of which is covered with the cicatrices of leaf-stalks, as in the Lepidodendron. The form of the cicatrix and point of attachment is shown at B; figure A, is the restored outline of a leaf.

"Dr. Martins refers the fossil plants of this type to a recent shrubby genus of syngenesious plants, which cover the plains of Brazil, and which he names *Lychnophora,* whence he formed this fossil genus, by changing the termination to *ites,* according to the common usage."—*Artis.*

The specimen represented is in sandstone, from Swinton Common, near Rotherham, Yorkshire.

This tree seems to be closely allied to the Lepidodendra.

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PLATE XXVIII.

"Eared Neuropterite."

(*Neuropteris auriculata,* Brongniart. Hist. Veg. Foss, tab. 66.
Filicites Osmunda, of Artis.)

The general aspect of this beautiful filicite very much resembles that of our well-known flowering fern, the elegant *Osmunda regalis ;* the auriculated or one-eared base of the lanceolated leaflets forms, however, a distinguishing character. It belongs to the genus *Neuropteris* (nerved-leaf fern) of M. Brongniart, which comprises many species of delicately-veined ferns: the veins in this fossil plant are very fine, arched, and rise obliquely from the base of the leaflet.

The leaflets are often found detached, and in many instances, though completely carbonized, are so firm, and so slightly attached to the shale, that they may be separated by a pair of forceps: when removed, their impression remains on the stone, as is shown in the light-coloured part of the figure 2 ; the form and distribution of the rib, and nervures or veins, are seen in fig. 3.

From Elsecar colliery.

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PLATE XXIX.

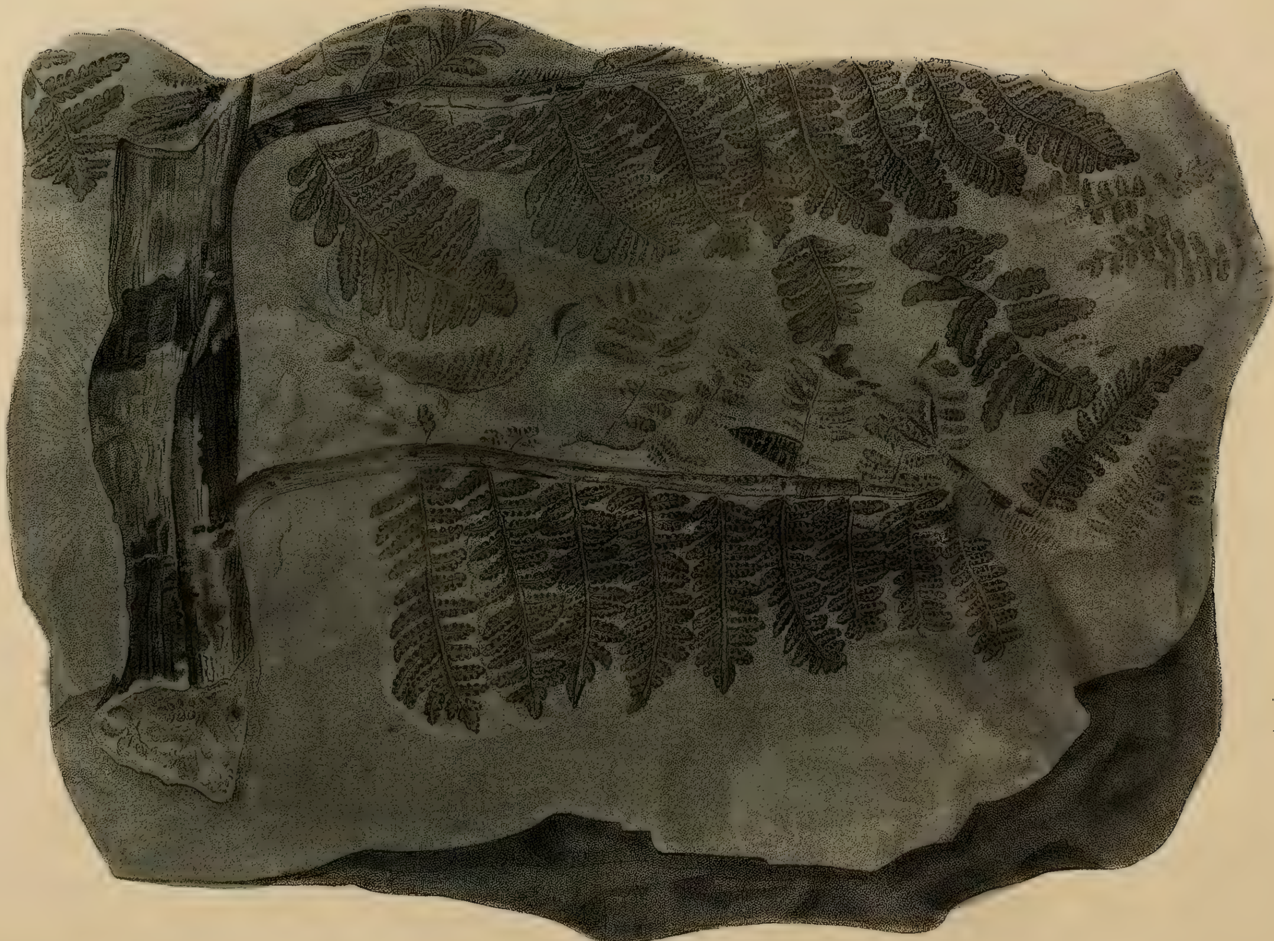
"TRIFOLIATE SPHENOPTERITE."

(*Sphenopteris trifoliata,* Brongniart, Hist. Veg. Foss. tab. 53, fig. 3.
Filicites trifoliatus, of Artis.
Cheilanthites; from its supposed analogy to the recent genus *Cheilanthes.* Göppert. *Trans. Academy of Bonn.*)

THIS is a rare species of fern from the coal shale of Yorkshire, Elsecar Colliery. It has the leaf or frond tripinnate; the pinnæ, lobes, or wings, alternate with an odd one; the leaflets are ternate, with roundish, convex lobes.

This plant has been referred to the tropical ferns, and is nearly allied to the genera *Davallia,* or *Cheilanthes;* but from the almost general absence of the organs of fructification in fossil ferns, it is impossible to refer them with any certainty to living genera. It belongs to the Sphenopteres, or wedge-shaped-leaf ferns, of M. Brongniart.

A, shows the cast or matrix of the under side of the leaf; B, the upper side in relief.



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Waddell Sc.

PLATE XXX.

"MILTON FILICITE."

(*Pecopteris Miltoni,* Brongniart, Hist. Veg. Foss. tab. 114.
Filicites Miltoni, Artis.)

THIS exquisite specimen exhibits part of two leaves attached to the stem, the under surface of the fronds, on which the fructification is beautifully displayed, being exposed. The frond is tripinnate, the stipes large and strong, the leaflets linear with the tip rounded. The fructification is arranged in lines near the margin; but slight traces of the venation of the leaflets are distinguishable.

From Milton, in Yorkshire.

J. Curtis Del. Weddell Sc

PLATE XXXI.

"PLUMOSE PECOPTERITE."

(*Pecopteris plumosa,* Brongniart, Hist. Veg. Fos. tab. 121.
Filicites plumosus, Artis.)

THIS elegant fern is characterized by the plumose or wavy character of the stipes or stems of the fronds, which are tripinnate; the leaflets are lanceolate and sessile,—that is, are closely attached by their base, without a stalk. The fructification is seen disposed near the margins of the leaflets on the left hand upper part of the specimen.

From the same locality as the last.

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Weddell Sc.

PLATE XXXII.

"Decurrent Filicite."

(*Alethopteris decurrens*, of Göppert.
Pecopteris heterophylla, Lindley and Hutton, tab. 38.
Filicites decurrens, of Artis.)

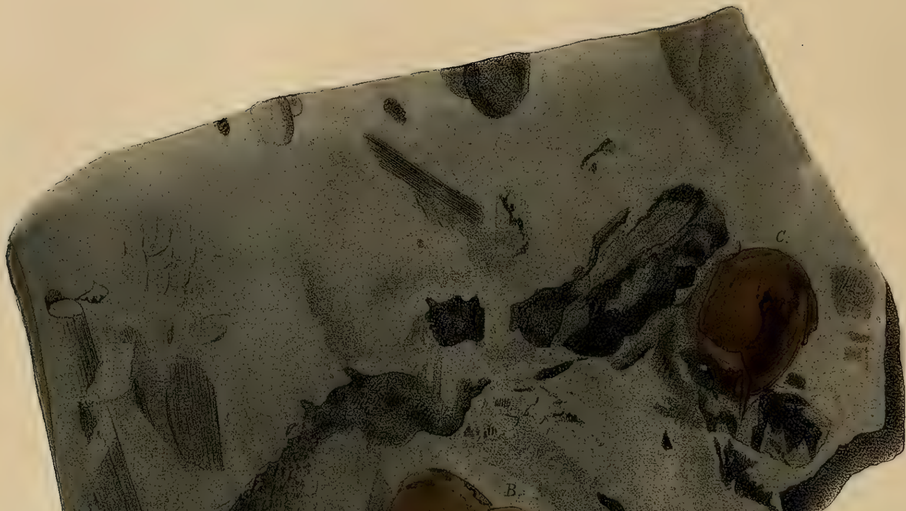
The drawing represents but a small portion of the specimen, which indicated a plant of gigantic size.

"The leaf or frond of this fern is very large, tripinnate or quadripinnate ; the stipes is broad and undulated; the leaflets are sessile, linear-lanceolate; the ribs pinnate, the secondary ribs perpendicular to the main rib ; the first leaflet on the superior side of the pinnule adheres by its side to the rachis."—*Artis.*

This fern, which closely resembles some recent species, (*Pteris aurita,*) occurs in great abundance in the shale at Alverthorpe near Wakefield. Notwithstanding the profusion with which the foliage of many kinds of ferns is distributed throughout the coal formation, the undoubted stems of tree-ferns are so rare, that it may admit of question whether some of the leaves which from the analogy of their structure to recent forms have been referred to the ferns, may not have belonged to the stems of unknown trees with which they are associated in the strata ; for as, in the animal kingdom, distinct types of living organisms are often found blended in the extinct races, so in the vegetable, it is possible, that foliage and stems, of apparently discordant types, may have belonged to the same extinct species or genus of trees. This problem can only be solved by diligent and continued research in the richest localities of coal-plants.

M. Brongniart remarks that every bed of coal is the product of a special vegetation, often different from that which preceded, and that which followed it. Each bed thus resulting from a distinct vegetation, is characterized by the predominance of certain impressions of plants, and the experienced miners distinguish in many cases the beds they are working, by their practical knowledge of the plants that prevail.

The same beds of coal, and the deposits which cover it, ought therefore to contain the different parts of the plants that were living at the period of its formation ; and by carefully studying the association of these different fossils, forming thus little special floras, generally of but few species, we may hope to acquire data by which we may advance the means of reconstructing the anomalous vegetable forms of the ancient world. M. Brongniart strongly urges attention to this circumstance in the examination of the coal strata, with the view of determining the identity of the scattered leaves, stems, and fruits, in any particular stratum. By such a procedure, much addition would be made to our knowledge of the entire structures of many of the fossil plants of which we now only know the fragments. Thus we may hope to ascertain the foliage of the Sigillariæ, the roots of which, by a similar method, have but recently been determined to be the fossils called *Stigmariæ.*



J. Curtis Del.

Weddell Sc.

PLATE XXXIII.

"CARPOLITHE, OR FOSSIL SEED-VESSEL."

(*Carpolithus marginatus,* of Artis.)

THE carbonized husks or shells of nuts, and other carpolithes, or seed-vessels, are not unfrequently met with in the coal and coal-shale. In the slab of shale figured, there are three specimens of an oval nut, B, G, which is striated longitudinally. These are associated with other vegetable remains, among which part of a Lepidostrobus, the supposed cone or strobilus of a species of Lepidodendron (see description of Plate IX.), is conspicuous at A.

PART II.

FOSSIL FAUNA.

Plates XXXIV. to LXXIV. inclusive.


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PLATE XXXIV.

(Plates XXXIV. to LXXIV. inclusive, are from Parkinson's Organic Remains.)

Fossil Tubipore, from Derbyshire.

(*Syringopora geniculata*, of Phillips, from the Mountain Limestone, Derbyshire.)

The specimen figured is a mass of limestone, on the surface of which is spread out in high relief a delicate tubiporite, or fossil coral, allied to the Tubipora, or "Organ-pipe coral," so generally preserved in cabinets of natural curiosities, from the beauty and elegance of its crimson tubes. The fossil, however, though somewhat resembling the recent coral in its general form, belongs to an extinct genus.

This Syringopora appears to have been very abundant in the sea in which the strata of mountain or carboniferous limestone were deposited, for it forms entire beds of great extent. A beautifully figured marble results from this coral, when the interstices of its tubes have been filled up with compact calcareous matter. A small polished slab is represented in fig. 2. At Matlock, vases, and other ornamental articles, are made of it; and the sections of the coral tubes impart considerable variety of figures.[1]

Some slabs of this fossil coral are of a dull red hue, which there is every reason to conclude is due to the colour of the original; and not only are traces of the natural tints of the living zoophyte preserved, but even the animal membrane of the coral; and this may be exposed by immersing a fragment of the marble in dilute muriatic (hydrochloric) acid. Mr. Parkinson thus describes the result of his first experiment:—

"A fragment of the marble (Plate XXXIV. fig. 2) was exposed to the action of muriatic acid in a very dilute state. As the calcareous earth was dissolved, and the carbonic acid escaped, I was delighted to observe the membranaceous substance appear, depending from the stone in light, flocculent, elastic flakes. Many of these retained a deep red colour, and appeared in a beautiful and distinct manner, although not absolutely retaining the form of the tubipore. A faithful representation of this appearance is given in fig. 3."

This experiment of Mr. Parkinson was highly important, as proving the previously almost incredible fact, that animal membrane, when hermetically sealed, as it were, in the solid stone, was as indestructible as the rock itself. It suggested, too, the probability that vestiges of other animal tissues might be traced in organic remains, and encouraged subsequent observers to seek

[1] Articles of this kind may be obtained of Mr. Tennant, 149, Strand.

PLATE XXXIV.—*continued.*

for evidence of the soft parts of animal bodies entombed in the strata. It was the first step in the right direction, and led to the detection of many highly interesting phenomena. In Dr. Buckland's Bridgewater Essay will be found figures and descriptions of the eyes of crustacea; of the wings, elytra or wing-covers, and the integuments of the body of insects; of the skin of reptiles; and, in the "Wonders of Geology," and "Medals of Creation," of the membranes of the air-bladder, and of the capsule of the eye of fishes; of the soft parts of the animalcules called foraminifera, &c. The bodies of mollusca, or shell-fish, converted into a dark brown mass (*mollushite*), occur in such abundance in some deposits, as to yield a rich manure from the quantity of phosphate of lime. The excrementitious substances termed by Dr. Buckland "Coprolites," are also used for agricultural purposes.

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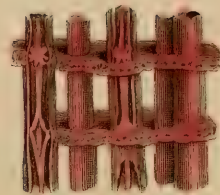

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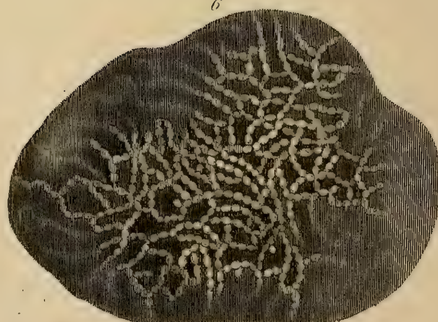

PLATE XXXV.

The subjects here figured are Fossil Corals.

Fig. 1. (*Syringopora ramulosa.*) A fragment of another species of the coral previously described; from the mountain limestone.

Fig. 2, represents four connected tubes of the recent organ-pipe coral (*Sarcinula musica*) of New Holland, to show the structure of this type of Zoophytes. Coloured figures of the live polypes of this coral are given in Wonders of Geology, sixth edition, vol. ii. plate vi.

Fig. 3. A polished slab of marble, the white markings in which are produced by sections of the tubes of the same species of coral as that represented in fig. 1.

Fig. 4. (*Catenipora escharoides.*) The fossil here delineated is well known to collectors by the name of "*chain-coral,*" derived from the elegant cateniform markings produced by transverse sections of the parallel tubes, which being of an oval form, and in close apposition, give rise to chain-like figures, as shown in figs. 5 and 6. From Dudley.

This fossil coral abounds in that division of the Silurian formation termed the Wenlock or Dudley limestones, wherever these deposits occur. The most exquisite specimens are obtained from the Falls of the Ohio, at Louisville, in the United States of America. A coral reef of the Silurian epoch here exists in the bed of the mighty stream of fresh water, almost as perfect as when growing in its native sea! The river dashes over the entire mass in the season of high water; but in those periods when the stream is low, the ridge of coral is exposed, and its surface then presents the most extraordinary display of Silurian corals, of numerous species and genera, standing in relief on the more compact masses of the rock. The substance of the corals, being siliceous, resists the action of the cataract, while the softer calcareous matter which filled up the interstices of the tubes, lamellæ, &c. of the zoophytes, is washed away atom by atom; and natural dissections are formed, which art would in vain attempt to imitate. Dr. Yandell, of the Medical College, Louisville, and Dr. Clapp, of New Albany, have splendid collections from the Falls, which every geologist and intelligent traveller who visits Kentucky should not fail to examine: the masses of Astreæ, Madrepores, &c. are so fresh in their aspect, as not to be readily distinguished from the recent specimens of the same genera which are placed beside them.[1]

Fig. 5, is a transverse section of a mass of chain-coral from Dudley.

Fig. 6. The same, as seen by transmitted light.

[1] See Sir Charles Lyell's Travels in the United States; and Drs. Yandell and Shumard's "Contributions to the Geology of Kentucky." Louisville, 1847.


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PLATE XXXVI.

VARIOUS FOSSIL CORALS FROM DIFFERENT FORMATIONS.

FIGS. 1, 2, 3. (*Cyathophyllum turbinatum*, of Goldfuss.) These three turbinated or top-shaped corals are referable to a genus of which many species are exceedingly abundant in the Wenlock or Dudley limestone of the Silurian System. They belong to the Anthozoa, or flower-like corals. The living animal, of which the *coral* is but the durable earthy fabric or skeleton, bore a close analogy to the sea-anemone, or animal flower (*Actinia*), of our coasts. Each of these specimens belonged but to a single animal: the Cyathophylla are not, like the tubipores previously described, an aggregation of numerous individual polypes.[1]

FIG. 4. A small coral (*Fungia*) from Dudley.

FIG. 5. On this block of mountain limestone there are the remains of two different kinds of corals. The upper cylindrical part is a fragment of Cyathophyllum, to the lower part of which is attached a species of another genus (*Michelinia*).

FIG. 6, is a small coral (*Fungia numismalis*, of Goldfuss), common in the Oolite.

FIG. 7. A piece of encrinital limestone, from Derbyshire, having a conical cast—that is, the stone has been moulded in the interior or cavity—of a turbinated coral (*Turbinolia*).

FIG. 8. A longitudinal section, showing the transverse cells and lamellæ of the same kind of coral (*Cyathophyllum*) as figs. 1, 2, 3.

FIG. 9. A species of Turbinolia (*Turbinolia complanata*, of Goldfuss).

FIG. 10. A small turbinated coral (*Turbinolia mitrata*, of Hesinger), from the Silurian strata of Gothland.

FIG. 11. A Turbinolia from the Silurian deposits of Sweden.

FIG. 12. A remarkable coral (*Petraia*, of Munster), from the Devonian strata.

FIGS. 13 & 14, are sections of Cyathophylla, like figs. 1, 2, 3, to exhibit the internal structure.

FIGS. 15 & 16. Two elegant simple corals (*Caryophyllia centralis*, of Mantell), from the chalk of Kent. The form and disposition of the lamellæ of the cavity, as seen at the upper part of the specimens, are shown at *a* and *b*.

FIG. 17. A transverse and polished section of a species of Cyathophyllum, from the Devonian strata, at Blackenberg on the Rhine.

[1] For a popular account of the nature of Corals and the animals which form them, see Wonders of Geology, vol. ii. Lect. vi. p. 589.


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PLATE XXXVII.

Various Fossil Compound Corals.

Fig. 1. A beautiful specimen of Star-coral (*Astrea ananas,* of Goldfuss), from the Silurian strata of Sweden. At *a*, is shown "the mode in which, as in proliferous flowers, new polypes bud from the centre of the parent disk. At *b*, is represented the growth in the recent *Madrepora stellaris* of Linnæus."—*Mr. Parkinson.*

Fig. 2. An elegant Cyathophyllum (*C. dianthus,* of Goldfuss), from the Silurian formation of Sweden. At *c*, (the lower part of the plate,) is shown its probable mode of increase.

Figs. 3 & 6. A columnar compound coral (*Lithostrotion striatum,* of Lhwyd), from the mountain limestone of Derbyshire; fig. 3, is a transverse section of fig. 6, showing the basaltiform arrangement of the columns.

Fig. 4. "A fossil madrepore, from Lincolnshire."—*Mr. Parkinson.*

Fig. 5. A very elegant and abundant coral (*Caryophyllia annularis,* of Parkinson), in the bed termed "Coral Rag," of the oolite of Wiltshire, Berkshire, &c. Large conglomerated masses of this branched species form a considerable proportion of the fossil coral-reef which traverses some parts of the oolite: and when this bed is worked for road materials, blocks of this coral, more or less changed into calcareous spar, may be seen lying on the way-side. Near Faringdon, in Berkshire, a quarry in the Coral-rag has yielded many beautiful examples.

Fig. 7. Called "Spider-stone," by Mr. Parkinson. It is a species of *Astrea: d*, is an enlarged view of one of the polype-cells.

Fig. 8. A beautiful fossil coral, from Transylvania (apparently a species of Lithostrotion?).

Fig. 9. The specimen figured is from the mountain limestone of the Mendip Hills. (It is the *Michelinia tenuisepta,* of Phillips; *Manon favosum,* of Goldfuss?) It is described by Mr. Parkinson as "bearing somewhat of a honeycomb appearance."


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PLATE XXXVIII.

Fossil Corals, and Coral Marbles.

Fig. 1, is a polished slab of the carboniferous limestone, well known as the Kilkenny marble, and much used for chimney-pieces. The figures exposed on the surface are produced by sections of enclosed corals (some species of Cyathophyllum), which are transmuted into white calcareous spar.

Fig. 2. A coral of the same kind (*Cyathophyllum turbinatum*), from the mountain limestone of Derbyshire.)

Fig. 3. A polished slice of Derbyshire marble, the markings on which are derived from sections of enclosed branches of corals (*Syringopora*), resembling that figured in Pl. XXXIV.

Fig. 4. An elegant compound coral, called "Spider-stone" by collectors (*Astrea arachnoides*, of Dr. Fleming); from Wiltshire: the geological habitat uncertain; probably the Oolite.

Fig. 5. This specimen appears to be a cluster of corals belonging to the genus Cyathophyllum.

Fig. 6. A magnified sketch of one of the cells of fig. 4.

Fig. 7. A polished transverse section of a coral; the precise relation of this species is not certain.

Fig. 8. This is a very abundant coral in some of the beds of mountain limestone, (*Lithodendron fasciculatum*, of Phillips.) The specimen figured is from Clifton, near Bristol. The marble cups, and other ornaments, manufactured from the rocks near that place, often exhibit sections of this species.

Fig. 9. A mass of coral from Ingleborough, (*Cyathophyllum fungites.*)

Fig. 10. A polished slice of a beautiful marble richly marked by the sections of the enclosed corals (*Astrea undulata*, of Dr. Fleming); from Switzerland: probably from the Oolitic or Jurassic formation.

Fig. 11. Vertical section of a fossil coral, showing the transverse arrangement of the internal cells.

Fig. 12 & 13. These specimens are polished sections of a very beautiful compound coral (*Astrea Tisburiensis*, of Miss Benett), which occurs in a silicified state in the Portland beds that are quarried at Tisbury, in Wiltshire. Masses of chert (a kind of coarse silex or flint), wholly made up of this coral, are often met with, and when sliced and polished are extremely beautiful and interesting; the originally calcareous fabric of the zoophytes being perfectly transmuted into silex, and the interstices filled up with a similar substance, but of a different colour.[1]

[1] Specimens of the Tisbury Astrea, and of most if not all of the coralline marbles figured and described, may be obtained of Professor Tennant; and also vases, &c. of the various marbles of Derbyshire.


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PLATE XXXIX.

Various Fossil Corals and Sponges, or Amorphozoa.

Fig. 1. A coral from the Dudley limestone. (*Favosites?*)

Fig. 2, is a vertical section of figs. 4 and 5, to show the internal arrangement of the cells.

Fig. 3. The under surface of a very common species (*Favosites Gothlandica,* of Goldfuss); from the Wenlock limestone of Dudley. A magnified view of part of the surface, to show the honeycomb structure, is given in fig. 7.

Fig. 4, the under, and fig. 5, the upper surface, of a small coral (*Cyclolites?*) from the Oolite.

Fig. 6. A silicified branched sponge, (*Spongites lobatus,* of Dr. Fleming,) from the chalk of Berkshire.

Fig. 9, is a beautiful silicified, lobate, spongoid body, (*Siphonia,*) probably from the greensand. Siliceous cruciform spicula obtained from this fossil are represented in fig. 8.

Zoophytes of this kind, like many of the sponges, have their tissues strengthened by, and largely composed of spicula, which vary in form and size in the different species and genera. Many sponges and Siphoniæ in flint, and in the chert of the greensand, consist almost entirely of spicula, which may be easily detected by a slightly magnifying power.

Fig. 10. Another common Dudley Coral. (*Porites pyriformis,* of Mr. Lonsdale.)

Fig. 11. A beautiful coral (*Explanaria flexuosa,* of Dr. Fleming), from the Coral Rag of Steeple Ashton, Wilts. The outline indicates the mode of increase, according to Mr. Parkinson, of this form of zoophyte.

Fig. 12. This is a portion of a delicate ramose sponge (*Spongites ramosus,* of Mantell), whose remains are abundant in the chalk-flints, and have given rise to the irregularly branched siliceous nodules. A specimen nine inches long, with seven branches, is figured in Fossils of the South Downs, Pl. XV. fig. 11. Siliceous spicula are thickly interspersed throughout the mass.


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PLATE XL.

Fossil Corals, &c.

Fig. 1. The shells of Oysters, and other mollusca, are subjected to the ravages of a parasitical sponge, (*Cliona*, of Dr. Grant,) which is beset with minute siliceous spines or spicula, and inhabits hollows formed in the substance of the shell. Shells thus honeycombed, as it were, may often be found on the sea-shore with the excavated parts filled up by sponge. I have shells collected by my eldest son on the shores of New Zealand, that are hollowed out in a similar manner, and occupied by sponge. Whether these cavities are produced by mechanical means, or are the result of the decay and absorption of the shell induced by the growth of the parasite, are questions still undetermined. There are several kinds of shells found fossil, which were infested with a similar parasitical sponge; and when the cavities thus produced have been filled up by flint, and the shell has subsequently decomposed, or been worn away, the surface of the flint is studded with the casts of the cells, in the form of small irregular globular bodies, connected by filaments or strings of flint. The fossil, fig. 1, is a fossil of this kind, described by Mr. Parkinson as being "covered with minute round bodies, the nature of which is unknown;" fig. 12, is an enlarged view of five of these globular casts connected by filaments.

The origin of these fossils was first pointed out by the Rev. W. Conybeare.[1] The fibrous shells of a fossil genus of bivalves named *Inoceramus*, of which several species abound in the Chalk, appear to have been particularly subjected to depredations of this kind. Hence among partially water-worn flints, specimens of the siliceous casts are common; figs. 8, and 10, are examples from the Hackney gravel-pits.

Mr. Morris has named these fossils, *Clionites ;* fig. 1, is *C. Parkinsoni*.

Figs. 2, 4, 7, are portions of a recent species of jointed zoophyte (*Isis*), from a modern concretionary deposit on the shores of the Mediterranean, Sicily.

Fig. 3. A branched fossil coral (*Millepora ramosa*, of Dr. Fleming), imbedded in compact oolitic limestone from Wiltshire. A portion of the surface magnified is represented in fig. 11.

Fig. 5, appears to be a fungiform Spongite; its locality is not mentioned.

Fig. 6. Portion of a fossil coral (*Ceriopora*), from Switzerland.

[1] See Medals of Creation, vol. i. p. 396, fig. 94.

PLATE XL.—*continued.*

FIGS. 8, & 10. These pebbles have the surface covered with casts of Clionites (*Clionites Conybeari*, of Mr. Morris.[1])

FIG. 9. Fragments of the radicle processes of attachment of some Apiocrinite or Lily-shaped animal in chalk; see description of Plate LI.

FIG. 14. A section of a siliceous nodule; probably the cellular appearance is inorganic: fig. 13, is a magnified section of the cells.

[1] Mr. Morris thus defines the generic character of these fossil bodies:—"Reticular masses of a more or less compressed globular, elliptical, or polygonal form; rugose and sometimes papillose; connected by minute tubuli or fibrillæ. Dendritical, dichotomous, or irregularly aggregated." *Clionites Conybeari* is characterized by "Cells irregular, somewhat polygonal, with one or more papillæ; surface finely tuberculated, connecting threads numerous." Note from Mr. Morris, April, 1850.

The fossils, however, do not appear to be the silicified sponge (*Cliona*) by which the ravages in the shell have been effected; they are merely casts of the cavities produced.

PLATE XLI.

A Silicified cup-shaped Sponge, from Touraine.

(*Chenendopora Parkinsoni,* of Michelin.
Spongites Townsendi, of Mantell.)

This beautiful plate of a petrified zoophyte allied to the Spongia, formed the frontispiece to Mr. Parkinson's second volume. The fossil delineated is from Touraine in France, and is one of the most perfect examples of this kind hitherto observed. It belongs to a group of cup-shaped *Amorphozoa,* (as these organisms are now named by naturalists, from the great irregularity of shape which they assume,) termed *Chenendopora.* The original organic substance is transmuted into silex, and the interstices are filled up with carbonate of lime. The same species occurs in the greensand in the Vale of Pewsey in Wiltshire, and, I believe, also in the white-chalk; for many cyathiform flints from the South Downs appear to have the same internalstructure.

In the so-called "gravel-pits," near Faringdon, in Berkshire,—which are quarries of a loosely-aggregated grit of the greensand, almost wholly made up of the relics of shells, corals, amorphozoa, &c.—numerous sponges of this genus are met with. One beautiful species (*Chenendopora fungiformis*) has acquired, from its cup-like form, the local name of "petrified salt-cellar."[1]

[1] Wonders of Geology, vol. ii. p. 637; and Medals of Creation, "Excursion to Faringdon," vol. ii. p. 923.

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PLATE XLII.

THE FOSSILS REPRESENTED IN THIS PLATE ARE CHIEFLY ZOOPHYTES IN FLINT.

FIG. 1. A flint from the gravel-pits at Hackney. Its form is derived from the enclosed zoophyte, part of whose structure is exposed in the upper portion of the figure. This fossil zoophyte (*Choanites Königi*, of Mantell) is very abundant in some of the chalk strata, and many of the most beautifully marked pebbles cut and polished for brooches by the lapidaries of Brighton, Bognor, and the Isle of Wight, are the silicified soft parts of this animal. The original was of a subglobular form, and probably of a soft fleshy consistence; it had a deep central cavity, whence numerous tubes diverged, and ramified throughout the mass; it was fixed at the base by radicle or root-like processes.[1]

FIG. 2. This is another characteristic and abundant fossil zoophyte of the chalk and flint. The specimen figured is a water-worn pebble, and therefore gives but obscure indications of the form and structure of the original. The fungiform flints—called in Sussex petrified mushrooms—belong to the same genus (*Ventriculites*, of Mantell): and highly interesting specimens occur in which some part of the zoophyte is invested with flint, and the other part expanded in the chalk. The original was probably a polyparium—that is, the skeleton or support of an aggregation of coral-polypes—of a funnel shape, the polype-shells being situated on the inner surface: the base was attached by root-like fibres.[2] The polype-cells are cylindrical and regular, and clusters of beautiful casts of them often occur on flints.

FIG. 3. This specimen is described by Mr. Parkinson as "a pear-shaped alcyonite from Switzerland." It is probably one of those fossil zoophytes allied to the sponges (called *Siphonia*), in which the upper part is of a bulbous or pear-like form, and is supported by a stem with root-like processes at the base. The bulb has a central cavity studded with irregular pores, that communicates with the parallel longitudinal tubes of which the stem is composed: a structure admitting of that ready ingress and egress of the sea-water, which this class of organisms requires. There are numerous species in the greensand of the chalk formation.[3]

[1] See Medals of Creation, p. 264. "THOUGHTS ON A PEBBLE," (eighth edition,) contains coloured figures and a full description of these fossils.

[2] Consult Medals of Creation, pp. 270—279: and Wonders of Geology, sixth edition, p. 638.

[3] Medals of Creation, p. 258, Lign. 56.

PLATE XLII.—*continued.*

Fig. 4. A variety of Siphonia (*Jerea excavata*, of Michelin), from the greensand of Wiltshire.

Fig. 5. A silicified Siphonia from Saumur.

Fig. 6. A Ventriculite from a gravel-pit; the markings are produced by the exposed and partially abraded outer integument, which in perfect examples consists of a regular net-work of subcylindrical fibres.

Fig. 7, is a transverse section of a Siphonia (*Siphonia pyriformis* of Goldfuss).

Fig. 8. A nearly perfect specimen of a similar fossil. In fig. 7, are shown sections of tubes passing from the periphery to the centre; in fig. 8, the central aperture of the cavity of the bulb, and part of the stem, are displayed.

Figs. 9, & 10, are imperfect specimens of Choanites: fig. 10, is a vertical section showing the central cavity and the connected tubes.

Fig. 11, is another example of *Siphonia pyriformis*.

Fig. 12, a vertical, and fig. 13, a transverse section, of the same species of Siphonia.

Fig. 14. A small turbinated calcareous spongite from Switzerland.

Fig. 15. The appearance of the animal membrane exposed by immersion of the fossil (fig. 14), in diluted hydrochloric acid.


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PLATE XLIII.

Fossil Corals, and other Zoophytes.

Figs. 1, 2, 3, & 4, are representations of different aspects of a simple coral (*Fungia polymorpha*, of Goldfuss); the locality is uncertain. Fig. 1, the base; fig. 2, a magnified representation of part of the same; fig. 3, magnified view of part of the lamellated surface of fig. 4.

Fig. 5. The nature of this fossil is not obvious; it may be a rolled Siphonia.

Fig. 6, is a fine specimen of a Siphonia (*Jerea pyriformis*, of Lamouroux). At both extremities the apertures of the numerous tubuli are seen.

Figs. 7, 8, & 9, are varieties of the same species of fossil sponge (*Scyphia articulata*, of Goldfuss), from Switzerland.

Fig. 10. A spongite of a very peculiar form.

Fig. 11. A spongite investing a fossil shell (*Nerita*), from Faringdon.

Fig. 12, is an imperfect specimen of a Ventriculite (*Ventriculites alcyonoides*, of Mantell), from the chalk of Wiltshire.

Fig. 13. A calcareous spongite which has been immersed in dilute hydrochloric acid to show its structure.

Fig. 14. A pebble deriving its shape from a zoophyte apparently related to the Ventriculites (*Spongites labyrinthicus*, of Mantell). The aperture at the base has arisen from the decomposition of the process of attachment.

Fig. 15. A pebble enclosing part of the base of a Ventriculite; the circular spots on the large end are sections of the ramifications of the stirps or base of the zoophyte; for this figure and the following are drawn in an inverted position.

Fig. 16, is a similar fossil, split vertically, and showing the enclosed stem of the Ventriculite.


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PLATE XLIV.

Fossil Zoophytes.

Fig. 1. A spongite (*Scyphia costata,* of Goldfuss), from Switzerland. The fossil spongeous bodies named *Scyphia,* are characterized by the "mass or body being either cylindrical, simple or branched; fistulous, and terminating in a rounded pit; entirely composed of a firm reticulated tissue."[1] Like the other bodies comprised in the group of *Amorphozoa,* the form in this genus is exceedingly diversified, and as the structure is often but obscurely shown, the determination of these fossils is oftentimes impossible. It is however convenient, in the present state of our knowledge, to distinguish the principal kinds by names which may be modified or abandoned, when the structure and natural affinities of the original organisms are more accurately determined.

Fig. 2. Another species of Scyphia from Switzerland; a small portion of the surface magnified is seen at *a.*

Fig. 3. The peculiar form and tissue of another genus of Amorphozoa (*Cnemidium rimulosum,* of Goldfuss), are shown in this beautiful specimen.

Fig. 4, is a section of a chalk flint, from Wycombe Heath; the purple body, partially invested by a white border, is evidently a mass of the soft parts of some zoophyte, which served as a nucleus to the siliceous nodule. A purple or pink hue often prevails in the sections of zoophytes immersed in flint, and doubtless depends on the original colour of the living animal.

Fig. 5. A very fine spongite (*Chenendopora fungiformis,* of Michelin), from France.

Fig. 6. This is evidently a fossil zoophyte, but the structure exposed is not sufficiently characteristic to determine the genus.

Fig. 7. A beautiful fungiform Scyphia.

Fig. 8. This elegant specimen, which Mr. Parkinson highly valued, is evidently a *Choanite* imbedded in flint. The body retains a pink colour, and is surrounded by a white band, which is probably the remains of the cortical or external tissue of the original zoophyte. I have seen many transverse sections in which the central mass was either of a pink or purple colour, and encircled by a white zone, in the squared flints of the walls of churches and other ancient edifices in Sussex.[2]

[1] Medals of Creation, p. 237.

[2] Polished specimens of the pebbles of the Isle of Wight, exhibiting sections of the Choanites, Ventriculites, &c., may be obtained of *Mr. Fowlestone,* Lapidary, 4, Victoria Arcade, Ryde; who also has generally on sale a good series of the fossils of the Island. The minute organisms that occur in flints, many of which are highly interesting objects when seen by transmitted light under a good microscope, can be procured of *Mr. Topping,* that well-known preparer of microscopic objects, New Winchester Street, Pentonville Hill; and fossil infusorial earths, &c. in great perfection of Mr. Poulton, Microscopic Artist, Reading, Berks.


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PLATE XLV.

Fossil Corals and other Zoophytes.

Fig. 1. "A fossil body, from near Bath, the surface of which is covered by stelliform markings, which seem to have been formed by a coralloid."—*Parkinson.* This fossil is supposed by Mr. Morris to be the cast of one of those mollusca which form and inhabit hollows in stone, coral, &c. (hence termed *Lithodomi*). In the present instance, the mollusk had bored into a mass of coral, the imprints of the stellular polype-cells of which remain on the surface of the cast. It closely resembles fig. 3, Plate XXXVI. of Faujas St. Fond, Hist. Mont. St. Pierre, which is described as a coral; it is the *Astrea geometrica,* of Goldfuss.

Fig. 2. A fossil coral from Maestricht. At *b,* is shown an enlarged view of one of the stars.

Fig. 3. "A siliceous fossil from Essex."—*Mr. Parkinson.* (*Ventriculites racemosus,* of Mr. Toulmin Smith.) I must confess myself unable to determine the nature of this specimen.

Figs. 4, & 6. Corals from the cretaceous strata of St. Peter's Mountain, Maestricht (*Gorgonia bacillaris?* of Goldfuss). At *a,* is shown one of the cells in fig. 6, magnified.

Fig. 5. A pebble, split asunder, exposing the remains of a spongite, which formed the nucleus of the flint.[1]

Fig. 7. Another spongite in a pebble; from Sewardstone, Essex.

Fig. 8. A waterworn, silicified, or rather chalcedonic Ventriculite, from France.

Fig. 9. A very beautiful transverse section of the stem of a Ventriculite in a flint; the colour of the original being retained. This was another precious gem in the estimation of the amiable author of "The Organic Remains of a Former World."

Fig. 10. A portion of a Choanite in flint; from gravel, Islington.

Fig. 11. A perfect specimen of a small simple coral (*Fungia*), from Maestricht.

Fig. 12. A spongite in a pebble; similar to fig. 5. Such specimens are very common in the shingle along the sea-shore at Brighton, Dover, &c.

Fig. 13. A fossil coral in limestone, from Maestricht. It is too imperfectly defined to determine the species or genus; an enlarged sketch of the structure is given at *c.*

[1] For an account of the formation of flint, see Wonders of Geology, vol. i. p. 300. (*6th Edition.*)

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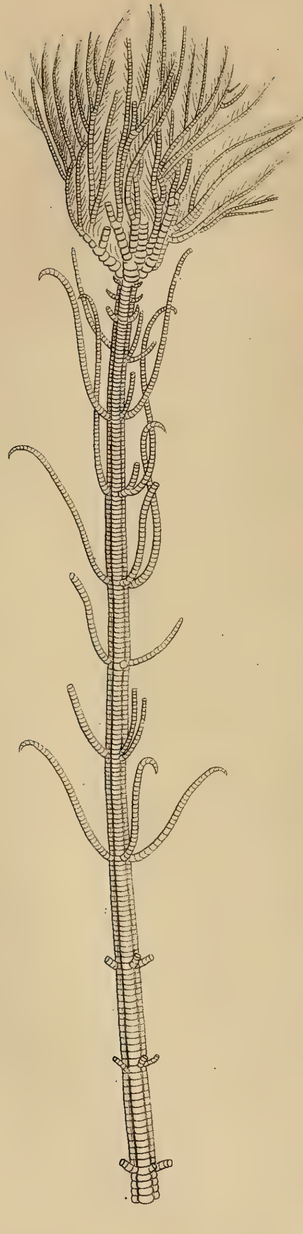

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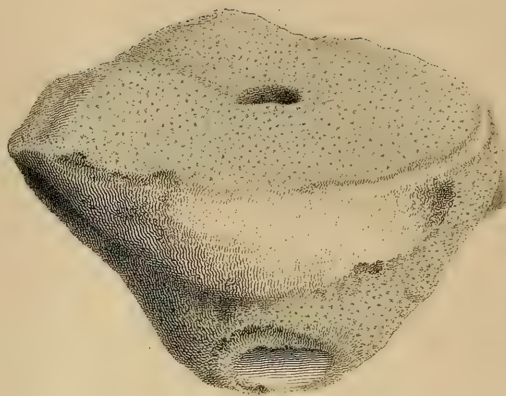

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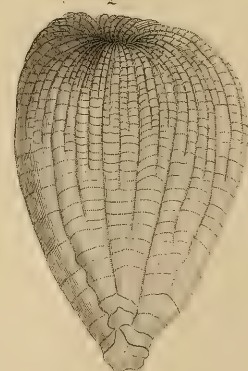

PLATE XLVI.

PENTACRINUS.

FIG. 1. Specimen of a recent *Pentacrinus Caput Medusæ,* from the Carribean Sea.

The Lily-shaped animals (*Crinoidea*), so named from a fancied resemblance of some species when in a state of repose to a closed lily, may be compared to a Feather-star (*Comatula*) fixed to a jointed column, with its mouth upwards; the base of the stem being attached to the rock by root-like processes. The only known living genus inhabits the seas of the West Indies, and the specimen figured represents the body (or upper part of the animal), with a considerable portion of the stem remaining attached. The Crinoidea are divided into two groups; Encrinites, having the ossicula (little bones) of the stem rounded, and Pentacrinites, in which the ossicula of the column are pentagonal, or angular. The Crinoidea are characterized by having a fixed base, a column or stem composed of numerous separate articulated pieces of a solid calcareous substance, supporting on its summit a vase, or receptacle, formed by a series of closely adjusted plates, which contain the body, or viscera. The upper part of the receptacle is covered by a plated integument, on one side of which an aperture or mouth is placed. From the upper margin proceed five articulated tentacula or arms, which subdivide into branches that in some species are very numerous and of extreme tenuity. On the inside, the arms are beset with articulated cirri or feelers. The joints composing the column are perforated by a central opening; there are also side-arms, that radiate from the column in groups of five at different points. When the animal is alive, the skeleton is covered by a soft integument, as in the star-fishes, and the arms spread out and expand, forming a net, by which living prey is captured and conveyed to the mouth by the tentacula, in the same manner as in the fresh-water polype or Hydra.

The fossil remains of Crinoidea consist of the ossicula of the column, arms, and tentacula; of the plates of the vase, or receptacle; and of the peduncle, or base of attachment. This family of Radiaria, though now of such excessive rarity, swarmed in the seas that deposited the ancient secondary strata; whole mountain chains and extensive tracts of country are composed of strata almost entirely made up of their fossil remains.[1] The number and species of genera is very great.

FIG. 2, is a remarkably beautiful specimen of the receptacle of a Pentacrinite from Gloucestershire, showing the arms introverted, as if the animal had suddenly perished while in the act of closing over its prey; the stem is wanting.

Fig. 3. A spongite (*Chenendopora subplana,* of Michelin) from the greensand of the Vale of Pewsey, in Wiltshire.

[1] Wonders of Geology, vol. ii. p. 645. Medals of Creation, p. 312.

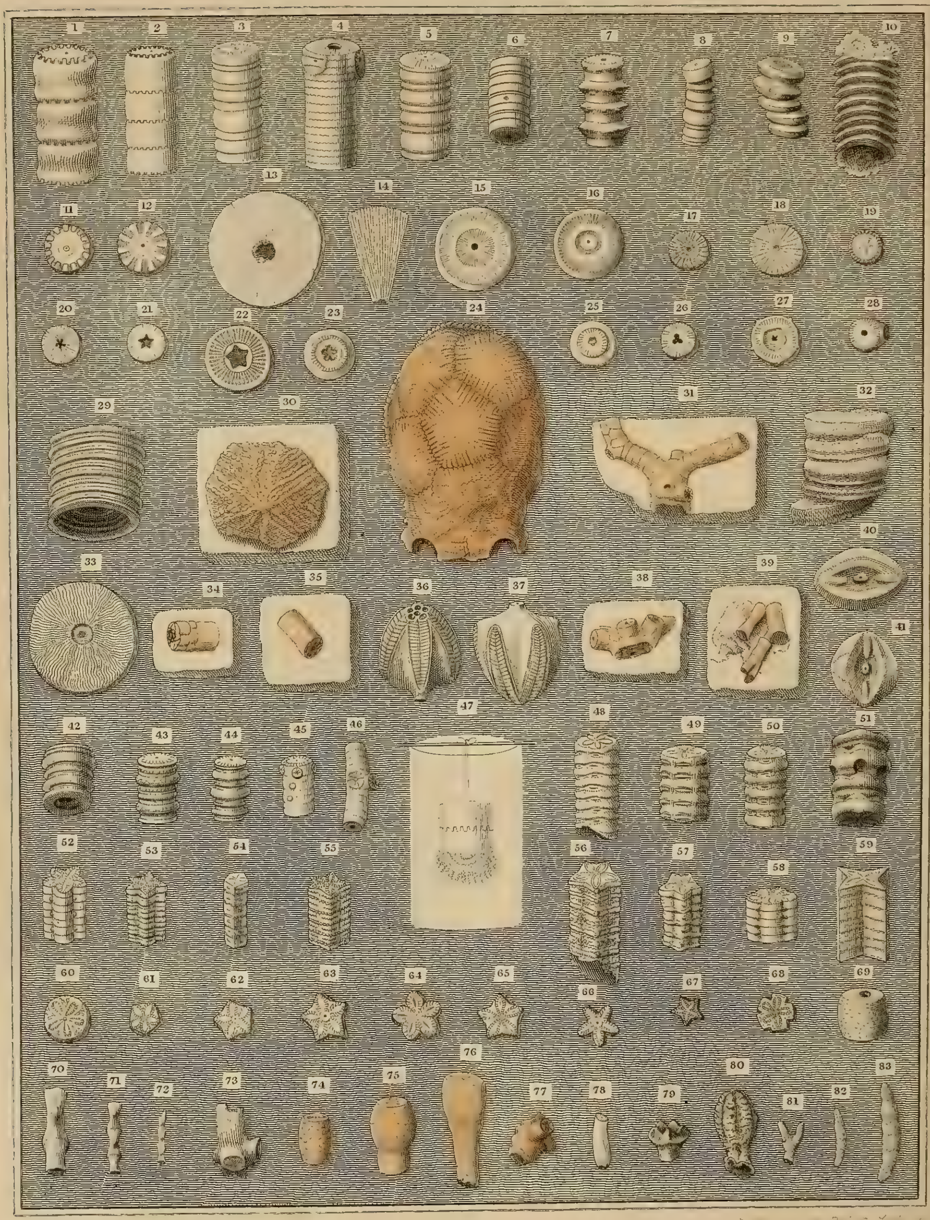
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PLATE XLVII.

Fossil Remains of Crinoidea.

In this beautiful plate Mr. Parkinson has figured a great variety of ossicula and portions of stems belonging to many species and genera of Crinoidea; the markings or sculpturing on the articulating surfaces of the columnar ossicula are represented with great accuracy. It is not within the plan of this work to give detailed descriptions of these numerous detached parts; a few of the most interesting objects only will be particularized.

The specimens figured in the upper part of the plate, figs. 1 to 28, are cylindrical ossicula, and portions of stems of Encrinites: those in the lower division are for the most part pentagonal, and therefore belong to Pentacrinites.

Fig. 24. The "Tortoise Encrinite," of Mr. Parkinson, (*Marsupites Milleri*, of Mantell,) from the chalk of Kent. The specimen figured is the receptacle or body of a very remarkable crinoideal animal which forms the link that unites the Lily-shaped animals with the Star-fishes; like the former, the receptacle is composed of articulated plates, closed at the top by a tesselated plate-work with a buccal aperture, and surrounded by five flexible arms; but the original animal, like the Star-fishes, was destitute of a stem, and could float through the water at pleasure. Its true structure was first pointed out by me in 1822;[1] the name *Marsupite* was suggested by the purse-like form. In the figure, the base of the receptacle is uppermost. Fig. 30, is a single plate of a Marsupite attached to a piece of chalk.

Figs. 31, 35, 38, 39, 40, 41, 74, 75, 76, 77. These are portions of a small species of Encrinite (*Apiocrinus ellipticus*) peculiar to the white chalk, in some localities of which the detached ossicula and peduncles are abundant. At Northfleet, near Gravesend, these fossils are often met with. Figs. 75, and 76, are portions of the receptacle with part of the column; figs. 31, 38, and 39, are parts of the processes of attachment. I have never seen any specimen with the arms.[2]

Fig. 34. This is part of the receptacle and stem of another small chalk Encrinite (*Bourgeticrinus*, of D'Orbigny) from Kent; it is remarkable for the very slight increase in bulk of the receptacle, and the peculiar form of the plates of which it is composed.

[1] See "Fossils of the South Downs."

[2] Medals of Creation, p. 321.

PLATE XLVII.—*continued.*

FIGS. 36 & 37. Two views of the receptacle of a very remarkable crinoidean animal (*Pentremites florealis*, of Say), from the cherty carboniferous limestone of Kentucky. This zoophyte, though resembling the Crinoidea in having a plated receptacle supported by an articulated stem, has a remarkable affinity to the Sea-urchins (*Echinidæ*) in the porous bands and pentagonal aperture, and in being destitute of arms or tentacula. Some of the Kentucky limestone beds swarm with the remains of these zoophytes.[1]

FIG. 47. "Two ossicula of the Lily Encrinite immersed in diluted muriatic acid, by which the animal membrane was exposed, and is seen hanging in flocculæ from the bottom of the fossil."—*Mr. Parkinson.*

FIGS. 57, 64, 66. Part of the stem, and the articulating surfaces of two ossicles of a very elegant pentacrinite (*Pentacrinus scalaris*, of Goldfuss), from the Lias of Lyme Regis.

FIGS. 53, 56, 59, 61, 62, 63, 65, 67. Portions of stems, and the various modifications of the ossicula of another Lias Pentacrinite (*Pentacrinus basaltiformis*, of Goldfuss).

FIG. 79. This elegant little crinoidean receptacle was named the "Clove Encrinite," by Mr. Parkinson, from its form; (*Eugeniacrinus caryophyllatus*, of Goldfuss). It is from the Oolite of Mount Randen, in Switzerland.[2]

FIGS. 80, 81, 82, & 83. Appear to be fossil corals of the genus *Ceriopora.*

[1] Medals of Creation, p. 327. [2] Ibid. p. 327.

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PLATE XLVIII.

The Lily Encrinite (*Encrinites moniliformis*).

This exquisite species of the extinct Crinoideans which swarmed in the seas of the secondary ages of Geology, is equally interesting and attractive to the amateur collector and the scientific observer. The specimen figured is a charming example of the "*Stone Lily*" partly expanded, attached to a block of limestone studded with encrinal ossicula. Mr. Parkinson informed me that it was formerly in the collection of Mr. Jacob Forster, and cost him twenty guineas; from five to ten guineas is now the usual price for a specimen in a good state of preservation, with any part of the column attached. This Encrinite is not known to occur in England. The specimens seen in collections are for the most part from Lower Saxony: this species has only been found in the limestone strata called "*Muschelkalk*," one of the subdivisions of the *Trias*, or New Red Sandstone formation, of Germany.[1] The most celebrated locality of these fossils is in Brunswick, near the village of Erkerode, about two miles from the town bearing the same name. The bed in which they are found is a soft argillaceous cream-coloured limestone, about one foot and a half in thickness; and the stone is composed chiefly of trochites, or detached ossicula of the stems, and a few fragile shells and corals.

An elaborate account of the structure of the skeleton of the Lily Encrinite is given by Mr. Miller, in his valuable work, "The Natural History of the Lily-shaped Animals," (1 vol. 4to. 1821.) Mr. Parkinson had previously carefully investigated the different parts which enter into the composition of the receptacle and column, and had given them names analogous to those employed to designate the bones of the skeleton in vertebrated animals. This nomenclature has very properly been abandoned; but I subjoin Mr. Parkinson's description of the figures, to record his ingenuity and skill in dissecting organic remains:—

"Fig. 1. The Lily Encrinite, with part of its vertebral column attached. In this specimen is seen the extensive capacity for motion yelded by the peculiar form of the vertebræ in the superior part of the column; and by the fortunate removal of a portion of the fingers, a fair view is given of the natural arrangement of the tentacula.

Fig. 2. The pentagonal base, composed of the ossa innominata, and forming with the scapulæ and clavicles, the pelvis, in which were contained the organs of digestion, &c.

[1] Medals of Creation, vol. i. p. 322. Wonders of Geology, vol. ii. pp. 534, 549.

PLATE XLVIII.—*continued.*

FIG. 3. The Lily Encrinite, detached from its vertebral column.

a, the centre of its base, formed by five cuneiform ossicula, or *ossa innominata.*

a, one of the *ossa innominata* detached.

b, the ribs, or *articuli trapezoides;* forming, with the preceding bones, the pentagonal base.

b, one of the ribs detached, showing its internal surface.

c, the clavicles.

c 1, the interior surface.

c 2, the superior surface.

d, the scapulæ.

d 1, the inferior surface.

d 2, the superior surface.

e, the arms.

f, the two first bones of the arms united.

g, *h*, *i*, *k*, *l*, *m*, the bones of the fingers gradually diminishing.

FIG. 4. Part of the supposed base, or organ of attachment, of the Lily Encrinite.

FIG. 5. The supposed base, or organ of attachment, of the '*Cap Encrinite.*'"

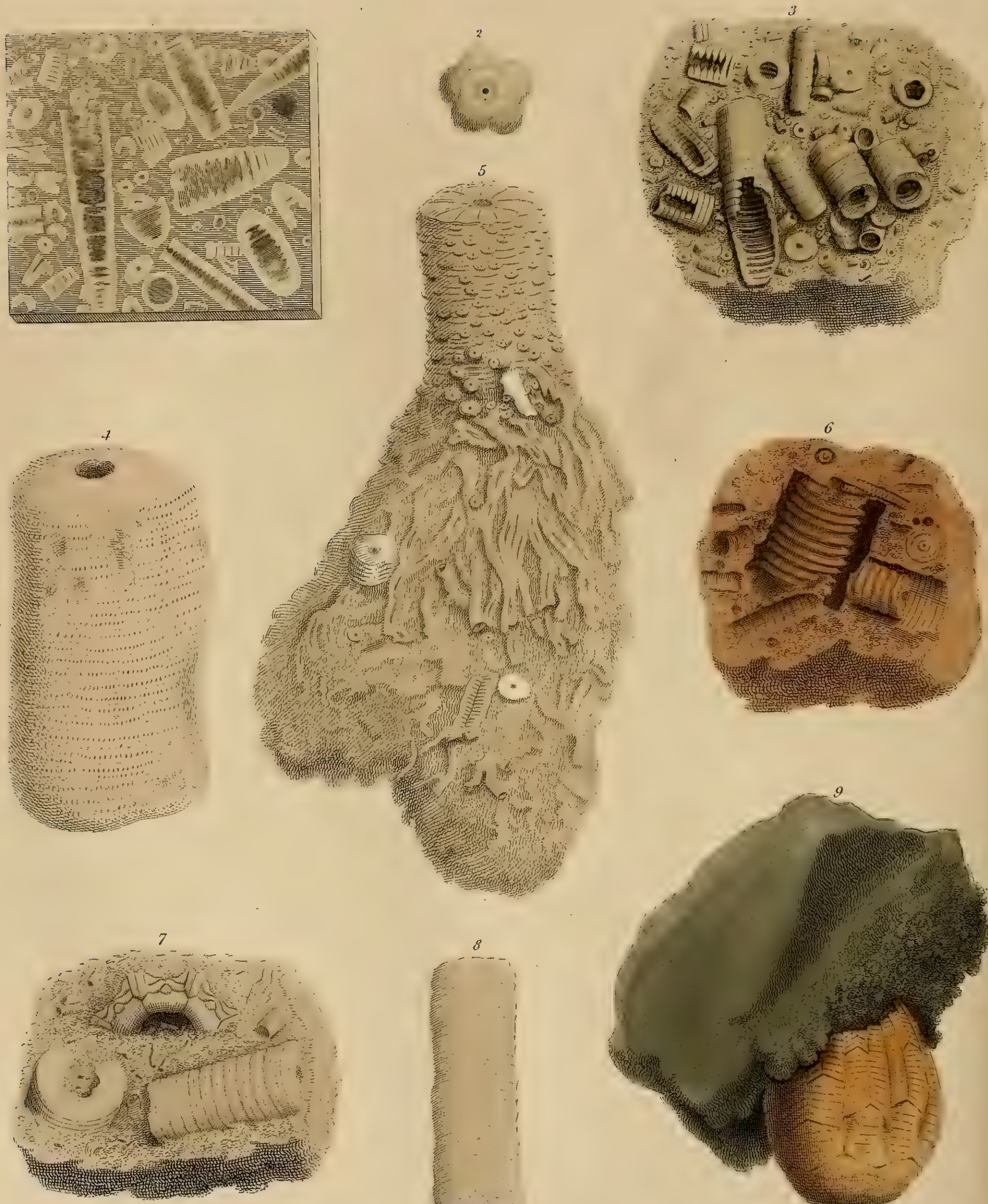
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PLATE XLIX.

Remains of Encrinites.

Fig. 1. A polished slab of limestone formed of portions of the stems of encrinites; the white figures are produced by sections of the calcareous spar into which the ossicula are transmuted. The dark spots are the cavities of the entrochites, filled with mineral matter of a different colour.

Fig. 2, is the pentagonal base of the receptacle of the Derbyshire Encrinite.

Fig. 3. A mass of Derbyshire encrinal marble, with numerous portions of stems lying in relief.

The Derbyshire encrinal marble is so extensively employed in the manufacture of tables, chimney-pieces, vases, &c., that it must be familiar to every reader; and yet probably but few are aware of its origin, or of the nature of the fossil remains of which it is composed, and that give rise to the elegant figures in which its beauty consists. On Middleton Moor, near Matlock, extensive quarries of this marble are worked, and good specimens of the ossicula and stems may be easily obtained.[1]

Fig. 4. Part of the stem of a large Encrinite, (*Cyathocrinus rugosus*, of Miller,) from the Wenlock limestone, Dudley.

Fig. 5. A fine specimen of the lower part of the stem, and the root-like processes of attachment of the base, of the same species as fig. 4: from Dudley.

Fig. 6, is called the "*Screw or Pulley-stone*" of Derbyshire. These curious fossils are found in the chert (a kind of flint) which occurs in veins and layers in some of the limestone strata: they are siliceous casts of the interior cavities of the stems, and small branches of ossicula, of Encrinites. Plate XLVII. fig. 10, is a detached specimen of this kind.

Fig. 7, is described by Mr. Parkinson as "a piece of marble from Shropshire, in which is discovered a part of the pentagonal base of the Turban or Shropshire Encrinite."

Fig. 8, is part of the column of the same species. These specimens belong to the Rose Encrinite (*Rhodocrinus verus*, of Miller).

Fig. 9. The receptacle of a very remarkable form of Encrinite, called by Mr. Parkinson "the *Cap Encrinite* of Derbyshire." I can find no notice of this beautiful and unique specimen in the work of Miller or of subsequent authors; neither am I aware of any data by which a relation can be established between this receptacle and the ossicula and stems, so abundant in the carboniferous limestone of Derbyshire.

[1] See Medals of Creation for "A Geological Excursion from Matlock to Middleton Moor, returning by Stonnis," p. 968.


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PLATE L.

Encrinites and Pentacrinites.

The Pear Encrinite of Bradford; Mr. Parkinson.
(*Apiocrinus rotundus*, of Miller.
——— *Parkinsoni*, of Bronn.)

The most generally known of the British Crinoidea, from its size, and abundance in one particular locality, is the "*Pear Encrinite*" of Bradford in Wiltshire, some of the quarries of the oolite on the heights above that picturesquely-situated town, yielding not only immense quantities of detached plates and ossicula, but also numerous examples of the receptacle, and occasionally the entire skeleton from the peduncle of the base to the extremities of the arms. The lamented Mr. Channing Pearce, and his father (now of Percy Place, Grosvenor, Bath), when resident at Bradford, paid such unremitting attention to the collection of these fossils, that perfect specimens were obtained, exhibiting the entire structure of the originals; of these some fine examples are preserved in the British Museum. Sir Charles Lyell mentions a very interesting fact relating to the occurrence of these Crinoidea in the strata. He states that the upper surface of a bed of limestone at Bradford is incrusted with a continuous pavement formed by the stony roots of the Apiocrinites; and upon this is a layer of clay in which are the stems and bodies (receptacles) of innumerable examples; some erect, others lying prostrate; while throughout the clay are scattered detached arms, stems, and receptacles. This submarine forest of Crinoideans must therefore have flourished in the clear sea-water till invaded by a current loaded with mud, which overwhelmed the living zoophytes, and entombed them in the argillaceous deposit in which their remains are now imbedded.[1]

The receptacle of this Apiocrinite is pyriform and very smooth, the plates are large and thin, with radiating articulated surfaces; the stem is short, smooth, and strong, the arms are simple, and like those of the Marsupite; the peduncle spreads out into an expanded base, which is firmly attached to the rock; sections of this part are generally of a purple colour.

Fig. 1. Part of the column of the Bradford Encrinite. 2. Part of the receptacle; a minute incrusting coral (*Bryozoa*) is attached to the lower part, giving the stem a rough appearance.

Figs. 3, & 4. Surface of detached plates of the receptacle.

Fig. 5. Portion of the column partly covered with a cortical covering of a purple colour possibly the original investing membrane.

[1] See Wonders of Geology, vol. ii. p. 653.

PLATE L.—*continued.*

Fig. 6. A receptacle, in which a few of the ossicula of the arms remain attached to the margin.

Fig. 7. Another receptacle, in which the plates called by Mr. Parkinson "clavicles and scapulæ," are retained in their natural positions.

Fig. 8. A receptacle, in which the principal plates are well defined: these are named by Mr. Parkinson as follow: *a, clavicle; b, scapula; c, ossicula of the arms; d,* the last series of the same. The ossicles forming the elongated tentacula, Mr. P. termed "*bones of the fingers.*"

Fig. 9. Portion of an encrinital stem with digitated processes: the nature of this fossil is unknown to me.

Fig. 10. Three united ossicula of a Pentacrinite with depressions for side-arms: from the Lias of Lyme Regis.

Fig. 11. A distorted pentacrinal ossicle; said to be from Africa.

Figs. 12, & 14, are vertical polished sections of the peduncle, or base of the stem, of the Bradford Encrinite.

Fig. 13. Vertical section of the peduncle of a Pentacrinite from Soissons.

Fig. 15. A polished slab of pentacrinal marble from Charmouth, Dorsetshire.

Fig. 16. Variously contorted pentacrinal stems with numerous side-arms, from Charmouth.

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PLATE LI.

Fossil Crinoidea, or Lily-shaped Animals.

Fig. 1. Part of the receptacle of the "*Nave Encrinite*," of Mr. Parkinson (*Actinocrinus*, of Miller). Mountain limestone.

Fig. 2. A portion of the receptacle of a "*Rose Encrinite*" (*Rhodocrinus*), viewed from the base.

Fig. 3. The "Nave Encrinite" (*Actinocrinus triacontadactylus*, or thirty-fingered, of Miller), from the mountain limestone. This is a good example of the structure of the receptacle in this group of Crinoideans, which is distinguished by the arms passing off at right angles from the periphery of the receptacle, like the spokes of a wheel; whence the name, Nave Encrinite. The upper part is covered by closely adapted plates, and the buccal aperture or mouth is situated at the side. The stem of this group is thickly beset with side-arms. (Fig. 7 is a very small detached one.) The arms are numerous (amounting to thirty in the species figured), and of great length; these subdivide into jointed filaments of extreme minuteness. Slabs of limestone are often entirely covered with them, and many layers are wholly made up of their aggregated remains. The plates of the receptacle are generally highly ornamented: in one species the sculpturing so closely resembles that of the *Marsupites ornatus* of the chalk, that it was with difficulty I convinced Mr. Parkinson that the latter did not possess a stem, and therefore was not an Actinocrinite.[1]

Figs. 4, & 5. Portions of receptacles of Actinocrinites.

Figs. 6, & 8. Fragments of stems of a Pentacrinite (*Pentacrinus scalaris*, of Goldfuss); from Gloucestershire.

Fig. 9. A Pentacrinite expanded on a slab of Lias-shale. Gloucestershire.

Fig. 10. Stem, receptacle, and arms of a Crinoidean (probably a *Cyathocrinite*); it s drawn in an inverted position. The figure is stated by Mr. Parkinson to be copied "from a plate by Dr. Capeller." Neither the locality, nor the stratum from which it was obtained, is mentioned.

Fig. 11. Part of the stem of a Pentacrinite (*P. basaltiformis*, of Miller); from the Lias, Gloucestershire.

[1] See Medals of Creation, p. 325; Wonders of Geology, p. 654; Miller's Crinoidea, p. 94.

PLATE LI.—*continued.*

Fig. 12. The receptacle of a Crinoidean (*Platycrinus lævis,* of Miller); from the mountain limestone, Ireland. Fig. 13, ossicles of the arms; and fig. 14, joints of the stems, slightly magnified.

Fig. 15. "The superior part of the Briaræan pentacrinite." Mr. Parkinson.—(*Pentacrinus Briareus,* of Miller.) The specimen is a slab of Lias, almost wholly made up of crinoideal remains. In relief on the surface are the stems and dislocated ossicles of the receptacle; the latter are thus enumerated by Mr. Parkinson;—*a,* scapula; *b,* clavicle; *c,* first bone of the arm; *d,* second arm-bone; *e,* commencement of the two series of bones forming the fingers.

Fig. 16, is another slab of pentacrinal Lias limestone, with portions of a stem and numerous side-arms: these are generally electrotyped, as it were, with a brilliant pyrites, giving a rich metallic lustre to the animal remains. In the British Museum there are many splendid specimens of this highly interesting family of Radiaria. I would especially direct the intelligent visitor's attention to a slab of stone, many feet in height and breadth, on which a group of Pentacrinites is displayed, as palpable and perfect as if the animals were sporting in their native element. This matchless specimen is from Germany.

Fig. 17. One of the small auxiliary lateral tentacles of a Pentacrinite.

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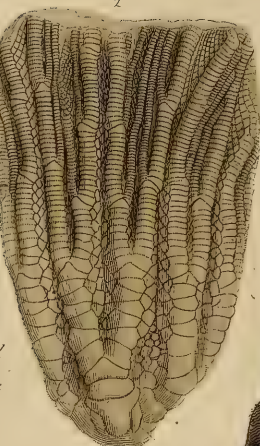

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PLATE LII.

Pentacrinites.

Fig. 1. This specimen displays the usual appearance of the mode in which the arms of Pentacrinites are spread out in relief on the pyritous lias limestone of Charmouth.

Fig. 2. The arms, from the upper part of the receptacle to their third or fourth subdivision of the Briarean Pentacrinite. Charmouth.

Fig. 3. A small specimen, showing the ramifications and delicacy of the extremities of the arms or tentacula.

Fig. 4. "A fossil body, supposed to be a species of oval encrinite."—*Mr. Parkinson.* This fossil is certainly a coral, probably some species of Turbinolia, from the Devonian formation.

PLATE LIII.

Fossil Star-Fishes and Echini.

The radiated animals popularly called Star-fishes, from their stellular figure, are so abundant along our sea shores, that the nature of the common five-rayed species (*Asterias*, or *Uraster rubens*)[1] must be familiar to most of my readers. This species belongs to the group in which the rays are elongated, and far exceed in length the diameter of the disk; in another subdivision (the *Goniaster*, or Cushion-star), the body is angular, and the lobes or rays are short, and do not exceed in length the diameter of the body. In another group (the *Comatula*, or Feather-star), the rays are fringed with long jointed tentacula, which divide and subdivide like those of the Crinoidea; and these star-fishes may, in fact, be regarded as free Lily-shaped animals.[2] There is another tribe in which the arms are elongated into slender rays, without grooves or tentacula; these are called the Serpent Star-fishes (*Ophiura*). Species of all these groups occur in a fossil state.[3]

Fig. 1. "Part of a fossil lunated star from the chalk of Kent."—Mr. Parkinson. (*Goniaster semilunata*, of Parkinson; *Goniaster Parkinsoni*, of Prof. E. Forbes). Remains of Star-fishes are by no means rare in the chalk strata of Kent; in those of Sussex they are far less common. When the "Fossils of the South Downs" was published, in 1822, a few fragments only had been discovered. Of late years, some beautiful examples have been obtained from the chalk-pits near Arundel and Worthing, by Mr. Dixon, Mr. Coombe, Mrs. Smith, of Tunbridge Wells, and other collectors. The cabinet of the Marquess of Northampton is very rich in this class of fossils. Several unique examples of new species have been obtained from the chalk near Maidstone.

Fig. 2. "An echinite, from France."—*Mr. Parkinson.* The locality of this fossil is uncertain; no similar specimen is known either to Mr. Morris, or the other eminent palæontologists I have consulted; and the original cannot be discovered. I have reason to believe it was purchased, after Mr. Parkinson's death, together with the greater number of the fossils already described, by an American gentleman, and taken to the United States.

Fig. 3. "Part of a stellite or fossil star-fish, resembling *Pentagonaster regularis*."—Mr. Parkinson. This well-known chalk species (*Goniaster Mantelli*, of Prof. E. Forbes), occurs frequently in an imperfect state in the quarries near Gravesend. The collection of the Marquess of Northampton contains a perfect and exquisite specimen attached to a flint, from that locality.

Fig. 4. A beautiful example of the Turban Echinite (*Cidaris Parkinsoni*, of Dr. Fleming), from Wiltshire.

1 See Professor Forbes's delightful "History of the British Star-Fishes."

2 In the young state the Comatulæ have a jointed stem, and are attached to other bodies; being in this stage true Crinoideans.

3 Medals of Creation, p. 332.

PLATE LIII.—*continued.*

The *Cidaris*, or Turban Echinite, belongs to the family of radiated animals, of which the recent Sea-urchin (*Echinus sphæra*) is a well-known example. The globular shell or envelope of these animals is composed of numerous calcareous polygonal plates, arranged in regular and elegant patterns, like the lines of the meridian on a globe. These plates are externally covered with papillæ of various sizes, to which spines of corresponding magnitude are articulated. In some of the *Cidares* the principal tubercles are very large, and their spines several inches in length. The number and variety of the animals of this family that occur in a fossil state are so great, that a work expressly devoted to the subject would be required to thoroughly investigate the characters and relations of the known species. An elementary knowledge of this class of fossil remains may be obtained by reference to "Medals of Creation," chap. xi. p. 240.

FIG. 5. Part of the case of a Cidaris attached to a flint by its outer surface, surrounded by upwards of twenty spines; the interior of the shell, of a light pink colour, is exposed. This exquisite fossil is now in the cabinet of the Marquess of Northampton. It was purchased by Mr. Parkinson for the sum of twenty guineas; but this was in the palmy days of the study of organic remains, before the terms Geology and Palæontology were invented, and when a choice relic of "a former world" was cheap at any price, in the opinion of the enthusiastic collector.

FIG. 6. A Turban Echinite (*Cidaris* (*Hemicidaris,* of Agassiz) *crenularis,* of Lamarck): from the Coral Rag of Wiltshire.

FIG. 7. A siliceous cast—that is, a flint that has been moulded in the interior of the shell, and received the impress of the internal structure—of "*Cidaris corollaris,*" of Parkinson; (*Cyphosoma correlare,* of Agassiz): from Sussex.

FIG. 8. Cidaris with spines, from the Oolite of Stonesfield.

FIG. 9. A specimen of one of the Cidares with large tubercles (*Cidaris coronatus,* of Goldfuss); from the Coral Rag, Oxfordshire.

FIG. 10. An elegant chalk echinus (*Cidaris Konigi,* of Mantell;[1] *Cyphosoma Milleri,* of Agassiz; *C. granulosus,* of Goldfuss): from Kent.

FIG. 11. A fine species from the chalk at Gravesend (*Cidaris vesiculosus,* of Goldfuss).

FIG. 12. A peculiar type of Cidaris (*Salenia scutigera,* of Goldfuss), from the freestone or upper greensand of Warminster, Wilts.

FIG. 13. Another species of the same genus (*Salenia stellulata,* of Agassiz); from Warminster.

FIG. 14. An enlarged view of part of the structure around the vertex of fig. 13.

FIG. 15. A species of Feather-star (*Comatula pectinata,* of Goldfuss); from Solenhofen.

FIGS. 17, 18, 19, 20. "Minute *Stellitæ* (that is, fossil Star-fish); from Verona."—*Mr. Parkinson.* These are probably the bodies or disks of *Ophiuræ* deprived of their arms.

FIG. 16. The nature of the specimen figured is unknown to me.

[1] Fossils of the South Downs, p. 189. (1822.)

PLATE LIV.

Various Species of Fossil Sea-Urchins.

Fig. 1. A large, discoidal echinite, of the type called *Clypeus* or *Shield-echinus*, (*Clypeus sinuatus*, of Leske,) from the Coral Rag of Oxfordshire. This species abounds in the beds of this division of the Oolite in Berkshire, Wiltshire, Gloustershire, &c.

Fig. 2. "*Echinanthites orbicularis* (*Pygurus*) of Leske."—Mr. Parkinson.

Fig. 3. An imperfect flint cast of an echinus (*Discoidea*), from the South Downs.

Fig. 4. The Helmet Echinite, (*Ananchytes ovatus*, of Lamarck,) from the Chalk of Kent. This is a characteristic species of the white chalk, and abounds in the strata of the North and South Downs. At Northfleet, near Gravesend, the quarry-men find beautiful specimens.

Fig. 5. An oval echinite (*Nucleolites*,) from Verona.

Fig. 6. A portion of a very flat echinite, in which the rays or ambulacra are in a floriform arrangement, (*Echinodiscus bisperforatus*, of Parkinson; *Lobophora biperforata*, of Desor,) from Tertiary Strata, Verona.

Fig. 7. A small discoidal echinite (*Discoidea subuculus*, of Leske,) from the upper greensand of Warminster.

Fig. 8. The floriform radiated part of the shell of an echinite (*Clypeaster*), from the tertiary strata of Malta.

Fig. 9. A cast in flint of part of the interior of the case or shell of an echinite.

Fig. 10. An elegant conical echinite (*Conulus albogalerus*, of Leske; *Galerites*, of Agassiz), common in the chalk of Kent and Sussex.

Fig. 11. View of the base of fig. 10, showing the situation of the two apertures of the shell.

PLATE LV.

Fossil Sea-Urchins, or Echinites.

Fig. 1. The shell of a Turban Echinite (*Cidaris saxatilis,* of Parkinson), broken in two, and each piece imbedded in the same fragment of flint. From Kent.

Fig. 2. A round Buckler Echinite (*Echinodiscus* (*Clypeaster*) *subrotundus,* of Parkinson), from Italy.

Fig. 3. The upper surface of an Echinite (*Spatangites* (*Disaster,* of Agassiz) *ovalis,* of Parkinson); from Scarborough.

Fig. 4. View of the upper, and fig. 5, of the lower surface of an Echinite, (*Spatangus* (*Hemipneaster,* of Agassiz) *radiatus,* of Parkinson,) from the cretaceous strata of St. Peter's Mountain, Maestricht.

Fig. 6. A small Echinite (*Echinites* (*Nucleolites,* of Leske) *pyriformis,* of Parkinson), from the cretaceous strata of Maestricht.

Fig. 7. A small Echinite of a different genus (*Echinites* (*Cassidulus,* of Lamarck,) *Lapis cancri,* of Parkinson), from Maestricht.

Fig. 8. An Echinite (*Spatangites* (*Nucleolites*) *brissoides ovalis,* of Parkinson). Locality unknown.

Fig. 9. A beautiful specimen of a large heart-shaped Echinite of a recent species (*Spatangus purpureus*), from a modern tertiary deposit, Malta.

Fig. 10. An Echinite (*Echinodiscus* (*Clypeaster*) *laganum,* of Parkinson), from a tertiary deposit, Verona.

Fig. 11. This is a very abundant Spatangus or heart-shaped echinite, (*Spatangus cor marinum,* of Parkinson; *Cor testudinarium,* of Goldfuss; *Micraster cor anguinum,* of Agassiz,) in the chalk of Kent, and some parts of Sussex. Siliceous casts, forming cordiform flints, with deep imprints of the pentapetalous rays on the vertex, are common among the stones of the ploughed fields of the Downs.

Fig. 12. A *Spatangite,* (*Spatangus* (*Micraster,* of Agassiz) *lacunosus,* of Parkinson), from tertiary strata, Malta.


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PLATE LVI.

Echinites and Echinital Spines.

Fig. 1. A fragment of the shell of a Turban Echinite, with three clavated or club-shaped spines attached, on chalk, from Kent (*Cidaris claviger*, of König). The inner surface of the fragment of shell is exposed.

Fig. 2. A crushed shell of an elegant species of Turban Echinite (*Cidaris sceptrifera*, of Mantell), on a block of chalk; with two displaced spines near it. The sceptre-like form of the spines suggested the specific name. The chalk has been carefully cut away so as to display the shell and spines as much as possible without detaching them. From Sussex; common in the chalk near Gravesend.

Fig. 3. Part of the shell, with two spines of another species (*Cidaris vesiculosus*, of Goldfuss), from Kent.

Fig. 4. "A fossil echinital spine resembling a belemnite."—*Mr. Parkinson.* I am unable to determine either the species or locality of this fossil: it is indeed doubtful whether it is a spine of an echinus.

Figs. 5 to 19, represent various kinds of echinital spines of Turban Echinites or Cidarites.

Fig. 5. "A fossil spine named '*Bacolo di Santo Paulo,*' by Scilla."—*Mr. Parkinson.* From Verona.

Figs. 6, 8, 9, 10, 11, 14, 15, 16, 17, & 18, are, I believe, referable to various species of Cidaris that occur in the Oolite or Jurassic deposits.

Figs. 9 and 11. Species of *Cidaris glandiferus*, of Goldfuss.

Fig. 15, is a well known form, which occurs in thousands in the Oolite Limestone, the Coral Rag, of Caen, and other localities in Wiltshire; it belongs to a beautiful Cidarite (*Cidaris Blumenbachii*[1]), which is occasionally found with similar spines attached.

Fig. 12. "A flat serrated spine from Verona."—*Mr. Parkinson.* It belongs to the *Cidaris Schmidelii*, of Goldfuss.

Fig. 7. The interior of the upper part or vertex of a large Echinus, from the tertiary strata of Malta. The greater portion of the shell is broken away, but a small fragment showing the outer surface remains on the upper left hand of the specimen. The five large petalous ambulacra are beautifully seen. Perfect examples of this echinite (*Echinanthus Clypeaster altus*, of Parkinson), are not uncommon.

Fig. 19. A spine of *Cidaris sceptrifera*, from the chalk of Kent.

Fig. 20. An elegant Turban Echinite, (*Hemicidaris crenularis*, of Lamarck,) common in the Coral Rag of Wiltshire. Groups of this beautiful echinoderm, with numerous spines attached, are found at Caen. I have seen on one slab of limestone, upwards of twenty individuals with the spines radiating round the shell, as if the animals were alive on a mud bank in shallow water.

Fig. 21. A fragment of the shell with two spines (*Cidaris claviger*), attached to a flint; from Kent.

[1] See Wonders of Geology, vol. ii. p. 500, figs. 3 and 5.


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PLATE LVII.

Fossil Shells.

Figs. 1, & 3. Upper and under view of a discoidal spiral univalve shell (*Euomphalus pentangulatus,* of Sowerby), from the mountain limestone of Derbyshire. The extinct genus *Euomphalus,* a name suggestive of the deeply excavated disk, comprises many species which occur in the Silurian, Devonian, and Carboniferous formations. The shell has chambers, or rather obsolete cavities sealed up by a shelly partition, in the abandoned part of the spire.[1]

Fig. 2. An elegant univalve shell, completely silicified or transmuted into flint (*Natica canrena,* of Parkinson, *Natica Gentii,* of Sowerby), from the upper greensand of Blackdown.

Figs. 4, & 6. Two views of the same specimen; a univalve (*Nerita conoidea,* of Lamarck), in which the apex or upper part is destroyed, and the interior of the shell is filled with yellowish brown chalcedony; in fig. 4, a cast of the spire is seen, and in fig. 6, the mouth of the shell, with the chalcedony partially filling up the interior. From tertiary strata near Paris.

Fig. 5. A beautiful fossil univalve shell, from the "Red Crag" of Suffolk, known to collectors as the "Essex reversed whelk," from the spire being coiled in the opposite direction to the common mode; the mouth is consequently situated to the left of the observer; the same species occurs with the spire in the usual direction. This shell is the *Murex* (*Fusus*) *contrarius,* of Parkinson.

Figs. 7, & 8. Under and upper view of another species of Euomphalus (*E. rugosus,* of Sowerby), from the Wenlock limestone, Dudley.

Fig. 9. An enlarged view of fig. 10. "A shell of the genus *Sigaretus.*"—Mr. Parkinson. Mr. Morris thinks it is merely an operculum of a small univalve.

Fig. 11. A chambered cephalopodous shell (*Lituites lituus,* of Hisinger), from Silurian strata, Sweden.

Figs. 12, & 13. These curious contorted bodies are named "*Vermiculitæ*" by Mr. Parkinson. They occur in the cream-coloured limestone of Pappenheim and Solenhofen. They are termed "*Lumbricaria colon*" by Goldfuss; and "*Cololites*" by M. Agassiz; the last-named eminent naturalist has demonstrated that they are the fossilized intestines of fishes.[2]

[1] Medals of Creation, pp. 425—427.

[2] See Dr. Buckland's Bridgewater Essay, vol. ii. plate 15.


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PLATE LVIII.

Fossil Shells.

Fig. 1. "Part of a hexahedral Serpulite."—*Mr. Parkinson.*

Fig. 2. A silicified mass of delicate filiform serpulæ, from the upper greensand of Devonshire (*Serpula filiformis*, of Sowerby).

Fig. 3. Portion of a species of *Siliquaria*, from tertiary strata, France. It is the shell of an Annelide related to *Dentalium*.

Fig. 5. A spiral Serpulite (it resembles the *Serpula conica*); probably from the cretaceous beds of the Isle of Rugen.

Fig. 6, is a piece of polished sandstone, from the upper greensand of Wiltshire, "the markings on which are produced by sections of a species of Serpula (*Vermetus concavus*, of Sowerby)."—*Mr. Morris.*

Fig. 7. A species of *Vermetus*; from Bayonne?

Figs. 8, & 9. A species of *Vermetus* which abounds in the coarse arenaceous limestone of Bognor Rocks, in Sussex (*Vermetus Bognoriensis*, of Sowerby).

Fig. 10. "A section of the shell of a Nautilus, to show that the siphuncle sometimes suffered distension."—*Mr. Parkinson.*

Fig. 11. A species of Serpula (*Serpula ampullacea*, of Sowerby), from the chalk of Kent.

Fig. 12. A fragment of the back or dorsal part of the shell of a fossil Nautilus (*Nautilus centralis*, of Sowerby), from the London clay, Brentford. The outer shell is broken away, and the siphuncle, traversing five of the septa of the chambers, is exposed.

Fig. 13. "The outline of the back of a Nautilus."—*Mr. Parkinson.*

Fig. 14. An Orthoceratite (*Orthoceras annulatum*, of Sowerby; *O. undulatum*, of Hissinger), from the Wenlock Limestone, Dudley.

Fig. 15. A fragment of a fossil Nautilus (*Nautilus Parkinsoni*, of Mr. Edwards), from the London clay of Harwich. It shows the situation of the siphuncle and the form of the septa, as indicated by the sinuous transverse lines.

Fig. 16. A polished section of a Nautilus (*N. truncatus*, of Sowerby), from the Inferior Oolite of Yeovil, Somersetshire. The chambers are filled up with crystalline limestone, with the exception of the six outermost cells, in which are left hollows that are lined with calcareous spar.

Fig. 17. Polished section of an Orthoceratite, from the Silurian strata of Oëland, Sweden.

Fig. 18. The discoidal part of a Lituite from the same locality as fig. 17.

Fig. 19. A polished slab of grey marble, from the Devonian formation of the Rhine. The figures are sections of *Orthoceratites*, *a*; and *Lituites*, *b*.


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PLATE LIX.

Fossil Cephalopoda, &c.

Fig. 1. A fossil shell named Hippurite (*Hippurites bioculatus,* of D'Orbigny), from the south of France. This shell belongs to a family termed *Rudistes,* whose characters are somewhat problematical,—some naturalists referring them to the bivalves, and others to the univalves. The Hippurite is generally of an elongated conical form, and has internally two obtuse longitudinal ridges; the base is sometimes partitioned by transverse septa.

Fig. 5, is a longitudinal section of a specimen in which septa are displayed. The aperture is closed by a moveable operculum, or upper valve, as in the specimen fig. 1. The substance of the shell is cellular and very thick, and when fractured, resembles that of the lamelliferous corals. Some kinds attain a large size, and are called "petrified horns" by the inhabitants of the districts in the Pyrenees where they abound. Though Hippurites are abundant in the chalk of the south of France, and in Spain and Portugal, none have been found in England. The *Spherulite,* a nearly allied genus, which has no internal longitudinal ridges, occurs in the chalk of Sussex: it was first discovered near Lewes. (*Spherulites Mortoni,* of Mantell.) [1]

Fig. 2. The siphuncle of a very large Orthoceratite ("related to the genus *Ormoceras,*" Mr. Morris), from the Rhine.

Figs. 3 & 4, "show the direction in which the siphuncle in Orthoceratites intersects the septa."

Fig. 6. Siphuncle of an orthoceratite (related to *Orthoceras duplex,* of Hissinger), from the Silurian strata, Sweden.

Fig. 7. An Orthoceratite (*O. pyriforme,* of Sowerby), from the Silurian strata, Dudley.

Figs. 8—15. Various kinds of Belemnites.

In the "*Supplementary Notes*" I have, under the head, "*Belemnites,*" explained somewhat fully the nature of those fossils which, by the name of "thunderbolts," have for so many centuries excited the interest and perplexed the ingenuity of collectors of fossil remains. Referring the reader to that note, I shall therefore in this place merely give such specific names of the specimens figured by Mr. Parkinson as I have been able to determine.

Fig. 8. "A Belemnite of large size," Mr. Parkinson. This specimen is part of the phragmocone from near the lower apical portion, partially invested with the fibrous rostrum or guard. It is the species named *Belemnites giganteus* by M. D'Orbigny; from the Oxford clay of Wiltshire.

[1] Medals of Creation, p. 428.

PLATE LIX.—*continued.*

Fig. 9. The guard of a Belemnite, eroded by some Annelide.

Fig. 10, is a vertical section of a fragment of a Belemnite, showing the alveolus or cavity for the reception of the apex of the phragmocone in the upper part.

Fig. 11. The distal or apical part of the rostrum or guard of a Belemnite. The annexed outline of a transverse section exhibits the radiated structure.

Fig. 12. The distal part of the guard of a chalk Belemnite (*Belemnitella mucronata*); from Norwich. Siliceous casts of the phragmocone of *Belemnitella* are occasionally met with in the flints of the South Downs. This phragmocone has a longitudinal flat band or ridge, extending down the dorsal aspect: the chambers are very numerous; the slit or fissure in the ventral aspect of the guard, is occupied by a thin expansion of the phragmocone.

Fig. 13. A Belemnite from the great oolite of Stonesfield (*Belemnites fusiformis*, of Parkinson). The upper part shows the alveolus for the reception of the apex of the phragmocone.

Fig. 14. A fragment of a guard split vertically, the flat surface showing a section of the alveolus filled with spar. This specimen belongs to the *Belemnites cylindriformis*, of Parkinson.

Fig. 15. A Belemnite (*Belemnites coniformis*, of Parkinson), having part of the guard broken off, to show the alveolus or hollow in which the apical part of the phragmocone is received. The removed portion has the cast of the alveolus attached to it.

Fig. 16, of which fig. 17, is an enlarged view, is a species of chambered foraminiferous shell, called *Nodosaria* (*N. raphanistrum*, of Lamarck); from Sienna. See description of Plate LXII.


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PLATE LX.

Ammonites.

Fig. 1. A Belemnite (*Belemnitella mucronata*) attached to a flint. Kent.

Fig. 2. Cast of part of a straight-chambered shell (*Baculites Fraujasii*, of Lamarck), in which the septa, or partitions, are deeply and regularly sinuated. In fossils of this kind, the cast of each chamber is distinct from the others; but the series is held together by the flexuosities of the septa. From Maestricht.

Fig. 3. A limestone cast of the chamber of an Ammonite: from Bath. The elongated channel in the middle indicates the position of the siphuncle.

Fig. 4. Fragment of an Ammonite, showing cavities of two chambers, and the canal of the siphuncle, partly lined with calcareous spar.

Fig. 5. Polished sections of an Ammonite (*Ammonites Walcotii*) from the Lias, Whitby. The chambers are filled with semi-transparent spar. The siphunculus is seen running along the dorsal, or outer margins of the volutions. The dark appearances observable in several parts of the siphuncle result from the carbonization of the animal membrane with which the tube was lined in the living state.

Fig. 6. "An *Oval Ammonite*."—Mr. Parkinson. This is evidently the cast of a discoidal shell pressed into an elliptical form. In the Chalk-marl, casts of Ammonites, Nautilites, &c. are very commonly more or less distorted by compression. The marl appears to have remained in a plastic state after the decomposition of the shell in which it was moulded, and to have admitted of being squeezed into close contact with the surrounding matrix; when the stratum became consolidated the cast retained its accidental shape, and adhering but slightly to the investing marl, was separable by a properly directed blow. This explains the otherwise unintelligible fact of a cast being closely invested by the rock, and all traces of the shell in which it was formed absent. When both the cast and the matrix became solid and uncompressible before the shell was decomposed, then loose casts were formed; as is common in the Portland stone, &c. The fossil figured appears to be an indifferent example of a common chalk-marl species (*Ammonites Mantelli*, of Sowerby).

Fig. 7. A beautiful cast of an Ammonite, in which the foliaceous septa transmuted into pyrites (sulphuret of iron, or *marcasite*), are exquisitely shown.

Fig. 8. A very fine specimen of an Ammonite (*Ammonites lautus*, of Sowerby), from the "*Galt;*" a subdivision of the Lower chalk, in which Ammonites, with their pearly shells beautifully preserved, are abundant. From Folkstone, in Kent; a celebrated locality for these and other fossils of the same cretaceous deposits.

Fig. 9. Sections of a pyritous cast of an Ammonite, showing the sinuous edges of the septa.


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PLATE LXI.

Fossil Cephalopoda, &c.

Fig. 1. Part of the cast of a species of Hamite (*Hamites intermedius*, of Sowerby), from the Galt of Folkstone. The name *Hamites* was employed by Mr. Parkinson to designate a genus of chambered shells, in which the direction of the spire, instead of being straight, as in *Baculites*, or discoidal, as in *Ammonites*, was bent like a hook beyond the inner reflected part. All the specimens here figured are but fragments.[1]

Figs. 2, & 5. Portions of *Hamites intermedius*, of Sowerby.

Fig. 3. *Hamites plicatilis*, of Sowerby.

Fig. 4. A fragment of *Hamites rotundus*, of Sowerby.

Figs. 6, & 7. Two views of a species of an extinct genus, the shells of which, though not chambered, are supposed to have been inhabited by Cephalopoda, like the recent Argonaut. The specimen (*Bellerophon costatus*, of Sowerby) is from the Mountain limestone of Derbyshire.[2]

Figs. 8, & 9. An Ammonite with a contracted aperture, and three deep constrictions across the disk. From the Inferior oolite of Normandy.

Figs. 10, & 11. Two specimens of "*Scaphites*, or Boat-like Ammonite," of Mr. Parkinson. A remarkable cretaceous genus of extinct cephalopoda. The specimens figured are from the Lower chalk of Sussex (*Scaphites costatus*, of Mantell; *S. equalis*, of Sowerby).

Fig. 12. Cast of a spiral chambered shell, called *Turrilite*, of which many species occur in the lower cretaceous strata (*Turrilites costatus*, of Langius). The quarries of lower chalk at St. Catharine's Mount, near Rouen, in Normandy, have long been celebrated for the number and perfection of specimens of this elegant type of cephalopodous shells. The first known English examples of this genus, as well as of Scaphites, were discovered by me in the chalk marl, at Hamsey, near Lewes, in Sussex, in 1810. Several very fine specimens of a large species (*Turrilites tuberculatus*), some of which are more than two feet in length, have been obtained from the same strata. The tubercles on the casts of this species are the bases of strong spines. The siphunculus, in the state of a pyritous cast, is preserved in some examples.

Figs. 13 to 27. These figures all refer to a very curious group of fossils, termed *Nummulites*, from the supposed resemblance of some of the flat disks to a piece of money. The complexity of their internal structure, and the supposed resemblance of their organization to that of the true Cephalopoda, led to many erroneous opinions as to the

[1] Medals of Creation, vol. ii. p. 500. [2] Ibid p. 477.

PLATE LXI.—*continued.*

nature of the originals. That eminent physiologist, Dr. W. B. Carpenter, has recently investigated the intimate structure of the whole group, and the results are given in a beautiful and masterly memoir in the Quarterly Journal of the Geological Society of London.[1] Dr. Carpenter has clearly shown that these fossils belong to the *Foraminifera,* and not, as some eminent naturalists have supposed, to the *Bryozoa,* or "*Moss-corals.*" As the family to which they belong comprises a numerous assemblage of minute organic remains, many of which are delineated in the next plate (Plate LXII.), the reader is referred to the "*Supplementary Notes,*" for a general description of the *Foraminifera,* in which is given a restored figure of the supposed living animal of the Nummulite, from Dr. Carpenter's memoir.

Fig. 13. The usual appearance of the common species of Nummulite (*Nummulina lævigata*). From Egypt.

Fig. 14. A specimen rubbed down, and exposing the internal cellular structure.

Fig. 15. An example in which the outer investment is partly removed.

Fig. 16. A vertical section of the same.

Fig. 17. This fossil, of which fig. 18, is a vertical section (*Nummulites obtusa,* of Sowerby), appears to belong to a different genus; probably *Orbitolites,* or *Marginopora.* Tertiary strata.

Fig. 19. A vertical section of a Nummulite, showing a cavity in the centre, probably from decomposition.

Fig. 20. A section of another species of Nummulite (*N. dispansa*? of Sowerby);[2] Tertiary strata, India.

Figs. 21 to 26, are various sections of a fossil Nummulite, of which fig. 27, represents the flat surface (*Nummulites complanata,* of Parkinson. This fossil belongs to the genus *Discospira* of Mr. Morris).[3]

Fig. 28. A species of Formanifera (*Fasciolites,* of Parkinson; *Alveolina elliptica,* of D'Orbigny).

Fig. 29. A transverse section.

Figs. 30, & 31. Enlarged views of the same fossil. Fig. 31. A longitudinal section.

[1] No. 21, for February 1850. "On the Microscopic Structure of Nummulina, Orbitolites and Orbitoides."

[2] See Sowerby's Mineral Conchology, vol. i.; and Mantell's Fossils of the South Downs.

[3] "*Discospira,* Nov. Gen. Disciform, volutions distrial, not embracing the previous ones, cells numerous." *Mr. Morris,* 1850.

PLATE LXII.

Fossil Foraminifera.

With the exception of figs. 23, 24, 29, 31 and 32, all the specimens delineated in this Plate belong to the Foraminifera. The figures represent magnified views; the natural size is indicated in some instances by a minute outline. Under the article "Foraminifera," in the "*Supplementary Notes,*" a general account is given of the structure and economy of the living animalcules. A list of names is subjoined.

Figs. 1, & 2. *Rotalia trochiliformis*, of Lamarck. Tertiary.

Fig. 3. *Rotalia Beccarii*, of Linnæus. Tertiary.

Fig. 4. *Cristellaria rotulata*, Lamarck. Chalk.

Figs. 5, 6, 7. *Lituola nautiloidea*, Lamarck. Chalk.

Fig. 8. *Spirolina depressa*, Lamarck. This and the specimens to fig. 21 inclusive, are tertiary fossils.

Fig. 9. *Spirolina cylindracea*, Lamarck.

Fig. 10. *Orthocerina clavulus.*

Fig. 11. *Biloculina ringens*, Lamarck.

Figs. 12, & 13. *Quinqueloculina cor anguinum*, Lamarck.

Figs. 14, 15, & 16. *Quinqueloculina.*

Figs. 17, 18, 19. *Triloculina trigonula*, Lamarck.

Fig. 20. *Quinqueloculina opposita*, Lamarck.

Fig. 21. *Peneroloplis opercularis.*

Fig. 22. *Adelosina*, of D'Orbigny; a recent species.

Figs. 23, & 24. *Gyrogonites.* The fossils here figured on a magnified scale as microscopic shells of the same family as those above described, received the name of *Gyrogonites*, or *twisted stones.* They prove to be the seed-vessels of a species of the common fresh-water plant, the *Chara.* The fruit of this genus consists of minute nuclei, with an external calcareous covering, composed of five spirally twisted plates, which unite at the summit. These fossils occur by myriads in many of the fresh-water secondary and tertiary limestones, as well as in the calcareous deposits now in progress of formation in our lakes. In the lacustrine limestones of the Isle of Wight (at Binstead, White Cliff, &c.), beautiful specimens may be obtained.[1] Professor E. Forbes has discovered Gyrogonites in the Wealden strata of the Isle of Purbeck, associated with shells of the genera *Planorbis, Physa, Paluolina*, &c.

[1] See Geological Excursions round the Isle of Wight. 2d Edit. 1850, p. 108.

PLATE LXII.—*continued.*

FIG. 25. *Polystomella crispa,* of Linnæus. From the tertiary strata of the Apennines.

FIG. 26. *Cristellaria?*

FIGS. 27, & 28. *Rotalia Beccarii.* Apennines.

FIG. 30. *Cristellaria galea,* of Lamarck. Apennines.

FIG. 29. Cast of a species of *Arca;* a bivalve shell, from tertiary strata, Bordeaux.

FIG. 31. A curious pteropodous shell (*Vaginella depressa*), from tertiary strata, Basterot.

FIG. 32. This appears to be an imperfect specimen of a bivalve having a fibrous structure, like *Pinna.* It is probably a fragment of an Inoceramus.

PLATE LXIII.

TRIGONIÆ.

FIGS. 1, & 2, represent the structure of the hinge in both valves of a genus of bivalves of which numerous fossil species are met with in the secondary strata, and two or three species still exist in the Pacific Ocean. The genus is named *Trigonia,* from the form of the hinge, and the specific names below are those given by Mr. Parkinson.

FIG. 3. *Trigonia clavellata,* of Parkinson, from the Kimmeridge clay, Hartwell, Bucks.

FIG. 4. *Trigonia costata,* Oxford clay, Wilts.

FIG. 5. *Trigonia excentrica*; upper greensand, Blackdown. Like most of the shells from this locality, the Trigoniæ are transmuted into silex.

FIG. 6. *Trigonia dædalea,* Blackdown.

FIG. 7. ——— *spinosa,* Blackdown.

FIG. 8. Enlarged view of the spines of the above.

FIG. 9. *Trigonia alæformis,* Blackdown.

FIG. 10. ——— *rudis,* Blackdown.

FIG. 11. A bivalve shell of the genus *Productus* (*P. antiquatus,* of Sowerby ?), from the Mountain limestone. See description of fig. 9, Plate LXVII.

FIG. 12. Cast of a species of *Trigonia* (*T. clavellata*), from the Portland rock. Many beds of this oolitic limestone are almost entirely made up of casts of Trigoniæ, and chiefly of this species.

FIG. 13. *Trigonia sinuata,* from Blackdown.

FIGS. 14 to 18. "Different views of a species of *Harpax.*"—Mr. Parkinson (*Plicatula spinosa*). From the Lias, Gloucestershire.

FIG. 14. The inner surface of the flat valve.

FIG. 15. Inner surface of the convex valve.

FIG. 16. Magnified hinge teeth of the flat, and fig. 17, of the convex valve.

FIG. 18. Magnified view of the adpressed spines on the external surface of the shell.

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PLATE LXIV.

FOSSIL SHELLS.

FIG. 1. A perfect specimen of one valve, showing the character of the hinge of *Cucullæa decussata*, of Parkinson. London clay. Herne Bay.

FIG. 2. Interior view of *Crassatella tumida*, of Lamarck. Eocene strata, Paris.

FIG. 3. *Cardium Hillanum*, of Sowerby. A beautiful silicified bivalve from Blackdown.

FIG. 4. *Nucula ovum*, of Sowerby. A common bivalve, in the Lias, Yorkshire.

FIG. 5. Inner view of *Cyrena deperdita*, of Parkinson. Plastic clay, Woolwich.

FIG. 6. *Lima gigantea*, of Sowerby, from Lyme Regis. This is a young and small specimen of a large bivalve that occurs in great perfection in the Lias.

FIG. 7. *Cardinia Listeri*, of Sowerby. From the Lias, Gloucestershire.

FIG. 8. Cast of a bivalve; genus uncertain.

FIGS. 9 to 12. These fossils are the *Trigonellites* of Mr. Parkinson; and have since been referred to a genus named *Aptychus*. Their true relations are very problematical. Though found in pairs, there is no hinge or natural connexion. Some naturalists suppose they may belong to the internal organization of Ammonites, because certain kinds have been found collocated with particular species of that genus of Cephalopoda. At present I do not think there is any satisfactory evidence as to their real nature. Species occur in the Kimmeridge clay, and other subdivisions of the Oolite formation.

FIGS. 9, & 12. *Trigonellites lata*, of Mr. Parkinson.

FIGS. 10, & 11. ———— *lamellosa*.

FIGS. 13, & 14. *Corbula revoluta*, of Sowerby. London clay, Highgate.

FIG. 16. An imperfect specimen of *Lusianassa* (*Mya*) *literata*, from the fullers' earth of the Oolite, Wiltshire.

FIGS. 15, & 17. *Cardita senilis*, of Sowerby. From the Red crag of Suffolk.

PLATE LXV.

Fossil Shells.

Fig. 1. A single valve, viewed interiorly, of a fine shell (*Panopœa Aldrovandi*, of Faujas St. Fond) from the Pleistocene or Newer Tertiary strata, that form a chain of low hills near Palermo, in Sicily. The shells in these deposits comprise almost all the genera and species that now inhabit the Mediterranean. They occur in the most beautiful state, deprived only of their colour; and groups are often met with of extreme elegance. The cabinet of the Marquess of Northampton contains an extensive and unrivalled series of these fossils, collected during his Lordship's residence at Palermo.

Figs. 2, & 4. A boring bivalve (*Fistulana* or *Lithodomus*) from the Oolite, Bath.

Figs. 3, & 5. Valves of a small Oyster from the Crag of Essex.

Fig. 6. A group of Lithodomi in limestone from the Oolite, Bradford, Wilts.

Fig. 7. A detached specimen from the same, showing the enclosed bivalve.

Figs. 8, & 10. Fine but imperfect specimens of a species of *Teredo* (*Teredina personata*, of Lamarck), from the Plastic clay of Epernay, France.

Fig. 9. A snail-shell (*Helix arbustorum*) found associated, and evidently contemporaneous, with bones of Mammoth, and extinct species of Deer, and other mammalia. From Brentford, in a bed of light calcareous earth, twenty feet below the surface.

Fig. 11. "A concamerated Teredo."—*Mr. Parkinson.* I am unable to ascertain the nature of this fossil.

Fig. 12. A species of *Fistulana*, from France.

Fig. 13. External surface of *Chama squamosa* of Brander. London clay, Hordwell.

Figs. 14, & 15, are the anchylosed caudal vertebræ of the tails of fishes. From the London clay, Isle of Sheppey.

Fig. 16. "A small oyster with a spathose structure."—*Mr. Parkinson.* This shell is probably the flat valve of a species of *Dianchora*, of Sowerby; from the Chalk.


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PLATE LXVI.

Fossil Bivalve Shells.

Fig. 1. A fossil Oyster (*Ostrea Marshii,* of Sowerby), from the Cornbrash of the Oolite, Wiltshire.

Fig. 2. The fossil Cockscomb Oyster, (*Ostrea carinata,* of Lamarck,) from the Lower chalk, Havre, France.

Fig. 3. The elegant fossil shell here figured is a peculiar and most abundant species in the Lias formation; specimens are not uncommon, in which every part of the shell is as perfect as if just thrown up on the seashore. It belongs to the genus Gryphites (*Gryphea incurva,* of Sowerby,) the shells of which are nearly related to the oysters, but are distinguished by the deep concave under-valve, and its curved beak, and the almost flat upper shell. The testaceous substance is of a finer laminated structure than in the Ostrea, and the hinge-ligament is inserted in an elongated curved groove.[1]

Fig. 4. "*Ostrea vel frons folium.*"—Mr. Parkinson. This species appears to be the *Ostrea gregarea* (?) of Sowerby, which occurs in the chlorite marl or firestone of the Lower chalk in Sussex and Kent.

Fig. 5. The fossil is the cast of an oyster-like bivalve, called Perna, (*Perna quadrata,* of Sowerby,) which is easily recognisable, even in casts, by the line of distinct teeth which compose the hinge. This species is abundant in the Portland limestone, particularly in the quarries around Swindon, in Wiltshire; but from the close adhesion of the outer surface of the shell to the surrounding stone, they can seldom be extracted, the casts only being readily obtainable. In the Kimmeridge clay, which lies above the Portland rock, the shells may be met with in great perfection. The best locality is near Hartwell, in Buckinghamshire, where the clay is extensively dug for the brick manufactures.

Figs. 6, & 7. Two views of a small shell of the genus *Crenatula,* from Bedfordshire.

Fig. 8. Portion of a very large species of Perna (*Perna maxillata,* of Sowerby), from tertiary strata, Piedmont. The figure shows the inner surface of the shell with part of the broad crenulated hinge.

[1] Medals of Creation, vol. i. p. 387.

PLATE LXVII.

Fossil Shells of Brachiopoda, &c.

Fig. 1. A species of *Radiolites* (*R. agariciformis*, of M. D'Orbigny), from the Cretaceous strata of France. This genus is only known in a fossil state; it belongs to the same group of shells (order, *Rudistes*) as the Spherulites and Hippurites: the lower valve is conical, and much larger than the upper, which is slightly convex; it is deeply channelled longitudinally.

Fig. 2. Smooth valve of a species of Corbula (*Corbula gallica*, of Lamarck); abundant in some of the Eocene deposits of the Paris basin.

Fig. 3. A single valve; the inner surface is shown in the figure, of a remarkable genus of shells (*Crania personata*, of Lamarck), frequently occurring attached to Echinites and other bodies of the white chalk.

Fig. 4. A species of *Terebratula* (*T. diphya*, of Lamarck). The shells of this genus belong to that division of mollusks termed *Brachiopoda* (arm-feet), from their having internally two spiral fleshy arms developed from the sides of the alimentary orifice. These organs are supported by shelly processes, curiously modified in different genera, which often occur in a fossil state. Although the fossil Terebratulæ are very numerous, the recent species are but few, and are inhabitants of the seas off Australia. They form two natural groups; in the one the shells are smooth, but perforated all over with minute openings or foramina; and these are often filled with a dark substance, which is the carbonized soft parts: in the other division the shells are plicated or furrowed, and are not foraminiferous.[1] The Spirifers, another group of Brachiopoda, have a pair of internal spiral appendages.

Fig. 5. *Terebratula coarctata*, of Parkinson. Bradford clay, Wilts.

Figs. 6, & 7, show the internal structure of recent Terebratulæ from New Holland. The complicated shelly apophyses which supported the arms are quite perfect.

Fig. 8. *Terebratula triquetra*, of Parkinson (*T. diphya*, of Lamarck); another example of the species, fig. 4.

Figs. 9, & 10. Different parts of the same specimen of a brachiopodous bivalve belonging to the genus *Productus*, so named from the lengthened or produced form of the convex

[1] On the structure of shells the reader should consult the admirable papers of Dr. Carpenter, in the British Association Reports.

PLATE LXVII.—*continued.*

valve. "This is generally filled with limestone, which conceals the internal structure; but, with a slight blow, the shell divides, when the edge of the small valve rests against the inside of the produced cylindrical part of the larger one; generally about half an inch from the top of the shell: one side of the valve, before hidden, fig. 9 *a*, is then exposed, as shown in fig. 10."—*Mr. Parkinson.*

Fig. 9. *a*, the beak of the upper valve; *c*, a cavity in the superior part of the shell.

Fig. 10. The under part of the shell; *b*, a depression receiving the beak of the upper valve, *a*.

Fig. 10*. The inner surface of another upper valve, having a longitudinal fissure. The species figured is the *Productus Martini* of Mr. Sowerby. From the mountain limestone of Derbyshire; in which deposit numerous examples occur.

Fig. 11. A large species of Spirifer (*Spirifer striatus*, of Sowerby), from the mountain limestone of Derbyshire. In this species the upper valve is broken away, and one of the large spiral apophyses is seen lying imbedded in the limestone with which the cavity of the shell is filled.

Fig. 13, is a beautiful example of part of one of the spiral appendages of the same species.

Fig. 12. "A patch of square scales of a fish from Dorsetshire."—*Mr. Parkinson.* These evidently belong to a Lepidoid fish (*Dapedius*), whose remains are common in the Lias;[1] perfect specimens are often obtained. The British Museum contains some beautiful examples of this fossil fish.

Figs. 14, & 15. A curious fossil bivalve, from the Devonian strata of the Eifel. The flat valve is shown in fig. 14; and the deep conical valve in fig. 15; *a*, tooth in the posterior margin; *b*, a part of the surface magnified, to show its cellular structure. The species is *Calceola sandalina*, of Lamarck.

Fig. 16. A species of Spirifer; *a*, medial convexity of the upper valve; *b*, the triangular foramen at the beak.

Fig. 17. Spirifer (*S. cuspidatus*, of Mr. Martin), from the Mountain limestone of Derbyshire.

Fig. 18, represents a common appearance in certain chalk flints. Although I have examined hundreds, and some in which the form was more definite than in the specimen figured, I am not able to offer any probable suggestion as to their origin, should they be organic bodies, of which there is much doubt.

Fig. 19. "*Coronulites diadema.*"—Mr. Parkinson. Probably a species of Balanus, from a tertiary deposit.

Fig. 20. Cast of one of the shells of a bivalve (*Pentamerus*), from the Wenlock limestone of Dudley.

[1] Wonders of Geology, vol. ii. p. 529.


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PLATE LXVIII.

Fossil Crustacea.

Figs. 1, & 3. "Fossil *Crabs*, from Sheppey."—*Mr. Parkinson.* The London clay of this celebrated locality contains an abundance of the fossil remains of Crustacea; and the visitor may purchase of the local collectors fossil crabs and lobsters, as readily as the recent species from the neighbouring sea. Good specimens are however rare, and command high prices. The specimens figured are two common species.

Fig. 1. *Cancer Leachii*, of MM. Desmarest and Brongniart.

Fig. 3. *Inachus Lamarckii.*

These fossils show the usual mode in which the crustaceæ occur in the hardened clay of Sheppey. The thorax is bent over the abdomen, and the pair of large chelate claws drawn towards each other.

Fig. 2. Fossil Insects from the lithographic stone of Pappenheim. "*a*, an insect with a bifurcated caudal extremity; *b*, the sting which has passed out of its sheath; *c*, the termination in a single point."—*Mr. Parkinson.*

Fig. 4. "A fossil Shrimp, from Anspach."—*Mr. Parkinson.*

Fig. 5. "Impression of an unknown fossil."—*Mr. Parkinson.*

Fig. 6. "The claw of a Crab, from Maestricht, &c."—*Mr. Parkinson.* Claws of this kind are frequent in the soft sandy limestone of St. Peter's Mountain, but no other vestiges of the Crabs to which they belonged have been met with. The cause of this has been ascertained: the claws belong to a species of Hermit Crab (*Pagurus Faujasii*, of Desmarest), which like the living species had the body covered by a delicate membrane, the claws only possessing a durable crustaceous shell.[1]

Fig. 7. "An extended trilobite, from Dudley."—*Mr. Parkinson.* Among the organic remains of the inhabitants of the seas, in whose abysses were formed the Silurian, Devonian, and other ancient sedimentary strata, an extinct family of crustaceans, comprising numerous genera, are among the most characteristic and remarkable. The name "*Trilobite*," first given by Mr. Parkinson, expresses the most obvious character of the longitudinally trilobed, convex, segmented, carapace of the body, of the most common forms; but so great is the number of species, and so dissimilar the groups, now known, that the nomenclature of this class of fossils is greatly extended. In Sir R. I. Murchison's splendid work on the Silurian System, the genera and species of the formations therein comprised are beautifully illustrated. The specimen

[1] Wonders of Geology, p. 338.

PLATE LXVIII.—*continued.*

figured is an expanded specimen of the species commonly known as the *Dudley Locust* or *Insect*, (*Calymene Blumenbachii*), from the Wenlock limestone, Dudley.

Fig. 8. A coiled-up specimen; in this view are seen both ends of the crustaceous covering of the animal: *a*, "the eye enlarged."

Fig. 9, is part of the head of the same species.

Fig. 10. "A fossil Crab from the East Indies."—*Mr. Parkinson.* Beautiful specimens of this species of Crab (*Gonoplax Latreilli*, of Mr. Edwards) have been obtained from the tertiary strata of India.

Fig. 11. Another form of Trilobite (*Ogygia Buchii*, (*Asaphus*,) of the Silurian System), from the Llandeilo flagstones.

Fig. 12. "Remains of some large unknown insect."—*Mr. Parkinson.* This figure is not sufficiently defined to admit of interpretation.

Fig. 13. "Part of a trilobite with tuberculated head," (*Calymene variolare*,) from the Wenlock limestone, of Dudley.

Fig. 14. Posterior part of a trilobite with a caudal style or process, (*Asaphus caudatus*,) from the Wenlock shale, Dudley.

Fig. 15. A nodule of ironstone from Coalbrook Dale, in which is imbedded a small crustacean allied to the recent King Crab or *Limulus*; a genus abundant in the seas of India and America.[1] (*Limulus trilobitoides*, of Dr. Buckland. *Bellinurus bellulus*, of Mr. König.)

[1] Medals of Creation, vol. i. p. 550.

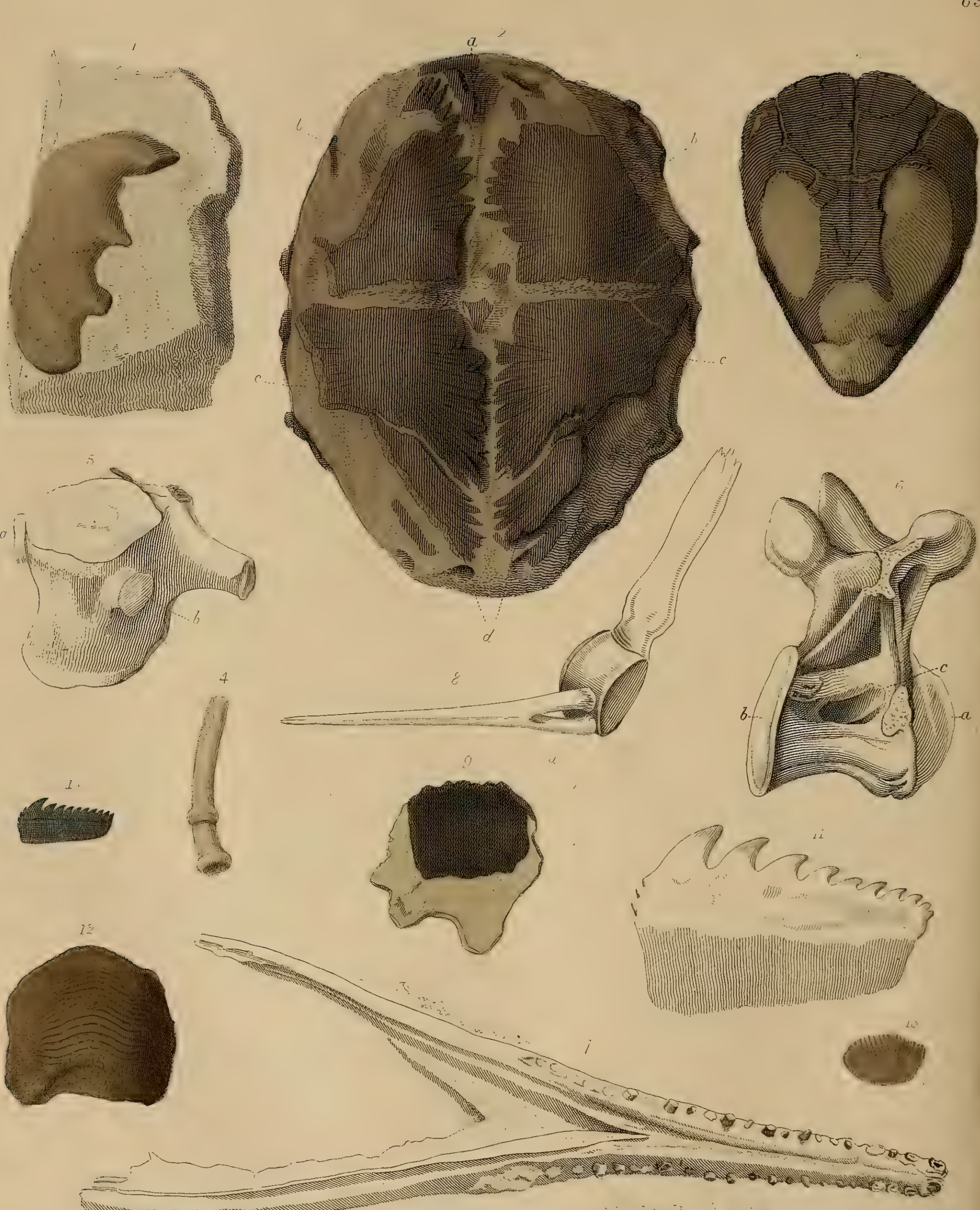
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PLATE LXIX.

Fossil Fishes and Reptiles.

Fig. 1. "A fossil body resembling part of a Tortoise, from Gloucestershire."—*Mr. Parkinson.* This specimen is probably one of the mandibles of a remarkable extinct genus (*Ceratodus*) of fishes, whose dental organs, like those of the recent *Chimæra*, consisted of consolidated plates instead of separate teeth; each side of the jaw was formed by one of these mandibular processes; the upper margin is deeply undulated. The bone-bed of the Lias at Aust Cliff near Westbury, Somersetshire, is rich in these remains.

Fig. 2. The plastron, or inferior aspect of the carapace of a fossil Turtle (*Chelonia breviceps*), from the London Clay of the Isle of Sheppey. *a*, fragment of the *entosternal* plate; *b*, *b*, *hyosternal* plates; *c*, *c*, *hyposternals ; d*, *xiphisternals.*[1]

Fig. 3. The cranium of the same species of Turtle, from the Isle of Sheppey.

Equally rich in the remains of Chelonian reptiles, as in those of Fishes, Crustaceans, Serpents, and Mollusks, the little Island at the mouth of the Medway has yielded to the indefatigable researches of Mr. Bowerbank the most extensive series of fossil Turtles hitherto discovered in England. The various genera and species will be figured and described in a work now in progress by Professors Bell and Owen, under the auspices of the Palæontographical Society.

Fig. 4. A Serpula (*S. antiquata ?*), from the chalk, Sussex.

Fig. 5. A dorsal vertebra of a fossil crocodilian reptile (*Steneosaurus*), from the Oxford Clay of Honfleur. *a*, *b*, costal depressions.

Fig. 6. A dorsal convexo-concave vertebra of a crocodilian or gavial-like reptile (*Streptospondylus*), from the same locality. This figure shows the remarkable character whence the name of this genus: the convexity of the body of the vertebra (*a*) being situated anteriorly as in mammalia, the reverse of the position of the bones forming the vertebral column in the existing Crocodilians and Lacertians. *b*, the posterior concavity; *c*, a deep depression beneath the neural arch.

Fig. 7. Sketch of the lower jaw of an extinct gavial-like reptile (*Steneosaurus*): the vertebra, fig. 5, probably belongs to the same species. From Honfleur. This figure, and figs. 5, 6, and 8, are copied from Cuvier, "*Annales du Muséum.*"

Fig. 8. A caudal vertebra of the Fossil Animal of Maestricht (*Mosasaurus*); *a*, the chevron bone or inferior spinous process (*hæmapophysis*), anchylosed to the middle of the body of the vertebra.

Fig. 9. Fossil scale of a ganoid fish (probably *Lepidotus*), from Kent.

Fig. 10. Fossil tooth of a fish of the Shark family (*Notidanus microdon*, of Agassiz,) from the chalk of Kent.

Fig. 11. Recent "tooth of one of the Dog-fish," (Mr. Parkinson,) for comparison with fig. 10.

Fig. 12. Tooth of an extinct group of squaloid fishes (*Ptychodus decurrens*, of Agassiz,) from the chalk of Kent.[2]

Fig. 13. A ctenoid (or comb-like) scale of a fish, (probably of a species of *Beryx*,) from the chalk of Kent.

[1] See Parkinson, p. 269.

[2] See Medals of Creation, vol. ii. p. 617.

PLATE LXX.

Fossil Reptiles and Fishes.

Fig. 1. A reduced figure of the celebrated specimen of the jaws, &c. of the "Fossil Animal of Maestricht," (*Mosasaurus Hoffmani*,) from the cretaceous strata of St. Peter's Mountain. See "*Supplementary Notes*," art. *Mosasaurus*.

"*a, b.* The left side of the lower jaw, nearly whole, and seen on its outer side.

c, d. Right side of the lower jaw, viewed on the inner side, the posterior part of which, a little concealed by the palate bones, is continued to *e*.

f, g. The right side of the upper jaw, seen on its inner side, and with the palate bone. This part is nearly in its natural position in relation to the corresponding ramus of the lower jaw.

h, i. A fragment of the left side of the upper jaw, displaced and fallen across the lower jaw.

k, l, m; *k', l', m', o'*. The two palate bones displaced and thrown one over the other, and also over the right side of the lower jaw. In the original specimen a portion of bone is placed from *m* to *p*, and another at *q*, which are omitted to render the figure more intelligible."—*Mr. Parkinson*.

Figs. 2 to 18, are fossil teeth of various kinds of fishes, principally of the Shark and Ray families.

Fig. 2. Tooth of a shark (*Lamna*), from Malta.

Fig. 3. Tooth of a shark (*Galeus pristodontus*), chalk marl, Kent.

Fig. 4. Tooth of a Saurian, the upper and lower end imperfect; probably of a species of *Steneosaurus*, from Bath.

Figs. 5, & 8. Teeth of a shark (*Otodus*,) London Clay, Isle of Sheppey.

Fig. 6. Tooth of a fish, (*Spherodus*,) from the Oolite, Gloucestershire.

Fig. 7. Part of the fossil jaw with three rows of teeth of a fish, (of the *Pycnoid*[1] family,) from the Oolite, Gloucestershire.

Fig. 9. Tooth of a species of *Lamna*, from Sheppey.

Fig. 10. Tooth of a species of *Hybodus*,[2] Stonesfield.

[1] Medals of Creation, vol. ii. p. 641. [2] Ibid. p. 621.

PLATE LXX.—*continued.*

Fig. 11. A very large tooth of a Shark, (*Carcharias megalodon,*) from the tertiary deposits of Malta.

Fig. 12. Fragment of a bone, with two teeth, probably of a species of *Pycnodus.*

Fig. 13. "The mandible and tooth of a recent fish (*Diodon*), to compare with the fossils figs. 16, and 17."—*Mr. Parkinson.*

Fig. 14. "Fossil palate of a fish, from Sheppey."—*Mr. Parkinson.* This evidently belonged to a species of *Ray;* possibly to the Eagle rays (*Miliobatis*).

Fig. 15. Tooth of a fish allied to the *Cestracionts,* or Port Jackson Shark, (probably of the genus *Acrodus,*[1]) from Bath; commonly called "*Leech palates*" by the quarrymen.

Figs. 16, & 17. "Fossil palates of fishes of the Ray kind, from Sheppey."—*Mr. Parkinson.* These appear to belong to the Miliobates (*M. micropleuris,* of Agassiz). Beautiful examples of these fossils have been obtained from the Bracklesham clay, on the coast of the West of Sussex. The late Frederic Dixon, Esq. of Worthing, whose untimely death is so much to be deplored, had a matchless suite of specimens from that locality.

Fig. 18. A fine specimen of a fossil tooth of a fish of an extinct genus, of which many species occur in the chalk (*Ptychodus polygurus,* of Agassiz). The teeth of various species of this genus of Sharks abound in the chalk of almost every part of England.[3]

[1] Medals of Creation, p. 614. [2] Ibid. p. 630. [3] Ibid. p. 616; and plate vi. fig. 2.


24 inches
10 feet 10 inches

PLATE LXXI.

Fossil Remains of Mammalia.

Fig. 1. "A fossil tooth, probably of some animal of the whale kind."—*Mr. Parkinson.* I am not able to determine the nature of this specimen.

Fig. 2. The antlers and skull of the Fossil Elk, of Ireland, (*Megaceros Hibernicus.*) The original was nearly eleven feet across, from the point of one antler to another. A perfect skeleton of this extinct gigantic deer is exhibited in the Gallery of Organic Remains in the British Museum. For an account of this animal see Wonders of Geology, vol. i. p. 132; and *Supplementary Notes*, p. 189. The following measurements of the specimen figured are given by Mr. Parkinson:—

	Feet.	Inches.
a to *b*	10	10
c to *d*	5	2
e to *f*	3	7½
g to *h*	2	6
i to *k*	1	10½
d to *l*	1	2
Diameter of the horn at *m*	0	2¼
Circumference, "	0	8
" at the root	2	11
Length of the cranium from *n* to *o*	2	0
Width " " *p* to *q*	1	0

"A similar pair, found ten feet under ground in the county of Clare, was presented to Charles the Second, and placed in the guard-room of Hampton Court Palace."

Fig. 3. Fragment of the fossil horn of some species of Cervus or Deer, from Etampes, in France.

Fig. 4. Two teeth of a ruminant, (a species of *Bos* or *Ox*,) in breccia, from Gibraltar.[1]

The remaining figures, Figs. 5, 6, 7, 8, represent the worn surfaces of molars or grinding teeth of the extinct species of Elephants termed Mammoths, (*Elephas primigenius*, of M. Bojanus.)

Fig. 9, shows the structure of part of the tooth.

These were regarded by Mr. Parkinson as referable to two or more species of Mammoth; but Professor Owen, after an examination of the vast number of specimens that modern researches have brought to light, and which are deposited in the public and private collections of Great Britain, concludes that the specimens here figured belong to but one species. The differences observable in the surface of the crowns, are due to abrasion, and to the latitude of variety to which the highly complex molars of this extinct Elephant were subject.[2]

[1] Wonders of Geology, vol. i. p. 186.

[2] British Association, Report for 1843. Fossil Mammalia, p. 213. For an account of the Mastodon and Mammoth, see Wonders of Geology, vol. i. pp. 151—161.


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PLATE LXXII.

Fossil Teeth of Mammalia.

Fig. 1. A right lower molar tooth of an extinct species of Hippopotamus (*H. major*, of Cuvier), from France.

Fig. 2. Upper molar of an extinct species of Rhinoceros (*R. leptorhinus*, of Cuvier), from the bone-cave near Torquay, Devonshire.

Fig. 3. The crown of a molar tooth of the "gigantic Tapir" of Baron Cuvier; the *Dinotherium* of M. Kaup.[1]

Fig. 4, "the outer, and fig. 5, the inner, surface of the fourth molar of *Palæotherium medium*, of M. Cuvier."—*Mr. Parkinson.* From the eocene tertiary deposits of Paris.

Fig. 6, the outer, and fig. 7, the inner, aspect of an upper molar of the same animal.

Figs. 8, & 9. Lower molars of *Amplotherium commune*, of M. Cuvier.[2]

Fig. 10. An ungueal or bone of the claw, of a gigantic animal of the Sloth tribe (*Megalonyx Jeffersoni*); the figure is half the linear diameter of the original.[3]

Fig. 11. Vertical section of a tooth of the same. These remains of a colossal animal of that remarkable group of mammalia—the Edentata—are from Bigbone Cave, in Kentucky. The Megalonyx resembled the Megatherium in its general characters but was one-third smaller. See *Supplementary Notes*, p. 184.

[1] Wonders of Geology, vol. i. p. 174. [2] Ibid. p. 256. [3] Ibid. p. 169.

PLATE LXXIII.

MEGATHERIUM AND FOSSIL BEARS.

FIG. 1, is a sketch, on a very small scale, of the skeleton of a colossal extinct animal of the Sloth tribe, discovered in the alluvial deposits of the Pampas, and preserved in the museum at Madrid. A plaster model of a skeleton, restored from the remains of various individuals, dispersed in different collections, is just completed, and exhibited to the public in the Gallery of Organic Remains of the British Museum.[1] This extinct animal is named the *Megatherium* (*gigantic wild animal*) *Cuvieri.* It was seven feet high, and nine long, and therefore larger than the largest rhinoceros. It possessed no incisor teeth; and the grinders, which are seven inches long, are of a prismatic form, and like those of the sloths, are composed of dentine and cement. They are so formed that the crown always presents two cutting, wedge-shaped, salient angles; they are therefore admirably adapted for cutting and bruising vegetable substances. The entire fore-foot is about a yard in length, and armed with strong claws. The Megatherium held an intermediate place between the sloths, armadillos, and ant-eaters. The celebrated specimens of different parts of the skeleton of this colossal creature, preserved in the Hunterian Museum of the College of Surgeons of England, were collected and presented by Sir Woodbine Parish.

FIG. 2. The hindmost grinder of the upper jaw of the FOSSIL BEAR (*Ursus spelæus*) of the Caverns, from Gaylenreuth.[2]

FIG. 3. The middle upper grinder.

FIG. 4. The foremost upper grinder.

FIG. 5. The hindmost grinder of the lower jaw.

FIG. 6. The penultimate grinder of the lower jaw.

FIG. 7. The antepenultimate lower grinder.

FIG. 8. The foremost lower grinder.

FIG. 9. The canine tooth of the Fossil Bear.

[1] See Wonders of Geology, pp. 164—167. [2] Ibid. vol. i. p. 176

Drawn and Engraved by S. Springsguth

A grinding tooth of the MASTODON GIGANTEUS *of Ohio.* — *weight.* lb 4 . oz 7.

PLATE LXXIV.

Tooth of the Mastodon.

A molar tooth of the *Mastodon giganteus,* from Big-bone Lick, Kentucky; of the natural size.

From the great number of bones and teeth of animals of the extinct elephantine genus, to which the name of Mastodon was given by Cuvier (from the structure of the crowns of the teeth), that have of late years been brought to England, and are dispersed in our public and private collections, the intelligent reader must be familiar with the forms, characters, and gigantic proportions, of that stupendous tribe of animals which once ranged through the primeval forests not only of America, but also of some parts of Europe. From a perfect skeleton lately set up in the British Museum (in the same room with that of the Megatherium), a correct idea may be obtained of this peculiar type of mammalian structure. From this specimen it appears that the great Mastodon of the Ohio was not unlike the elephant in its general outline, though somewhat longer and thicker. It had a trunk or proboscis, tusks which curved upward, and four molar teeth in each jaw, but no incisors. But another remarkable peculiarity, and which entirely separates the Mastodon from the Elephant, is that the young animal had a pair of tusks, placed horizontally in the lower jaw, and of these tusks one only became developed, and that in the adult male: both were early shed in the female. In the midst of a collection of Mastodon bones imbedded in mud, a mass of small branches, grass, and leaves, in a half bruised state, and a species of reed common in Virginia, were discovered; the whole appeared to have been enveloped in a sac, probably the stomach of the animal. In another instance traces of the proboscis were observed. The tusks are composed of ivory, and vary somewhat in the direction and degree of their curvature. The bones of this colossal quadruped are found remarkably fresh and well preserved, and are generally impregnated with iron. No living instance of this creature is on record, and there can be no doubt that its race has long since been extinct.

"Big-bone Lick, where so many remains of the Mastodon and other extinct quadrupeds have been dug up, is distant from Cincinnati about twenty-three miles in a south-west direction. This celebrated bog is situated in a nearly level plain, in a valley bounded by gentle slopes, which lead up to flat table-lands composed of blue argillaceous (Silurian) limestone, and marl. The general course of the meandering stream which flows through the plain, is from east to west. There are two springs on the southern or left bank, rising from marshes, and two on the opposite bank; the most western of which, called the Gum Lick, is at the point where a small tributary joins the principal stream. The quaking bogs on this side are now more than fifteen acres in extent; but all the marshes were formerly larger, before the surrounding forest was partially cleared away. Within the memory of persons now living, the wild bisons or buffaloes crowded to these springs; but they have retreated many years, and are now as unknown to the inhabitants as the Mastodon itself. The bog in the spots where the salt springs rise is so soft, that a pole may be forced down into it many yards perpendicularly.

PLATE LXXIV.—*continued.*

"The greater numbers both of the entire skeletons and the separate bones have been taken up from black mud, about twelve feet below the level of the Creek. It is supposed that the bones of the mastodons found here could not have belonged to less than one hundred individuals: those of the fossil Elephant (*Elephas primigenius*) to twenty; besides which a few bones of the Megalonyx, and of a species of stag, horse, and bison, are stated to have been collected. The greatest depth of the black mud has not been ascertained; it is composed chiefly of clay, with a mixture of calcareous matter and sand, and contains 5 parts in 100 of sulphate of lime, with some animal matter. Layers of gravel occur in the midst of it at various depths. It contains remains of seeds, and of several species and genera of fresh-water and terrestrial shells. It is impossible to view this plain without at once concluding that it has remained unchanged in all its principal features, from the period when the extinct quadrupeds inhabited the banks of the Ohio and its tributaries.

"There are two buffalo paths or trails still extant in the woods, and both lead directly to springs: the one which strikes off in a northerly direction from the Gum Lick, may be traced eastward through the forest for several miles. It is three or four yards wide, and only partially overgrown with grass, and sixty years ago was as bare, hard, and well trodden, as a high road. It is well known that during great droughts in the Pampas of South America, the horses, deer, and cattle, throng to the rivers in such numbers, that the foremost of the crowd are pushed into the stream by the pressure of others behind, and are sometimes carried away by thousands, and drowned. In their eagerness to drink the saline waters and lick the salt, the heavy mastodons and elephants seem in like manner to have pressed upon each other, and sunk in the soft quagmires of Kentucky."[1]

[1] Extracted from Sir Charles Lyell's "Travels in North America," vol. ii. chap. xvii. 1845.

SUPPLEMENTARY NOTES.

I. Fossil Bears of the Caverns. (Plate LXXIII.) For many centuries certain caves in Germany have been celebrated for their osseous treasures, particularly those in Franconia. The most remarkable of these caverns is that of Gaylenreuth, which lies to the north-west of the village of that name, on the left bank of the river Wiesent, on the confines of Bayreuth.[1] The entrance to this cave is in the face of a perpendicular rock, and leads to a series of chambers from fifteen to twenty feet high, and several hundred feet in extent, terminating in a deep chasm. The cave is quite dark; and the icicles and pillars of stalactite, reflected by the light of the torches, which it is necessary to use, present a highly picturesque effect. The floor is literally paved with bones and fossil teeth, and the pillars and corbels of stalactite also contain similar remains. The bones are generally scattered and broken, but not rolled; they are lighter and less solid than recent bones, and are often incrusted with stalactites. Three-fourths of the bones belong to two species of bears (*Ursus*), the remainder to hyænas, tigers, wolves, foxes, gluttons, weasels, and other small carnivora. Those belonging to bears are referable to two extinct species: the largest has the skull more prominent on the front than any living species; it is named *Ursus spelæus*, or cavern bear; the other has a flat forehead, and is the *Ursus priscus* of Cuvier. The Hyena was allied to the spotted hyena of the Cape, but differed in the form of the teeth and skull. Bones of the Elephant and Rhinoceros are said to have been discovered, together with those of existing animals, and fragments of sepulchral urns of high antiquity.[2]

Similar ossiferous caves occur in England; of these, the most remarkable now accessible are Kent's Hole, near Torquay, and Banwell Cave, in the Mendip Hills, near the village of Banwell. The latter may be easily visited, as the Exeter railway passes within three miles of the village, and there is a station, with vehicles to convey passengers to Banwell.

II. The Belemnite. (Plates LIX. and LX.) Among the innumerable relics which abound in the secondary deposits, there are perhaps no fossil bodies that have excited so much curiosity, or given rise to so many fanciful conjectures as to their nature and origin, as the long, cylindrical, fusiform, crystalline stones, called *Belemnites* by naturalists, and *thunderbolts* by common observers. Mr. Parkinson gives an amusing account (vol. iii. p. 122) of the discordant opinions entertained at various times respecting the nature of these bodies.

[1] See Medals of Creation, vol. ii. p. 869, for an interesting account of the present state of these caverns, by my friend, Major Willoughby Montague.

[2] Dr. Buckland's "Reliquia Diluviana" contains a full account of the most remarkable ossiferous caverns and their contents.

It would be irrelevant to dwell on the history of the successive attempts that have been made to elucidate the origin and structure of the Belemnite. It will suffice to describe concisely the present state of our knowledge as to the organization of the original.

Mr. Miller, in 1823,[1] showed that the Belemnite was the rostrum or osselet of an animal allied to the Sepia, or Cuttle-fish, and gave a restored outline of the supposed form of the original, with the Belemnite in its presumed natural situation. Dr. Buckland and M. Agassiz imagined that they had traced a natural connexion between certain species of Belemnites that abound in the Lias, and the ink bag and other soft parts of the Sepiæ or Calamaries found associated with them; and they suggested the name of *Belemno-sepia* for the supposed animal of the Belemnite.[2]

In 1842, the late Mr. Channing Pearce described, under the name of *Belemnoteuthis antiquus,* a naked (destitute of a shell,) cephalopod, which occurs in immense numbers in certain beds of the Oxford clay, especially at Christian Malford, in Wiltshire. This animal has at the lower apical part a conical osselet of a horny substance, and fibrous structure, enclosing a chambered siphunculated shell, which becomes gradually thinner at the upper part, and forms a cup-like receptacle, in which is placed the ink-bag. The soft body of an elongated oval form, with a pair of lateral palleal fins, two large sessile eyes, and with eight uncinated arms and a pair of long tentacula, are preserved in a more or less distinct and perfect state in several specimens that have lately been discovered. Mr. Chaning Pearce, Mr. Cunnington, and other collectors of these interesting remains, were convinced that this cephalopod was entirely distinct from the animal to which the Belemnite belonged.

In 1844, Professor Owen laid before the Royal Society "A description of certain Belemnites preserved with a great proportion of their soft parts in the Oxford clay, at Christian Malford, Wilts."[3] In this memoir (for which one of the royal medals of the Society was awarded) the author describes as the soft parts of the Belemnite the remains of the animal which Mr. Chaning Pearce had two years previously shown to belong to a different genus *(Belemnoteuthis).* Relying on the correctness of Professor Owen's views, I gave an abstract of this memoir in my "*Medals of Creation,*" and stated that belemnites had been discovered with the osselet, receptacle, and ink-bag, in their natural position, and with remains of the mantle, body, fins, eyes, and the tentacula, with their horny rings and hooks.[4]

The discovery by my son (Mr. Reginald Neville Mantell) of some remarkably perfect specimens of belemnites in the Oxford clay, exposed in the railway works on which he was engaged, near Trowbridge, in Wilts, led me to examine the structure of the Belemnoteuthis with more attention than I had hitherto done, as well as the evidence adduced by Professor Owen in proof that the fossil osselet, the Belemnite, belonged to the same genus of cephalopoda. I found that *no specimen had been obtained in which the phragmocone, or terminal chambered part of the Belemnoteuthis* (of Pearce), *was situated in the alveolus of a Belemnite;* but Professor Owen having assumed that the osselet of the former must have originally been protected by a rostrum, or guard, described the soft parts as belonging to the animal of the Belemnite, conceiving that the phragmocone of the Belemnoteuthis was that of a Belemnite that had slipped out of the guard.

In a communication to the Royal Society, in 1848, I demonstrated how utterly at variance with the facts were these conclusions, and pointed out the essential distinctive characters that separated the two extinct genera, so far as the specimens then discovered would warrant.[5] Other

[1] Geological Transactions, New Series, vol. ii.; and Dr. Buckland's Bridgewater Essay.

[2] Bridgewater Essay, p. 374.

[3] Philos. Trans. Part I. 1844. p. 65.

[4] Medals of Creation, vol. ii. p. 467.

[5] Philos. Trans. 1848, p. 171.

illustrative examples of the Belemnite have since been obtained; and in a supplementary paper read before the Royal Society, February 14th, of the present year (1850), I have stated what appears to me to be the extent of our present knowledge of the organization of the Belemnite. I subjoin an abstract of that paper, which embodies the result of an examination of many hundred specimens of Belemnites and Belemnoteuthites. The annexed outline, or diagram, shows the known structures of the Belemnite; of the soft parts of the animal, a few imperfect carbonaceous traces, apparently of the mantle, around and between the shelly processes of the upper part of the phragmocone, are the only vestiges I have been able to detect. The most perfect Belemnite hitherto discovered consists of,

1. An external *Capsule* (*e*) which invested the osselet or sepiostaire, and extending upwards, constituted the external sheath of the receptacle.

2. The *Osselet*, characterized by its fibrous radiated structure, terminating distally in a solid rostrum or guard (*i*), having an alveolus, or conical hollow (*g*), to receive the apical portion of the chambered phragmocone, and expanding proximally into a thin cup, which became confluent with the capsule, and formed the receptacle (*b*, *b*,) for the viscera.

3. The *Phragmocone* (*d*), or chambered, siphunculated (*c*), internal shell; the apex of which occupied the alveolus (*g*) of the guard, and the upper part constituted a capacious chamber, from the basilar margin of which proceeded two long, flat, testaceous, processes (*a*, *a*,).

These structures comprise all that are at present known of the animal to which the fossil commonly called "*Belemnite*," belonged.

Of the *Belemnoteuthis*, the cephalopod which Professor Owen considers to be a Belemnite, many examples of the body with eight uncinated arms and a pair of long tentacula, and with an ink-bag, and palleal fins, have been discovered. The osselet of this animal, like that of the Belemnite, has a fibro-radiated structure, investing a conical chambered shell; but this organ, for reasons fully detailed in the memoir, could never have been contained within the alveolus of a Belemnite.

No *certain* evidence has been obtained of the occurrence of an *ink-bag* in natural connexion with a Belemnite.

In the annexed outline the several parts are represented in their natural relative positions. The capsule, or most external investment, (*e*) is seen only in section, being removed to expose the rostrum or guard (the fossil body generally known as the Belemnite). The upper three-fourths of the rostrum are also taken away, to show the phragmocone which it originally enveloped. The straight transverse lines denote the

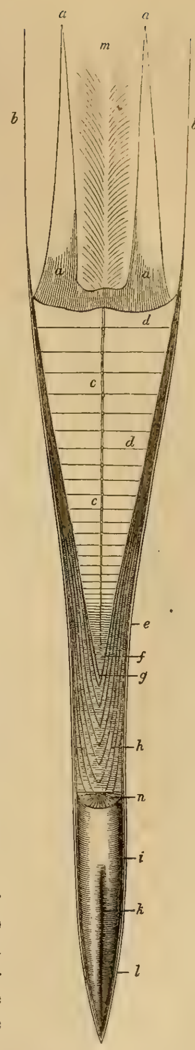


DIAGRAM OF THE KNOWN STRUCTURES OF THE *Belemnites Puzosianus*, FROM TROWBRIDGE.

a, *a*, dorsal processes.
b, *b*, the receptacle.
c, *c*, the siphuncle.
d, *d*, the phragmocone.
e, the capsule.
f, the inferior end of the phragmocone.
g, the alveolus of the guard.
h, vertical section of the guard.
i, the guard, or rostrum of the osselet.
k, sulcus, or furrow, on the ventral aspect of this species of Belemnite.
l, capsule, or periostricum.
m, the dorsal line.
n, transverse section, showing the fibrous radiated structure of the guard.

chambers of the phragmocone; the latter is seen extending downwards till it terminates in a point or apex; that part of the cavity in the guard is called the *alveolus*. The *siphuncle*, or tube which extends through the entire series of chambers, and is situated on the ventral margin, is indicated at *c*, *c*. The dorsal processes (*a*, *a*) are seen on their inner aspect at the upper part; the diverging lines (*m*) between them indicate the impressions of the soft parts, of which some traces remain.

III. Fossil Remains of Birds.—*The Moa, or Dinornis of New Zealand.* The bones of birds are of extreme rarity in a fossil state. Throughout the immense series of the palæozoic and secondary formations—the accumulated sedimentary deposits of innumerable ages—no unquestionable indications of the existence of this class of highly organized beings have been brought to light.

In the Triassic, or New Red argillaceous sandstones of the valley of the Connecticut River, in North America, some very remarkable phenomena have, however, been discovered, and which in the opinions of many eminent observers render it highly probable, that at the period when these strata were deposited, numerous birds, some of colossal magnitude, abounded on the then dry land. When slabs of these sandstones are split asunder, or exposed, so as to exhibit the sedimentary surface which separates one layer from another, the foot-prints of many species of bipeds are perceived deeply impressed on the stone, and disposed in such manner as to prove that they are the tracks of animals that walked over the surface of the deposit when it was in a soft or plastic state. The close analogy of these imprints to those of birds' feet, not only in their general resemblance, but also in the disposition of the tracks, and in the relation of the distance of the stride, and the depth and shallowness of the impressions, to the size of the respective feet, tends to corroborate the inference first enunciated by Professor Hitchcock, and subsequently confirmed by other geologists, that these mysterious markings on the rock, are natural records of the existence of various tribes of birds during the Triassic period;[1] but unfortunately the only certain evidence of the correctness of this opinion—remains of the skeletons—is wanting; not a vestige of a vertebrated animal of a higher class than fishes and reptiles has been discovered.[2]

In the vast fluviatile formation—the Wealden—of the south-east of England, which abounds in the remains of terrestrial plants and reptiles, many fragments of bones of such tenuity as to indicate that they belonged to animals capable of flight, have from time to time been collected since my first discovery and announcement, in 1822, of supposed birds' bones in the strata of Tilgate Forest. Some of these relics were declared by Baron Cuvier, and subsequently by Professor Owen, to be unquestionably those of birds; probably some species of waders. But recent observations have rendered it doubtful whether all the specimens of this class from the Wealden, like those from Stonesfield, are not to be regarded as referable to flying reptiles (Pterodactyles).[3]

In the chalk of Kent several bones of a very large flying animal have been obtained from a quarry at Burham, near Maidstone; some of these are figured and described in Professor Owen's beautiful work on British Fossil Mammals and Birds, as those of a bird allied to the Albatross; but the occurrence in the same quarry of jaws with teeth, and other undoubted remains of a gigantic Pterodactyle,[4] and the absence in the specimens figured of osteological characters exclusively ornithic, seem to support the conclusion that these also must be ascribed to flying reptiles.

[1] Travels in North America, vol. ii. pl. 7.

[2] See Wonders of Geology, vol. ii. p. 556. Ornithichnites, or Fossil Footprints of Birds; Medals of Creation, vol. i. p. 808.

[3] Wonders of Geology, vol. i. p. 438, 440. I still think it probable, however, that bones of birds will be detected among the Wealden fossils.

[4] These fossils are in the splendid museum of J. S. Bowerbank, Esq. of Highbury Grove, Islington.

In the most ancient tertiary strata unquestionable vestiges of birds occur; in the Sub-Himalaya eocene deposits, they are associated with bones of the extinct elephantine mammalia of India; in those of the Paris basin with the remains of the Palæotheria, &c. In the miocene and pliocene formations, the bones and even egg-shells of several species and genera have been detected. The remains of birds, however, even in comparatively recent deposits, were of such rare occurrence as to be ranked by the collector of fossils among the most precious of his acquisitions; but a few years ago, a most extraordinary discovery in our Antipodean colony, New Zealand, astonished and delighted the palæontologist, by placing before him hundreds of bones of numerous extinct genera of birds, some of which far exceed in magnitude those of the most gigantic living species, the Ostrich.

In various localities of the maritime districts of New Zealand, there had been observed in the beds of rivers and streams, fossil bones of birds of colossal magnitude, belonging to many species and several genera, associated with similar relics of smaller species. These bones had attracted the attention of the natives long ere the country was visited by Europeans; and traditions are rife among the New Zealanders that this race formerly existed in great numbers, and served as food to their remote ancestors. They also believe that some of the largest species have been seen alive within the memory of man; and even affirm that individuals still exist in the unfrequented and inaccessible parts of the interior of the country. They call the bird *Moa*, and state that its head and tail were adorned with magnificent plumes of feathers, which were worn by their ancient chiefs as ornaments of distinction.

Nine years since, a fragment of a thigh-bone of a bird larger than that of the Ostrich was brought to England by Mr. Rule, and submitted to the examination of Professor Owen, who pronounced it to belong to a gigantic bird of the *Struthious* (Ostrich) order. A few years afterwards several collections of vertebræ, bones of the extremities, &c. were transmitted to England by Messrs. Williams, Wakefield, Earle, &c., which corroborated that opinion, and proved that there formerly existed in the islands of New Zealand, colossal birds of a type distinct from any known in other parts of the world. In 1846 and 1847, my eldest son, Mr. Walter Mantell, who has resided in New Zealand several years, made an extensive and highly interesting collection of these fossil remains, which arrived in England in 1848. This series contains *skulls*, with the *mandibles or beaks*, bones of other parts of the skeleton, and *portions of the egg-shells*, of several extinct species and genera of birds; presenting remarkable deviations from the previously known types to which they are most nearly allied.

This valuable accession to our knowledge of the osteology of this extinct race of Ostrich-like birds—some individuals of which must have attained a height of from ten to twelve feet—has yielded important results as to the form, structure, and economy, of these colossal bipeds, and the prevailing characters of the terrestrial fauna of New Zealand in very remote periods. The collection, consisting of above 700 specimens, is now in the British Museum: it was obtained chiefly from a bed of *menaccanite* or titaniferous iron-sand, that had evidently been washed down by torrents from the volcanic region of Mount Egmont; that snow-capped ridge which forms so striking a feature in the physical geography of the North Island, and is the source of the fresh-water streams that discharge themselves into the ocean along the western shore. The tract of sand from which my son dug up these relics, is on the coast near the embouchure of a small river called Waingongoro, between Wanganui and Waimate. That stream evidently once flowed into the sea far from its present course, for lines of cliffs extend inland from the now dry sand-spit, and bear marks of the erosive action of currents.[1] A few months since,

[1] I must refer for details to the Quarterly Journal of the Geological Society, No. XV. August 1848.

I received from my son another most interesting collection of fossil bones (comprising above 500 specimens), chiefly obtained from the eastern shores of the Middle Island of New Zealand, when engaged as Government Commissioner for the settlement of native claims. These were dug up from a morass of small extent, lying in a little creek or bay at Waikouaiti, some twenty miles north of Otago. This swamp, which is only visible at low water, is composed of vegetable fibres (apparently of the *Phormium tenax*), sand, and animal matter. The bones are of a deep brown colour, and almost as fresh as if recently taken from a tan-pit. Among the specimens are crania and mandibles, and bones of enormous size. The most remarkable are *the entire series of phalangeals, and the two tarso-metatarsals,* (26 in number,) *of the right and left foot of the same individual bird* (*Dinornis robustus*), which were found standing erect, one a yard in advance of the other; as if the bird had sunk into the mire, and unable to extricate itself, had perished on the spot. These bones were carefully exhumed and numbered seriatim, and are the only instances of the bones of the foot and metatarsus found in natural connexion; they are, consequently, the first certain examples known of the structure of the feet of the colossal birds of New Zealand. The foot of the Moa, to which these bones belonged, must have been 16 inches long, and 18 inches wide; and the height of the bird about ten feet. (*See the Frontispiece.*)

It would extend this article far beyond the limits assigned to this work, were I to attempt even a cursory account of all the facts and inferences connected with these discoveries. The anatomical and physiological characters of many species and genera will be found in the admirable Memoirs on the *Dinornis, Palapteryx, Notornis,* &c. by Prof. Owen, in the Transactions of the Zoological Society.[1]

From the facts at present known as to the position of the ossiferous deposits of New Zealand, there is reason to conclude that they bear the same relation to the present state of the country, as the alluvial loam and clay containing the bones of mammoths, Irish Elks, &c. to that of Great Britain. I think we may safely infer that at a period geologically recent, but historically very remote, those islands were densely peopled by tribes of ostrich-like birds of species and genera which have long since become extinct; that many species existed contemporary with the Maories or native human inhabitants, and that the last of the family were exterminated, like the Irish Elk, and the Dodo, by man. If, as the natives affirm, some of the race still exist in the unfrequented parts of the country, they are probably diminutive species, like the Apteryx or *Kivi-Kivi,* which is the only living representative known to naturalists, of this once numerous tribe of colossal Struthionidæ. The only fossil osseous remains from New Zealand not referable to birds are bones of two species of Seals, and one femur and a few other bones of a Dog. Associated with the relics of the Dinornis and other extinct genera, and unquestionably coeval with them, are crania, mandibles, and other bones, of the living species of Apteryx, Albatross, Penguin, Notornis, Nestor, Water-hen, &c.

The fragments of egg-shells of Dinornis, from Rangatapu, belong to three distinct types, each of very large size; my son, to convey an idea of the magnitude of one egg, of which he dug up a large portion, says, " a gentleman's hat would make a capital egg-cup for it." The markings on the surface of the shells bear a greater resemblance to those on the eggs of the Rhea and Cassowary than of the Ostrich.

[1] I regret to state that the egg-shells, and many highly interesting bones, belonging to unknown genera of birds, from Rangatapu or Waingongoro, in my son's first collection, remain undescribed. My notes and observations on the geological position of the ossiferous deposits of the North Island of New Zealand, derived from the sketches and letters of Mr. Walter Mantell, are published in the Geological Journal; those on his collection of fossils from the Middle Island will appear in the same publication in the course of the present year (1850).

A remarkable fact mentioned by my son throws some light as to the comparatively recent extirpation of the Moa. In one spot the natives pointed out some little mounds covered with herbage, as consisting of heaps of ashes and bones, the refuse of the fires and feasts left by their remote ancestors. Upon digging into them, a quantity of burnt bones was discovered: these belonged to Man, Moa, and Dog, and were promiscuously intermingled. These calcined bones present no traces whatever either of the earthy powder or manaccanite sand which the cells and pores of the fossil bones invariably contain. If, as the natives affirm, these are the rejectamenta of the feasts of the aborigines, the practice of cannibalism by the New Zealanders must have been of very ancient date, and could not have originated, as Professor Owen supposed, from the want of animal food in consequence of the extirpation of the colossal birds. (See *ante*, p. xi.)

IV. Botanical arrangement of Fossil Vegetables.—Mr. Artis, in the Introduction of his work, offers some judicious observations as to the proper method in which the study of Fossil Botany should be pursued. He remarks, "that from the imperfect state in which fossil vegetables are generally found, the ordinary characters by which recent plants are referred to their congeners, can scarcely ever be detected in them. The sexual organs on which the systems of Linnæus and Jussieu are founded, and even the integuments of those organs while in the state of flowering, have uniformly perished. The external parts of the seed or fruit exist, indeed, in a fossil state, but they are almost always insulated from the other organs. If leaves are found, it is almost certain that scarcely any portion of the stem will be attached to them; if the external parts of a trunk, then very rarely any vestiges of the branches and foliage. And when traces of the internal structure can be discovered, it is seldom that the external character of the stem remains.

"In consequence of this deficiency of the essential characters on which the determinations of the botanist are founded, there exists a necessity for examining more minutely and accurately than has yet been done, the internal structure of recent plants; their habits of growth, the cicatrices or scars left on the stem by the leaves that are spontaneously shed, the different appearances which their fruits exhibit in their various stages of development—all these points must be minutely studied before we can obtain any certainty as to the identity of fossil and living species of plants.

"It is not by publishing detached and unconnected delineations and descriptions of fossil plants, as they occasionally occur, that the knowledge of them can be considerably promoted. A systematic arrangement must be formed; and the first step to this is the accurate determination of the species. *Hoc opus, hic labor est.*"

"It will be seen," he observes, "in the course of this work, how easy it would be to imagine parts of the same specimen to be different species, when they happen to be broken and dispersed. I can confidently assert, that in at least a thousand different specimens which I have had in my possession, not more than a hundred distinct species can be recognised. Furthermore, still fewer indeed can be referred to any living species; for it is not the fern-like leaf of a plant, the palm-like cicatrix, or the cane-like joint of a stem, that will suffice to identify them with those tribes of the vegetable kingdom. The whole anatomy of the plant must be studied. The subject has, indeed, been begun by Professor Martius, in his comparison of certain fossil stems of plants with those of the living plants growing in the Brazils, but the study is as yet too new to afford certain results. Accordingly, several of that professor's opinions are at variance with those of M. Adolphe Brongniart, who has also compared the recent and fossil vegetables together on this plan. But by following up the comparison, which has been so successfully adopted by Baron Cuvier, in the study of fossil animals,[1] similar results may be expected, and a knowledge of the extinct plants be at length attained."

Mr. Artis then gives an abstract of the systems of Baron Schlotheim, Count Sternberg, Professor Martius, and M. Adolphe Brongniart, which I am induced to subjoin as a useful record of the state of fossil botany twelve years ago:—

"The Baron Schlotheim, who published in 1804 the first part of a Flora der Vorwelt, followed up his researches of this kind by a catalogue of his cabinet, under the title of 'Die Petrefactenkunde auf ihrem jetzigen Standpunkte erläutert,' published in 1820, to which two Appendices have since been added in 1822 and 1823.

"The arrangement made by the Baron, so far as regards the vegetable part of his cabinet, is as follows. His specimens are first divided into five Sections, or Orders:—

1. Dendrolithes, containing the remains of trees, which are subdivided into three sub-sections.

A. *Lithoxylites*, of which no characters are given, but from the specimens mentioned by him, he evidently arranges in this place the wood-stone and wood-opal of the mineralogists.

B. *Lithanthracites*, in which are placed the bituminized stems, and other parts of trees.

C. *Bibliolithes.*—Fossil leaves, mostly of the later formations.

2. Botanolithes.—Comprising those kinds of fossil plants which cannot be considered either as trees or shrubs, nor as belonging to the plants of the old coal formation.

All the specimens belonging to the preceding sections are merely enumerated, and not distinguished by generic and trivial names, as is the case with the following.

Phytotypolithes.—Fossil plants of the stone-coal formation. These are divided systematically into genera and species. The genera are as follow:—

a. *Palmacites*, containing fifteen species.
b. *Casuarinites*, „ five.
c. *Calamites*, „ ten.
d. *Filicites*, „ twenty-three.
e. *Lycopodiolithes*, „ five.
f. *Poacites*, „ four.

In the whole sixty-two species.

4. Carpolithes.—Of which he enumerates fifteen species as present in his collection. This division is considered as a genus, as is also the next.

5. Anthotypolithes.—The cabinet contains only one species, namely the *Anthotypolithes ranunculiformis.*

In 1820, Gaspard Count Sternberg published in German, the first number of a work which has been translated by the Comte de Bray, under the title of "Essai d'un Exposé Geognostico-Botanique de la Flore du Monde Primitif." Of this translation a second and third part appeared in 1823 and 1824. In these successive numbers the Count has communicated the state of his knowledge as it grew up under his hands, in consequence of his own labours and those of his friend, Baron Schlotheim. The genera, as they are successively developed in the work, are the following:—

[1] Recherches sur les Ossemens Fossiles.

1. *Lepidodendron.*—Stem scaly; the scales leaf-bearing, surrounding the stem spirally. In a subsequent number, what are here called scales, are denominated scale-like cicatrices.

This genus is subdivided in the first number into two sub-genera, but this division is not noticed in the additional species quoted in the succeeding numbers.

Lepidotæ.—Scales convex.

Alveolariæ.—Scales sub-concave.

2. *Variolariæ.*—Stem shield-bearing, or warty; shields leaf-bearing, surrounding the stem spirally.
3. *Calamitæ.*—Stem striated, intercepted with sutures at the articulations.
4. *Syringodendron.*—Stem arborescent, in the form of pipes agglutinated together, with naked glandules surrounding the stem spirally.

In the second number the following genera are given:—

5. *Rhytidolepis.*—Stem arborescent, streaked longitudinally with elevated wrinkles; shields surrounding the stem spirally.
6. *Flabellaria.*—Leaves part stalked, divided and expanded like a fan.
7. *Schlotheimia.*—Stem jointed, contracted at the articulation, verticillate.
8. *Annularia.*—Leaves disposed in a whirl, inserted in a proper ring.
9. *Nœggerathia.*—Stem as thick as a goose-quill; leaves alternate, approximate, reverse-ovate, half embracing the stem, pectinato-toothed at the top, the remainder of the edge uncut.
10. *Osmunda.* } This and the following have no generic characters assigned to them,
11. *Asplenium.* } the recent genera being referred to.
12. *Rotularia.*—Leaves verticillate, expanded in the form of a small wheel.

The third number contains the following additional genera:—

13. *Lepidolepis.*—Scale-like cicatrices truncated at their top.
14. *Thuites,* of which he gives no characters, but refers to his figures.
15. *Antholites.*
16. *Carpolites.*
17. *Conites.*—Fossil strobili.
18. *Sphenopteris.*
19. *Polypodiolithus.*
20. *Myriophyllites.*
21. *Phyllites.*
22. *Algacites,* which the French translator, on obtaining the opinion of Professor Agardh, has changed into *Sargassum;* that celebrated algologist having considered it as identically the same as that genus of recent algæ.

The genera thus successively established, may be arranged in the following order:—

A. Fossil plants of unknown origin, in which the stem is large, and forms the only, or at least the most prominent character; including, 1. *Lepidodendron;* 2. *Variolaria;* 3. *Calamites;* 4. *Syringodendron;* 5. *Rhytidolepis;* 13. *Lepidolepis.*

B. Fossil plants, of unknown origin, in which the leaves form the prominent character; including, 6. *Flabellaria;* 7. *Schlotheimia;* 8. *Annularia;* 9. *Nœggerathia;* 12. *Rotularia.*

C. Fossil parts of unknown plants; including, 15. *Antholites;* 16. *Carpolites;* 17. *Conites.*

D. Fossil plants, or parts of plants referable to living types; including, 10. *Osmunda;* 11. *Asplenium;* 14. *Thuites;* 18. *Sphenopteris;* 19. *Polypodiolites;* 20. *Myriophyllites;* 22. *Algacites.*

In November 1821, Professor Martius read to the Botanical Society of Ratisbon, a paper which was afterwards published in its Memoirs for 1822. This paper was entitled, "*De Plantis nonnullis Antediluvianis ope specierum inter tropicos viventium illustrandis;*" in it several of the species mentioned by Baron Schlotheim and Count Sternberg are referred to the orders and genera of recent plants; and the following genera are proposed:—

1. *Filicites,* analogous to the Arborescent ferns.
2. *Palmacites,* analogous to the Palmæ.
3. *Bambusites,* analogous to Bambusia, and other arborescent grasses; these are the *Calamites* of other authors.
4. *Yuccites,* analogous to the Cuciphoræ, Dracenæ, Pandani, Yuccæ, and Velloriæ, of botanical writers.
5. *Cactites,* analogous to the Cacti.
6. *Euphorbites,* analogous to the Cereiform species of Euphorbia.
7. *Lychnophorites,* analogous to *Lychnophora,* a genus of plants found by Martius in Brazil, which belongs to the order of the Compositæ, and is allied to the *Vernoniæ* of Linnæus and the *Pollalestæ* of Humboldt.

M. Adolphe Brongniart has given the following classification of fossil plants, in his Essay "*Sur la Classification et la Distribution de Végétaux Fossiles,*" inserted in the "Mémoires du Muséum d'Histoire Naturelle;" and also printed separately in quarto, Paris, 1822:—

STEMS.

Class I.—Stems whose internal organization is recognisable.

1. Exogenites.—Wood formed of regular concentric layers.
2. Endogenites.—Wood composed of insulated bundles of vessels, which are more numerous towards the circumference than at the centre.

Class II.—Stems whose internal organization is no longer distinct, but which are characterised by their external form.

3. Culmites.—Stem jointed, smooth; a single impression at each articulation.[1]
4. Calamites.—Stem jointed, regularly striated; impressions rounded, small, numerous, forming a ring round each articulation, or sometimes wanting.[2]
5. Syringodendron.—Stem channelled, not jointed; impressions dot-like or linear, arranged in quincunx.[3]
6. Sigillaria.—Stem channelled, not jointed; impressions in the form of disks, arranged in quincunx.

[1] These stems appear to M. Brongniart to belong to the arborescent grasses, to *Calamus* or its allied genera.

[2] M. de Candolle suggested to M. Brongniart that these stems belong to some plants of the natural order of Equisetaceæ.

[3] M. Brongniart considers these remains to belong to genera which are entirely extinct.

7. Clathraria.—Stem neither channelled, nor jointed; impressions in the form of rounded disks, disposed in quincunx.[1]
8. Sagenaria.—Stem without joints, or furrows, covered with conical rhomboidal tubercles disposed in quincunx, having at their upper extremity an impression in the form of a disk.[2]
9. Stigmaria.—Stem without joints, or furrows; impressions rounded, distant, disposed in quincunx.[3]

FOLIAGE.

10. Lycopodites.—Leaves linear, or setaceous, without ribs, or traversed by a single rib, inserted all round the stem, or in a double row.

This genus is subdivided into four sections, as follow:—

a. Leaves narrow, lanceolate, inserted in a regular manner all round a stem having the characters of Sagenaria.
b. Leaves setaceous, inserted in a double row only; stem not reticulated. These he considers as the proper Lycopodites.
c. Leaves broad, without any apparent ribs, inserted irregularly all round the stem. These differ much from the rest of the genus.
d. Leaves blunt, short, closely applied to the stem.

Class III.—11. Filicites.—Frond disposed on a flat surface, symmetrical; secondary rib simple, forked, or rarely anastomosing.

These are divided into five sub-genera:—

a. *Glossopteris.*—Frond simple, not jagged, traversed by a single mid-rib, without distinct secondary ribs.
b. *Sphenopteris.*—Pinnules wedge-shaped, rounded or lobed at the extremity; ribs palmate or radiating from the base of the pinnule.
c. *Neuropteris.*—Pinnules rounded, not lobed, nor adhering to the rachis by their base; ribs scarcely visible beyond the base, in general very distinct, and two-forked.
d. *Pecopteris.*—Frond pinnatifid; pinnules adherent by their base to the rachis, traversed by a mid-rib; secondary ribs pinnate.
e. *Odontopteris.*—Pinnules adhering to the rachis by the whole of their base; mid-rib none; secondary ribs running out perpendicularly from the rachis.

12. Sphœnophyllites.—Leaves verticillate, wedge-shaped, truncate; ribs radiating, two-forked.[4]
13. Asterophyllites.—Leaves verticillate, with a single rib.[5]

[1] M. Brongniart shows in his paper the great agreement between these two genera, and the stems of ferns, in every respect excepting magnitude, and considers them as evidently owing their origin to plants of that natural order rather than to the palms.

[2] The stems of this genus are referable, in the opinion of M. Brongniart, to those of plants belonging to the family of *Lycopodiaceæ*, notwithstanding the great difference of size between them and those of the recent plants of that natural order.

[3] These stems, M. Brongniart supposes, belong rather to plants of the natural order of *Aroideæ*, than to the *Euphorbiaceæ*, or to the Palms to which they have been ascribed by other authors.

[4] M. Brongniart considers these to belong to some extinct genus of plants, allied to, although perfectly distinct from, the recent genus *Marsilea*.

[5] These the author thinks are the remains of an extinct genus of plants.

14. Fucoides.—Frond not symmetrical, often disposed on a flat surface; ribs none, or badly defined.
15. Phyllites.—Leaves with ribs well defined, repeatedly divided, or anastomosing.[1]
16. Poacites.—Leaves linear; ribs parallel.
17. Palmacites.—Leaves fan-shape.

Class IV. *Organs of fructification.*

Order I. Carpolithes.—Fruits or seeds.

Order II. Antholithes.—Flowers.[2]

The numerous additions and modifications, which subsequent experience and discoveries have led M. Brongniart to introduce into his classification, will be found in an article recently published (1849) in the "Dictionnaire Universel d'Histoire Naturelle," under the title of "Tableau des Genres de Végétaux Fossiles, considérés sous le point de vue de leur classification botanique et de leur distribution géologique."

V. Fossil Cephalopoda, Nautilus, Ammonite, &c.—The fossil remains of the molluscous animals, named *Cephalopoda*, from their organs of prehension being arranged around the head or upper part of the body, are the most ancient, numerous, and interesting, of this class of animated nature in the mineral kingdom. These relics are among the most varied and striking of the extinct beings that occur in the sedimentary strata, from the most ancient secondary formations, to the most recent tertiary. The living species are but a feeble representation of the countless myriads which must have swarmed in the ancient seas.

The animal of the Cephalopods is composed of a body, which is either enclosed in a shell, as in the Nautilus, or contains a calcareous osselet or support, as in the Sepia or Cuttle-fish; it has a distinct head, and eyes as perfect as in the vertebrated animals, with complicated organs of hearing, and a powerful masticating apparatus, surrounded by arms or tentacula. Below the head there is a tube which acts as a locomotive instrument, to propel the animal backwards, by the forcible ejection of the water that has served the purpose of respiration, and which can be ejected with considerable force by the contraction of the body.

Their fossil remains consist of the external shell and the internal osselet; and in the naked tribes, of the soft parts of the body, the ink-bag, &c., as noticed in the account of the Belemnite and Belemnoteuthis.

The shell varies exceedingly in the different genera. In the group characterised by smooth septa, and a medial or submedial siphuncle, as the Nautilus, the earliest or most ancient type is straight, as in the *Orthoceras* (Plate LVIII. fig. 14) of the palæozoic formations; the intermediate forms present various modifications of the spiral, and terminate in the completely discoidal shell of the living genus; while the other group, that with sinuous or foliated septa and a dorsal siphuncle, commences in a discoidal type—the Ammonite, which gradually passes through the various modifications of *Crioceras*, *Scaphites* (Plate LXI. fig. 10), *Hamites* (Plate LXI. fig. 3), *Turrilites* (Plate LXI. fig. 12), &c.; and finally becomes extinct in the straight *Baculites* (Plate LX. fig. 2).

In argillaceous strata, as the Kimmeridge and Oxford clay, London clay, &c., the shells of Cephalopoda are oftentimes beautifully preserved; the chambers are frequently filled with the solid matrix, but in many instances these cavities are lined either with brilliant pyrites or spar. Stony or sparry casts of the cells or chambers, the shell having perished, are another common

[1] The character of the ribs here given belongs exclusively to leaves of plants of the dicotyledonous tribe; as those of the next genus *Poacites* equally restricts them to the other great tribe of monocotyledonous plants.

[2] These orders are too little known to be divided at present into genera.

state in which vestiges of these animals occur. Sometimes the cast of each chamber is isolated, so as to present a series from the innermost to the outermost cell. Sections of those casts, in which the chambers are filled up with spar, constitute specimens of great beauty and interest. The so-called snake-stones are, of course, mere casts of Ammonites;[1] those of Whitby, from the lias limestone, are well known to every collector; the casts of a very large species are common in the oolite, especially at Swindon, in Wiltshire, and in the neighbourhood of Bath.

VI. The Carboniferous Deposits, *or Coal Measures.*—The various deposits of Coal have manifestly been formed under different local circumstances. Some have been peat-bogs, to which repeated additions have been made by successive subsidences of the land; others have been deposited at the bottom of lakes and rivers, and these are associated with remains of fresh-water shells and crustacea; others have accumulated in the abyss of the ocean, having been formed by the drifting and engulfing of immense rafts of trees and other vegetable matter, like those of the Mississippi; others in inland seas, the successive layers of vegetables having been supplied by periodical land-floods. There can be no doubt that coal has been, and may be, produced under all these conditions; and at different periods, and in various localities, all these causes may have been in operation. But the great series of ancient coal-formations present a remarkable uniformity of character, not only throughout Europe, but also in America and other parts of the world. A coal-field (as a group of strata of this kind is commonly termed), is generally composed of a series of layers of coal, clay, shale, and sand, of variable thicknesses, based on grit or limestone, abounding in marine shells and corals; and the most remarkable phenomenon is the constant presence *beneath* every bed of coal, of a thick stratum of earthy clay, and of a layer of shale or slaty clay above it. One of the series of triple deposits of which a coal-field consists, presents therefore the following characters:—

1. *Under-clay;* the lowermost stratum. This is a tough argillaceous earth or clay, which on drying becomes of a grey colour, and very friable; it is occasionally black, from an intermixture of carbonaceous matter. This bed almost invariably contains an abundance of *Stigmariæ* (see Plates XXII. XXIII.), of considerable length, with their rootlets attached, and which extend in every direction through the clay (as shown in the figures 1, 2, 6, pp. 199, 201). These roots commonly lie parallel with the planes of the stratum, and nearer to the top than to the bottom.

2. *Coal.*—A carbonized mass, in which the external forms of the plants and trees composing it are obliterated, but the internal structure, in many instances, remains. Large trunks, and stems, and leaves, are rarely found in it.

3. *The Roof,* or upper bed.—This consists of slaty clay, abounding in leaves, trunks and branches, fruit, &c.; it includes layers and nodules of ironstone, inclosing leaves, insects, crustacea, &c. In some localities beds of fresh-water shells, in others of marine shells, are intercalated with the shale; finely laminated clay, micaceous sand, grit, and pebbles of limestone, sandstone, &c. are also often interstratified. The principal illustrative specimens of the leaves, fruit, &c. (as those in Plate XXX. to Plate XXXIV.) are found in this bed.

Thus an uninterrupted series of strata, in which triple deposits of this kind are repeated, (often thirty or forty times, and through a thickness of several thousand feet,) constitutes the predominant character of the ancient coal formations wherever they have been explored. The difficulties attending a satisfactory solution of this problem, are fully stated in the last edition of my Wonders of Geology (Vol. ii. Lecture vii.), and to that work I must refer the reader for a more extended consideration of this highly interesting subject.

[1] See Medals of Creation, vol. ii. chap. i.; and Thoughts on a Pebble, pp. 20, 69.

VII. Coal.—The numerous fossil plants from the carboniferous strata that are figured in this work, render it necessary to put the general reader in possession of a concise view of the nature and mode of formation of those ancient accumulations of vegetable matter, which now constitute the beds of mineral fuel termed coal.

Although at the present time no one at all conversant with geology doubts the vegetable origin of Coal, the period is not distant when many eminent philosophers were sceptical on this point; and the truth in this, as in most other questions in natural philosophy, was established with difficulty. The experiments and observations of the late Dr. Macculloch mainly contributed to solve the problem as to the vegetable origin of this substance; and that eminent geologist successfully traced the transition of vegetable matter from peat-wood, brown coal, lignite, and jet, to coal, anthracite, graphite, and plumbago. Nor must the important labours of Mr. Parkinson in this field of research be forgotten. The first volume of the "Organic Remains of a former World," which treats of vegetable fossils, contains much original and valuable information on the transmutation of vegetable matter, by bituminous fermentation, into the various mineral substances in which its original nature and structure are altogether changed and obliterated; and that work may still be consulted with advantage by the student.

But though the vegetable origin of all coal will not admit of question, yet evidence of the original structure of the plants or trees whence it was derived is not always attainable. The most perfect coal seems to have undergone a complete liquefaction, and if any portions of the vegetable tissue remain, they appear as if imbedded in a pure bituminous mass. The slaty coal generally preserves traces of cellular or vascular tissue, and the spiral vessels and dotted cells of coniferous trees may often be detected by the microscope. In many instances the cells are filled with an amber-coloured resinous substance; in others the organization is so well preserved, that on the surface of a block of coal cracked by heat, the vascular tissue, and the dotted glands, may be observed. Some beds of coal appear to be wholly composed of minute leaves or disintegrated foliage; for if a mass recently extracted from the mine be split asunder, the exposed surfaces are found covered with delicate laminæ of carbonized leaves and fibres matted together; and flake after flake may be peeled off through a thickness of many inches, and the same structure be apparent. Rarely are any large trunks or branches observable in the beds of coal; but the general appearance of the carboniferous mass is that of an immense deposit of delicate foliage shed and accumulated in a forest, and consolidated by great pressure while undergoing that peculiar process by which vegetable matter is converted into carbon.

The essential conditions for the transmutation of vegetable substances into coal, appear to be the imbedding of large quantities of recent vegetables beneath deposits which shall exclude the air, and prevent the escape of the gaseous elements when released by decomposition from their organic combination; hence, according as these conditions have been more or less perfectly fulfilled, coal, jet, lignite, brown-coal, peat-wood, &c. will be the result.

VIII. Fossil Corals.—The real nature even of recent Corals is in general so imperfectly understood by the intelligent reader who has not paid especial attention to the department of natural history which treats of the class of animated nature termed Zoophytes, that in describing the Fossil Corals in my Wonders of Geology, I felt it necessary to devote one Lecture to the consideration of Corals and Crinoidea, in order to afford a popular exposition of the structure and economy of these highly interesting tribes of animal existence.[1]

A very prevalent error regarding their nature is, that the beautiful stony substances generally

[1] See Wonders of Geology, vol. ii. Lect. vi. p. 588.

called corals, are fabricated by the animalcules which inhabit the cells when living, in the same manner as is the honeycomb of the bee and wasp. This opinion is utterly erroneous: the coral is secreted by the integuments or membranes with which when recent it was invested and permeated; in like manner as are the bones of the skeleton in the higher orders of animals by the tissues designed for that especial purpose, and wholly without the cognisance or control of the creature of which they constitute the internal support.

A general idea of the nature of the compound coral-zoophytes may be obtained by the examination of the common *Flustra* or Sea-mat. This form of polyparia, when taken out of the water, appears to the naked eye like a patch of fine varnished net-work, adhering to a piece of sea-weed or stone; when viewed with a magnifying lens of moderate power, the surface is found beset with pores regularly disposed: and if the Flustra be examined while immersed in sea-water, its surface is seen to be invested by a gelatinous substance, and every pore is the aperture of a cell, whence issues a tube fringed at the extremity with long tentacula or feelers. These expand, then suddenly contract, withdraw into the cell, and again issue forth: the whole surface of the Flustra being studded with the hydra-like animalcules; each enjoying a distinct existence, the entire group being united by one common integument or calcareous frame-work. When the Flustra is exposed to the air, the polypes soon perish, the animal matter rapidly decomposes, and the calcareous lace-like skeleton alone remains. In the larger and more compact corals the phenomena are similar, differing only in degree. In a fossil state, the durable remains of the corals consist for the most part of the calcareous framework (or polyparium, as it is termed), which often possesses a crystalline structure; and in some instances is completely transmuted into silex, as in specimens from Antigua, the Falls of the Ohio, and from Tisbury in Wiltshire. (See Plate XXXVIII. figs. 12, 13.)

I must refer to the Wonders of Geology for a more extended notice of fossil corals, and other zoophytes, and will only add that the calcareous and siliceous spines or spicula, not only of sponges, but also of Gorgoniæ, and other corals, are often met with in a fossil state.[1]

IX. Cuvier's Discoveries. *The Fossil Quadrupeds of Montmartre.* (Plate LXXII.)—The Palæotheria, Anoplotheria, and other genera of extinct quadrupeds related to the *Tapir*, whose remains were first noticed in the gypseous limestone of Montmartre, near Paris, and which have since been found in many other localities of the same strata, are familiar to every one, from the just celebrity attached to the labours of the illustrious Cuvier, who restored as it were these lost denizens of an earlier world, in their native character and forms, and distinguished them by names long since become classical in the sciences which treat of the ancient history of the earth and its inhabitants.

The gypsum quarries spread over the flanks of Montmartre were many years since known to contain fossil bones of extinct quadrupeds, and some of these had been figured and described in 1768 by Guettard, and afterwards by Pralon, Lamanon, and Parumot: but it was not till the attention of M. Cuvier was directed to the subject by some specimens put into his hands by M. Vuarin, that the interest and importance of these fossils were understood. The curiosity of Baron Cuvier was so much excited by an inspection of a large collection of these bones, soon after he had been successfully engaged in the investigation of the remains of fossil Elephants and Mastodons, that he immediately began to obtain specimens from the quarries, and by liberally rewarding the workmen, and by unremitting personal research, he soon accumulated an immense quantity of bones of all sorts, belonging to numerous individuals. He now perceived

[1] See Wonders of Geology, vol. ii. Lect. vi. p. 634.

that a new world was open to his view: and to use his own expressive language, he found himself in an ancient charnel-house, surrounded by a confused multitude of mangled skeletons of a great variety of unknown beings. To arrange each fragment in its proper place, and restore order to these heterogeneous materials, seemed at first a hopeless task: but a knowledge of the immutable laws by which the organization of animal existence is governed, soon enabled him to assign to each bone, and even fragment, its proper place in the skeleton; and the forms of beings hitherto unseen by mortal eye appeared before him. "I cannot," he exclaims, "express my delight in finding how the application of one principle was instantly followed by the most triumphant results. The essential character of a tooth and its relation to the skull being determined, all the other elements of the fabric immediately fell into their proper places; and the vertebræ, ribs, bones of the legs, thigh, and feet, seemed to arrange themselves even without my bidding, and in the very manner I had predicted." The principles of the correlation of structure which his profound researches in comparative anatomy had enabled him to establish, conducted to these important results, and laid the foundation of that science which has since received the name of Palæontology.[1] The mode of induction adopted by this illustrious philosopher, has been the mighty instrument by which subsequent labourers in this department of science have so largely contributed to our knowledge of the ancient condition of the earth, and of the structure and economy of the tribes of beings which have successively dwelt upon it. The examination of the fossil teeth (in Plate LXXII. figs. 4—9) showed that the animals were herbivorous; and the crown of the tooth being composed of two or three simple crescents, as in certain pachydermata, proved that they differed from the ruminants, which have double crescents, and each four bands of enamel. The two principal genera first established were the *Palæotherium* and *Anoplotherium*. The first approximates to the Tapirs in the number and disposition of the teeth; the second is remarkable in having no projecting canines, and in all the teeth forming a continued series, as in the human race. Remains of both these genera have been found in the eocene tertiary strata of the Isle of Wight,[2] and on the coast of Hampshire.

X. Fossil Edentata. *Megatherium, and Megalonyx.* (Plates LXXII. and LXXIII.)—The remains of these and other allied forms of the extinct gigantic Edentata, which once inhabited South America, occur in immense quantities throughout the Pampas—those vast plains which present a sea of waving grass for 900 miles. These plains consist of alluvial loam and sand, containing fresh-water and marine shells of existing species; they were evidently once, like Lewes Levels, a gulf or arm of the sea. Since the publication of Mr. Parkinson's work, vast numbers of bones have been exhumed, and many most interesting specimens sent to England by Sir Woodbine Parish, and Charles Darwin, Esq., in whose charming "Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of H.M.S. Beagle round the World," will be found many highly graphic notices of the discovery of these remains.[3] Mr. Darwin, under the head of *Bahia Blanca*,[4] describes the remains of no less than nine great quadrupeds found imbedded within the space of 200 square yards. They consisted of three heads and other bones of the *Megatherium*, of enormous dimensions; and bones of the *Megalonyx*.

[1] A concise exposition of the Cuvierian inductive philosophy will be found in Wonders of Geology, pp. 137—147.

[2] See my Geological Excursions round the Isle of Wight. For an account of the fossil animals of Paris, refer to Wonders of Geology, p. 254.

[3] Published by Mr. Murray, in one vol. 1845. The anatomical description of the fossil Edentata brought home by Mr. Darwin, by Professor Owen, will be found in the "Zoology of the Voyage of the Beagle."

[4] Mr. Darwin's Journal, chap. v. p. 81.

Of the *Scelidotherium*, an allied animal, Mr. Darwin obtained an almost perfect skeleton; it must have been as large as a rhinoceros; in the structure of the head, it approaches nearest the Cape ant-eater, in other respects it is related to the armadilloes. Remains of a different species of Mylodon, of another gigantic edental quadruped, and of a large animal with an osseous dermal coat in compartments, very like that of the Armadillo. Of this last, which has been named *Glyptodon*, there is a very fine specimen in the Hunterian Museum. Teeth and bones of an extinct species of horse, and of an unknown pachyderm, a huge beast with a long neck like the camel. Lastly the *Toxodon* (so named from the remarkable curvature of the teeth); this is perhaps one of the strangest animals ever discovered. In size it equals the elephant or megatherium, but the structure of its teeth shows it to have been intimately related to the gnawers—the order which at the present day includes the smallest quadrupeds. In many details it approaches to the pachydermata; judging from the position of its eyes, it was probably aquatic, like the Dugong and Manatee, to which it is also allied.

The beds containing the above fossil remains, consist of stratified gravel and reddish mud, and stand only from fifteen to twenty feet above the level of high water; hence the elevation of the land has been small since the great quadrupeds wandered over the surrounding plains; and the external features of the country must then have been very nearly the same as now.

In another place, Mr. Darwin observes, — "The number of the remains of these large quadrupeds imbedded in the grand estuary deposit which forms the Pampas and covers the granitic rocks of Banda Oriental, must be extraordinarily great. I believe, a straight line drawn in any direction through the Pampas, would cut through some skeleton or bones. Besides those which I found during my short excursions, I heard of many others; and the origin of such names as, 'the stream of the animal,' 'the hill of the giant,' is obvious. At other times, I heard of the marvellous property of certain rivers, which had the power of changing small bones into large; or as some maintained, the bones themselves grew. As far as I am aware, not one of these animals perished, as was formerly supposed, in the marshes or muddy river-beds of the present land, but their bones have been exposed by the streams intersecting the subaqueous deposit, in which they were originally imbedded. We may conclude that the whole area of the Pampas is one wide sepulchre of these extinct gigantic quadrupeds."[1]

XI. Flint.—*Animal Remains in siliceous nodules.*—So many beautiful specimens of siliceous petrifactions—that is, animal and vegetable remains transmuted into silex or flint—are figured in the subjoined plates, that it may be useful to offer a few remarks on this subject.[2] In many instances the organic remains in chalk-flints are simply incrusted by the silex; such is the state of numerous sponges which are as it were invested by the flint, and have all their pores and tubes filled up by the same material, the original tissue appearing as a brown calcareous substance. In other examples, the sponge has been enveloped in a mass of liquid flint, and has subsequently perished and decomposed; in this manner have been formed those hollow nodules, which on being broken present a cavity containing only a little white powder, or some fragments of silicified sponge; in many instances the cavity is lined with quartz crystals, or mammillated chalcedony. Frequently but part of the zoophyte is permeated by the silex, and the other portion is in the state of a friable calcareous earth imbedded in the chalk. Sponges and other zoophytes often form the nuclei of the flint nodules; the original substance of the organic

[1] Mr. Darwin's Journal, p. 135. The reader interested in these extraordinary fossil remains should visit the British Museum, and the Hunterian Museum of the Royal College of Surgeons in Lincoln's Inn Fields.

[2] See Wonders of Geology, vol. i. pp. 74—105, for a general view of the process of petrifaction.

body being in general silicified, and the most delicate internal structure preserved. Shells, corals, and the minute cases of foraminifera, are often immersed as it were in pure flint, appearing as if preserved in a semi-transparent medium.

But there are innumerable flint nodules in which no traces of spongeous tissue are apparent, and veins, dikes, and sheets of tabular flint, that are in a great measure free from organic remains; containing only such as may be supposed to have become imbedded in a stream of fluid silex that flowed over a sea-bottom. Wood perforated by lithodomi and silicified, is occasionally met with; and fuci or algæ are sometimes found, appearing as if floating in the liquid flint.

For the most part, the minute shells in the chalk and flint are filled with amorphous mineral matter; but in many examples, (as I have ascertained by direct experiment,) the soft parts of foraminifera remain in the shell.

XII. Foraminifera.—Plate LXII. contains figures of several species belonging to various genera of those minute fossil shells, the discoidal involute forms of which were once considered to belong to the Cephalopoda, and to be related to the Nautilus, Spirula, &c., but which are now grouped in one family, under the name of *Foraminifera;* a term derived from the foramina or perforations with which their shells are traversed, and which have relation to the peculiar organization of the animals.

Since microscopic observations have become so general, thanks to the genius and enthusiasm of Ehrenberg, these fossil bodies have acquired a degree of interest and importance, unsurpassed by more obvious organic remains. Whole mountain chains and extensive tracts of country are now known to be almost entirely composed of the aggregated shells of a few genera of these *microzoa.*[1] In other deposits their remains are associated with those of *Infusoria,*[2] (both animal and vegetable,) still more infinitesimal. As much error prevails among collectors as to the real nature of the fossil foraminifera, I am induced to annex the following remarks.[3]

The foraminifera are marine animals of low organization, and, with but few exceptions, extremely minute: in an ounce of sea-sand between three and four millions have been distinctly enumerated. When living, they are not aggregated, but always individually distinct; they are composed of a body (or vital mass) of a gelatinous consistence, which is either entire, and round, or divided into segments, placed either on a simple or alternate line, or coiled spirally, or involuted round an axis. This body is covered with an envelope or shell, which is generally testaceous, rarely cartilaginous, and is modelled on the segments, and follows all the modifications of form and contour of the body. From the extremity of the last segment, there issue, sometimes from one, sometimes from several openings of the shell, or through numerous pores or foramina, very elongated, slender, contractile, colourless filaments, more or less divided and ramified, serving for prehension, and capable of entirely investing the shell. The body varies in colour, but is always identical in individuals of the same species,—it is yellow, fawn-coloured, red,

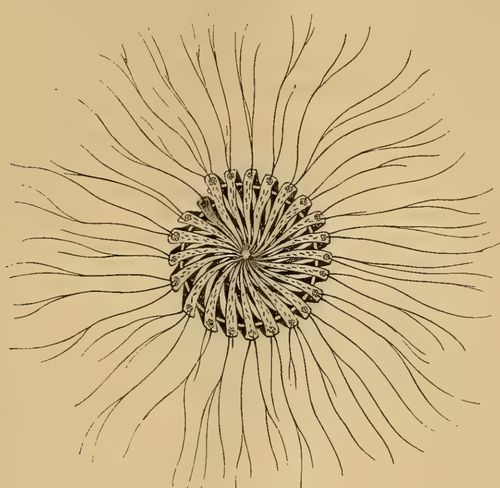
[1] A convenient term to express animal organisms that can only be distinctly examined by the aid of the microscope: strata in a great measure composed of such fossil remains may be distinguished as *microzoic* deposits.

[2] This term was first employed to denote the various minute forms of animal organization that appear in vegetable infusions; as Rotifers, Monads, Vorticella, &c. But with these, numerous vegetable forms generally appear, as Gaillonella, Bacellaria, Navicula, &c.: these were formerly also regarded as animals, and were consequently comprised under the same general appellation.

[3] The best scientific account of these animals will be found in M. D'Orbigny's work on the "Foraminifères Fossiles du Bassin Tertiaire de Vienne, (Autriche)." Paris, 1846. 1 vol. 4to, with plates.

violet, blue, &c. Its consistence is variable; it is composed of minute globules, the aggregation of which determines the general tint. It is sometimes entire, round, and without segments, as in *Gromia, Orbulina,* &c., which represent, at all ages, the embryonic state of all the other genera. They increase, without doubt, by the entire circumference. When the body is divided by lobes or segments, the primary lobe, as in the permanent condition of the Gromia, is at first round or oval, according to the genus; once formed it never enlarges, but is enveloped externally by testaceous matter; it may be compared to a ball on which is applied a second larger one, then a third still larger, and so on during the life of the animal.

The annexed figure of the animal of *Nummulina* (as given by MM. Joly and Leymerie) will serve to convey a general idea of the living Foraminifera.



THE ANIMAL OF THE NUMMULINA.

The segments, as the body increases, are agglomerated in six different ways, and these modifications are the basis of M. D'Orbigny's classification. The discoidal forms, as the *Rotalia, Rosalina, Cristellaria,* &c. are involuted like the nautilus, and divided by septa or partitions, the different lobes of the body occupying contemporaneously every chamber, and being connected by a tube or canal that extends through the entire series. In the spiral forms, the *Textilaria,* &c. the same structure is apparent. These two groups are the most abundant in the cretaceous strata; many beds of the white chalk consist almost wholly of the aggregated shells of the Rosalinæ, Rotaliæ, and Textilariæ.[1] Whatever the form of the body, the filaments always consist of a colourless matter as transparent as glass; they elongate from the base to six times the diameter of the shell. They often divide and subdivide, so as to appear branched. Though alike in form in the different genera, they vary much in their position. In some they form a bundle which

[1] See Wonders of Geology, p. 299.

issues from a single opening, and is withdrawn into the same by contraction; in others the filaments project only through each of the pores in the shell which covers the last segment; in others they issue from both the large aperture and the foramina. In fine, these filaments or pseudopodia fulfil in the foraminifera the functions of the numerous tentacula in the Asteriadæ, or Star-fishes, serving as instruments of locomotion and attachment.

Neither organs of nutriment nor of reproduction have been detected. In the genera having one large aperture from which the filaments issue and retract, we can conceive nutriment to be absorbed by that opening; but this cannot be the case in the species which have the last cell closed up; in these the filaments issuing through the foramina are probably also organs of nutrition. M. D'Orbigny considers the Foraminifera as constituting a distinct class in zoology; less complicated than the Echinoderms and the Polypiaria in their internal organization, they have by their filaments the mode of locomotion of the first, and by their free, individual existence—not aggregated and immovably fixed—they are more advanced in the scale of being than the latter. To me they appear to be merely hydra-form polypes of the most simple structure, protected by shells;[1] those composed of different segments, I conceive to be a single aggregated individual, and not a successive series of beings.

The white chalk is well known to be largely composed of a few kinds of foraminifera, but the occurrence of the soft bodies of these animalcules in a fossil state was first discovered by me, in 1845, in chalk-flints, and was announced in a paper, read before the Geological Society, entitled, "*Notes of a Microscopical Examination of Chalk and Flint.*"[2] This statement was regarded by some eminent palæontologists as so "startling and unsatisfactory," that I resumed the investigation, and communicated the result to the Royal Society, in a memoir "*On the Fossil Remains of the Soft Parts of Foraminifera discovered in the Chalk and Flint of the South-East of England;*"[3] and with the kind assistance of that able chemist and microscopist, Mr. Henry Deane, of Clapham Common, I obtained, by immersing chalk in dilute hydrochloric acid, and mounting the residue in Canada balsam, several specimens of the entire integuments of the bodies of Rotaliæ, as distinct as if recent! This fact is now admitted; and the experiment has been successfully repeated in India, by Mr. Carter, on the limestones of that country;[4] and in America, by Dr. Bailey, &c.[5] In some limestone recently collected by my eldest son, Mr. Walter Mantell, in the Middle Island of New Zealand, and which, like our cretaceous strata, is almost entirely made up of foraminifera, I have detected the soft parts of the bodies of Rotaliæ in the cells of the fossil shells, as distinctly as in the chalk of England; and two of the species appear to be identical with European forms.

M. D'Orbigny gives the following summary of the distribution of the known fossil species of Foraminifera:—

There are 228 species in the Tertiary deposits of Vienna alone, of which twenty-seven species are known living in the Adriatic and the Mediterranean.

Foraminifera are unknown in the Silurian and Devonian formations.

[1] An admirable paper on the "*Polystomella crispa,*" by Mr. Williamson, of Manchester, (Trans. Micros. Society of London, vol. ii.) should be consulted on this question.

[2] These "Notes" were withdrawn, and published in the Annals of Natural History for August, 1845.

[3] Published in Philos. Trans. Part iv. for 1846.

[4] "On the existence of Beds of Foraminifera, recent and fossil, on the South-East of Arabia," by H. J. Carter, Esq. Assistant Surgeon, Bombay. Proceedings of the Bombay Asiatic Society, 1848.

[5] A remarkable foraminiferous deposit of chalk detritus occurs at Charing, in Kent, and was first examined and described by William Harris, Esq.; it contains immense numbers of many kinds of foraminifera, and of the cases or shells of entomostraca, of the genus Cytherina, with spicules of sponges, &c.—See Wonders of Geology, vol. i. p. 324.

One species only is known in the Carboniferous system of Russia, the *Fusulina cylindrica.*

Jurassic or Oolitic formation	Genera	5	Species	20
Cretaceous	„	34	„	280
Tertiary	„	56	„	450
Living in the present seas	„	68	„	1,000

Of these last, 575 species inhabit tropical seas, 350 the seas of temperate, and 75 the seas of cold climates.

XIII. Fossil Elk of Ireland, *or Cervus megaceros.* (Plate LXXI.)—The shell-marls of Ireland contain in abundance the bones of an animal, which like the Dodo, was once contemporary with the human species, but has long been extinct: the last individuals of the race were, in all probability, exterminated by the early Celtic tribes. The remains of this noble creature generally occur in the deposits of marl that underlie the peat-bogs, which are apparently, like those of Scotland, the sites of ancient lakes or bays. In Curragh immense quantities of these bones lie within a small area; the skeletons appear to be entire, and are found with the skull elevated, and the antlers thrown back on the shoulders, as if a small herd of these Elks had sought refuge in the marshes, and had been engulfed in the morass, in the same manner as the Mastodons of America. (See description of Plate LXXIV., *ante*, p. 167.)

This creature far exceeded in magnitude any living species of elk or deer. The skeleton is upwards of ten feet in height to the top of the skull, and the antlers are from ten to fourteen feet from one extremity to the other. The fine perfect skeletons in the British Museum, College of Surgeons, and in the Museum at Edinburgh, render a particular description unnecessary. The bones are generally well preserved, of a dark brown colour, with patches of blue phosphate of iron. In some instances they are in so fresh a condition, that the hollows of the long bones contain marrow having the appearance of fresh suet. Remains of this majestic animal have been found collocated with ancient sepulchral urns, stone implements, and rude canoes, in such manner, as to leave no doubt that this now extinct deer was coeval with the early human inhabitants of these Islands. Its bones and antlers have been found at Walton, in Essex, associated with the remains of the Mammoth, or fossil elephant.[1]

XIV. Fossil Infusoria—*Infusorial Earths.*—In the note on Foraminifera some account is given of various rocks composed of the fossil remains of those minute animals; but the durable relics of the yet more infinitesimal organisms designated by the terms *Infusoria*, or *Infusorial animalcules*, form deposits of equal interest and importance. Strata of great extent and thickness are wholly, or in great part, made up of innumerable layers, consisting of the aggregated siliceous cases or shields of Infusoria: and similar structures are found to be the chief constituents of the white earthy deposits of lakes, rivers, and basins of brackish water, in every part of the world.

Slowly, imperceptibly, but incessantly, are the vital energies of the feeblest and minutest animal and vegetable existences separating from the element in which they live, the most enduring of mineral substances, silex—fabricating it into structures of the most exquisite forms and sculpturing, and thus adding to the accumulations of countless ages, which make up the sedimentary strata of the crust of the globe.

In the "Medals of Creation"[2] will be found a summary of what was then known as to the formation and composition of many tertiary deposits which the indefatigable Ehrenberg, Dr. Bailey, and other eminent observers, had carefully investigated and described. The five years

[1] Wonders of Geology, p. 134. [2] Medals of Creation, vol. i. p. 211.

that have since elapsed have been fruitful in results of the most important and interesting character; from every quarter of the world, from the loftiest mountain peaks, and from the deepest recesses of the ocean which the plummet can reach, from the ashes of volcanoes and from the snow of the glaciers, the durable remains of Infusoria have been obtained. That excellent scientific periodical, Silliman's American Journal, contains numerous interesting communications on this subject from the eminent chemical professor of the Military College at West Point, Dr. J. W. Bailey; and the labours of Mr. Bowerbank, Williamson, and other active members of the Microscopical Society of London, have yielded much interesting information on the infusorial deposits of our own country.

The present note will be restricted to remarks on the nature of the organisms which enter so largely into the composition of certain tertiary deposits; since the opinion once entertained of the animal nature of many infusoria, now regarded as true vegetables, materially affects the geological conclusions respecting the persistence of certain species of organisms through long periods of time, during which the mollusca, zoophytes, &c. underwent repeated mutations both in the species and genera. Thus, for example, the *polierschiefer*, or polishing-slate of Bilin, and the berghmehl of Tuscany, are described by Ehrenberg as masses of the siliceous shells of animalcules of such extreme minuteness, that a cubic inch of the stone contains upwards of forty millions; the infusorial earth of Richmond, in Virginia, in like manner, is stated to be made up of the siliceous skeletons of animalcules of infinitesimal minuteness. But later investigations have (I conceive) satisfactorily established, that the greater part of these fossil organisms belongs to the vegetable and not to the animal kingdom.[1] The whole of the figures in Plate IV. of the "Medals of Creation," described as living Infusoria, on the authority of Ehrenberg, are undoubted vegetables, belonging to the great botanical groups called *Diatomaceæ* (from the angular segments into which they separate by partial division), and *Desmidiaceæ*.[2] The entire family of *Bacillaria* belongs to this group. These simplest forms of vegetable structures abound in every lake or stream of fresh and brackish water, in every pool, or bay, and throughout the ocean, from the equator to the poles; they secrete siliceous envelopes, which present an endless variety of form and structure, and after the death and decomposition of the perishable tissues of the plants, remain as perfectly transparent colourless shields of pure silica; such are the *Gaillonellæ, Euastra, Closteria, Naviculæ, Synhedræ, Podosphenicæ, Xanthidia*, &c., which constitute so large a proportion of the infusorial earths described by Ehrenberg and other authors.[3]

The extent of this infinitesimal flora throughout regions where no other forms of vegetation are known, is strikingly demonstrated by the observations of the eminent botanist and traveller, Dr. Hooker, in his account of the Antarctic regions.

"Everywhere," he states, "the waters and the ice alike abound in these microscopic vegetables. Though too small to be visible to the unassisted eye, their aggregated masses stained the iceberg and pack-ice wherever they were washed by the sea, and imparted a pale ochreous colour to the ice. From the south of the belt of ice which encircles the globe, to the highest latitudes reached by man, this vegetation is everywhere conspicuous, from the contrast between its colour and that of the white snow and ice in which it is imbedded. In the eightieth degree

[1] In my little work on Recent Infusoria, entitled "Thoughts on Animalcules, or a Glimpse of the Invisible World revealed by the Microscope," I have expressed my conviction of the vegetable nature of these organisms, as a reason for omitting figures and descriptions of any of the species in a work on living fresh-water animalcules.

[2] The name Diatomaceæ is restricted by M. Brébisson to those species which have a siliceous envelope, or cuticle; and that of Desmidiæ to those which are not siliceous, but reducible by heat to carbon.

[3] The reader interested in this subject should consult the beautiful work of Mr. Hassall on the Desmidiaceæ, published by Messrs. Reeve & Benham.

of south latitude all the surface ice carried along by currents, and the sides of every berg, and the base of the great Victoria barrier itself—a perpendicular wall of ice, from one to two hundred feet above the sea-level—were tinged brown from this cause, as if the waters were charged with oxide of iron. The majority of these plants consist of simple vegetable cells, enclosed in indestructible silex (as other *Algæ* are in carbonate of lime); and it is obvious that the death of such multitudes must form sedimentary deposits of immense extent.

"The universal existence of such an invisible vegetation as that of the Antarctic ocean, is a truly wonderful fact, and the more so, from its being unaccompanied by plants of a high order. This ocean swarms with mollusca, and entomostracous crustaceans, small whales, and porpoises; and the sea with penguins and seals, and the air with birds: the animal kingdom is everywhere present, the larger creatures preying on the smaller, and these again on those more minute; all living nature seems to be carnivorous. This microscopic vegetation is the sole nutrition of the herbivorous animals; and it may likewise serve to purify the atmosphere, and thus execute in the antarctic latitudes the office of the trees and grasses of the temperate regions, and the broad foliage of the palms of the tropics." [1]

Dr. Hooker also observes, that the siliceous cases of the same kind of Diatomaceæ now living in the waters of the South Polar Ocean, have contributed in past ages to the formation of European strata; for the tripoli and the phonolite stones of the Rhine contain the siliceous shields of identical species. Such are the comments of one of our most eminent botanists on the phenomena under review. The reader will probably ask,—What, then, are the essential characters which separate the animal from the vegetable kingdom? To this question it is impossible to give a satisfactory reply: perhaps the only distinction that will be generally admitted by zoologists and botanists is the following:—*animals require organic substances for their support; vegetables derive their sustenance from inorganic matter.*

The facts thus cursorily reviewed throw much doubt on many of M. Ehrenberg's statements as to the identity of species of animalcules now living, with those whose remains occur in the eocene, and in the secondary strata. The so-called *Xanthidia* of the chalk, are certainly altogether distinct from the recent diatomæ to which the name was first applied; the chalk organisms are probably the gemmules of sponges or other zoophytes.[2]

Infusorial earths may therefore be composed either of microscopic vegetable or animal remains, or of both. The brackish and fresh-water deposits I have examined are siliceous and almost wholly diatomaceous: the marine calcareous strata composed of microscopic organisms, consist chiefly of various kinds of foraminifera, a large proportion belonging to the polythalamia, or chambered shells. I am not certain as to the animal or vegetable nature of some of the beautiful siliceous disks (*Coscinodisci, Arachnoidisci, Actinocyclus, &c.*) so abundant in the Richmond, Barbadoes, and Bermuda infusorial earths, and which occur in so splendid a state in the Guano deposits of Ichaboe.

With the corrections which the above remarks will enable the reader to make, I would refer to the account of Fossil Infusoria in the Medals of Creation, and Wonders of Geology.[3]

XV. The Mosasaurus, *or Fossil Reptile of Maestricht.* (Plate LXX.) The occasional discovery of bones and teeth of an unknown animal in the limestone of St. Peter's Mountain, near Maestricht, and the innumerable shells, corals, teeth of fishes, claws of crabs, echini, and other

[1] From Dr. Hooker's account of the botany of the South Polar regions in Sir J. Ross's Voyages of Discovery.

[2] It would be convenient to distinguish these fossils by another name, and thus avoid the perpetuation of the error; I would propose that of *Spiniferites*, in allusion to the numerous spines with which all the species are beset.

[3] See also "Thoughts on Animalcules."

organic remains, had long since attracted the attention of naturalists, and rendered these quarries celebrated throughout Europe. In 1770, M. Hoffman, the surgeon of the Fort, who had for some years been assiduously collecting the fossils of this locality, had the good fortune to discover a specimen which has conferred an enduring celebrity on his name. Some workmen, on blasting the rock in one of the caverns of the interior of the mountain, perceived to their astonishment the jaws of a large animal attached to the roof of the chasm. The discovery was immediately made known to M. Hoffman, who repaired to the spot, and for weeks presided over the arduous task of separating the mass of stone containing these remains from the surrounding rock. His labours were rewarded by the successful extrication of the specimen, which he conveyed in triumph to his house. This extraordinary discovery soon became the subject of general conversation, and upon reaching the ears of the Canon of the cathedral which stands on the mountain, excited in that functionary a determination to claim the fossil, in right of being lord of the manor; and he unfortunately succeeded, after a long and harassing lawsuit, in obtaining this precious relic. It remained for years in his possession, and Hoffman died without regaining his treasure, or receiving any compensation. At length the French revolution broke out, and the armies of the republic advanced to the gates of Maestricht. The town was bombarded; but at the suggestion of the committee of *savans* who accompanied the French troops to select their share of plunder, the artillery was not suffered to bombard that part of the city in which the celebrated fossil was known to be preserved. In the mean time, the Canon of St. Peter's, shrewdly suspecting the reason why such peculiar favour was shown to his residence, removed the specimen, and concealed it in a vault; but when the city was taken, the French authorities compelled him to give up his ill-gotten prize, which was immediately transmitted to the Jardin des Plantes, at Paris, where it still forms one of the most striking objects in that magnificent collection.[1]

The beautiful model of this most interesting fossil in the British Museum, was presented to me by Baron Cuvier. It is four and a half feet long, and two and a half wide; it consists of the jaws, with teeth, palatal bones, and the tympanic bone, or *os quadratum*, a bone possessed by reptiles, as well as birds, and in which the auditory cells are contained. There are likewise some fine portions of jaws, with teeth, in the British Museum, presented by Camper. The original animal was probably a terrestrial reptile, holding an intermediate place between the Monitors and Iguanas. It was about twenty-five feet long.

I discovered, many years since (1820), some vertebræ in the chalk near Lewes, which closely resemble the corresponding bones of the Mosasaurus, and in all probability belong to another species. In the cretaceous strata of New Jersey, Dr. Harlan found and described, and my friend, Dr. Morton, of Philadelphia, sent me, in 1834, teeth which cannot be distinguished from those of Maestricht. Vertebræ, and other bones, have since been obtained from the same deposits by Professor Rogers, and described by Professor Owen in the Geological Journal.

XVI. Fossil Reptiles. Although when Mr. Parkinson's work was published many fossil bones and teeth of reptiles had been discovered in various parts of England, yet the abundance and variety, and the extraordinary modification of form and structure of this class of vertebrated animals, which prevailed throughout the secondary geological formations, were not for a moment suspected. The few examples of the remains of fossil reptiles described by Mr. Parkinson, serve to mark the

[1] Faujus St. Fond, in whose beautiful work on the fossils of St. Peter's Mountain the above account is given, remarks with much sang froid, "La *justice*, quoique tardive, arrive enfin avec le tems!" The reader will probably think that although the Canon was justly despoiled of his ill-gotten treasure, the French *savàns* were a very equivocal personification of *Justice!*

degree of knowledge which then existed respecting a department of palæontology that rapidly acquired an importance and interest unsurpassed by any other branch of fossil osteology.

The announcement of the founder of palæontology,[1] that there was a period when the lakes and rivers of our planet were peopled by reptiles, and cold-blooded oviparous quadrupeds of appalling magnitude were the principal inhabitants of the dry land; when the seas swarmed with saurians, exclusively adapted for a marine existence, and the regions of the atmosphere were traversed by winged lizards instead of birds; was an enunciation so novel and startling, as to require all the prestige of the name of Cuvier, to obtain for it any degree of attention and credence, even with those who were sufficiently enlightened to admit, that a universal deluge would not account for the physical mutations which the surface of the earth and its inhabitants had, in the lapse of innumerable ages, undergone.

Subsequent discoveries have established the truth of this proposition to an extent beyond what even its promulgator could have surmised; and the "*Age of Reptiles*" is now admitted into the category of established facts.

During the incalculable ages which the formation of the various systems of secondary strata must have comprised, we find no evidence in the fossils hitherto observed, of the existence of birds and mammalia, as the characteristic types of the faunas of the dry land. On the contrary, throughout the immense accumulations of the spoils of the ancient islands and continents, amidst innumerable relics of reptiles of various orders and genera, a few jaws and bones of two or three kinds of extremely small marsupials, and the bones of a species of wader, are the sole indications of the presence of the two grand classes of Aves and Mammalia, which now constitute the chief features of the terrestrial zoology of almost all countries.

The earliest indications of air-breathing vertebrata in the ancient secondary formations are those of small saurian reptiles in the carboniferous strata; a few vestiges occur in the succeeding group, the Permian. In the next epoch, the Triassic, colossal Batrachians (*Labyrinthodonts*) appear; and on some of the strata of this formation are the footmarks of numerous bipeds, presumed to be those of birds; but at present the evidence of the bones of the animals that made those imprints is required to establish the hypothesis.

In the succeeding eras, the Lias, Oolite, Wealden, and Cretaceous, swarms of reptiles of numerous genera and species everywhere prevail; reptiles fitted to fly through the air, to roam over the land, to inhabit the lakes, rivers, and seas; and yet not one identical with any existing forms! These beings gradually decline in numbers and species as we approach the close of the secondary periods, and are immediately succeeded in the eocene epoch, by as great a preponderance of warm-blooded vertebrata—birds and mammalia—as exists at the present time; and an equal decadence in the class of reptiles. With the Cretaceous Formation the "Age of Reptiles" may be said to terminate.

XVII.—Fossil Reptiles of the Wealden. *The Iguanodon.* The fluviatile deposits (termed *Wealden*), which in the south-east of England, and in the north of Germany, are intercalated between the oolitic and cretaceous formations, abound in the bones of terrestrial, fresh-water, and marine reptiles, comprising some of the most colossal land-saurians which have hitherto been brought to light. These remains belong to various genera of Chelonians, Saurians, and Crocodilians; and with these are associated those of flying lizards (*Pterodactyles*), Plesiosauri, gigantic whale-like reptiles (*Cetiosauri*), and of other oviparous quadrupeds of unknown species and genera.

[1] In the "Ossemens Fossiles;" tom. v. Reptiles Fossiles.

The occurrence of fossils of this nature in the strata forming the districts denominated the Wealds of Sussex and Kent, was first brought under the notice of geologists in 1822, in my work on the "Fossils of the South Downs," in which the remains of several unknown reptiles were described; and among them the teeth and bones of that extraordinary herbivorous lizard, the *Iguanodon,* on which I am induced to offer a few observations in this place; the recent discovery of some previously undetermined parts of the skeleton, having materially elucidated the structure and economy of the original.[1]

Since the first announcement of the discovery of the remains of the Iguanodon, vast quantities of bones belonging to a great number of individuals of all ages have been collected; but until a few years since, not a vestige of the jaws had been observed, notwithstanding the most diligent research. In the early part of the year 1848, I was surprised and highly gratified by receiving from Capt. Lambart Brickenden (at that time a personal stranger to me), who then resided at Warminglid, near Cuckfield, in Sussex, the greater part of the right side (or *ramus*) of the lower jaw, with several successional teeth in their natural position, of an adult Iguanodon.[2] See p. 202.

In the course of last summer I obtained a very instructive fragment of the middle part of the right ramus of the lower jaw of a much larger Iguanodon, found by Mr. Fowlestone, with some enormous bones of the extremities, in the Wealden strata of the Isle of Wight. A portion of the upper jaw (without teeth) was discovered some years since in Tilgate Forest, and is deposited, with the whole of the collection I formed at Brighton, in the gallery of organic remains of the British Museum. These three specimens are the only parts of the jaws of the Iguanodon, with the exception of a fragment of the angular bone, that I have had the opportunity of examining. The other portions of the skeleton hitherto discovered are the following: the tympanic bone;[3] cervical, dorsal, lumbar, and caudal vertebræ, and chevron bones; ribs; the iliac bones, and sacrum composed of *six* anchylosed vertebræ;[4] the coracoid, scapula and clavicles; humerus, radius? metacarpals; femur, tibia and fibula, metatarsals and ungueals. The cranium, carpals, and tarsals, have not been discovered.

With the exception of the assemblage of bones promiscuously grouped together in a block of *Kentish rag* (of the greensand formation), found in a quarry near Maidstone, by Mr. Bensted,[5]

[1] The following is the description of the specimens first discovered, given in the "Fossils of the South Downs; or, Illustrations of the Geology of Sussex," 1 vol. 4to. 1822: "Incisors and molar teeth evidently belonging to the same species of animal: they differ from any previously known; the masticating surface is perfectly smooth and rather depressed in the centre; these teeth consist of the crown only, and are quite solid. An incisor tooth 1.3 inch long is slightly bowed and smooth on its inner surface; but it has externally a ridge which extends longitudinally down the front. Its sides are angular, and the edges finely crenated." From the resemblance of these teeth in their general form to those of the Iguana, a common land lizard in the West Indies, I subsequently proposed the name of *Iguanodon* (implying an animal having teeth like the Iguana) for the fossil reptile. The teeth of an Iguana four or five feet long are not larger than those of a mouse; the Iguanodon's teeth are as large as the incisors of the rhinoceros. The Iguana's teeth, when used, are chipped off at the points, no existing reptile being capable of performing mastication; the teeth of the Iguanodon, on the contrary, are ground down like the worn molars of herbivorous mammalia, as I pointed out in my first memoir in the Philos. Trans. 1825.

[2] This beautiful and most instructive specimen is now in my possession; it is figured of the natural size in Philos. Trans. Part ii, for 1848, Plate XVI., as well as the portion of upper jaw in the British Museum, Plate XIX. The character of the upper and lower teeth of the Iguanodon are well represented in Plate XVIII. of the same memoir.

A specimen very similar to that discovered by Capt. Brickenden, but of a young individual, was found soon afterwards in a quarry near Horsham; but I was not allowed the privilege of figuring or describing it!

[3] This may or may not belong to the Iguanodon: no tympanic bone has been found in such connexion with other parts of the skeleton as to afford certain proof that this maxillary element is referable to the Iguanodon.

[4] In the Megalosaurus, the sacrum consists of five anchylosed vertebræ.

[5] This most instructive specimen is in a glass-case on the floor near the window, in the middle room of the Gallery of

a few connected caudal vertebræ, and two or three instances in which a femur, tibia, and fibula and some metatarsals, were found in contiguity, all the bones were isolated. They have been obtained from the quarries in St. Leonard's and Tilgate Forests, near Loxwood, Rusper, Horsham, Cuckfield, and Battel; and from the cliffs at Hastings, and in Sandown, and Brixton, and Brook Bays, on the southern shore of the Isle of Wight.

So anomalous is the osteology of the Iguanodon compared with that of existing saurians, that from my discovery of the first vestige of this reptile—a fragment of a tooth—thirty years ago, to the recent important acquisition of the jaws, I have had to contend with the opposition of eminent naturalists, who have refused assent to the physiological inferences suggested by the specimens which were from time to time brought to light, because the modifications of structure in a colossal herbivorous reptile, essentially differed from the hypothetical archetype skeleton of the class to which it belonged. When the first discovered teeth were shown to Baron Cuvier, he pronounced them to be the incisors of a Rhinoceros; the metatarsals, those of a Hippopotamus; the fragment of a femur, with a medullary canal, that of some large mammalian. But the candour and liberality of the founder of Palæntology were worthy of his transcendent genius; upon receiving further evidence, he immediately acknowledged the error, and expressed his conviction that the teeth and bones belonged to an herbivorous reptile more extraordinary than any that had previously been brought under his notice.[1]

Even the lower jaw, which presents characters so peculiar as to admit, as I conceive, of but one interpretation—that enunciated in my memoir on the teeth and jaws of the Iguanodon,[2]—has been adduced as affording a signal instance of the incorrectness of my physiological deductions. And why? Because in the entire class of living reptiles there is not a single species that has cheeks and flexible lips, which, according to my view of the subject, the Iguanodon must have possessed. But I do not hesitate to affirm that the structure and arrangement of the teeth, and the mammalian character of the bones of the extremities, are in perfect accordance with my exposition of the probable structure and functions of the maxillary organs of the original. The naturalists who advance these objections, forget that among the existing mammalia there is one genus, the *Ornithorhynchus*, or Duck-billed Platypus, that exhibits as striking a deviation from the typical maxillary structure of its class, as does the Iguanodon. If before the discovery of New Holland the jaw-bones of the Ornithorhynchus had been found in a fossil state in the strata of Tilgate Forest, and I had ventured to infer that the original, though a true mammalian, and giving suck to its young, had the extremities of the jaws covered with flat horny beaks, like those of a duck, instead of with the fleshy lips and integuments which are the peculiar attributes of its class, what censures would not my temerity have called forth! We cannot too often be reminded of the profound remark of William Penn: "Experience, which is continually contradicting theory, is the only test of truth."

The following are the physiological inferences relating to the structure and habits of the Iguanodon, which Dr. Melville and myself conceive our investigations have established: the

Organic Remains in the British Museum. All the Wealden reptilian remains of a large size, collected by me when residing in Sussex, are in the upright glass cases in the same apartment.

[1] See Cuvier's Ossemens Fossiles, tom. v. part. ii. It is much to be wished that those who aspire to emulate this great man in scientific fame, would also endeavour to imitate him in the yet nobler attributes of his character. It is stated by Professor Owen, in Brit. Assoc. Reports on Fossil Reptiles, that the *bones* of the Iguanodon were interpreted by me with the aid of Cuvier and Clift. This is a mistake. Baron Cuvier died before I had obtained any considerable portion of the skeleton; and neither Mr. Clift nor Mr. Owen at that time could afford me any assistance in determining the nature of the isolated bones I occasionally brought to the Hunterian Museum for comparison. Any aid I ever received in my investigations is most fully acknowledged in my works.

[2] See Philosophical Transactions, Part II. 1848.

discovery of the cranium, and of perfect examples of the upper and lower jaws with both successional and mature molars in their natural position, may modify, but, we believe, will in no material respect invalidate these conclusions.

In instituting a comparison between the maxillary organs of the Iguanodon, and those of the existing herbivorous lizards, we are at once struck with their remarkable deviation from all known types in the class of reptiles. In the *Amblyrhynchi* (of the Galapagos Islands), the most exclusively vegetable feeders of the Saurian order, the alveolar process beset with teeth is continued round the front of the mouth: the junction of the two rami of the lower jaw at the symphysis presenting no edentulous interval whatever, the lips not being more produced than in other reptiles; but this creature only bruises its food; it cannot grind or masticate it. In fact, the edentulous, expanded, scoop-shaped, procumbent symphysis of the lower jaw of the Iguanodon, has no parallel among either recent or fossil reptiles; and we seek in vain for organs at all analogous, except among the herbivorous mammalia. The nearest approach is to be found in certain *Edentata;* as for example in the *Cholœpus didactylus,* or Two-toed Sloth, in which the anterior part of the lower jaw is destitute of teeth, and much prolonged. The correspondence is still closer in the extinct gigantic *Mylodons,* in which the symphysis resembles the blade of a turf-spade, and has no traces of incisor sockets; and were not this part of the jaw elevated vertically in front, and the two sides confluent, it would present the very counterpart of that of the Iguanodon. The great number and size of the vascular foramina distributed along the outer side of the dentary bone in the Wealden reptile, and the magnitude of the anterior outlets which gave exit to the vessels and nerves that supplied the front of the mouth, indicate the great development of the integuments and soft parts with which the lower jaw was invested.

The sharp ridge bordering the deep groove of the symphysis, in which there are also several foramina, evidently gave attachment to the muscles and integuments of the under lip; and there are strong reasons for supposing that the latter was greatly produced, and capable of being protruded and retracted so as to constitute, in conjunction with a long extensile tongue, a suitable instrument for seizing and cropping leaves and branches, which, from the construction of the teeth, we may infer was the food of the Iguanodon.

Thus we find the mechanism of the maxillary organs of the Wealden herbivorous saurian, as demonstrated by recent discoveries, in perfect harmony with the remarkable dental characters which rendered the first known teeth so enigmatical. In the Iguanodon we have a solution of the problem, how the integrity of the type of organization peculiar to the class of cold-blooded vertebrata was maintained, and yet adapted by simple modifications to fulfil the conditions required by the economy of a gigantic terrestrial reptile, destined to obtain support exclusively from vegetable substances; in like manner as the extinct colossal sloth-like Edentata of South America. In fine, we have in the Iguanodon the type of the terrestrial herbivora, which in that remote epoch of the earth's physical history—the *Age of Reptiles*—occupied the same relative station in the terrestrial fauna, and fulfilled the same general purposes in the economy of nature, as the Mylodons, Mastodons, and Mammoths, of the tertiary periods, and the large pachyderms of modern times.

Although some important data are still required to complete our knowledge of the structure of the Iguanodon, we are warranted in concluding that this colossal herbivorous reptile was as bulky as the elephant, and as massive in its proportions: for, living exclusively on vegetable substances, the abdominal region must have been largely developed. Its limbs must have been of proportionate size to support and move so enormous a carcass. The hinder extremities probably presented the unwieldly contour of those of the Hippopotamus, and were based on strong short feet, protected by broad horny ungueal phalanges, or nails. The fore-legs appear to have been less bulky, and adapted for seizing and pulling down plants and branches: the teeth and jaws demonstrate the nature of its food; and the fossil remains of coniferous trees, arborescent ferns, and cycadeous plants, with which its relics are commonly associated, indicate the character of the flora adapted for its sustenance.[1]

XVIII. The Pelorosaurus.—The humerus of a terrestrial reptile of enormous magnitude, has lately been discovered by Mr. Peter Fuller of Lewes, in the quarry near Cuckfield, from which many remains of the Iguanodon and Hylæosaurus were obtained in my early researches. This bone more nearly resembles the humerus of the Crocodiles, than that of the Lizards. It is four and a half feet in length, and of corresponding proportions; it has a large medullary canal. As to the size of the animal to which it belonged, while disclaiming the idea that any certain conclusion can be drawn from a single bone, I may mention, with the view of conveying some general notion, that in a Gangetic crocodile eighteen feet long, the humerus is one foot: according to this scale the fossil animal would be eighty-one feet in length. I have proposed the name of *Pelorosaurus* (from *πέλωρ—pelŏr*—monster), or Colossal-saurian, for this new genus of reptiles which inhabited the country of the Iguanodon.[2]

XIX. Silicification, *or petrifaction by flint.*—The various forms in which silex occurs have depended on its state of fluidity. In quartz crystals the solution was complete; in agate and chalcedony it was in a gelatinous state, assuming a spheroidal or orbicular disposition according to the motion given to its particles. Its condition appears also to have been modified by the influence of organic matter. In some polished slices of siliceous nodules, the transition from flint to agate, chalcedony, and crystallized quartz, is beautifully shown. The curious fact that the shells of Echinites in chalk are almost invariably filled with flint, while their crustaceous shells are changed into calc-spar, is probably in many instances to be attributed to the animal matter having undergone silicification; for the most organized parts are those which appear to have been most susceptible of this transmutation. In some specimens the oyster is changed into flint, while the shell is converted into crystallized carbonate of lime. In a trigonia from Tisbury, formerly in the cabinet of the late Miss Benett, of Norton House, near Warminster, the body of the mollusk was completely metamorphosed into pure chalcedony, the branchiæ or gills being as clearly defined as when the animal was recent. In specimens of wood from Australia (presented to the British Museum by Sir Thomas Mitchell), which are completely permeated by silex, there are on the external surface some spots of chalcedony, that have apparently originated from the exudation of the liquid silex from the interior in viscid globules filled with air, which burst, and then collapsed, and became solidified in their present form.

In silicified wood, the permeation of the vegetable tissues by the mineral matter appears to have been effected by solutions of silex of a high temperature. In some examples mineralization has been effected simply by replacement: the original substance has been removed, atom by atom, and the silex substituted in its place. One of the most eminent naturalists and mineralogists of the United States, Mr. J. D. Dana,[3] suggests that the reason why silica is so common

[1] Philosophical Transactions, for 1848, pp. 196—198.

[2] A memoir on this fossil was read before the Royal Society, Feb. 14th, 1850; an abstract has been published in the Proceedings of the Society. It is entitled, "On the Pelorosaurus; an undescribed gigantic terrestrial reptile, whose remains are associated with those of the Iguanodon and other saurians in the strata of Tilgate Forest." It will appear in the Phil. Trans. Part II. 1850.

[3] American Journal of Science, for January, 1845.

a material in the constitution of fossil wood and shells, as well as in pseudo-morphic crystals,[1] consists in the ready solution of silex in water at a high temperature (a fact affirmed by Bergman[2]), under great pressure, whenever an alkali is present, as is seen at the present time in many volcanic regions, and its ready deposition again when the water cools. A mere heated aqueous solution of silica, under a high pressure, is sufficient to explain the phenomenon of the silicification of organic structures. Mr. Dana states that "a crystal of calc-spar in such a fluid, being exposed to solution from the action of the heated water alone, the silica deposits itself gradually on a reduction of temperature, and takes the place of the lime, atom by atom, as soon as set free. Every silicified fossil is an example of this pseudo-morphism; but there seems to be no union of the silica with the lime, for silicate of lime is of rare occurrence.[3]

XX. STIGMARIA, SIGILLARIA, *&c.*—The most remarkable peculiarity of the flora of the carboniferous period is the immense numerical preponderance of the vascular or higher tribes of cryptogamic plants, which amount to two-thirds of the species described. With these are associated a few Palms, Coniferæ, Cycadeæ, and dicotyledonous plants, allied to the *Cacteæ* and *Euphorbiaceæ.* The number and magnitude of the vegetables bearing an analogy to the *Ductulosæ,* but differing from existing species and genera, constitute therefore the most important botanical feature of the carboniferous flora. Thus we have plants allied to the Equisetum, or mare's-tail (*Calamites*), eighteen inches in circumference, and from thirty to forty feet high; Zamia-like coniferæ (*Sigillariæ*) fifty feet high; and arborescent club-mosses (*Lepidodendra*) attaining an altitude of sixty or seventy feet. Of this ancient flora, the fossil plants whose stems have been named *Sigillaria* (see Plate XXI.), and their roots *Stigmaria,* are especially remarkable in consequence of the peculiar circumstances under which upright examples of these trees are occasionally met with. Referring for details to "Wonders of Geology," Lecture VII., I purpose describing in this place the facts recently brought to light, which prove that certain species of Stigmaria are the roots of Sigillariæ; while others in all probability belong to Lepidodendra:—an opinion maintained more than thirty years ago by the Rev. H. Steinhauer.[4] To the late Mr. Binney we are indebted for the first confirmation of the inference of my friend, M. Adolphe Brongniart, (derived from an examination of the structure of those bodies,) that the Stigmariæ are the veritable roots of Sigillariæ. At St. Helen's, near Liverpool, Mr. Binney discovered, in 1844, an upright trunk of a Sigillaria, nine feet high, to which were attached ten roots, several feet long, that extended into the under clay in their natural position;[5] and these roots were unquestionable Stigmariæ, the tubercles with their attached rootlets being clearly displayed. In the floor of the Victoria Mine at Dunkinfold, near Manchester, at the depth of 1,100 feet from the surface, Mr. Binney also discovered a magnificent specimen of Sigillaria, which exhibited on its stem the respective characters of three supposed species, and had stigmaria-roots extending twenty feet.

In the Sydnéy coal-field at Cape Breton, Mr. Richard Brown has observed several upright

[1] Pseudo-morphic crystals are crystals moulded in the cavities left by other crystals, which they have replaced. See Dr. Blum on pseudo-morphous minerals; and Mr. Jefferey's experiments on the solution of silica in heated vapour; Wonders of Geology, p. 100.

[2] Bergman first determined the solubility of silex in simple water, aided by heat, and demonstrated its existence in the Geysers, and other boiling springs of Iceland. *Parkinson, Org. Rem.*, vol. i. p. 324.

[3] See my "Notes on a microscopical examination of chalk and flint," Annals of Natural History, August 1845.

[4] Transactions of the American Philosophical Society, New Series, vol. i.

[5] See Medals of Creation, vol. i. p. 143.

stems of Sigillariæ and Lepidodendra, with stigmaria-roots attached; and the same fact has been noticed in the Picton coal, in Nova Scotia. The following figures and notes from Mr. Brown's description of these interesting phenomena, will place the subject before the reader in a clear point of view.[1]

The main bed of coal is six feet in thickness, and is overlaid, as usual, by a roof of shale abounding in foliage and fragments of branches. As the coal is dug out, large masses of the shale fall in, and occasionally hollow spaces, called by the workmen *pot-holes*, are left in the roof; the fallen masses being the roots and truncated stems of Sigillariæ and other trees, which separate at the parting formed by the coaly bark covering the roots, when the supporting coal is removed.

The following sketch represents one of the specimens of the base of a stem of a Lepidodendron, with the roots (*stigmariæ*) attached. This figure (1) shows the position of the tree above the bed

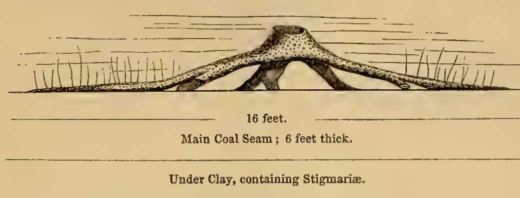


Fig. 1.
STEM OF LEPIDODENDRON WITH ROOTS.

of main coal, with the inclination and length of two of the principal roots, so far as they could be distinctly traced; and the following sketch (2) represents the trunk, with its branching roots, constructed from careful measurements of the dimensions and position of each root, drawn on the

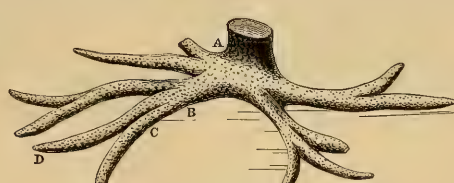


Fig. 2.

spot. The stem at the part marked A, was encrusted with a coaly bark, covered by the usual cicatrices of the Lepidodendra, and the roots at B, C, D, with a similar carbonaceous investment, impressed with the characteristic pits or areolæ of Stigmariæ.

In the instance of the upright stems of Sigillariæ in the same coal-field, the roots were also unequivocally Stigmariæ. Fig. 3, represents one of these erect stems, sixteen inches high and twelve inches in diameter at the top, which dropped from the roof of the bed after the coal had

[1] "Description of an upright Lepidodendron with Stigmaria-roots in the roof of the Sydney Main Coal, in the Island of Cape Breton. By Richard Brown, Esq."—*Geological Journal*, No. 13, for June, 1847, p. 46.

been removed. Part of the coaly bark remains at *c*. The decorticated part of the trunk is covered with minute scales as far as the point *h*, a few inches below the first ramification of the roots.

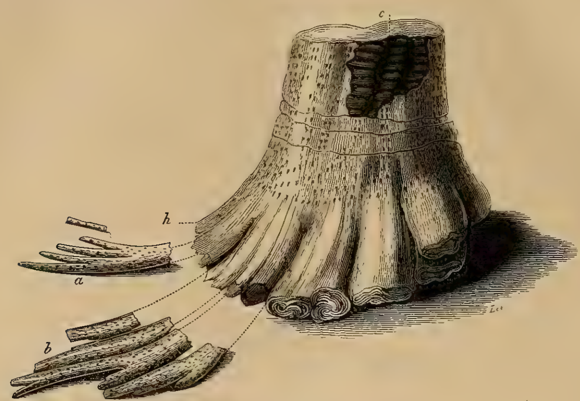


Fig. 3.

STEM OF SIGILLARIA ALTERNANS, $\frac{1}{12}$ *natural size.*

The carbonaceous crust investing the roots was thick at the upper part, but gradually became thin, and at *a*, and *b*, was a mere friable pellicle, that fell off upon the slightest touch.

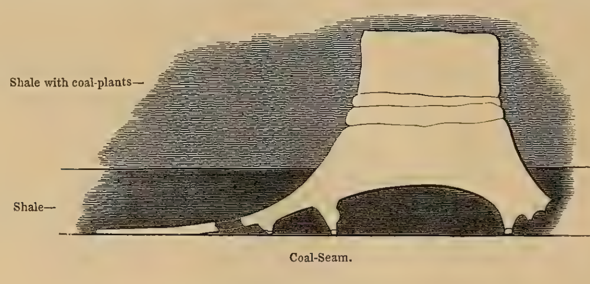


Fig. 4.

The exact position of the tree in relation to the underlying coal is shown in the above section, Fig. 4. Immediately over the coal there is a bed of hard shale, six inches in depth, in which no fossils are found; this is overlaid by a softer shale abounding in coal-plants; all the upright stems were rooted in the six-inch shale. Upon clearing the base of this tree, a complete set of conical tap-roots was discovered, arranged as in the annexed sketch, Fig. 5. There are four large tap-roots in each quarter of the stump, and five inches below these another set of smaller tap-roots; the total number amounting to eighteen. The horizontal roots are seen to branch off in a regular manner, the base being divided into four nearly equal parts by deep channels, extending from the centre to the points *i*, *k*, *l*, *m*.

Mr. Brown remarks, that these short thick tap-roots were evidently adapted only to a soft wet soil, such as we may conceive was the nature of the first layer of mud deposited upon a bed of peat which had settled down slightly below the level of the water. He supposes, from the presence of a layer of shale without fossil plants immediately over the coal, that the prostrate stems and leaves which occur in such large quantities in the next superincumbent bed, fell from trees growing on the spot, and were entombed in layers of mud held in suspension in the water, which at short intervals inundated the low marshy ground on which they grew; for had the plants been drifted from a distance, he conceives they would also occur in the first layer of shale, as well as in those higher up.

Fig. 5.

The under surface of Fig. 3, showing the conical tap-roots of the tree, $\frac{1}{12}$ natural size.

Having thus shown that the *Sigillaria alternans* was provided with roots adapted for a soft muddy soil, Mr. Brown next describes the specimen represented in Fig. 6, which is the stem of the same species of tree broken off near the roots; the hollow cylinder of bark (*a*) having been bent down and doubled over by the pressure of the surrounding mud, so as effectually to close up the aperture, leaving

Fig. 6.

STEM OF A SIGILLARIA BROKEN OFF CLOSE TO THE ROOTS, $\frac{1}{12}$ *natural size.*

only a few irregular cicatrices, of three or four inches in length, converging at the apex; the structure, arrangement, and number of the tap-roots, as well as the horizontal ramifications, are similar to those in Fig. 5. This fossil clearly explains the nature of the "*dome-shaped*" plant figured in the "Fossil Flora of Great Britain."[1]

"The roots of the preceding fossils repeatedly ramify as their distance from the stem increases, and ultimately terminate in broad flattened points. The whole of the spreading roots of these trees (the *Sigillariæ*) cover only an area of thirty square feet each; whilst those of the Lepidodendron (Fig. 1), whose stem is only two or three inches larger in diameter, covered a space of two hundred square feet. Since it is well known, from numerous examples, that the

[1] The figures 3, 4, 5, 6, and the descriptions, are from the paper of Richard Brown, Esq., published in the Journal of the Geological Society of London, for March, 1849, entitled, "Description of erect Sigillariæ, with conical tap-roots, found in the roof of the Sydney Main Coal, in the Island of Cape Breton."

Lepidodendra were lofty trees, with spreading branches, which therefore required wide bases for support, may we not conclude that Sigillariæ of the species described were, on the contrary, trees of low stature, without heavy branches?"

I cannot quit this subject without again adverting to the remarkable phenomenon mentioned in a previous note, namely, that in the bed of pulverulent earth—the *under-clay*—on which the coal invariably reposes, the roots (or Stigmariæ) of large trees are generally the only organic remains met with. The constant occurrence of these fossils in the under-clay, and their rarity in the coal and shale, was long ago pointed out by Mr. Martin, Dr. Macculloch, and other geologists; but the importance of the fact was not appreciated till Mr. Logan drew attention to it. In the Welsh coal-field, through a depth of 1,200 feet, there are sixty beds of coal, each of which lies on a stratum of clay abounding in Stigmariæ. In the Appalachian coal formation of the United States, the same phenomena occur.

Thus it appears that the under-clay is the natural soil in which the roots (*Stigmariæ*) of the Sigillariæ and Lepidodendra grew; the coal above it is composed of the carbonized stems and foliage of those trees; and the roof or coal-shale is formed by the leaves and branches of a forest overwhelmed and buried beneath the transported detritus of distant rocks. These phenomena may be explained by supposing that a plain, densely clothed with a luxuriant intertropical vegetation, was either inundated by an irruption of the sea, or overwhelmed by a flood, from the sudden breaking up of the barrier of an inland lake; or by the subsidence of the country on which the forests grew. But when we find an uninterrupted series, in which triple deposits of this character are repeated through many thousand feet, the solution of the problem is beset with difficulties, which the hypothesis of repeated periodical subsidences, however ingenious, does not, in my opinion, remove.[1]

*** Jaw of the Iguanodon.—*Additional note to* p. 194.—Since the preceding pages were struck off, I have, through the kindness and liberality of Samuel H. Beckles, Esq., of Hastings, obtained two portions of jaws from the Wealden of the Sussex Coast. One of these is a fragment of the left side of the lower jaw, with six well-defined dental sockets; the other specimen exhibits the position of the mature molars and the successional teeth in the upper jaw; and confirms the accuracy of the views of Dr. Melville and myself as to the ruminant character of the arrangement of the dental organs in the upper and lower jaws of the Iguanodon, as described in my memoir on the structure of the jaws and teeth; Philos. Trans. 1848, p. 183. When this specimen is completely developed, it will probably exhibit distinctly the relative position of the germs and mature teeth, and the form of the inner alveolar parapet.

[1] See Wonders of Geology, pp. 669, 718, 731.

INDEX.

D.

E.

F.

R. CLAY, PRINTER, BREAD STREET HILL.