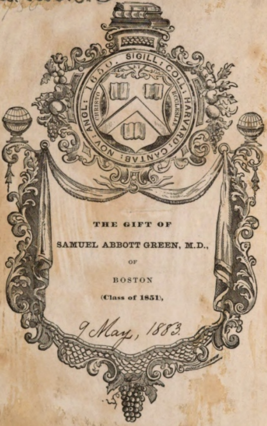

[illegible]

THE BRIDGEWATER TREATISES

ON THE

POWER WISDOM AND GOODNESS OF GOD

AS MANIFESTED IN THE CREATION

TREATISE VI.

GEOLOGY AND MINERALOGY CONSIDERED WITH REFERENCE TO
NATURAL THEOLOGY.

BY THE REV. WILLIAM BUCKLAND, D.D.

IN TWO VOLUMES.

VOL. II.

[illegible] OF THE EARTH
[illegible]

D MINERALO 1842.

THE BRIDGEWATER TREATISES

ON THE

POWER, WISDOM AND GOODNESS OF GOD

AS MANIFESTED IN THE CREATION.

TREATISE VI.

GEOLOGY AND MINERALOGY CONSIDERED WITH REFERENCE TO
NATURAL THEOLOGY.

BY THE REV. WILLIAM BUCKLAND, D. D.

IN TWO VOLUMES.

VOL. II.

THOU LORD IN THE BEGINNING HAST LAID THE FOUNDATION OF THE EARTH.
PSALM CII. 25.

"Let us take a Survey of the principal Fabrick, viz. the Terraqueous Globe itself; a most stupendous work in every particular of it, which doth no less aggrandize its Maker than every curious complete work doth its Workman. Let us cast our eyes here and there, let us ransack all the Globe, let us with the greatest accuracy inspect every part thereof, search out the inmost secrets of any of the creatures, let us examine them with all our gauges, measure them with our nicest rules, pry into them with our microscopes and most exquisite instruments, still we find them to bear testimony to their infinite Workman."

DERHAM'S PHYSICO-THELOOGY, BOOK II. P. 38.

"Could the body of the whole Earth - - be submitted to the Examination of our Senses, were it not too big and disproportioned for our Inquiries, too unwieldy for the Management of the Eye and Hand, there is no question but it would appear to us as curious and well-contrived a frame as that of a human body. We should see the same Concatenation and Subserviency, the same Necessity and Usefulness, the same Beauty and Harmony in all and every of its Parts, as what we discover in the Body of every single Animal."

SPECTATOR, NO. 543.

GEOLOGY AND MINERALOGY

CONSIDERED

WITH REFERENCE TO NATURAL THEOLOGY.

BY THE

REV. WILLIAM BUCKLAND, D. D.

CANON OF CHRIST CHURCH AND READER IN GEOLOGY AND MINERALOGY IN THE
UNIVERSITY OF OXFORD.

A NEW EDITION.

WITH SUPPLEMENTARY NOTES.

IN TWO VOLUMES.

VOL. II.

PHILADELPHIA:
LEA & BLANCHARD,
1841.

1883, May 9,
Gift of
Hon. S. A. Green,
of Boston.

GRIGGS & CO., PRINTERS.

LIST OF ENGRAVINGS.

* Besides 120 figures of Plants and Animals, this Plate represents 30 kinds of Sedimentary Deposites, and 8 varieties of Unstratified Rocks; it also shows the dispositions of intruded Dikes, Metalliferous Veins, and Faults.

Plate

Total number of Plates 87. Total number of figures 705.

EXPLANATION OF THE PLATES.

Introductory Notice, and Description of the Geological Phenomena illustrated by Plate I.

Plate 1,

Is an imaginary Section constructed to express, by the insertion of names, and colours, the relative positions of the most important classes, both of unstratified and stratified rocks, as far as they have yet been ascertained. It is founded on many series of accurate observations, on several lines taken across Europe, between the British islands and the Mediterranean Sea. Although no single straight line exhibits every formation complete in the full order of succession here represented, no fact is inserted for which authority cannot be found. The near approximation of this synoptic representation to the facts exhibited by an actual section, may be estimated by comparing it with the admirable section across Europe, published by Mr. Conybeare in the Report of the Proceedings of the British Association for the Advancement of Science, 1832, and with his sections of England, in Phillips and Conybeare's Geology of England and Wales.

The chief merit of the above Section is due to the Talents of Mr. Thomas Webster; it is founded on a more simple section which has for several years been used by him in his lectures, and which exhibits the relations of the Granitic and Volcanic rocks to the stratified formations, and to one another, more intelligibly than I have ever seen expressed elsewhere. This original drawing by Mr. Webster has formed the basis of the present enlarged and improved section, into which many important additions have been introduced by the joint suggestions of Mr. Webster and myself. The selection and arrangement of the animals and plants is my own; they have been drawn and engraved (together with a large proportion of the woodcuts) by Mr. J. Fisher, of St. Clements, Oxford.

For facility of reference, I have numbered the principal groups of stratified rocks represented in the section, according to their most usual order of succession; and I have designated by letters the crystalline or unstratified rocks, and the injected masses and dikes, as well as the metallic veins, and lines of fracture, producing dislocations or faults. The crowded condition in which all the Phenomena represented in this section, are set together, does not admit of the use of accurate relative proportions, between the stratified rocks and the intruded masses, veins and dikes by which they are intersected. The adoption of false proportion is, however, unavoidable in these cases, because the veins and dikes would be invisible, unless expressed on a highly exaggerated scale. The scale of height throughout the whole section is also infinitely greater than that of breadth. The plants and animals also are figured on no uniform scale.

The extent of the different formations represented in this section, taking their average width as they occur in Europe, would occupy a breadth of five or six hundred miles. A scale of heights, at all approaching to this scale of breadth, would render the whole almost invisible. The same cause makes it also impossible to express correctly the effect of valleys of *denudation*, which are often excavated through strata of one formation into those of another subjacent formation

As it would encumber the section to express *Diluvium*, wherever it is present, it is introduced in one place only, which shows its age to be more recent than the newest of the Tertiary strata; it is found also lodged indiscriminately upon the surface of rocks of every formation.

Granite.

In our early Chapters we have considered the Theory which refers unstratified rocks to an igneous Origin, to be that which is most consistent with all the known Phenomena of Geology, and the facts represented in the Section now before us are more consistent with the Postulates of this Hypothesis, than with those of any other that has hitherto been proposed. I have, therefore, felt it indispensable to adopt its language, as affording the only terms by which the facts under consideration can be adequately described.

Assuming that Fire and Water have been the two great Agents employed in reducing the surface of the globe to its actual condition, we see, in repeated operations of these agents, causes adequate to the production of those irregular Elevations and Depressions of the fundamental Rocks of the Granitic series, which are delineated in the lower Region of our Section, as forming the basis of the entire Superstructure of stratified Rocks.

Near the right extremity of this Section, the undulating surface of the fundamental Granite (a. 5. a. 6. a. 7. a. 8.) is represented as being, for the most part, beneath the level of the Sea.

On the left extremity of the Section (a. 1. a. 2. a. 3.) the Granite is elevated into one of those lofty Alpine ridges, which have affected, by their upward movement, the entire series of stratified Rocks.

Corresponding formations of Primary and Transition

Strata, are represented as occurring on each side of this elevated Granite, which is supposed to have broken through, and to have carried up with it to their present elevated and highly inclined position, strata that were once continuous and nearly horizontal.*

The general history of Elevation appears to be, that mountain chains of various extent, and various directions, have been formed at irregular intervals, during the deposition of stratified rocks of every age; and that Granite had, in many cases, acquired a state of solidity before the period of its elevation.

Within the primary Granite, we find other forms of Granitic matter, (a. 9.) which appear to have been intruded in a state of fusion, not only into fissures of the older Granite, but frequently also into the Primary stratified rocks in contact with it, and occasionally into strata of the Transition and Secondary series, (a. 10. a. 11.) these Granitic injections were probably in many cases, contemporaneous with the elevation of the rocks they intersect; they usually assume the Condition of Veins, terminating upwards in small branches; and vary in dimensions, from less than an inch, to an indefinite width. The direction of these veins is very irregular: they sometimes traverse the Primary strata at right angles to their planes of stratification, at other times they are protruded in a direction parallel to these planes, and assume the form of beds. Some of the relations of these Granitic Veins to the rocks intersected by them are represented at the left extremity of the Section. (a. 9.†)

---

* Cases of Granite thus elevated at a period posterior to the deposition of Tertiary Strata, occur in the Eastern Alps, where the Transition, Secondary, and Tertiary strata have all partaken of the same elevation which raised the central axis of the crystalline Granitic rocks. See Geol. Trans. N. S. Vol. III. Pl. 36. Fig. 1.

† In the Granite at the right extremity of the Section, the granitic veins are omitted, because their insertion would interfere with

A. 10. represents a dike and protruded mass of Granite, intersecting and overlying stratified rocks of the Primary and Transition series. A. 11. represents the rare case of Granite intersecting Red Sandstone, Oolite, and Chalk.[*]

Sienite, Porphyry, Serpentine, Greenstone.

Closely allied to Granite Veins, is a second series of irregularly injected rocks, composed of Sienite, Porphyry, Serpentine, and Greenstone (b. c. d. e.) which traverse the Primary and Transition formations, and the lower regions of the Secondary strata; not only intersecting them in various directions, but often forming also overlying masses, in places where these veins have terminated by overflowing at the surface, (b'. c'. d'. e'.) The crystalline rocks of this series, present so many modifications of their ingredients, that numerous varieties of Sienite, Porphyry, and Greenstone occur frequently in the products of Eruptions from a single vent.

The scale of our Section admits not of an accurate representation of the relations between many of these intruded rocks, and the strata they intersect; they are all placed, as

---

the representation of the injections of Basaltic and Volcanic matter which that portion of the section is intended to illustrate.

[*] An example of the rare Phenomenon of Granite intruded into the Chalk formation, in the hill of St. Martin, near Pont de la Fou in the Pyrenees, is described by M. Dufrenoy in the Bulletin de la Société Géologique de France, Tom. 2. p. 73.

At Weinböhla, near Meissen in Saxony, Prof. Weiss has ascertained the presence of Sienite above strata of Chalk; and Prof. Nauman states, that, near Oberau, Cretaceous rocks are covered by Granite, and that near Zscheila and Neiderfehre, the Cretaceous rocks rest horizontally on Granite; at both these places the Limestone and Granite are entangled in each other, and irregular portions and veins of hard Limestone, with green grains and cretaceous fossils, are here and there embedded in the Granite.

De la Beche. Geol. Manuel. 3d Edit. p. 295.

if they had been injected, either at the time of, or after the elevation of all the strata, and had produced but little disturbance in the rocks through which they are protruded. It should however be understood, distinctly, that some Injections may have preceded the elevation of Strata to their present height, and that numerous and successive elevations and injections, attended by various degrees of fracture and disturbance, have prevailed in various localities during all periods, and throughout all formations; from the first upraising of the earliest Primary rocks, to the most recent movements produced by existing Volcanoes. M. Elie de Beaumont has discovered probable evidence of no less than twelve periods of elevation, affecting the strata of Europe.

Examples of the fractures and dislocations attending these movements, and producing faults, are represented in our Section by the lines designated by the letter l. Some of these fractures do not reach to the present surface, as they affected the lower beds at periods anterior to the deposition of more recent strata, which cover unconformably the summits of the earlier fractures. (See l. l^1. l^2. l^3. l^6. l^7.)

Basalt.

A third series of Igneous Rocks is that which has formed dikes, and masses of Basalt and Trap, intruded into, and overlying formations of all ages, from the earliest Granites to the most recent Tertiary Strata. These basaltic rocks sometimes occur as Beds, nearly parallel to the strata, into which they are protruded, after the manner represented in the carboniferous Limestone of our Section, f. 2. More frequently they overspread the surface like expanded sheets of Lava. Our section gives examples of Trap under all these circumstances. At f. 1, it intersects and overlies Primary strata; at f. 2. f. 3. f. 4. f. 5. it stands in similar relations to Transition and Secondary strata; f. 6. represents an example of an extensive eruption of Basaltic matter, over Chalk and Tertiary strata, accompanied by an intrusion of vast irregular masses of the same materials into the body of the subjacent Primary and Transition rocks.

f. 7. represents strata of columnar Basalt, immediately beneath streams of cellular Lava, in regions occupied also by craters of extinct Volcanoes. f. 8. represents similar beds of columnar lava in the vicinity of active Volcanoes.

Trachyte and Lava.

The fourth and last class of intruded rocks, is that of modern volcanic Porphyries, Trachytes,* and Lavas. The undeniable igneous origin of rocks of this class forms the strongest ground-work of our arguments, in favour of the igneous formation of the older unstratified and crystalline rocks; and their varied recent products, around the craters of active Volcanoes, present gradations of structure, and composition, which connect them with the most ancient Porphyries, Sienites, and Granites.

The simplest cases of volcanic action are those of Trachyte (g. 1.) and of Lava (i. 5.) ejected through apertures in Granite; such cases prove that the source of volcanic fires, is wholly unconnected with the pseudo-volcanic results of the combustion of coal, bitumen, or sulphur, in stratified formations, and is seated deep beneath the Primary rocks.†

---

* The appellation of Trachyte has been given to a volcanic Porphyry, usually containing Crystals of glassy felspar, and remarkably harsh to the touch, (hence its name from τραχυς;) it does not occur in Britain, but abounds in the neighbourhood of almost all extinct and active volcanic craters.

† The occurrence of angular fragments of altered Granite, embedded in Pillars of columnar Lava, in the valley of Monpezat in the Ardêche, shows

Craters.

Our section represents three cases of Volcanic craters; the most simple (i. 5.) rising through Granite, or stratified rocks, at the bottom of the sea, and accumulating craters, which, like those of Lipari and Stromboli, Sabrina, and Graham Islands, are occasionally formed in various parts of the ocean.* The second case is that of volcanoes, which, like Etna and Vesuvius, are still in action on the dry land, (i. 1. to i. 4.) The third is that of extinct volcanoes, like those in Auvergne, (h^1. h^2.) which, although there exist no historical records as to the periods of their last eruptions, show by the perfect condition of their craters, that they have been formed since the latest of those aqueous inundations, that have affected the Basalt and Tertiary strata, through which they have burst forth.

One great difference between the more ancient Basaltic eruptions and those of the Lava and Trachyte of existing volcanoes, is that the emission of the former, probably taking place under the pressure of deep water, was not accompanied by the formation of any permanent craters.

In both cases, the fissures through some of which these Eruptions may have issued, are abundantly apparent under

---

that these fragments were probably torn off during the upward passage of the Lava through fractures in the sordid Granite.

At Graveneire, near Clermont, a stream of Lava still retains the exact form in which it issued through a fissure in the side of a mountain of Granite, and overflowed the subjacent valley. Most accurate representations of this, and many similar productions of Volcanic Eruptions from the Granite of this District may be seen in Mr. Poulett Scrope's inimitable Panoramic Views of the Volcanic formations of Central France.

* Within the last few years, the Volcanic Cones of Sabrina in the Atlantic, and of Graham Island in the Mediterranean, have risen suddenly in the sea and been soon levelled and dispersed by the Waves.

the form of Dikes, filled with materials similar to those which form the masses that have overflowed in the Vicinity of each Dike.*

Changes effected by the Igneous Rocks, on the Strata in contact with them.

The peculiar condition of the rocks that form the side walls of Granitic Veins and Basaltic Dikes, affords another argument in favour of their igneous origin; thus wherever the early Slate rocks are intersected by Granitic Veins (a. 8.) they are usually altered to a state approximating to that of fine-grained Mica-slate, or Hornblend-slate.

The secondary and Tertiary rocks also, when they are intersected by basaltic Dikes, have frequently undergone some change; beds of Shale and Sandstone are indurated, and reduced to Jasper; compact Limestone and Chalk are converted to crystalline Marble, and Chalk-flints altered to a state like that resulting from heat in an artificial furnace.†

In all these cases, the Phenomena appears to be throughout consistent with the theory of igneous Injection, and to be incapable of explanation on any other Hypothesis that has been proposed. A summary statement of the probable relations of the Granitic and Trappean Rocks to the other materials of the Globe, and to one another, may be found in De la Beche's Geological Researches, 1st Edit. Pag. 374, et seq.

---

[*] In many Dikes the materials have been variously modified, by their mode of cooling, and differ from the masses which overflowed the surface.

[†] Examples of this kind occur on the sides of Basaltic Dikes intersecting Chalk in the County of Antrim, and in the Island of Raghlin. See Geol. Trans. London, O. S. vol. iii. p. 210. pl. 10.

Explanation of Letters and Figures used in the references to unstratified and crystalline Rocks in Plate 1.

a. Granite.
b. Sienite.
c. Porphyry.
d. Greenstone.
e. Serpentine.
f. Basalt, or Trap.
g. Trachyte.
h. Products of Extinct Volcanoes.
i. Products of Active Volcanoes.

a. 1.—a. 3. Mountains of Granite, raised into lofty ridges, from beneath Gneiss and Primary Slates.
a. 4. Granite intermixed with Gneiss.
a. 5.—a. 8. Granite, subjacent to stratified rocks of all ages, and intersected by volcanic rocks.
a. 9. Granite Veins, intersecting Granite, Gneiss, and primary Slate.
a. 10. Granite Vein, intersecting Primary and Transition rocks, and forming overlying masses at the surface.
a. 11. Granite Vein intersecting Secondary strata, and overlying Chalk.[*]
b. Dikes of Sienite.
b. 1. Overlying masses of Sienite.
c. Dike of Porphyry.
c. 1. Overlying masses of Porphyry.
d. Dikes of ancient Greenstone.
d. 1. Overlying masses of the same. The Rocks represented by d. and e. often pass into one another.
e. Dikes of Serpentine.
e. 1. Overlying masses of Serpentine.
f. Dikes and intruded subterraneous masses of Basalt.
f. 1. to f. 7. Masses of Basalt protruded through, and overlying strata of various ages.

---

[*] In the locality quoted in the *Explanation of Plates*, Vol. II. p. 5, the Granite which comes to the surface over the Chalk, is not covered by Tertiary deposites, as represented in our section, Pl. 1.

f. 8. Basaltiform products of Modern Volcanoes.
g. Trachyte forming Dikes.
g. 1. Trachyte forming overlying Domes. (Puy de Dome.)
h. 1. h. 2. Lava of extinct Volcanoes, forming undisturbed Cones. (Auvergne.)
i.—i. 5. Lava, Scoriæ, and Craters of active Volcanoes. (i. 1.—i. 4. Etna. 1.—5. Stromboli.)
k.—k. 24. Metalliferous Veins.
k. 15'. Lateral expansions of Veins into metalliferous cavities, called by the Miners Pipe Veins, or Flats.
l.—l. 7. Faults, or fractures and dislocations of the strata. The continuity of stratified Rocks is always interrupted, and their level more or less changed on the opposite sides of a fault.

It is unnecessary here to give detailed descriptions of the 28 divisions of the Stratified Rocks represented in our Section. Their usual Order of Succession and Names are expressed in their respective places, and detailed descriptions of their several characters may be found in all good Treatises on Geology.

The leading Groups of Formations are united by colours, marking their separation from the adjacent groups; and the same colours are repeated, in the headings above the figures of Plants and Animals that characterize the several series of Formations, to show the extent of the strata over which the Organic Remains of each Group are respectively distributed.

Although the deposites of Peat Bogs, and Calcareous Tufa are of too local a nature to be generally included in the series of *stratified Rocks*, they are represented in the Section (Figs. 31, 32,) because they sometimes operate locally to a considerable extent in adding permanent and solid matter to the surface of the Globe.

List of the Names of the Plants and Animals, represented in Pl. 1. to denote the prevailing Types of Vegetable and Animal Life, during the formation of the three great divisions of stratified Rocks.

REFERENCES.

r. *recent.* f. *fossil.* Ad. B. *Adolphe Brongniart.*
L. *Lindley.* Ag. *Agassiz.* P. *Page of Vol.* I.

Remains in Transition Strata.

LAND PLANTS.

1. Araucaria. Norfolk Island Pine. r. & f. P. 364.
2. Equisetum. r. & f. P. 346.
3. Calamites nodosus. f. (L. Pl. 16.)
4. Asterophillites comosa. f. (L. 108.)
5. Asterophyllites foliosa. f. (L. 25.)
6. Aspidium. r. Pecopteris. f.
7. Cyathea glauca, Tree Fern. r. (Ad. B. Hist. Veg. Foss. Pl. 38.) P. 349.
8. Osmunda. r.* Neuropteris. f.
9. Lycopodium cernuum. r. (from Mirbel.) P. 350.
10. Lycopodium alopecuroides. r. (from Mirbel.) P. 350.
11. Lepidodendron Sternbergii. f.
12. Lepidodendron gracile ? f.
13. Flabelliform Palm. r. (from Mirbel.) Palmacites. f.

MARINE ANIMALS AND PLANTS.

14. Acanthodes. f. Ag.
15. Catopterus. f. Ag.
16. Amblypterus. f. Ag.
17. Orodus, extinct Shark. f. (imaginary restoration.)

* An error in this figure represents the fructification as branching from the tallest frond, instead of rising by a separate rachis from the root.

18. Cestracion Phillippi, Port Jackson Shark. r. (Phillip,) P. 220.*
18'. Palatal Tooth of Cestacion Phillippi. r.
19. Tooth of Psammodus, from Derbyshire limestone. f.
19'. Tooth of Orodus, from Mountain limestone, near Bristol. f.
20. Calymene. f. } Trilobites. P. 295.
21. Paradoxus. f. }
22. Asaphus. f. }
23. Euomphalus. f.
24. Producta. f.
25. Spirifer. f.
26. Actinocrinites. f. (Miller, P. 96.) P. 314.
27. Platycrinites. f. (Miller, P. 74.†)
27^a. Fucoides circinatus. f. (Ad. B.) From Transition sand-stone, Sweden.
28. Caryophyllia. r. & f.
29. Astrea. r. & f.
30. Turbinolia. r. & f.

Remains in Secondary Strata.

LAND PLANTS.

31. Pinus. r. & f.
32. Thuia. r. & f.
33. Cycas circinalis. r. Cycadites. f.
34. Cycas revoluta. r. Cycadites. f.
35. Zamia horida. r. Zamia. f.
36. Dracæna. r. Allied to Bucklandia and Clathraria. f.
37. Arborescent Fern. r. P. 350.
38. Pteris aquilina. r. Pecopteris. f.

---

* This shark is the only known living representative of the extinct genus Psammodus.

† Fig. 27. In most, if not all the species of Platycrinites the arms are subdivided; they are not so in this figure, as from its small size they could not well be represented. The figure is intended to give only a general idea of the subject.

39. Scolopendrium. r. Tæniopteris in Oolite Scarborough. f.

LAND ANIMALS.

40. Didelphys. r. Stonesfield slate, 2 small species. f.
41. Didelphys. r. Cheirotherium? f. P. 203.
42. Pterodactylus brevirostris. f.
43. Pterodactylus crassirostris. f.
44. Gavial. r. Allied to Teleosaurus. f.
45. Iguana. r. Iguanodon. f.
46. Testudo, Land Tortoise. r. Scales of Tortoises, at Stonesfield, Oxon. f. Footsteps of Tortoises, Dumfries. f.
47. Emys. r. Soleure. f.
48. Buprestis. r. Stonesfield. f.
49. Libellula. r. Solenhofen. f.

MARINE ANIMALS, AND PLANTS.

50. Plesiosaurus. f.
51. Ichthyosaurus. f.
52. Marine Turtle. r. At Luneville, in Muschel Kalk. f. P. 196.
53. Pygopterus. f. (Ag. Vol. I. Pl. D. 3.) In Magnesian Limestone.
54. Dapedium, in Lias. f.
55. Hybodus. f. Extinct genus of Sharks. (Imaginary restoration.)
56. Loligo. r. Lyme Regis. f.
57. Nautilus Pompilius. r. Many species. f.
58. Ammonites Bucklandi. f. Peculiar to Lias.
59. Astacus. r. & f.
60. Limulus, King Crab. r. Solenhofen. f.
61. Trigonia. f. New Holland. r.
62. Ophiura. r. & f.
63. Asterias. r. & f.

64. Echinus. r. & f.
65. Apiocrinites. f.
65ª. Fucoides recurves. f. (Ad. B. Hist. Veg. Foss. Pl. 5. Fig. 2.)

Remains in Tertiary Strata.

LAND PLANTS.

66. Mauritia aculeata. r. (Martius, T. 44.) Palmacites. Lamanonis. f. P. 166.
67. Elaeis guineensis. r. (Martius, T. 56.) Fruits of Pinnate Palms. f. P. 386.
68. Cocos nucifera. r. (Martius, Pl. 62.) Fossil Cocoanut, Sheppy, Brussels. P. 386.
69. Pinus, Pine. r. & f.
70. Ulmus, Elm. r. & f.
71. Popolus, Poplar. r. & f.
72. Salix, Willow. r. &. f.

LAND ANIMALS OF FIRST PERIOD.

Birds.

73. Scolopax, Woodcock. r. & f.
74. Ibis. r. & f.
75. Tringa, Sea Lark. r. & f.
76. Coturnix, Quail. r. & f.
77. Strix, Owl. r. & f.
78. Buteo, Buzzard. r. & f.
79. Phalacrocorax, Cormorant. r. Pelecanus. f.

Reptiles.

80. Emys, Fresh-water Tortoise. r. & f.
81. Trionyx, Soft Tortoise. r. & f.
82. Crocodilus, Crocodile. r. & f.

Mammifers.

83. Vespertilio, Bat. r. & f.
84. Sciurus, Squirrel. r. & f.
85. Myoxus, Dormouse. r. & f.

86. Castor, Beaver. r. & f.
87. Genetta, Genet. r. &. f.
88. Nasua, Coati. r. & f.
89. Procyon, Racoon. r. & f.
90. Canis Vulpes, Fox. r. & f.
91. Canis Lupus, Wolf. r. & f.
92. Didelphys, Opossum, small. r. &. f.
93. Anoplotherium commune. f.
94. Anoplotherium gracile. f.
95. Palæotherium magnum. f.
96. Palæotherium minus. f.

MARINE ANIMALS.

Mollusks.

Genera of Shells most characteristic of the Tertiary Periods . .

a. Planorbis. r. & f.
b. Limnæa. r. & f.
c. Conus. r. & f.
d. Bulla. r. & f.
e. Cypræa. r. & f.
f. Ampullaria. r. & f.
g. Scalaria. r. & f.
h. Cerithium. r. & f.
i. Cassis. r. & f.
j. Pyrula. r. & f.
k. Fusus. r. & f.
l. Voluta. r. & f.
m. Buccinum. r. & f.
n. Rostellaria. r. & f.

Mammifers.

97. Phoca, Seal. r. & f.
98. Trichechus, Walrus. r. & f.
99. Delphinus Orca, (Phocœna, Cuv.) Grampus. r. Delphinus. f.
100. Manatus, Lamantin. r. & f.
101. Balæna, Whale. r. & f.

LAND ANIMALS.*

Birds.

Aves	102. Columba, Pigeon. r. & f.
	103. Alauda, Lark. r. & f.
	104. Corvus, Raven. r. & f.
	105. Anas, Duck. r. & f.

Mammifers.

Ruminantia	106. Alces, Elk. r. & f.
	107. Elaphus, Stag. r. & f.
	108. Bos Urus, Bison. r. & f.
	109. Bos Taurus. Ox. r. & f.
Rodentia	110. Lepus, Hare. r. & f.
Carnivora	111. Urus, Bear. r. & f.
	112. Mustela, Weasel. r. & f.
	113. Hyæna. r. & f.
	114. Felis, Tiger. r. & f.
Pachydermata	115. Sus, Hog. r. & f.
	116. Equus, Horse. r. &. f.
	117. Rhinoceros. r. & f.
	118. Hippopotamus. r. & f.
	119. Elephas. r. Mammoth. f.

Animal of the present Epoch, supposed to have recently become extinct.

120. Didus, Dodo. r. & f.

The bones of the Dodo have been found under lava of unknown age in the Isle of France, and in a cavern in the Island of Roderigue. See Zoological Journal, 1828, p. 554. Loudon's Mag. Nat. Hist. Vol. II. p. 442. and London and Edin. Phil. Mag. Dec. 1832.

---

* Many of the following genera occur both in the second, third and fourth formations of the Tertiary series, and also in Caverns, Fissures, and Diluvium.

Plate 2. V. 1. p. 64.

A. Jaw of Didelphys, Bucklandi (Magnified to twice nat. size,) in the Collection of W. I. Broderip, Esq. and described by him in the Zoological Journal, V. III. p. 408, Pl. XI. (Broderip.)

2. Second molar tooth magnified.

5. Fifth molar tooth still farther magnified.

B. Fragment of lower Jaw of a small Didelphys from Stonesfield, in the Oxford Museum, (magnified one-third.) This jaw has been examined by Cuvier, and is figured by M. Prevost, Ann. de Sci. Nat. Avr. 1825, p. 389, Pl. 18. The removal of a part of the bone displays the double roots of the teeth, in their alveoli, and the form of the teeth shows the animal to have been insectivorous. (Original.)

4. Fourth molar tooth magnified.

9. Ninth molar tooth magnified.

C. 1. Lower Jaw of Dinotherium giganteum, (Tapirus Giganteus, Cuv.) The length of this Jaw, including the Tusk, is nearly four feet. V. I. p. 110. (Kaup.)

2. Lower Jaw and part of upper Jaw of Dinotherium medium. (Kaup.)

3. Jaw of Dinotherium medium, exhibiting the Crown of five molar teeth, most nearly resembling those of a Tapir. (Kaup.*)

---

* All these unique remains of Dinotherium are preserved in the Museum at Darmstadt; they were found in a Sand pit containing *marine* shells at Epplesheim near Alzey, about forty miles N. W. of Darmstadt, and are described by Professor Kaup.

Bones of Dinotherium have lately been found in Tertiary *Fresh-water* limestone, near Orthes, at the foot of the Pyrenees; and with them, remains of a new Genus, allied to Rhinoceros; of several unknown species of Deer; and of a Dog, or Wolf, the size of a Lion.

Our figures of Dinotherium are copied from the Atlas of Kaup's Description d'Ossemens fossiles de Mammifères, Darmstadt, 1832-3.

Plate 3. V. I. p. 70.

Imaginary restoration of four species of Pachydermata, found in the Gypsum Quarries of Mont Martre. (Cuvier.)

Plate 4. V. I. pp. 70, 73.

Nearly perfect skeletons of the four species of fossil animals, whose restored figures are given in the last Plate. (Cuvier.)

Plate 5. V. I. p. 112.

1. Skeleton of Megatherium, copied from Pander and D'Alton's figure of the nearly perfect skeleton of this animal, in the Museum at Madrid.
2. Bones of the Pelvis of the Megatherium, discovered by Woodbine Parish, Esq. near Buenos Ayres, and now placed in the Museum of the Royal College of Surgeons, London. The bones of the left hind-leg, and several of those of the foot, are restored nearly to their natural place. (Original.)
3. Front view of the left Femur.
4. Front view of the left Tibia and Fibula.
5. Bones of the foot, imperfectly restored.

5′. Large ungual bone, supposed to be that of a Toe of the hind-foot.

6—11. Teeth of Megatherium.

From the near approximation of this animal to the living Tapir, we may infer that it was furnished with a Proboscis, by means of which it conveyed to its mouth the Vegetables it raked from the bottom of Lakes and Rivers by its Tusks and Claws. The bifid ungual bone (Kaup, Add. Tab. 11,) discovered with the other remains of Dinotherium, having the remarkable bifurcation which is found in no living Quadrupeds, except Pangolins, seems to have borne a Claw, like that of these animals, possessing peculiar advantages for the purpose of scraping and digging; and indicating functions, concurrent with those of the Tusks and Scapulæ. (see Vol. I. Page 110.)

12, 13. Armour supposed to be that of Megatherium.*
14—19. Armour of Dasypus and Chlamyphorus.

Plate 6. V. I. p. 118.

1. Sections of Teeth of Megatherium, illustrating the relative dispositions of the Ivory, Enamel, and Crusta petrosa, or Cœmentum. (Original. Clift.)
2. Posterior surface of a caudal vertebra of Megatherium exhibiting enormous transverse processes. On its lower margin are seen the articulating surfaces which received the chevron bone; the superior spinous process is broken off. V. I. p. 121. (Sir F. Chantrey. Original.)

Plate 7. V. I. p. 133.

Ichthyosaurus platyodon from the Lias at Lyme Regis, discovered by T. Hawkins, Esq. and deposited in the British Museum, together with all the other splendid fossil remains that are engraved in his memoirs of Ichthyosauri and Plesiosauri. This animal, though by no means full grown, must have measured twenty-four feet in length. The extremity of the tail, and left fore paddle, and some lost

---

* Mr. Darwin has recently discovered the Remains of Megatherium along an extent of nearly six hundred miles, in a North and South line, in the great sandy plains of Pampas of Buenos Ayres, accompanied by bones and Teeth of at least five other Quadrupeds. He has also found that the Bones of this Animal are so often accompanied by those of the Mastodon angustidens, as to leave no doubt that these two extinct species were contemporary.

I learn from Professor Lichstenstein, that a fresh importation of Bones of Megatherium, and bony armour has lately been sent to Berlin from Buenos Ayres, and that there remains no room to doubt that some portion of this armour appertained to the Megatherium.

It appears very probable, from more recent discoveries, that several other large and small animals, armed with a similar coat of mail, were co-inhabitants of the same sandy regions with the Megatherium.

fragments of the rest of the skeleton, are artificially restored. (Hawkins.)

PLATE 8. V. I. p. 135.

1. Skeleton of a young Ichthyosaurus communis, in the collection of the Geological Society of London, found in the Lias at Lyme Regis. (Scharf. Original.)
2. Ichthyosaurus intermedius, from Lyme Regis, belonging to Sir Astley Cooper. (Scharf. Original.)

PLATE 9. V. I. p. 135.

1 and 2. Ichthyosaurus tenuirostris, from the Lias near Glastonbury, in the collection of the Rev. Dr. Williams, of Bleaden, near Bristol. The position of the ribs is distorted by pressure.)Scharf. Original.)

3. View of the right side of the head of the same animal. (Original.)

PLATE 10. V. I. pp. 135, 137.

1. Head of Ichthyosaurus platyodon, in the British Museum, from the Lias at Lyme Regis, copied from Sir E. Home's figure in the Phil. Trans. 1814.
2. Copied from Mr. Conybeare's figure, (in the Geol. Trans. Lond. O. S. Pl. XL. Fig. 11.) showing the analogies between the bones of the head of Ichthyosaurus, and those which Cuvier has marked by corresponding letters in his figure of the head of the Crocodile.
3. Two of the bony plates in the sclerotic coat of the Eye of Ichthyosaurus platyodon.
4. Circle of bony plates in the Eye of the snowy Owl. (Yarrel.)
5. Circle of similar plates in the Eye of the golden Eagle. (Yarrel.)

6. Front view of bony plates in the Eye of an Iguana.
7. Profile of the same.
8. Two of the fourteen component scales of the same.

I owe these last three figures to the kindness of Mr. Allis of York.

A 1, 2, 3, 4. Petrified portions of the skin of a small Ichthyosaurus, from the Lias of Barrow on Soar, Leicestershire, presented to the Oxford Museum, by the Rev. Robert Gutch, of Segrave. (Original.)

In Fig. 1; a, b, c, d, are portions of ribs, and e, f, g, h, are fragments of sterno-costal bones (nat. size.)

The spaces between these bones, are covered with the remains of skin; the Epidermis being represented by a delicate film, and the Rete mucosum by fine threads of white Carbonate of Lime; beneath these the Corium, or true skin, is preserved in the state of dark Carbonate of Lime, charged with black volatile matter, of a bituminous and oily consistence.

2. Magnified representation of the Epidermis and Rete mucosum. The fine superficial lines represent the minute wrincles of the Epidermis, and the subjacent larger decussating lines, the vascular net-work of the Rete mucosum.

In Fig. 3, the Epidermis exhibits a succession of coarser and more distant folds or wrinkles overlying the mesh-work of the Rete mucosum.

In Fig. 4, the Epidermis has perished, and the texture of the fine vessels of the Rete mucosum is exhibited in strong relief, over the black substance of the subjacent Corium, in the form of a net-work of white threads.*

---

* Nothing certain has hitherto been known respecting the dermal covering of the Ichthyosauri; it might have been conjectured that these reptiles were incased with horny scales, like Lizards, or that their skin were set with dermal bones, like those on the back of Cro-

PLATE 11. V. I. p. 138.

1. Side View of the head of an Ichthyosaurus, marking by corresponding letters, the analogies to Cuvier's figures of the same bones in the head of the Crocodile. (Conybeare.)
2. Posterior part of a lower jaw of Ichthyosaurus communis, in the Oxford Museum. (Conybeare.]

3—7. Sections presented by the component bones of Fig. 2 in fractured parts above each section. (Conybeare.)

8. View of the lower jaw of Ichthyosaurus seen from

codiles; but as the horny scales of Fishes, and dermal bones of Crocodilean animals are preserved in the same Lias with the bones of Ichthyosauri, we may infer that if the latter animals had been furnished with any similar appendages, these would also have been preserved, and long ere this discovered, among the numerous remains that have been so assiduously collected from the Lias. They would certainly have been found in the case of the individual now before us, in which even the Epidermis, and vessels of the Rete Mucosum have escaped destruction.

Similar black patches of petrified skin are not unfrequently found attached to the skeletons of Ichthyosauri from Lyme Regis, but no remains from any other soft parts of the body have yet been noticed.

The preservation of the skin shows that a short interval only elapsed between the death of the animal, and its interment in the muddy sediment of which the Lias is composed.

Among living reptiles, the Betrachians afford an example of an order in which the skin is naked, having neither scales or dermal bones.

In the case of Lizards and Crocodiles, the scaly, or bony coverings protect the skin from injury by friction against the hard substances with which they are liable to come into contact upon the land; but to the Ichthyosauri which lived exclusively in the sea, there would seem to have been no more need of the protection of scales or dermal bones, than to the naked skin of the Cetacea.

In the case of Plesiosauri also, the non-discovery of the remains of any dermal appendages with the perfect skeletons of animals of that genus, leads to a similar inference, that they too had a naked skin. The same negative argument applies to the flying Reptile Family of Pterodactyles.

beneath, exhibiting the course of its over-lapping bones. (Conybeare.)

A. Tooth of a Crocodile, showing the incipient absorption of the hollow cone which forms its base, from the effect of pressure of a new tooth rising beneath. (Conybeare.)

B. Similar effects shown in the transverse section of the upper and lower jaws of an Ichthyosaurus. (Cuvier.)

C. Example of the same kind of absorption produced by the pressure of a new tooth, on the base of an older tooth in the jaw of Ichthyosaurus. (Conybeare.)

Plate 12. V. I. p. 142.

1. Sternal Arch and Paddles of Ichthyosaurus. See V. I. p. 182, Note. (Home.)
2. Sternal Arch of Ornithorhynchus. (Home.)
3, 4, 5, 6. Occipital and Cervical Bones of Ichthyosaurus, from the Lias at Lyme Regis.* (Original.)

---

* Sir Philip de Malpas Grey Egerton has pointed out some beautiful examples, hitherto unnoticed, in the Atlas and cervical Vertebræ of Ichthyosauri, of peculiar mechanical contrivances to support and regulate the movements of their enormous heads. (See Lond. and Edin. Phil. Mag. Nov. 1835. p. 414.)

Fig. 3, a. represents the Basilar portion of the Occipital bone of a very large and aged Ichthyosaurus, from the Lias of Lyme Regis, (scale one-eighth.) The nearly hemispherical process (a) articulated with a comparatively shallow socket in front of the Atlas, (4. a.) and this ball and socket, or universal joint, gave freedom of motion and support to a weighty head.

Fig. 4. Atlas and Axis of a very young Ichthyosaurus, (two-thirds of nat. size.) These bones adhere together by two nearly flat surfaces, admitting of the least flexure of any of the Vertebræ in the whole body, but giving the greatest strength to that part of the Column, where strength rather than flexure was required.

On the inferior margins of the Atlas and Axis, and third cervical vertebra, are triangular facets articulating with three strong wedge-shaped sub-vertebral bones (c) hitherto undescribed.

A. Hollow conical Vertebræ of a fish. (Original.)

B. C. D. Vertebræ of Ichyosaurus. See note, V. I. p. 212. (Home and Conybeare.)

D. a. g. E. a. g. Spinous processes, showing the peculiar articulation of their annular portions, with the Vertebræ, to be adapted to increase the flexibility of the spine. See Note, V. I. p. 134. (Home.)

Plate 13. V. I. p. 149.

Skeleton of a small Ichthyosaurus, from the Lias at Lyme

Fig. 4, b. Oblique triangular facet on the lower margin of the front of the Atlas; this facet articulated with the first sub-vertebral wedge, placed between the Atlas and Occiput.

Between the Atlas and Axis, the two sub-vertebral facets formed a triangular cavity for the reception of a second wedge (Fig. 4. c.) and a similar, but smaller cavity received another wedge of the same kind, between the Axis and third Vertebra. This third wedge gave less support to the head, and admitted of more extensive motion than the second. All these three wedge-shaped bones are seen nearly in their natural position in a specimen from Lyme Regis, in the Collection of Sir P. G. Egerton.

Fig. 4'. First sub-vertebral wedge, auxiliary to the anterior cavity of the Atlas, in completing the articulating socket for the basilar process of the Occiput (3. a.)

4. a. Crescent-shaped front of the first sub-vertebral wedge.

4'. b. Head of the same Wedge.

4'. c. Obtuse apex of the same, articulating with the triangular frontal facet of the Atlas (4. b.) In young animals this frontal facet is nearly smooth and flat; in older animals (3. b'.) it is rugged and furrowed. This articulation must have given to the first sub-vertebral wedge great power as a stay or prop, to resist the downward pressure of the head, at the same time facilitating the rotatory movements of the Occipital bone.

Fig. 4. c. Second sub-vertebral wedge articulating with the triangular cavity formed by the marginal facets of the Atlas and Axis. This second Wedge acted as a strong prop supporting firmly the lower portion of the Atlas, and at the same time admitting the small amount of motion here required.

c'. Head of the sub-vertebral wedge (c) strengthened by a projecting boss of solid bone.

Regis, presented to the Oxford Museum by Viscount Cole, enclosing within its ribs scales, and digested bones of Fishes, in the state of Coprolite. This coprolitic mass seems nearly to retain the form of the stomach of the animal. c, Coracoid bone. d, Scapula. e, Humerus. f, Radius. g, Ulna. (Scharf. Original.)

Plate 14. V. I. p. 152.

Skeleton of the Trunk of a small Ichthyosaurus in the

Fig. 5. Nearly flat articular surface of (probably) the third cervical vertebra of the same large Individual as Fig. 3. This surface of the bone has only a small cylindrical depression at its centre, instead of the deep, conical cup of the more flexible vertebræ, C. B. E.

Near its upper margin is a wedge-shaped elevation (b) and near the inferior margin, a notch or furrow (a.) These salient and re-entering portions articulated with corresponding depressions and projections on the surface of the adjacent vertebra, and acted as pivots, admitting a limited amount of lateral vibrations, and at the same time preventing any slip, or dislocation.

Fig. 6. Concave surface of Fig. 5.; the wedge-shaped projection near its lower margin (a) must have articulated with a corresponding groove or depression on the front of the vertebra adjacent to it, like that at (Fig. 5. a.) As one surface only of these vertebræ had a conical cavity, the intervertebral substance must have formed a single cone, admitting in the neck but half the amount of motion, that the double cones of intervertebral matter allowed to the dorsal and caudal vertebræ, (C. B. E.) where greater flexure was required, to effect progressive motion by vibrations of the body and tail.

These dispositions of the articulating facets of the cervical vertebræ, acting in conjunction with the three sub-vertebral wedges before described, afford an example of peculiar provisions in the neck of these gigantic Reptiles, to combine a diminished amount of flexure in this part, with an increased support to their enormous heads.

It is probable that every species of Ichthyosaurus had peculiar variations in the details of the cervical vertebræ, and sub-vertebral wedges, and that in each species these variations were modified by age.

In the Gavial Mr. Mantell has recently observed that the first caudal vertebra is *doubly convex*, like the last cervical vertebra in Turtles. These peculiar contrivances give to the animals in which they occur increased flexibility of the Tail and Neck.

Oxford Museum, from the Lias at Lyme Regis, containing within the ribs, a coprolitic mass of digested bones, interspersed with scales of fishes. a, Furcula. b, Clavicle, c, Coracoid bone. d, Scapula. e, Humerus. (Fisher. Original.)

PLATE 15. V. I. p. 147.

The specimens are all of the natural size except where the figures denote otherwise. (Original.)

1 and 2. Intestines of the two most common English species of Dog-Fishes, injected with Roman cement. The vascular structure, which is still apparent in the dessicated membrane, resembles the impressions on the surface of many Coprolites.

3. Coprolite from the Lias at Lyme, exhibiting the spiral folding of the plate of digested bone, and impressions of the intestinal vessels and folds upon its surface. (See Note, V. I. p. 152. et seq.)

3'. Magnified scale of Pholidophorus limbatus, embedded in the surface of the Coprolite, Fig. 3. This scale is one of those that compose the lateral line, by which a tube passes to convey mucus, from the head, along the body of fishes; a. is the hook, on the superior margin, which is received by a depression on the inferior margin of the scale above it, corresponding with b.; c. is the serrated edge of the posterior margin, perforated at e. for the passage of the mucous duct; d. is a tube on the interior surface of the scale to carry and protect the mucous duct. (See note V. I. p. 150.)

3''. Exterior of the scale 3'.; the same parts are represented by the same letters; the larger portion is covered with enamel; the smaller portion next d. is the bony root forming the anterior margin of the scale.

4. Transverse section of another Coprolite from Lyme, showing the internal foldings of the plate, with sections of scales of fishes embedded in it.

5. Exterior of a spiral Coprolite, from the Chalk Marl, near Lewes, showing folds and vascular impressions analogous to those in No. 3.

6. Longitudinal section of another Coprolite, from the same Chalk Marl, showing the spiral manner in which the plate was folded round itself.

7. Exterior of another spiral Coprolite, from the Chalk at Lewes, showing vascular impressions on its surface, and the transverse fracture of the spiral fold at b.

In many other figures of Plate 15, a similar abrupt termination of the coiled plate is visible at b.

8, 9. Two other small species of spiral Coprolites in chalk; these as well as Figs. 5, 6, 7, are probably derived from fishes found with them in the chalk, near Lewes.

10, 11, 12. Coprolites from the Lias at Lyme, exhibiting well-defined characters of the spiral fold, with vascular impressions on their surface.

13. Similar appearances on a Coprolite found by Dr. Morton in the Greensand of Virginia.

14. Coprolite from the Lias at Lyme, bearing strong corrugations, the result of muscular pressure received from the intestines.

15. Transverse section, showing the abrupt termination of the folded plate in Fig. 14, and representing the flattened form of the spiral intestine.

16. Longitudinal section of the intestinal tube of a recent Shark, showing the spiral valve that winds round its interior, in the form of an Archimedes screw; a similar spiral disposition of the interior is found in intestines of Dog-Fishes, Figs. 1 and 2.

17. Coprolite from Lyme, containing large scales of Dapedium politum.
18. Coprolite from the Lias at Lyme, containing undigested bones of a small Ichthyosaurus.

Plate 15′. V. I. p. 156.

Cololite, or petrified intestines of a fossil fish from Solenhofen. (Goldfuss.)

Plate 16. V. I. p. 157.

1. Conjectural Restoration of the Skeleton of Plesiosaurus dolichodeirus. (Conybeare.)
2. Skeleton of Plesiosaurus delichodeirus, in the British Museum, from the Lias at Lyme Regis. (Scharf. Original.)

Plate 17. V. I. p. 158.

A nearly entire and unique skeleton of Plesiosaurus dolichodeirus, 5 feet 7 inches long, from the Lias of Street, near Glastonbury. This skeleton forms part of the splendid series of fossil Saurians, purchased for the British Museum, from T. Hawkins, Esq. in 1834. See V. I. p. 162, and Note. (Hawkins.)

Plate 18. V. I. p. 160, Note.

1. Under jaw of Plesiosaurus dolichodeirus, forming part of the series last mentioned. (Original.)
2. Head of the Plesiosaurus, figured in Pl. 16. Fig. 2. seen from beneath. (Original.)
3. Ventral portion of the ribs of the Plesiosaurus, figured in Pl. 17. See V. I. p. 162. (Original.)

a. c. Central bones forming the crown of the sterno-costal arch. b. triple series of intermediate bones between the central bones, a. c. and the true ribs, d. d. e. e. lower extremity of coracoid bones.

PLATE 19. V. I. p. 160.

Fig. 1. A beautiful specimen of Plesiosaurus macrocephalus hitherto undescribed, found in the Lias marl at Lyme Regis, by Miss Anning, and now in the collection of Lord Cole. (Original.)

On comparing this figure with those of P. Dolichodeirus at Pl. 16, 17. The following differences are obvious:

1. The head is very much larger and longer, being nearly one-half the length of the neck.

2. The vertebræ of the neck are thicker and stronger in proportion to the greater weight they had to sustain.

3. The hatchet-shaped bones differ in form and size, as may be seen by comparing them with those of P. dolichodeirus. Pl. 19. Fig. 2. and Pl. 17.

4. The bones of the arm and thigh are shorter and stronger than in P. Dolichodeirus, and corresponding differences may be traced throughout the smaller bones of the Paddles; the general adjustment of all the proportions being calculated to produce greater strength in the P. Macrocephalus, than in the more slender limbs of P. Dolichodeirus.

These differences are not the effect of age; as the two specimens, from which they are here described, are nearly of the same length.

Fig. 2. Hatchet-shaped bones of the neck of Plesiosaurus Dolichodeirus, copied from the specimen figured in Pl. 17.

3. Anterior extremity of an insulated lower Jaw of Plesiosaurus, from the Lias at Lyme Regis, in the British Museum, part of the collection of Mr. Hawkins. V. I. p. 160. Note. (Original.)

4. The entire bone, of which Fig. 3. forms part, reduced to a small scale.

Plate 20. V. I. p. 167.

Head of the Mosasaurus, or Great Animal of Maestricht. (Cuvier.)

Plate 21. V. I. p. 171.

Pterodactylus longirostris in the lithographic slate of Aichstedt. (Cuvier and Goldfuss.)

In this Plate, and Plate 22, the same letters and figures designate the corresponding Bones in the different Animals to which they are affixed; they are copied chiefly from the figure and Explanations of Dr. Goldfuss, in his Beitrage zur Kenntniss verschiedener Reptilien der Vorwelt.

Γ. Cavitas narium.
Δ. Cavitas intermedia.
Θ. Orbita.
a. Maxilla superior.
b. Vel os nasi vel inter-maxillare?
c. Operculum nasale.
d. Aut os frontis anterius vel nasale?
e. Os frontis proprium.
f. Os parietale.
g. Os petrosum.
H. Pars basilaris ossis occipitis.
h. Pars lateralis.
i. Os tympanicum s. quadratum.
k. Os frontis posterius.
l. Os mastoideum.
m. Os zygomaticum.
n. Aut os lacrymale vel superciliare?
o. Annulus orbitalis.
P. Corpus ossis sphenoidei.
p. Processus transversus ossis sphenoidei.

q. Os pterygoideum.
r. Os transversum.
s. Os palatinum.
t. Processus palatinus maxillæ superioris.
v. Pars augularis inferior maxillæ inferioris.
w. Pars angularis superior.
x. Pars condyloidea.
y. Pars complementaria, Cuv. (coronalis, auctor.)
z. Os hyoideum.
I. Atlas.
II. Epistropheus.
III—VII. Vertebræ colli.
VIII—XXII. Vertebræ dorsi.
XXIII. XXIV. Vertebræ lumborum.
XXV. XXVI. Os sacrum.
XXVII. Ossa coccygea.
XXVIII. Sternum.
1—15. Costæ.
16. Scapula.
17. Os coracoideum.
18. Ilium.
19. Os pubis.
20. Os ischium.
21. Humerus.
22. Ulna.
23. Radius.
24. Carpus.
25. Os metacarpi primum s. pollicis.
26. O. m. secundum.
27. O. m. tertium.
28. O. m. quartum.
29. O. m. quintum.
30, 31. Phalanges pollicis.
32—34. Ph. indicis.
35—38. Ph. digiti medii.

39—43. Ph. digiti annularis.
44—47. Ph. digiti auricularis.
48. Femur.
49. Tibia.
50. Fibula.
51. Tarsus.
52—56. Metatarsus.
57, 58. Phalanges digiti primi.
59—61. Ph. d. secundi.
62—65. Ph. d. tertii.
66—70. Ph. d. quarti.
71—74. Ph. d. quinti.
δ Impressions of the membrane of the wing.*

Plate 22. V. I. p. 171.

A. Restoration of the Skeleton of Pterodactylus crassirostris. (Goldfuss.)
B. Fore-foot of a Lizard. (Cuvier.)
C. Restoration of the fore-foot, or right hand of Pterodactylus crassirostris. (Goldfuss.)
D. The right fore-foot, or hand of P. longirostris. (Cuvier and Soemmerring.)
E. The Fore-foot of P. macronyx. (Buckland, Geol. Trans. Lond. 2d. Ser. Vol. 3. Pl. 27.)
F. The hind-foot of a Lizard. (Cuvier, Oss. Foss. Vol. V. Pt. II. Pl. XVII.)
G. Right foot of P. crassirostris, as conjecturally restored

---

* Professor Agassiz considers that the Corrugations on the surface of the Stone (δ,) which Dr. Goldfuss supposed to be the impressions of Hairs, or Feathers, are only casts of the minute foldings of the contracted membrane of the wing. It is probable that Pterodactyles had a naked skin like the Ichthyosaurus; (See Pl. 10. A.) because the weight of scales would have encumbered their movements in the air.

by Dr. Goldfuss. No authority for this seems to be afforded by the fossil specimen N.

H. Right foot P. longirostris. (Cuvier.)

I. Foot of P. macronyx. (Buckland.)

K. Hind-foot of a Bat.

L. Skeleton of Draco volans. (Carus. Comp. Anat. P. 370.) showing the elongated bones, or false ribs, which support the membranous expansion of its Parachute.

M. Skeleton of a Bat. (Cheselden.)

N. Skeleton of P. crassirostris, in the Museum at Bonn, in Solenhofen slate. (Goldfuss.)

O. Skeleton of P. brevirostris, near Aichstadt, in the same slate. (Goldfuss.)

P. Imaginary restoration of Pterodactyles, with a cotemporary Libellula, and Cycadites.

PLATE 23. V. I. p. 180.

Fig. 1'. Anterior extremity of the right jaw of Megalosaurus, from the Stonesfield slate, Oxon. (Buckland.)

Fig. 2'. Outside view of the same, exhibiting near the extremity, large perforations of the bone for the passage of vessels. (Buckland.)

Fig. 1. Tooth of Megalosaurus, incomplete towards the root, and seen laterally as in Fig. 1'. Nat. size. (Buckland.)

Fig. 2. Side view of a tooth nearly arrived at maturity. The dotted lines mark the compressed conical cavity, containing Pulp, within the Root of the growing tooth. Scale two-thirds. (Buckland.)

Fig. 3, Transverse section of Fig. 1'. showing the thickness of the largest tooth (a.) and its root set deep and firmly in the bony socket, which descends nearly to the bottom of the Jaw. Scales two-thirds. (Buckland.)

Fig. 4. Transverse section of the tooth (Fig. 2.) showing the manner in which the back and sides are enlarged, and rounded in order to give strength, and the front brought to a strong and thin cutting edge at D′. (Buckland.)

Plate 24. V. I. p. 184.

Fossil Teeth and bony nasal horn of Iguanodon; and lower Jaw and Teeth of Iguana. (Mantell and Original.)

In Mr. Mantell's collection there is a perfect thigh bone of this animal, 3 feet 8 inches long, and 35 inches in circumference at its largest and lower extremity.

Plate 25. V. I. p. 191.

Fig. 1. Fossil Crocodilean found at Saltwick near Whitby, eighteen feet long, and preserved in the Museum of that town. This figure is copied from Plate XVI. of Bird and Young's Geol. Survey of the Yorkshire coast. As this appears to be the same species with that engraved in the Phil. Trans. 1758, Vol. 50. Pt. 2. Tab. 22, and Tab. 30, and presented to the Royal Society by Captain Chapman, Mr. König has applied to it the name of Teleosaurus Chapmanni.

Fig. 2. Another head of Teleosaurus Chapmanni, also in the Museum at Whitby, and from the Lias of that neighbourhood. (Original.)

Fig. 3. Head of a third Individual of the same species from the same locality, placed in 1834, in the British Museum, showing the outside of the lower Jaw. (Young and Bird.)

Fig. 4. View of the inside of a lower Jaw of the same

species, in the Oxford Museum, from the Great Oolite, at Enslow, near Woodstock, Oxon. (Original.)

PLATE 25′. V. I. p. 192.

Fig. 1. Head of a Crocodile found in 1831, by E. Spencer, Esq. in the London Clay, of the Isle of Sheppy. See V. I. p. 192. (Original.)

Fig. 2. Extremity of the upper and lower Jaw of Teleosaurus in the Oxford Museum, from the Great Oolite at Stonesfield, Oxon. See V. I. p. 193. (Original.)

Fig. 3. Anterior extremity of the upper Jaw of Steneosaurus, in the Museum of Geneva, from Havre; the same species occur in the Kimmeridge Clay of Shotover hill, near Oxford. See V. I. p. 192. (De la Beche.)

Fig. 4. Fossil Turtle, from the slate of Glaris. See V. I. p. 196. (Cuvier.)

PLATE 26. V. I. p. 198.

Fossil Footsteps indicating the Tracks of ancient animals, probably Tortoises, on the New Red Sand-stone near Dumfries. (From a cast presented by Rev. Dr. Duncan.)

PLATE 26′. V. I. p. 201.

Fig. 1. Impressions of footsteps of several unknown animals upon a slab of New Red Sand-stone found at the depth of eighteen feet in a quarry at Hessberg, near Hilderburghausen in Saxony. (Sickler.)

The larger footsteps a. b. c. are referred to an animal named provisionally, Chirotherium. The fore-feet of this animal were less by one half than the hind-feet, and the tracks of all the feet are in the same straight line. The footsteps d. e. f. form part of another track of the same kind. Some of the large toes of the Chirotherium, and also of the smaller species, have left distinct impressions of nails: g. h. i. k. l. m. n. o. p. q. from the track of an animal of another species, probably a Tortoise crossing the same slab in a different direction.

The irregular cylindrical concretions that intersect each other on the surface of this slab, appear to have been formed in cracks, caused by the contraction of a thin bed of green marl, interposed between two deposites of sand-stone. See note, V. I. p. 203.

Fig. 2. One of the impressions of the hind-feet of Chirotherium, on the slab Fig. 1; half nat. size. (Sickler.)

Fig. 3. One of the footsteps in the track of the smaller animal, upon this slab; nat. size. (Sickler.)

M. Link has made out the footsteps of four species of animals in the Hildburghausen sand-stone, and it has been conjectured that some of these have been derived from gigantic Batrachians.

Plate 26″. V. I. p. 203.

Impression of the hind-foot of Chirotherium, selected from a well-preserved Track upon a slab of sand-stone from Hildburghausen, in the British Museum. (Original.)

Plate 26‴. V. I. p. 203.

Footsteps of a small web-footed animal, probably crocodilean, drawn from a Cast of impressions on Sand-stone, found near Hildburghausen. (Original.)

The Sand-stones in which all these fossil footsteps have been discovered in Germany and Scotland, appear to be referable to the same division of the secondary strata, which lies in the middle region of that large, and widely extended series of Sand-stones, and Conglomerates, Limestones, and Marl, which English Geologists have usually designated by the common appellation of the *New red Sandstone* Group, including all the strata that are interposed between the Coal formation, and the Lias.

M. Brongniart, in his *Terrain de l'Ecorce du Globe*, 1829, has applied to this middle division the very appropriate name of *Terrain Pœcilien*, (from the Greek ποικίλος), a term equivalent to the names Bunter Sandstein, and Grés bigarré, which it bears in Germany and France; and indicating the same strata which, in England, we call the new Red Sandstone. (See Plate 1. Section No. 17.)

Mr. Conybeare, in his Report on Geology to the British Association at Oxford, 1832 (Page 379, and P. 405, Note,) has proposed to extend the term *Pœcilitic* to the entire Group of strata between the Coal formation and the Lias; including the five formations designated in our section (Pl. 1, No. 15, 16, 17, 18, 19,) by the names of New Red Conglomerate, Magnesian Limestone, Variegated Sandstone, Shell Limestone, and Variegated Marl. Some common appellative for all these formations has been long a desideratum in Geology; but the word *Pœcilitic* is in sound so like to *Pisolite*, that it may be better to adhere more literally to the Greek root ποικίλος, and apply the common name of *Poikilitic* group to the strata in question.*

---

* The general reception of such a common name for all these strata, and the reception of the Gruwacké series into the *Cambrian* and *Salurian* systems, as proposed by Professor Sedgwick and Mr. Murchison, will afford three nearly equal and most convenient groups or systems, into which the strata composing the Transition and Secondary series may respectively be divided; the former comprehending the Cambrian, Salurian, and Carboniferous systems, and the latter comprehending the Poikilitic, Oolitic, and Cretaceous Groups.

PLATE 26ª.

Ornithichnites, or foot-marks of several extinct species of birds, found in the New Red sand-stone of the Valley of the Connecticut.* (Hitchcock.)

---

* In the American Journal of Science and Arts, January, 1836. V. XXIX. No. 2. Professor Hitchcock has published a most interesting account of his recent discovery of *Ornithichnites*, or foot-marks of birds in the New Red sand-stone of the valley of the Connecticut. These tracks have been found at various depths beneath the actual surface, in quarries of laminated flag-stones, at five places near the banks of this river, within a distance of thirty miles. The sand-stone is inclined from 5°, to 30°, and the Tracks appear to have been made on it before the strata received their inclination. Seven of these tracks occur in three or four quarries within the space of a few rods square; they are so distinct that he considers them to have been made by as many different species, if not genera, of birds. (See Pl. 26a. Figs. 1—14.

The footsteps appear in regular succession, on the continuous track of an animal in the act of walking or running, with the right and left foot always in their relative places.

The distance of the intervals between each footstep on the same track is occasionally varied, but to no greater amount than may be explained by the Bird having altered its pace. Many tracks of different individuals and different species are often found crossing one another; they are sometimes crowded like impressions of feet on the muddy shores of a stream, or pond, where Ducks and Geese resort. (See Pl. 26a. Figs. 12. 13. 14.)

None of the footsteps appear to be those of Web-footed Birds; they most nearly resemble those of Grallæ, (Waders) or birds whose habits resemble those of Grallæ. The impressions of three toes are usually distinct, except in a few instances; that of the fourth or hind toe is mostly wanting, as in the footsteps of modern Grallæ.

The most remarkable among these footsteps are those of a gigantic bird, twice the size of an Ostrich, whose foot measured fifteen inches in length, exclusive of the largest claw, which measured two inches. All the three toes were broad and thick. (Pl. 26a. Fig. 1. and Pl. 26b. Fig. 1.) These largest footsteps have as yet been found in one quarry only, at Mount Tom near Northampton; here, four nearly parallel tracks of this kind were discovered, and in one of them six footsteps appeared in regular succession, at

The fossil tracks on this plate are all nearly on the same scale: viz. one twenty-fourth. The recent footsteps are on a larger scale.

the distance of four feet from one another. In others the distance varied from four to six feet; the latter was probably the longest step of this gigantic bird while running.

Next in size to these are the footsteps of another enormous bird (Pl. 26a. Fig. 4.) having three toes of a more slender character, measuring from fifteen to sixteen inches long, exclusive of a remarkable appendage extending backwards from the heel eight or nine inches, and apparently intended, like a snow-shoe to sustain the weight of a heavy animal walking on a soft bottom. (See Pl. 26b. Fig. 2.) The impressions of this appendage resemble those of wiry feathers, or coarse bristles, which seem to have sunk into the mud and sand nearly an inch deep; the toes had sunk much deeper, and round their impressions the mud was raised into a ridge several inches high, like that around the track of an Elephant in Clay. The length of the step of this Bird appears to have been sometimes six feet. On the other tracks the steps are shorter, and the smallest impression indicates a foot but one inch long, with a step of from three to five inches. (Pl. 26a. 2-3. 5—14.)

In every track the length of the step increases with the size of the foot, and is much longer in proportion than the steps of any existing species of birds; hence it is inferred that these ancient birds had a greater length of leg than even modern Grallæ. The steps at four feet asunder probably indicate a leg of six feet long.

In the African Ostrich, which weighs 100lbs., and is nine feet high, the length of the leg is about four feet, and that of the foot ten inches.

All these tracks appear to have been made on the Margin of shallow water that was subject to changes of level, and in which sediments of sand and mud were alternately deposited, and the length of leg, which must be inferred from the distance of the footsteps from each other, was well adapted for wading in such situations. No Traces of any Bones but those of fishes (Palæothrissum) have yet been found in the rock containing these footsteps, which are of the highest interest to the Palæonthologist, as they establish the new fact of the existence of Birds at the early epoch of the New Red sand-stone formation; and farther show that some of the most ancient forms of this class attained a size, far exceeding that of the largest among the feathered inhabitants of the present world, and were adapted for wading and running, rather than for flight.

Fig. 1. Ornithichnites giganteus. Many tracks of this species occur at Mount Tom, near Northampton, U. S.

Fig. 2. O. tuberosus. Portions of three tracks, and a single footstep of a fourth appear on the same slab. The longest two of them are in opposite directions.

Fig. 3. O. tuberosus, on a slab in front of the Court House in Northampton, from Mount Tom.

Fig. 4. O. Ingens, from a quarry called the Horse Race, near Gill. The appendage to the heel is not distinct in this track.

Fig. 5. O. diversus, on a flag-stone near the first church door at Northampton, U. S.

Fig. 6. O. diversus. We have here three rows of tracks and a single footstep, from the Horse Race Quarry. These tracks show no marks of any appendage to the heel.

Fig. 7. O. diversus; found near South Hadley, U. S.

Fig. 8. O. diversus; curvilinear track from the Horse Race Quarry.

Fig. 9. O. diversus. Two parallel tracks from the Horse Race Quarry.

Fig. 10. O. diversus; nearly parallel tracks of two birds, with an appendage behind each foot; from the quarries at Montague, U. S.

Fig. 11. O. minimus; common at the Horse Race Quarry; similar impressions of the feet of small birds vary from half an inch to an inch and half in length.

Figs. 12. 13. 14. O. diversus; from the Horse Race Quarry. Tracks of different individuals of different species, and different sizes cross one another confusedly in these three slabs.

Fig. 15. Recent track of probably a Snipe.

Fig. 16. Recent track of a Pea-hen.

Fig. 17. Recent track of a domestic hen.

Plate 26b.

Fig. 1. Ornithichnites giganteus. The natural cast here figured represents the form and size of the foot, and part of the claws. (Hitchcock.)

Fig. 2. Ornithichnites diversus, with impressions of the appendage to the heel, drawn from a plaster mould sent by Prof. Hitchcock to the Geol. Soc. of London. (Original.)

Fig. 3. Track of a small animal on Oolitic slate near Bath. See Journal of Royal Institution of London, 1831, p. 538, Pl. 5. (Poulett Scrope.*)

Plate 27. V. I. p. 205.

Figs. 1—8. Tubercles and Scales, illustrating the four new Orders of Fishes, extablished by Professor Agassiz. (Agassiz.)

---

[*] Mr. Poulett Scrope has presented to the Geol. Soc. of London a series of Slabs selected from the tile quarries worked in the Forest Marble beds of the Oolite formation near Bradford and Bath. The surface of these beds is covered with small undulations or ripple markings, such as are common on the sand of every shallow shore, and also with numerous tracks of small animals. (apparently Crustaceans) which traversed the sand in various directions, whilst it was yet soft, and covered with a thin film of clay. These foot-marks are in double lines parallel to each other, showing two indentations, as if formed by small claws, and sometimes traces of a third claw. (See Pl. 26b, Fig. 3.) There is often also a third line of tracks between the other two, as if produced by the tail or stomach of the animal touching the ground. Where the animal passed over the ridges of the ripple markings or wrinkles on the sand, they are flattened and brushed down. Thus a ridge between b. and d. (Pl. 26b, Fig. 3) has been flattened, and there is a hollow at e. on the steep side of the ridge, which may have been produced by the animal slipping down or climbing up the acclivity.

Fig. 8. *a*. Tube on the under surface of a scale for the passage of the mucous duct. See V. I. Note, p. 150. (Agassiz.)

Fig. 9. Anterior extremity of the lower jaw of Holoptychius Hibberti, from the Limestone of Burdie house, near Edinburgh. See Note, V. I. p. 209. The rugged surface of this bone is very remarkable. (Hibbert.)

Fig. 9'. Small teeth of Holoptychius Hibberti, fluted externally towards their base, and having a hollow cone within. (Hibbert.)

Fig. 9''. A small tooth magnified. (Hibbert.)

Fig. 10. One of the larger teeth in the Jaw of Holoptychius Hibberti, deeply fluted at the base, and having a hollow cone within. None of these teeth have sockets, but they adhere by a bony attachment to the jaw. (Hibbert.)

Fig. 11. Tooth of Holoptychius Hibberti. (Hibbert.)

Fig. 12. Tooth of Megalichthys Hibberti.* (Hibbert.)

Figs. 13, 14. Teeth of the Holoptychius Hibberti. (Hibbert.)

Figs. 11. 12. 13. 14. are from Burdie house.

---

* Since the discovery of Megalichthys, which we have quoted in V. I. p. 210, Mr. W. Anstice of Madeley, has found two jaws and punctate scales of the same species, in nodules of Iron stone from the Coal field of Coalbrook Dale; he has also found Ichthyodorulites, bones of fishes, and Coprolites, forming the nuclei of other balls of the same Iron stone.

Mr. Murchison has still more recently (1835) discovered remains of the Megalichthys, Holoptychius, and Coprolites, with several species of Unio, in the Wolverhampton Coal field. These great Sauroid fishes, which were first recognised at Edinburgh, in Sept. 1834, have also been detected in the English Coal fields of Newcastle on Tyne, Leeds, and Newcastle under Lyne.

Plate 27ᵃ. V. I. p. 212.

Fig. 1. Lepidosteus osseus, or bony Pike of North America. (Agassiz. Vol. 2. Tab. A.)

Fig. 2. Portion of the lower jaw of Lepidosteus osseus, showing the occurrence of a row of larger conical hollow teeth, fluted externally, between two rows of smaller Teeth. (Original.)

2. *a*. Longitudinal section of a large Tooth, showing the internal hollow cone. (Original.)

2. *b*. Transverse section of a large Tooth. (Original.)

Fig. 3. Transverse section of the Jaw. fig. 2. (Original.)

Fig. 4. Fragment of a small upper Jaw of Megalichthys Hibberti, from Burdie house, showing a disposition of large and small teeth, similar to that in fig. 2. (Hibbert.)

4. *a*. *b*. Transverse section of the larger teeth.

4. *c*. Longitudinal section of a large Tooth.*

4. *d*. Punctate scale of Megalichthys.

Fig. 5. Aspidohrynchus: a fossil Sauroid fish from the Limestone of Solenhofen. (Agassiz, Vol. I. Tab. F.)

Plate 27ᵇ. V. I. p. 212.

Amblypterus: one of the fossil fishes peculiar to the Carboniferous strata. (Agassiz, Vol. I. Tab. A. fig. 3.)

---

* It appears that in the Megalichthys and Holoptychis the structure of the teeth, both large and small, was precisely the same as in the large and small teeth of Lepidosteus osseus, both as to the hollow internal conical cavity, and the external flutings towards the base, and also as to their mode of growth by ascent of fibrous matter from the bony substance of the jaw, and not from roots placed in deep alveoli, as in many of the Saurians.

PLATE 27^{c}. Vol. I. p. 214.

Fig. 1. Fossil fish of the genus Microdon, in the family Pycnodonts. (Agassiz, Vol. I. Tab. G. fig. 3.)

Fig. 2. Os Vomer of Gyrodus umbilicatus, from the Great Oolite of Durrheim, in Baden. (Agassiz.)

Fig. 3. Os Vomer of Pycnodus trigonus, from Stonefield, Oxon. (Original.)

PLATE 27^{d}. V. I. p. 218, Note.

A. Teeth of a recent Shark, allied to fossil species.

Fig. 1. Anterior and Palatal Teeth of the Port Jackson Shark, (Cestracion Phillippi.) (Phillip.)

Fig. 2. Anterior cutting teeth of Port Jackson Shark, in the College of Surgeons, London. (Owen.)

Fig. 3. Flat tessellated tooth of the same. Nat. size. *a.* Outer articular facet, showing the tabular structure of the bony base. *b.* Punctate surface of the superficial enamel. (Owen.)

Fig. 4. Mesial, and inner articular facet of another large tooth of the same. *a.* Upper concave margin thinly covered with enamel. *b.* Lower bony margin without enamel. *a'*. *b.'* Bony base of the tooth exposed by removal of the Enamel. The surface is areolar, from the bending and blending together of the bony tubes. *c*. *c'*. Fractured edge of the marginal and superficial enamel. (Owen.)

Fig. 5. Another anterior cutting tooth. *a.* Smooth enamelled point. *b.* Minutely rugous and tuberculated base. In some of the cutting teeth both sides of the base are rugous. (Owen.)

B. Various forms of fossil Teeth, in the three sub-families of Sharks. (B. 1. to B. 13. Agassiz.)

Fig. 1—5. Teeth of fossil Sharks in the sub-family of Cestracionts. See V. I. p. 218.

Fig. 1. Psammodus, from Mountain limestone, Bristol.

Fig. 2. Orodus, from the same.

Fig. 3. Acrodus, from the Lias, Lyme Regis.

Fig. 4. Ptychodus, (upper surface) from the Chalk.

Fig. 5. Side View of fig. 4.

Figs. 6—10. Teeth of extinct fossil Sharks in the sub-family of Hybodonts; in this family the enamel is *plicated* on *both* sides of the teeth. See V. I. p. 219. Note.

Fig. 6. Side view of tooth of Onchus, from the Lias at Lyme Regis.

Fig. 7. Front view of the same.

Figs. 8. 9. 10. Teeth of Hybodonts, from the Oolitic slate of Stonesfield, Oxon.

Figs. 11. 12. 13. Fossil Teeth of true Sharks in the Squaloid division of that family, having the Enamel *smooth* on the *outer* side. From the Chalk and London clay. See V. I. p. 220, Note.

Fig. 14. Palatal teeth of Myliobates striatus, from the London clay of Barton cliff, Hants. See V. I. p. 221. Much of the enamel is worn away by use, as frequently happens in the tongue and palatal bones of living Rays. (Original.)

C. Petrified remains of an extinct Genus of Shark.

Fig. 1. Jaw of Hybodus reticulatus, from the Lias at Lyme Regis. (scale one-half.) Many of the Teeth retain their place on the margin of the bone. The granulated structure of bone is distinctly preserved. (De la Beche.)

Fig. 2. Teeth selected from the Jaw last figured. Nat. size.

Fig. 3. Ichthyodorulite, from the Lias at Lyme Regis, being the Dorsal spine of Hybodus incurvus, set with teeth-like hooks, to suspend the membrane of the dorsal fin. (De la Beche.)

A double row of similar hooks occurs on the first dorsal ray of the Barbel, (Barbus Vulgaris.) And on the anterior ray both of the dorsal and anal fins of the Carp, (Cyprinus Carpio.)

Fig. 4. Transverse Section of fig. 3, at *a*.* (De la Beche.)

Plate 27^{e}. V. I. p. 220.

Fig. 1. Portion of the palatal teeth of Acrodus nobilis, resembling a cluster of contracted Leeches. These teeth are in their natural place, adhering to the curved granular bone of the palate, which is well preserved, and impregnated with Carbonate of lime. (Miss S. C. Burgon. Original.)

Fig. 2. Continuation of the three rows of teeth on the reverse of fig. 1. Scale one-half. (Original.)

Fig. 3. One of the largest teeth on the centre row, having the upper part of the Enamel worn away by friction. Nat. size. (Original.)

Fig. 4. Magnified view of the minute tubercles of Enamel which grew upon the skin; the decay of the skin

---

* In the Lond. and Edin. Phil. Mag, Jan. 1836, the author has published a notice of his recent discovery of the jaws of four extinct species of fossil fishes of the genus Chimæra, a genus hitherto unknown in a fossil state. The only known species (C. montrosa) approximates most nearly to the family of Sharks; and is found pursuing Herrings and other migratory fishes. The Chimæra is one of the most remarkable among living fishes, as a link in the family of *Chondropterygians;* and the discovery of a similar link, in the geological epochs of the Oolitic and Cretaceous formations, shows that the duration of this curious genus has extended through a greater range of geological epochs, than that of any other genus of fishes yet ascertained by Professor Agassiz, and leads to important considerations in Physiology.

The Chimæra partakes of one remarkable character with the Cestracion Phillippi, whereby this species alone, among living Sharks, is connected with the extinct forms of that family, in having the first ray of the dorsal fin enlarged into a strong bony spine armed with sharp hooks, like the *Ichthyodorulite* of the earliest fossil Sharks.

has brought clusters of these tubercles into contact with the bone in several parts of fig. 1. (Original.)

Fig. 5. Magnified view of similar minute tooth-like tubercles of Enamel, forming the Shagreen on the skin of the head of the recent Squatina angelus. See V. I. p. 205, Note. (Original.)

PLATE 27^{f}. V. I. pp. 217 & 220.

Beautiful cluster of palatal teeth of Ptychodus polygyrus, from the Chalk. Insulated teeth of many species of this Genus abound throughout the Chalk formation. The mouth of these and all the other numerous extinct species of Sharks in the family of Cestracionts, was lined with a pavement of similar powerful teeth, forming a most efficient apparatus, for crushing the shells of Crustacea and Conchifera, which probably formed their principal food. The surfaces of the Enamel are often worn away, like that at Pl. 27^{e}. fig. 3. The strength and efficacy of these teeth, viewed as Intruments for crushing shells, is very remarkable. Beneath the Enamel, the body of each tooth is composed of a strong mass of bone. (Miss F. C. Burgon. Original.)

PLATE 28. V. I. p. 230.

Fig. 1. represents the common calmar or squid (Loligo vulgaris, Lam. Sepia loligo, Linn.) showing the place and excretory duct of its Ink bag, and the position of the feet on the anterior margin of the head. (Blainville.)

Fig. 2. Side view of the Pen of the Loligo vulgaris, showing its position in the back of the animal, fig. 1. (Original.)

Fig. 3. Concave under surface of the same pen. (Original.)

Fig. 4. Convex upper surface of portion of another recent pen, of the same kind. The structure of figs. 3 and 4 closely resembles that of the fossil species represented at fig. 6, of this same Plate, and also at Pl. 29. fig. 1. and Pl. 30. In all of them, the horny plates are composed of a series of longitudinal fibres, intersected by another series of transverse fibres. The disposition of the transverse fibres is most simple in the recent species; passing obliquely outwards from each side of the central shaft, like the barbs or fibrils in the vane of a feather, and being the most distinct towards the outer margin.

The longitudinal fibres are scarcely visible in the recent species, except where they are collected into fluted fasciculi, (Pl. 28. fig. 4. BB.) in those parts which correspond with the *marginal bands* of the fossil species. (Original.)

C. Central part of the Pen, raised like the shaft of a quill between its fibrils.

Fig. 5. Ink bag of a recent Cuttle fish, dissected by the author at Lyme Regis, 1829, containing its natural Ink in a desiccated state; it is a black shining Jet-like substance, having a splintery fracture, and resembling the substance and fracture of the fossil Ink. Its bulk is not much reduced by desiccation. (Original.)

Fig. 6. Upper convex surface of a fossil pen of Loligo Aalensis from the Lias of Lyme Regis. A.A. the barbs; B.B. the marginal bands; C. axis of the shaft; D. excretory duct of the Ink bag, distended with petrified Ink.* (Original.)

---

* In this specimen we see distinctly the disposition of the marginal bands.

Fig. 7. Upper surface of Fossil Loligo from the Lias of Lyme Regis. A,A, Barbs of the Pen. B,B, Marginal bands. C, Axis of the Pen. *d*, upper plate of marginal band, having an unusually corrugated surface, which may be the result of imperfect growth of the transverse fibres; if fully expanded they would probably have resembled those of the subjacent Plate at *d''*. (Original.)

d'. Magnified representation of the rugous surface of *d*.

d'''. Magnified representation of the second plate of the marginal band, Fig. 7. *d''*.

e. Upper surface of second Plate of the shaft of the pen; here the transverse wavy lines predominate over the vertical straight lines; but both are visible.

f. Upper surface of third plate; here the vertical straight fibres prevail over the transverse wavy fibres.

Plate 29. V. I. pp. 232 and 234.

Fig. 1. Fossil Loligo from Lias at Lyme, in the collection of Miss Philpot, exhibiting nearly the same structure at figs. 6. 7. at Pl. 28. and containing beneath the pen, a very large Ink bag, D. The greater proportionate size of this Ink bag indicates a difference in species from fig. 3. (Mrs. Buckland. Original.)

Fig. 2. Loligo Aalensis from Lyme Regis showing the under surface or concave side, and the duct of the Ink bag distended with Ink. A.A. Barbs or filaments of the Pen; B.B. Marginal bands; C. Axis of Shaft; D. Duct of Ink bag. (Mrs. Buckland. Original.)

The wavy lines here seen between the Ing bag and the apex of the Pen, are the inferior termination of the successive laminæ of growth; each larger and superior Plate overlapping the edges of the next subjacent and smaller plate. These edges are rendered more irregular by decomposition.

d'. Magnified representation of very minute curved lines passing from the marginal band across the shaft, at d.

e. Thin lamina of the white pulverulent substance of a decomposed Plate: it retains partial traces of the transverse wavy fibres.

f. Minute perpendicular filaments prevailing over the transverse fibres of the shaft.

Fig. 3. Fossil Loligo from Lyme Regis, showing the same structure as the preceding figures, in the several portions of the Pen that are preserved; and having its Ink bag distended nearly in its natural shape and place beneath the Pen. (Original.)

C.C. Axis of the shaft.

Figs. 4. 5. 6. 7. 8. 9. Fossil Ink bags from Lyme Regis. The membranous sacs and excretory ducts are still preserved, and closely resemble those of a recent Ink bag; see Pl. 28. fig. 5. (Original.)

Fig. 10. Fossil ink bag found by Miss Anning in the Lias near Watchet, Somerset. (Original.)

PLATE 30. V. I. p. 234.

A large fossil pen of Loligo; from the Lias at Lyme Regis. In the collection of Miss Philpot. (Mrs. Buckland. Original.)

A.A. Barbs of the pen, proceeding from the outer edges of the marginal bands.

B.B. Marginal bands dividing the bases of the barbs from the internal part or body of the shaft.

C. Axis of the Pen, dividing the body of the shaft into two equal parts.

D. Transverse section across the Ink bag.

d. First or upper plate. This plate is very thin, and smooth, and its structure is obscure, except on the right marginal band at *d'*, where the longitudinal ridges on its surface are very distinct.

e. Upper surface of second plate, marked with broad wavy lines, passing on each side from the axis outwards, across the body of the shaft, and over the marginal bands.

f. Upper surfaces of a third plate, exhibiting minute curved striæ, ascending symmetrically in opposite directions from each side of the axis of the shaft C, and descending towards its margin. These curved striæ are intersected by minute longitudinal straight lines, running nearly parallel to the axis of the shaft. Towards the apex of the shaft at *f*, the broad transverse curves predominate over the fine longitudinal fibres which lie beneath them. At *g*, no transverse curves are visible.* (Mrs. Buckland. Original.)

Plate 31. V. I. p. 240.

Fig. 1. Animal of Nautilus Pompilius, fixed in its shell. The shell is copied from one in the collection of Mr. W. I. Broderip. (Animal from Owen. Shell original.)

n. The Hood, or ligamento-muscular disk that surrounds the head.

p. The digital tentacles protruded from their sheaths.

k. Funnel.

a, *b*. *c*. *d*, *e*. Siphuncle. The desiccated membrane of

---

* Herman von Meyer (Palæologica, 1832, P. 322,) mentions the occurrence of ink bags, together with the horny internal shells of Sepia, (Onychoteuthis) in the Lias of Culmbach and Banz.

the siphuncle is laid bare at *a. b. c. d.* At *e, e,* and from thence inwards, it is covered by a soft calcareous coating or sheath.

y. y. Collar, projecting inwards from the transverse plates, and supporting the Siphuncle. See Note, V. I. p. 243.

Fig. 2. Upper horny mandible of the animal, with a hard calcareous point. (Owen.)

Fig. 3. Lower horny mandible, armed with a similar calcareous point. (Owen.)

Fig. 4. Calcareous point, and palate of upper mandible separated from the horny portion. (Owen.)

Fig. 5. Under surface, or palate of a Rhyncholite, or fossil beak, from the Lias at Lyme Regis, analogous to the recent specimen, fig. 4. (Original.)

Fig. 6. Upper view of another Rhyncholite from the same stratum and place. Black portions of the horny substance, in a state resembling charcoal, remain attached to its posterior surfaces. (Original.)

Fig. 7. Side view of the calcareous portion of an upper mandible, from the Muschel kalk of Luneville. (Original.)

Fig. 8. Upper view of another Rhyncholite from Luneville. (Original.)

Fig. 9. Palatal view of fig. 8. (Original.)

Fig. 10. Calcareous point of an under mandible from Luneville. The dentations on its margin resemble those on the recent mandible, fig. 3, and co-operating with the dentations on the Margin of the upper mandible, fig. 9, must have formed an Instrument (like the recent beak, figs. 2 and 3,) well fitted for the rapid demolition of Crustacea and small Shells. (Original.)

Fig. 11. Under surface of fig. 10.; it is strengthened by

a double keel-shaped indented process, enlarging from its apex backwards.[*] (Original.)

Plate 32. V. I. p. 244.

Fig. 1. Part of the petrified shell, and casts of the interior of some of the chambers, of a Nautilus hexagonus, from Marcham, Berks. This fossil exhibits at its smaller End, from *d* to *b*., a series of casts of the Air-chambers, from which the external shell has been removed. The cavity of each chamber is filled with a disc of pure calcareous spar, representing the exact form of the chamber into which it had been infiltrated. In the larger portion of this fossil, the petrified shell retains its natural place, and exhibits fine wavy lines of growth forming minute Ribs across its surface. (Original.)

Fig. 2. Fractured shell of N. hexagonus, from the Calcareous grit of Marcham. The chambers are lined with calcareous spar, and a circular plate of the same spar is crystallized around the siphon. The interior of the siphon is filled with a cast of Calcareous grit, similar to that which forms the rock from which the shell was taken. See V. I. p. 247.[†] (Original.)

---

[*] Although the resemblances between these fossil beaks, and that of the animal inhabiting the N. Pompilius, are such as to leave no doubt that Rhyncholites are derived from some kind or other of Cephalopod, yet, as they are found insulated in strata of Muschel kalk and Lias, wherein there occur also the remains of Sepiæ that had no external shells, we have not yet sufficient evidence to enable us to distinguish between the Rhyncholites derived from naked Sepiæ, and those from Cephalopods that were connected with chambered shells. I possess a specimen of a fossil Nautilus from the Lias at Lyme Regis, in which the external open chamber contains a Rhyncholite.

[†] This fossil exhibits the Siphuncle in its proper place, passing across

Fig. 3. represents in its natural size, a portion of the Siphuncle which in Fig. 2. is laid bare along its course through the chambers, *d. e. f.* In the transverse Plate *h*, the siphuncular collar is entire, but a Section of another collar in the transverse Plate, *i*, shows the contraction of the Siphon at its passage through this aperture, and exhibits also the overlapping, or squamous suture by which the Collar is fitted to the superior and inferior portions of the calcareous Sheath of the Siphon. See V. I. pp. 247, 248. Note. (Original.)

A similar structure may be seen at the Collars of the transverse Plates of the N. Striatus. See Pl. 33.

---

the cavities of the Air-chambers. As in the recent Nautilus Pompilius, there is no communication between the interior of the Siphon and that of the Air-chambers, so in this fossil shell, there is proof that no communication existed between these cavities. A transverse section at *a.* shows the thin edge of the sheath of the siphuncle, surrounded externally with calcareous spar, and filled internally with Grit. Other Sections of the Siphuncle at *b. d. e. f.* show the calcareous Grit within its cavities to be contracted at its passage through the collars of the transverse plates, and most enlarged midway between one transverse plate and another.

This fossil affords two proofs that no communication existed between the interior of the Siphuncle and that of the Air-chambers. 1st. the calcareous sheath of the Siphuncle is seen at *d. e. f.* completely enclosing the calcareous grit which forms the cast within it. 2dly, had there been any communication between the interior of the siphuncle, and that of the air-chambers, these chambers must have received some portion of the materials of the grit that have filled this Siphuncle: not a particle of grit is found in any one of the adjacent air-chambers, but they are all lined, and some of them nearly filled with a crystalline deposite of Carbonate of Lime, disposed in uniform plates around the interior of each chamber, and around the Siphuncle. *See Fig.* 2. *c.* c^1. *a.* a^1. a^2. a^3. *and Fig.* 3. *d—k.* This deposite can only have been formed from water charged with carbonate of lime, introduced by infiltration, after the interment of the shell, and filling the chambers which are thus uniformly invested.

PLATE 33. V. I. pp. 247, 248. Note.

Longitudinal Section of Nautilus Striatus, from the Lias at Whitby, in the collection of Mrs. Murchison. The interior of the Chambers is filled exclusively with calcareous spar, and that of the Siphuncle with Lias. (Original.)

a. The Siphuncle: the union of the siphuncular calcareous sheaths, with the aperture or collar of each transverse Plate, is so closely fitted, that no fluid could have passed between them into the air-chambers.

b. One of the transverse Plates forming the Air-chambers.

c. White calcareous spar, filling the middle region *only* of the air-chambers.

d. Stratified zones of dark coloured calcareous spar, deposited in equal thickness on both sides of the transverse plates, and also on the inside of the shell, and around the calcareous sheath of the siphuncle.*

e. Portion of the external shell, showing a laminated structure.

PLATE 34. V. I. p. 249. Note.

Drawing of the animal of the Nautilus Pompilius, prepared at my request by Mr. Owen, to show the manner in which the siphuncle terminates in the Pericardium. (Original.)

---

* The successive zones of this dark Spar show that the Lime composing it was introduced by slow and gradual infiltrations into the cavity of the air-chambers. Hence it follows that no communication existed between the Siphuncle and these chambers, at the time when this Pipe was filled with the fluid mud, that has formed a cast of Lias within it. As the fractures across the Siphuncle in the 2d and 3d chambers are filled only with spar, of the same kind as that within these Chambers, these fractures could not have existed, when the Mud of the Lias formation entered the Siphuncle, without admitting it also into the chambers adjacent to them.

a. The Heart.

b. A bristle passing from the pericardium through the membranous siphuncle laid bare.

c. Bristles passing from the pericardium through the orifices of communication with the Branchial chamber.

d. d. d. d. Follicles communicating with the Branchial Arteries.*

'd. 'd. 'd. 'd. Pericardial septa, forming thin muscular Receptacles of the follicles.

e. e. The Branchiæ.

f. The Branchial Chamber.

g. The Funnel, or Branchial outlet.

h. The infundibular valve.

i. i. The digital processes.

k. The Gizzard.

l. The Ovary.

m. m. The mantle dissected off.

n. The membranous siphuncle.

o. o. The siphuncular artery.

p. p. The Boundaries of the Pericardial cavity.

q. Portion of the Siphuncle between the Pericardium and first transverse plate of the shell.†

---

* Mr. Owen supposes that these follicles discharge the impurities of the blood into the Pericardium, when there is no access of water to the Branchiæ, during the time that the animal is contracted within its shell. The overflowings of this pericardial fluid may pass out through the orifices marked by the bristles, c. c.

† This upper portion or neck of the Siphuncle, has the form of a flattened canal, with thin Parietes of the same substance as the Pericardium; when the animal expands itself at the bottom of the sea, this neck is probably closed by the lateral pressure of the gizzard, *k*, and ovary, *l*, and so acts instead of a valve to prevent the return of the pericardial fluid into the Siphuncle. At such times the deep-sea water must press with great force on the exterior of the Pericardium, and tend to force the pericardial fluid into the Siphuncle; but as an equal amount of pressure is applied simultaneously to the Ovary and

PLATE 35. V. I. p. 257.

Cast of the interior of the Shell of Ammonites obtusus from Lyme. Fragments of the shell remain near *b.* and *e.*

One object of this Plate and of many of the figures at Pl. 37. is to show the manner in which the external shell is fortified by Ribs and Flutings, (PP. 257. 258.) and farther supported by the edges of the internal transverse plates, that form the air-chambers. See V. I. p. 263, Note. (Original.)

PLATE 36. V. I. p. 256. Note.

Longitudinal section of another shell of Ammonites obtusus from the Lias at Lyme Regis. (Original.)

The greater part of the outer chamber, and the entire cavities of the air-chambers are filled with calcareous spar, and the Siphuncle, (preserved in a carbonaceous state,) is seen passing along the entire dorsal margin to the commencement of the outer chamber. See V. I. p. 265, Note.

Von Buch has found evidence to show that the membranous siphuncle of Ammonites was continued to a considerable distance along the outer chamber, beyond the last or largest transverse Plate. This discovery accords with the analogies afforded by the membranous neck of the siphon of the N. Pompilius, which is continued along the outer chamber from the last transverse Plate to the Pericardium. See Pl. 34. *q.**

Gizzard, the lateral pressure of these two organs on the neck of the Siphuncle would tend to close it with a force exactly counterbalancing the external pressure on the Pericardium.

* As the body of the animals that inhabited the Ammonites was more elongated than that of those inhabiting the shells of Nautili, in consequence of the smaller Diameter of their outer Chamber, the place of their Heart was probably more distant from the last transverse Plate, than that of the Heart of Nautili; and the membranous Siphon connected with the Pericardium consequently longer.

Plate 37. V. I. p. 258. Note.

Figs.			Locality.	Stratum.
1.	Ammonites Amaltheus Gibbosus	(Schlotheim)	Gloucester	Lias.
2.	A. Varicosus	(Sowerby)	Black Down, Devon.	Green Sand.
3.	A. Humphriesianus	(Sowerby)	Shernborne.	Inferior Oolite.
4.	A. Lamberti	(Sowerby)	Oxford	Oxford Clay.
5.	A. Planulatus	(Schlotheim)	Franconia	Jura Limestone.
6.	A. Bucklandi	(Sowerby)	Bath	Lias.
7.	A. Lautus	(Sowerby)	Folkstone	Gault.
8.	A. Catena	(Sowerby)	Marcham	Calcareous Grit.
9.	A. Varians	(Zieten)	Geislingen	Jura limestone.
10.	A. Striatus	(Reinicke)	Gros Eislingen	Lias.

a. Exterior dorsal margin.
b. Back view of the shell.
c. Transverse section of shell.

The figures in this Plate are selected to exemplify some of the various manners in which the shells of Ammonites are adorned and strengthened by ribs, and flutings, and bosses. In Vol. I. p. 257, instances are mentioned of similar contrivances which are applied in Art to strengthen thin plates of metal. Workers in Glass have also adopted a similar expedient in their method of fortifying small wine flasks of thin glass, made flat, and portable in the pocket, with a series of spiral flutings passing obliquely across the sides of the flask, as in many of the flattened forms of Ammonite. Similar spiral flutings are introduced for the same purpose on the surface of thin glass pocket smelling-bottles. In other glass flasks of the same kind which are made in Germany, the addition of bosses to the surfaces of the flat sides of the bottles, produces a similar double result of ornament and strength.

Plate 38. V. I. p. 262. Note.

Air-chambers of Ammonites heterophyllus, filled with Lias, and showing in a remarkable degree the effect of the undulating course of the edges of the transverse plates beneath the flat sides of the outer shell.

A portion of the outer shell is preserved at *c.* and impressions of the fluted interior of the shell, which has fallen off, are visible at *d.* (Original.)

PLATE 39. V. I. p. 263. Note.

This Plate presents a longitudinal view of the same fossil, of which a side view is given in the last figure. The same transverse plates that approximate so closely beneath the sides of the shell, where it is flat and feeble, (Pl. 38.) are distant from each other along the dorsal portion, which from its convex form is strong.

The siphuncle is preserved in its proper dorsal place at *d.*

The elevations and depressions of the transverse plate in front of this figure exemplify the theory of Von Buch, respecting the use of the Lobes and Saddles formed by the undulations of its outer margin. See V. I. p. 267, and Note. (Original.)

PLATE 40. V. I. p. 272. Note.

Fig. 1. Ammonites Henslowi (Goniatites,) from Transition limestone in the Isle of Man.

The Lobes are simple, and without foliations; their form resembles that of the slipper-shaped lobe of the Nautilus Ziczac, and Nautilus Sypho. See Pl. 43.

The Lobes D. L. l. V. are *pointed* inwards, and the intermediate Saddles S. d. S. L. S. V. are *rounded* outwards; according to the type of Ammonites. (Original.)

Fig. 2. Ammonites striatus (Goniatites,) from the Coal Shale of Lough Allen in Connaught, having its lobes and saddles disposed in the same directions as in Fig. 3, the delicate longitudinal striæ and

transverse ribs of the outer shell are strengthened by repeated intersections of the subjacent edges of the transverse Plates. (Original.)

Fig. 3. Back view of Ammonites sphæricus, from the limestone of Derbyshire, showing the position of the siphuncle upon the dorsal margin, with its collar advancing outwards between the two simple dorsal lobes; the lateral lobes are also simple and without foliations, and pointed inwards. (Martin Pet. Der. T. 7.)

Fig. 4. Ammonites nodosus (Ceratites.) This is one of the species peculiar to the Muschel kalk. The descending lobes terminate in a few small denticulations, *pointed* inwards, and the ascending saddles are *rounded* outwards, after the normal character of Ammonites. (Zeiten. Tab. II. Fig. 1. a.)

Fig. 5. Back of A. Nodosus, showing the dorsal lobes *pointed* inwards, and the collar around the siphuncle advancing outwards. No edges of the transverse plates are placed beneath the dome-shaped Tubercles; these derive sufficient strength from their vaulted form. (Zeiten. Tab. II. Fig. 1. b.)

PLATE 41. V. I. p. 264.

Ammonites giganteus, found in the Portland stone at Tisbury in Wiltshire. This beautiful fossil is in the collection of Miss Benett. The chambers are all void, and the transverse Plates and Shell converted to Calcedony. (Original.)

PLATE 42. V. I. pp. 264, 265. Note.

Fig. 1. Cast of a single chamber of Nautilus hexagonus, showing the simple curvatures of the edges of the transverse plates, and the place of the Siphuncle. (Original.)

Fig. 2. Cast of a chamber of Ammonites excavatus, having a complex form derived from the denticulated edges of the transverse plates. See V. I. pp. 264, 265, Note. (Original.)

Fig. 3. Casts of three chambers of Ammonites catena, with the Membrane of the Siphuncle on its dorsal margin. See V. I. p. 264, Note, and p. 265, Note.

The course of the transverse plates is beneath the *depressed* and weakest parts of the external shell, avoiding the bosses at c, d, e, which from their form are strong. (Original.)

Fig. 4. Ammonites varicosus, from the Green Sand of Earl Stoke, Wilts. Nat. size. See V. I. p. 265, Note. (Original.)

Figs. 5. 6. Portions of the same shell, having the transverse Plates and Siphuncle converted to Calcedony. See V. I. pp. 265 and 266, Note. (Original.)

Fig. 7. Ammonites varicostatus, (nobis,(an undescribed species of Ammonite from the Oxford Clay at Hawnes, 4 m. S. of Bedford. Diameter 9 inches.

The name Varicostatus expresses the remarkable change in the character of the Ribs, near the outer termination of the air-chambers.

On the inner whorls of the shell, these ribs are narrow, and highly raised, set close to one another, and bifurcated at the back of the shell, (from *d.* to *c.*;) but near the outer chamber (*b.* to *a.*) they become broad and distant, and the dorsal bifurcation ceases.

The edges of the transverse plates are exposed by the removal of the shell from *c.* to *b.*, they appear also at *a. d.* (Original.)

Similar variations in the form of the ribs occur in Ammonites biplicatus and Ammonites decipiens.

PLATE 43. V. I. pp. 270. 271.

Fig. 1. Fragment of Nautilus sypho, in the collection of W. I. Broderip, Esq. from the Miocene division of the Tertiary formations at Dax, near Bourdeaux. The accidental fractures of this fossil afford an instructive display of the disposition of the transverse Plates and Siphuncle. (Original.)

Fig. 2. Another fractured shell of the same species from Dax, in the collection of Mrs. Buckland, showing at a^1, a^2, a^3, the disposition of the lateral lobes. See V. I. p. 271, Note. (Original.)

Fig. 3. Cast of the interior of Nautilus Ziczac, in the collection of Mr. James Sowerby, showing the disposition of the lateral lobes. (See V. I. pp. 271, 272. (Original.)

Fig. 4. Cast of a single chamber of Nautilus Ziczac, in the collection of Mr. J. Sowerby, showing the disposition of the ventral and dorsal Lobes and Siphuncle. See V. I. p. 271, Note. (Original.)

PLATE 44. V. I. p. 273, et seq.

Fig. 1. Molluscous animal enclosing the Spirula Peronii. See V. I. p. 273.* (Blainville.)

Fig. 2. Section of a Spirula (Nat. size,) showing its transverse Plates and siphuncular sheath. (Original.)

---

* M. Robert has recently discovered between the Canaries and Cape Blanc, several imperfect bodies of a small species of Molluscous animal, each enclosing a Spirula.

In all these the position of the shell is not at the posterior extremity, as in the figure of the specimen found by Peron, but in the back, parallel to the axis of the body, like the shell of the Sepiostaire, or internal shell of the common Sepia. This position agrees with that of the animal figured by Blainville, if we suppose the caudal portion of the latter to have been lost.

On each side of the body are two expansions that act like Fins, as in the Sepiole. Beneath the neck is the aperture of the Funnel. In

Fig. 3. Lituite in the Transition limestone of Oeland.

a. Siphuncle of Lituite. (Original.)

Fig. 4. Section of an Orthoceratite in the Transition limestone of Oeland, in the collection of C. Stokes, Esq. (Original.)

a. Siphuncle of the same.

Fig. 5. Baculite, from Chalk of the Cotentin; terminating at its large end in the chamber *a*. (Original.)

Fig. 5. *b*. Front view of the transverse plate of a Baculite, showing the margin to be disposed in lobes and saddles, and the place of the Siphuncle to be on the back of the shell at *c*. (Original.)

Fig. 6. Transverse section of a Nummulite. (Parkinson, V. 3. Pl. X. Fig. 16.)

Fig. 7. Longitudinal section of another Nummulite.* (Parkinson.)

one specimen the Eye is preserved, and is very large in proportion to the body. These Mollusks form the prey of the Physali, and were caught entangled in their Tentacula.

L'Echo du Monde Savant, 1 Mai. 1836.

[*] Among the microscopic fossil shells placed by D'Orbigny in the same Order as Nummulites (*Foraminiféres*,) Count Munster enumerates 40 species from the Cretaceous free stone of Maestricht. Mr. Lonsdale also has discovered 16 species of microscropic foraminifers in the English Chalk. (See V. I. p. 337, Note.) Microscopic shells of this Order occur in countless myriads throughout the Tertiary strata. (See V. I. p. 290.)

The Sand of the Shores of the Adriatic, and many Islands in the Archipelago, is crowded with recent microscopic shells of the same kind.

It is mentioned in our Note, V. I. p. 288, that doubts have arisen as to the supposed origin of many of these minute multilocular shells from Cephalopods. Some recent observations of M. Dujardin have induced him to refer the Animals which construct the Miliola and some other microscopic foraminiferous shells, to a new Class of animals of a lower degree than the Radiata, and possessing a locomotive power by means of minute tentacular filaments. He proposes to give them the name of Rhizapodes. Ann. des Sci. Nat. Mai, 1835. p. 312.

Fig. 8. Hamites Bucklandi, (Phillips,) from the Gault or Speeton Clay, in the collection of Mr. I. Phillips, of York. (Original.)

Fig. 8^a. Transverse septum of Fig. 8, showing the lobes and saddles, and the siphuncle at *a*.

Fig. 9. Hamites armatus, from the upper Green Sand, near Benson. (Sowerby.)

Fig. 10. Transverse section of the same, showing the siphuncle, on the back, between the spines.

Fig. 11. Hamites from Folkstone Clay, showing the spiral Ribs of the outer shell. At *a*. we see the Siphuncle, and the lobes and saddles of the transverse Plate.

Fig. 12. Fragment of the cast of the interior of another Hamite from Folkstone Clay, showing the Siphuncle at *a*. The removal of the outer shell shows the sinuous edges of the transverse Plates beneath the Ribs. (Original.)

Fig. 13. Fragment of Hamites articulatus (Sow.) from the Green Sand at Earl Stoke, showing the Siphuncle (*a*.) covered by a small portion of the shell. The sinuous terminations of the transverse plates are visible beneath the ribs, having their secondary lobes *rounded* outwards (*b*.) and *pointed* inwards (*c*.) like the secondary lobes of Ammonites. (Original.)

Fig. 14. Fragments of Turrilites Bergeri, in the collection of G. B. Greenough, Esq. from the Green Sand formation. The siphuncle is seen near the upper or dorsal margin of two whorls at *a*. *a*.; the sinuous edges of the transverse plates are visible on the middle whorl; and the entire surface of a transverse plate is laid open at the smaller end of a third whorl, showing its lobes and saddles to be analogous to the same parts in Ammonites. (Original.)

Fig. 15. Scaphites Equalis, from Chalk near Rouen, in the collection of Mr. J. Sowerby; the sides of the external shell are strengthened and ornamented by ribs and tubercles; and the edges of the transverse plates disposed in sinuous foliations (*c.*) as in Ammonites. The mouth or outer margin (*b.*) returns so nearly into contact with the air-chambers (*c.*,) that the want of space at this part for the expansion of arms and head, makes it probable that the Scaphite was placed entirely within the body of its animal. (Original.)

Fig. 16. Transverse section of the chambered portion of Fig. 15, showing the arrangement of the lobes and saddles to be similar to that of Ammonites; the siphuncle also is seen on the dorsal margin at *a.* (Original.)

Fig. 17. Longitudinal section of the calcareous Sheath and Alveolus of a Belemnite.

a. Alveolus, or internal shell, divided by transverse Septa into air-chambers. See V. I. p. 281.

b. Siphuncle, passing along the margin of the air-chambers.

c. Apex of the fibro-calcareous sheath, or solid Cone of the Belemnite.

PLATE 44'. V. I. p. 280, et seq.

Illustrations of the probable nature of the Animals that gave origin to Belemnites.*

---

* In the description of Pl. 44'. and Pl. 44''. the following letters indicate the same parts in each specimen to which they are applied.

a. The Apex of the calcareous shell, or sheath.

b. Alveolar portion, or chambered shell.

c. Ink bag.

d. } Portions of the thin anterior horny sheath, sometimes highly na-
e. } creous.

f. Neck of Ink bag.

Fig. 1. Imaginary restoration of Belemnosepia, showing the probable place of its Ink bag, and of the internal shell or Belemnite. The three component parts of this Belemnite are represented as if longitudinally bisected: the place assigned to this Ink bag is nearly the same as in the recent Loligo. (Original.)

Fig. 2. Sepia officinalis, showing the position of the internal shell or sheath (Sepiostaire) within the dorsal portion of its sac. Its apex (*a*,) and calcareous dorsal plates (*e*,) correspond with the apex calcareous conical sheath of a Belemnite.

Fig. 3. Sepia officinalis, laid open along the ventral portion of its Sac, to show the position of its Ink bag. (Original.)

Figs. 3. *a*. 3. *b*. 3. *c*. Rhyncholites, found in contact with Belemnites in the Lias at Lyme Regis. Nat. size. (Original.)

Fig. 3. *d*. Beak of a small Testudo from Chalk, in the collection of Mr. Mantell, showing a fibro-cancellated bony structure, very different from the compact shelly condition of the Rhyncholite, for which it may from its size and shape be mistaken. (Original.)

Fig. 4. Ventral surface of a Sepiostaire; the elongated shallow cone, or cup, (*e*. *e*. *e*.' *e*.') is composed of very thin calcareous plates, alternating with horny membranes, which are expanded outwards to form the thin margin of the cone. This irregular cone or shell represents the hollow cone at the larger extremity of the Belemnite, (Fig. 7. *b*. *b*'. *e*. *e*'. *e*''.) which includes its Alveolus (*b*. *b*'.) and Ink bag (*c*.) Within this shallow sub-conical shell of the Sepiostaire is contained its alveolus, or calcareous chambered portion, (Fig. 4. *b*.) which represents the

chambered alveolus in the Belemnite, (Fig. 7. *b. b.*) but has no Siphon. (Blainville.)

Fig. 4'. Longitudinal section of the apex of the shell of Sepia officinalis. This apex is composed of granular calcareous matter (*a.*,) alternating with conical horny laminæ, which expand laterally into the horny margin (*e.*) (Original.)

Fig. 5. Longitudinal view of Fig. 4. The apex (*a.*) represents the apex of a Belemnite. The back of the shell (*e.*) the dorsal part of a Belemnite; and the alveolar portion (*b. b'.*) represents the internal chambered shell of a Belemnite. (Blainville.)

Fig. 6. Anterior extremity of the lamellæ, or alveolar plates, exposed by a longitudinal section in Fig. 5. In the mature animal these lamellæ are nearly 100 in number; a few of them only are here represented.

These alveolar plates form the internal chambers of the Sepiostaire, and represent the transverse plates of the Alveolus in Belemnites, and other chambered shells; but as the Sepiostaire has no siphuncle, its chambers seem not subservient, like those of the Belemnite, to the purpose of *varying* the specific gravity of the animal; the intervals between its plates are occupied by an infinite number of thin winding partitions standing perpendicularly between the lamellæ.

Figs. 6'. 6''. Thin calcareous partitions winding between and supporting the alveolar plates of the Sepiostaire. The sinuous disposition of these partitions increases their efficacy in resisting pressure, on the same principle, as in the foliated edges of the transverse plates of Ammonites.* The sinuosity of the cal-

---

* Dr. Fleming has accurately described the structure of these partitions, as exhibiting perpendicular laminæ, waved and folded in brainlike gyrations, which occasionally anastomose.

careous partitions is least near the margin of the lamellæ. See Fig. 6'. (Original.)

Fig. 6'''. Columnar appearance of the sinuous partitions when viewed laterally. (Original.)

Fig. 7. Unique specimen of Belemnites ovalis, from the Lias at Lyme Regis, in the collection of Miss Philpotts. A fracture at *b*, shows the chambered areolæ of the Alveolus. At *e*. the thin conical anterior horny sheath originates in the edge of the calcareous sheath, and extends to *e''*. The surface of this anterior sheath exhibits wavy transverse lines of growth; it is much decomposed, slightly nacreous, and flattened by pressure.

Within this anterior conical sheath the Ink bag is seen at *c*. somewhat decomposed, and partially altered to a dark gray colour. (Original.)

Fig. 8. Portion of the Ink bag broken off from Fig. 7. *c*. and covered by that portion of the horny case which lay above it. The transverse lines *e*. on this portion, are the continuation of the lines of growth on the horny sheath of Fig. 7. *e*. *e'*. *e''*. (Original.)

Fig. 9. Belemnites Pistilliformis? from the Lias at Lyme in the collection of Miss Philpotts, having a portion of its ink bag at *c*. (Original.)

Figs. 10. 11. 12. Belemnites from the Jura limestone of Solenhofen, figured by Count Munster in Boué's Mémoirs Géologiques, Vol. I. Pl. 4. In 10 and 12 the form of the anterior horny sheath is preserved, to a length equal to that of the calcareous shaft of the Belemnite, but in none of them is the Ink bag visible.* (Munster.)

---

* Von Meyer mentions (Palæologica, P. 322, first Edition, 1832,) that he has seen an Ink bag at the upper end of a Belemnite from the Lias of Banz, and asks, "Do Belemnites possess an Ink bag like that of the Sepia?"

Fig. 13. Chambered alveolar cone and horny sheath of a large Belemnite from the limestone of Solenhofen; the calcareous sheath or Belemnite itself has disappeared. (Munster.)

Fig. 14. Belemnites brevis? from the Lias at Lyme; Nat. size. The length of the shaft of this Belemnite does not exceed that of the Beloptera (Fig. 15;) a small fragment only of its alveolus is preserved, but the place it occupied is filled with calcareous spar, and the hollow cone above it with lias. (Original.)

Fig. 15. Beloptera. In this fossil we have an intermediate link between the Belemnite and the shell or sheath of Sepia officinalis. *a.* represents the apex of the sheath, *e. e.* its posterior expansion, analogous to that at Fig. 4. *e. e.* and at Fig. 4'. *e'*; *e'* is its anterior expansion, bearing on its internal surface annular marks derived from the transverse septa of these alveolus. (Blainville.)

PLATE 44''. V. I. p. 282. Note.

All the figures in this Plate are of nat. size.

Fig. 1. Anterior sheath and Ink bag of Belemno-sepia discovered by Miss Anning in 1828 in the Lias of Lyme Regis, and noticed by Dr. Buckland (Lond. and Edin. Phil. Mag. May, 1829, P. 388.) as "derived from some unknown Cephalopod, nearly allied in its internal structure to the inhabitant of the Belemnite." This sheath is, for the most part, nacreous; in some places (*d. d.*) it retains the condition of horn. The corrugations on its surface indicate the lines of growth. At *f.* a transverse fracture shows the neck of the ink bag. (Original.)

Fig. 2. The lower part of Fig. 1, seen from another side;