
MONUMENTUM ÆRE PERENNIUS

FIGURES

OF

CHARACTERISTIC BRITISH FOSSILS:

WITH

DESCRIPTIVE REMARKS.

BY

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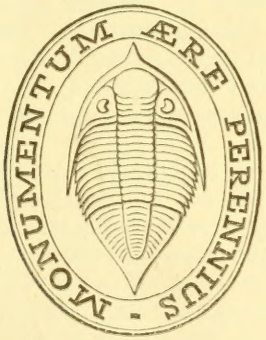

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42 PLATES & 18 WOOD-CUT ILLUSTRATIONS.

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PREFACE.

The rapid progress made in the advancement of the various Sciences, especially that of Geology, and its important branch of Palæontology, has necessitated, for instructive purposes, such a condensation of details, as may simplify the subject to the Students of that Science.

With this object the present work was projected, its design being to exhibit to the eye such fossils only as are considered characteristic of the principal groups or formations of the stratified rocks; requiring, necessarily, considerable judgment in their selection, from the large number now known, as well as truthfulness in depicting them; the author's long experience, and personal execution of the plates, may be considered a sufficient guarantee for their correctness. The descriptive remarks on the groups of fossils, with Woodcut Illustrations, is an additional part of the work not originally intended, but it is hoped this portion, with the aid of the excellent Wood Engravings by Mr. William Oldham, of recent and fossil forms, for comparison, will add to its clearness and utility.

It is a matter of regret that so long a time has elapsed between the publication of the first part and the conclusion of the Volume; this has arisen from various causes, over which the Author had no control.

This Volume has been made to complete the Palæozoic division of strata by the addition of two extra plates. It thus contains forty-two Lithographic plates, comprising more than 700 figures of fossils, over 300 of these being original. The descriptive remarks are illustrated by eighteen Wood Engravings, including fifty-eight figures. All the figures are of the natural size, except where otherwise mentioned, the subjects being arranged as far as practicable, zoologically, as well as stratigraphically.

Although complete in itself as far as the Palæozoic division extends, this volume is intended to be followed by others, including the Secondary and Tertiary formations.

WILLIAM HELLIER BAILY.

July 20th, 1875.

"There is no branch of science so closely associated with our immediate wants and enjoyments as that of Geology. In our daily walks we tread with heedless step upon the apparently uninteresting objects of which it treats; but could we rightly interrogate the rounded pebble in our path, it would tell us of the convulsions by which it was wrenched from its parent rock, and of the floods by which it was abraded and placed beneath our feet. In our visit to the picturesque and the sublime, we come into still closer proximity to geological truths In the precipices which defend our rock-girt Isle, and flank our mountain glens, and in the shapeless, fragments at their base which the lichen colours and round which the ivy twines, we see the remnants of uplifted and shattered strata which once peacefully reposed at the bottom of the ocean.

"But it is not merely among the scenes of external nature that forces, now subdued, are presented to our minds Our temples and our dwellings are formed from the rocks of a primæval age—bearing the ripple marks of a Pre-Adamite ocean,—ground by the friction of the once travelling boulder, and embosoming the relics of ancient life, with the plants which sustained it. Our houses are ornamented with variegated limestones, the indurated tombs of molluscous life, and our apartments heated with the carbon of primæval forests and lighted with the gaseous element which it confines.

"When the geologist begins his survey of the globe, he finds its solid covering composed of rocks and beds of all shapes and kinds, lying at every possible angle, and occupying every possible position. Here the granite rises in lofty peaks, or is scattered in rounded boulders. There the basalt throws its once liquid current over beds of sandstone, or sustains them upon its flanks. Here the strata, once at the bottom of the sea, rest in undisturbed tranquillity—the more recent deposits from a tranquil ocean. There they bristle up with their rugged margin, displaying, in serrated outline, the fractured edges of ancient and of recent beds. Everywhere, indeed, what was deep is brought into visible relation with what was superficial—what is old with what is new—what preceded life with what followed it.

"How these rocks came into their present place it is the business of the geologist to determine—to compute their relative ages—to fix the position which they originally occupied—to study the forces by which they were upheaved—and the remains of organic life which they entomb. Studies like these possess a home interest for reflecting and sympathizing man. Life claims kindred with what once lived. It owns the same relation between itself and that which is yet to breathe; and if on the tombs of our fathers is inscribed the law under which we are individually to join them, we read with no less distinctness among the cemeteries of primæval death that more general enactment under which the races of man, and the tributary creation which obeys him, shall take their place in the coming catastrophe, and reappear to future pilgrims—memorials of the age of genius—the cycle of intellectual and immortal generations."

Sir David Brewster.

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DESCRIPTIVE REMARKS.

It has been sufficiently proved that the three great divisions—Paleozoic, or *Primary;* Mesozoic, or *Secondary;* and Cainozoic, or *Tertiary;* under which the whole series of Fossiliferous Rocks are grouped, are distinguished by an assemblage of organic remains, differing essentially in character the one from the other; and that the *Formations* or *Periods*, second in importance, have also a peculiar and distinct set of Fossils; and even the minor subdivisions of strata, although they may not contain an entirely different assemblage, are sufficiently varied to allow of their identification (in the British Islands at least) by means of the fossil remains of extinct plants and animals contained in them.

The study of these fossils and their comparison with existing plants and animals constitute the science of Palæontology; and it is from a knowledge of the laws derived from this study geologists are enabled to determine with certainty the succession of strata, and to trace out by their aid many points in geology which would otherwise be obscure and inexplicable.

Each Formation, or group of strata, are considered to bear a corresponding importance in Geological, or *past time* with what are termed Natural History Provinces in Geographical Distribution, or *present space*, being like them characterized by a peculiar *Fauna* and *Flora* (animals and plants), differing from those of other Formations.

The first to point out the utility of organized Fossils in the identity of strata was William Smith, at the commencement of the present century. That acute and much-esteemed observer has since been followed by others eminent in the same branch of science, whose labours as separate volumes, and in the publications of the various scientific societies, and periodicals, may be consulted with advantage by those who wish to enter more extensively into the consideration of the subject.

To explain the position in the Animal Kingdom, of the Fossils figured, the following outline Table of Classification may be found useful:—

Kingdom—ANIMALIA.

INVERTEBRATA.

Sub-kingdom—PROTOZOA.

Class I. Amorphozoa—*Sponges.*
II. Rhizopoda—*Foraminifera*, &c.
III. Infusoria—*Polygastria* (Ehrenberg).

Province—Radiata.

Class I. Zoophyta—Hydrozoa—*Corallines* (?) *Oldhamia; Graptolites.*
II. ,, Anthozoa, *including the Lamelliferous or Stony Corals.*
III. Echinodermata—*Crinoids, Star Fishes, Sea Urchins*, &c.

Sub-kingdom—MOLLUSCA.

Class I. Ascidioda or Tunicata—*Hetero-branchiata* (Blainville.)
II. Polyzoa or Bryozoa—*Dictyonema; Fenestella;* &c.
III. Brachiopoda—*Pallio-branchiata* (Blainv.) *Lamp Shells.*
IV. Conchifera—*Lamelli-branchiata* (Blainv.), *Ordinary bivalve Shells.*
V. Gasteropoda—*Univalve Shells. Nucleobranchs*, or *Heteropoda, Bellerophon.*
VI. Pteropoda—*Theca; Conularia.*
VII. Cephalopoda—*Nautilus; Ammonites.*

Province—Articulata.

Class I. Annulata—Annelida—*Serpula.* (?) *Histioderma.*
II. Cirripedia—*Barnacles or Acorn Shells.*
III. Crustacea—*Crabs and Lobsters. Trilobites.*
IV. Insecta—*Insects.*

VERTEBRATA.

Class I. Pisces—*Fish.*
II. Reptilia—*Reptiles.*
III. Aves—*Birds.*
IV. Mammalia—*Quadrupeds.*

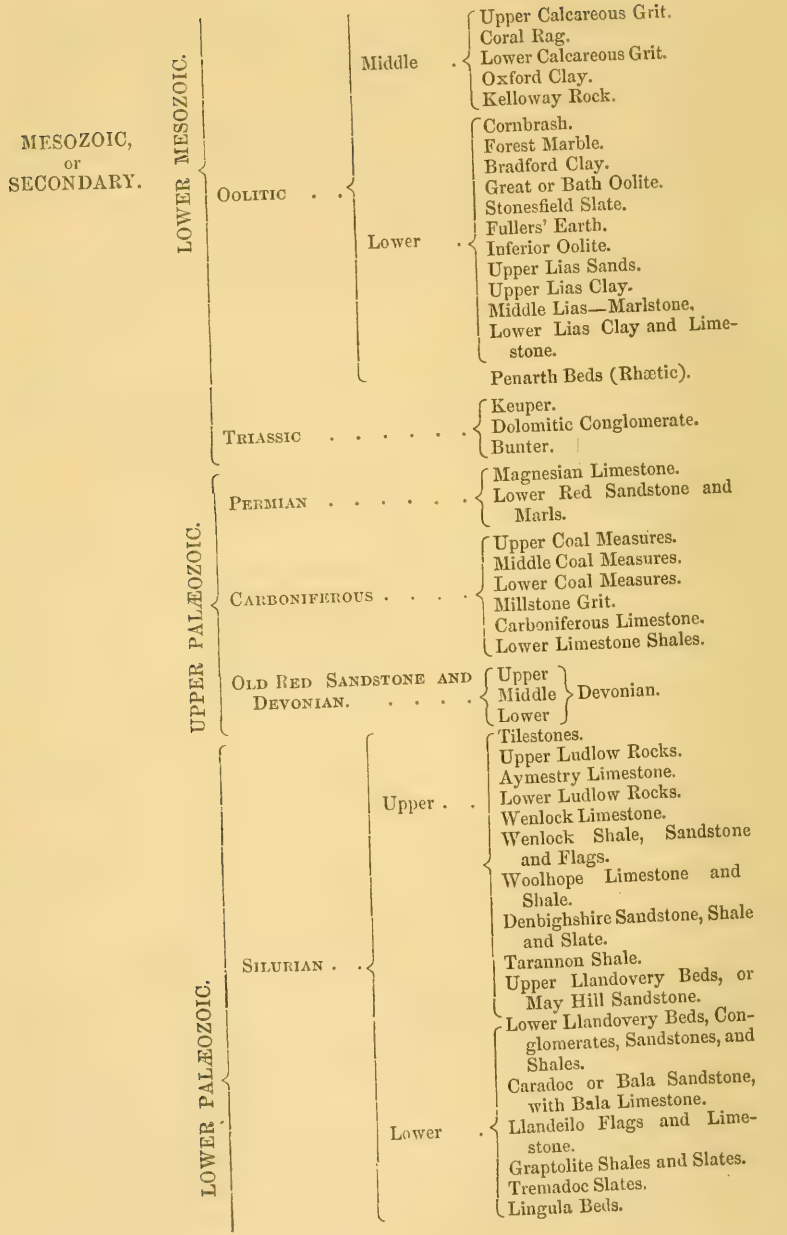
Some general remarks upon the assemblage of Fossils which are found to occur in each Formation will perhaps add to the utility of the figures, as well as facilitate their study.

Considering the groups of strata in the ascending order, we shall therefore commence with a short review of the Fossils of the Cambrian Formation, in which strata we find the earliest evidences (in the British Islands at least) of organic life.

To show their position in geological time, and the order of succession of the several strata, the following Table, adopted by the Geological Survey, is taken from the Catalogue of the Collection of Fossils in the Museum of Practical Geology (1865), and will no doubt be found useful for reference.

Table of the FOSSILIFEROUS *or* STRATIFIED ROCKS, *in their Order of Superposition.*

CAINOZOIC, or TERTIARY.	RECENT AND POST-GLACIAL BEDS.	Fresh water	BLOWN SAND.—PEAT.	
			Lake Deposits.	
			Old River Alluvium (Brick Earth), (Warp).	
			Clay and Sand of Humber.	
			Old River Gravel.	
		Marine	Shingle.	
			Recent Marine (Burtle Beds).	
			Cave Deposits.	
			Raised Beaches.	
	PLIOCENE	Newer	Sand, Gravel, and Brick Clays (Eskers).	
			Upper Erratic Boulder Beds.	
			Lower Boulder Beds (Till).	
			Grays, Copford, and Brentford Beds.	
		Older	Cave Deposits.	
			Norwich Crag.	
			Red Crag.	
			Coralline Crag.	
	MIOCENE?		Bovey and Isle of Mull Beds with Remains of Plants.	
	EOCENE	Upper	Hempstead Beds (Isle of Wight).	Fluvio-Marine.
			Bembridge Beds.	
			Headon, St. Helen's, & Osborne Beds.	
		Middle	Upper Bagshot Sands.	
			Barton Clay. / Bracklesham Sands.	Middle Bagshot.
			Lower Bagshot Beds.	
		Lower	London Clay.	
			Woolwich and Reading Beds.	
			Thanet Beds.	
MESOZOIC, or SECONDARY, UPPER MESOZOIC.	CRETACEOUS	Upper	Upper Chalk.	
			Lower Chalk.	
			Chalk Marl.	
			Chloritic Marl.	
			Upper Greensand.	
			Gault.	
		Lower	Lower Greensand.	
			Weald Clay.	
			Hastings Sands and Clays.	
		Upper	Upper / Middle / Lower	Purbeck Beds.
			Portland Stone.	
			Portland Sand.	
			Kimmeridge Clay.	


MESOZOIC, or SECONDARY.
LOWER MESOZOIC.
OOLITIC
Middle
Upper Calcareous Grit.
Coral Rag.
Lower Calcareous Grit.
Oxford Clay.
Kelloway Rock.
Lower
Cornbrash.
Forest Marble.
Bradford Clay.
Great or Bath Oolite.
Stonesfield Slate.
Fullers' Earth.
Inferior Oolite.
Upper Lias Sands.
Upper Lias Clay.
Middle Lias—Marlstone.
Lower Lias Clay and Limestone.
Penarth Beds (Rhætic).
TRIASSIC
Keuper.
Dolomitic Conglomerate.
Bunter.
UPPER PALÆOZOIC.
PERMIAN
Magnesian Limestone.
Lower Red Sandstone and Marls.
CARBONIFEROUS
Upper Coal Measures.
Middle Coal Measures.
Lower Coal Measures.
Millstone Grit.
Carboniferous Limestone.
Lower Limestone Shales.
OLD RED SANDSTONE AND DEVONIAN.
Upper
Middle
Lower
Devonian.
LOWER PALÆOZOIC.
SILURIAN
Upper
Tilestones.
Upper Ludlow Rocks.
Aymestry Limestone.
Lower Ludlow Rocks.
Wenlock Limestone.
Wenlock Shale, Sandstone and Flags.
Woolhope Limestone and Shale.
Denbighshire Sandstone, Shale and Slate.
Tarannon Shale.
Upper Llandovery Beds, or May Hill Sandstone.
Lower
Lower Llandovery Beds, Conglomerates, Sandstones, and Shales.
Caradoc or Bala Sandstone, with Bala Limestone.
Llandeilo Flags and Limestone.
Graptolite Shales and Slates.
Tremadoc Slates.
Lingula Beds.

CAMBRIAN	Harlech, Llanberis, St. David's, and Longmynd, Grits, Conglomerates, and Slates.
	Howth, Co. Dublin; Bray Head, &c., in Wicklow; and Forth Mountain, &c., in Wexford; Grits, Sandstones, and Slates.

FOSSILS OF THE CAMBRIAN ROCKS.

The Cambrian Formation, as described by Sir Roderick Murchison, in the 'Silurian System,' is shown to underlie the whole Silurian strata.

Professor A. C. Ramsay, in his Memoir on the Geology of North Wales,* enumerates six districts in which these rocks occur. First, that of Anglesea; the strata being mostly composed of mica and chlorite schists, gneissic rocks, grits, and quartz rock.

Second. The Bangor and Llanberis district, comprising the altered purple, green, and chloritic slates, sandstones, and conglomerate beds; west and south-west of Bangor, together with the purple and green slates, and grits on the banks of the Ogwen, around Bethesda, the Lakes of Llanberis, &c.

Third. The Lleyn district, consisting of schist rocks on the south side of Caernarvon Bay, &c., including Bardsey Island, and the coast from Bardsey Sound to Porth Nevin.

Fourth. The Harlech district between the Barmouth estuary and that of Traeth-bach, principally composed of greenish grits, occasionally interstratified with green and purple slates.

Fifth. The district of St. David's, comprising the purple sandstones and slates on the north side of St. Bride's Bay, in Pembrokeshire.

Sixth. The Longmynds and the neighbourhood of Shrewsbury, in Shropshire, consisting of purple and green grits, conglomerates and slaty beds.

No certain evidence of organic remains has yet been found in these rocks in Wales, except in the Bangor slate quarries, by Mr. J. W. Salter, who has described what he believes to be the filled-up burrows of marine worms, referred by him to *Chondrites*.† That palæontologist also alludes to the discovery of abundant traces of former life in some of the fine-grained sandstones and shales composing the strata of the Longmynds.‡ He described them, as consisting principally of the

* Memoirs of the Geological Survey of Great Britain (1866), pp. 8, 9, &c.

† Mem. Geol. Survey, vol. iii., Appendix, p. 243; woodcut, fig. 1.

‡ Journal of the Geological Society, vol. xii., p. 248 (1856); and vol. xiii., p. 206 (1857).

impressions, or surface holes and burrows of marine worms, or *Annelides* of two kinds ; naming them *Arenicolites didymus* and *sparsus* (Plate ii., figs. 1, 2); these he supposed to have burrowed in sand, like the *Arenicola* of the present day, having like them entrance and exit holes, always in pairs. He also describes what he believed to be a Crustacean, as "either the caudal shield of a Trilobite, or else a broad body segment of a Phyllopod allied to Hymenocaris."

In Ireland, rocks referred to the Cambrian Formation occur principally in three districts on the east coast. First—At Howth, near Dublin, extending over but a small area of about two miles; they consist of large masses of quartz rock, interstratified with green grits, and green and purple slates. Second—That of North Wicklow, commencing a little north of the town of Bray, and proceeding south to Wicklow, a distance of about seventeen miles, with a breadth of about seven at its widest part, including masses of quartz rock, which form the elevated peaks of the Great and Little Sugarloaf Mountains.

There are two small slightly detached districts in North Wicklow ; that nearest Dublin at Shankhill, being about one mile and a half long, and the third of a mile broad ; the other, extending over a greater surface, and more important on account of its fossils, is situated near Rathdrum, about five miles south-west of Wicklow, being six miles long, and nearly a mile broad at its widest part; it also includes masses of quartz rock, and forms the eminence called Carrick Mountain.

The Wexford Cambrian district occupies a considerably larger area than either of the others, commencing six miles north of Wexford, and terminating four miles east of Waterford Harbour—a length of thirty-six miles, with a breadth of about seven at the widest part, near Wexford. It includes the Forth Mountain, in South Wexford.

These rocks consist of a great series of sandstones or gritstones and slates, often interstratified with large masses and veins of quartz rock.*

As in the Cambrian rocks of England and Wales, fossils are here rarely met with; they were only discovered after great perseverance by the late Dr. J. R. Kinahan, on the north shore of the promontory of Howth; and, although not very definite, consist of track-like markings on the surfaces of some of the compact sandstone beds, which he considered referrible to Annelides and Mollusca ; from under these, in more slaty rock, he obtained slight impressions of what appears to be *Oldhamia antiqua*, a fossil occurring abundantly at Bray Head and Carrick Mountain, and up to the present time confined to Irish localities.

Professor Thomas Oldham† was the first to discover these remarkable fossils in the hard and fine-grained schists of Bray Head; they were afterwards described by Professor Edward Forbes as "the remains of marine animals, belonging either to Hydrozoa (corals), or Polyzoa (compound Mollusca"); and named by him *Oldhamia*, in honour of the dis-

* On the Lower Palæozoic Rocks of the South-East of Ireland, by J. Beete Jukes, Esq., and the Rev. Professor Haughton. Trans. Royal Irish Acad., vol. xxiii., p. 563, (1859).

† Now Superintendent of the Geological Survey of India.

coverer,* defining two species, *O. antiqua* and *radiata*, examples of which are figured, on Plate i., figs. 1 and 2. Several years later, Dr. Kinahan, who had collected better specimens, reviewed and figured them, giving scientific descriptions, with remarks respecting their affinities.†

The position these Fossils should occupy in the scale of organic life has been the subject of much discussion: by some palæontologists they are considered to be plants; others believe them to be allied to Graptolites. We prefer to leave them in the place originally assigned to them by Professor Forbes, because there appears to be no tangible ground for altering his opinion as to their alliance, and they resemble sufficiently close in their general appearance several of the Sertularian Zoophytes (commonly known as Corallines), particularly the arborescent forms of *Sertularia cupressina* and *argentea* ‡ (woodcut, fig. 1, *a*), which may be compared with *O. antiqua*. This species may be also compared with *Celluluria avicularia*,§ a Polyzoan of the family Escharidæ, woodcut, fig. 1, *b*; and the frondose or bushy variety of one of the Escharidæ, *Cellularia plumosa*‖ (woodcut, fig. 1, *c*, *d*), with *O. radiata*. If plants, they could only have been Nullipores or Algæ, and in that

Fig. 1.—*Recent Hydrozoa, &c., to compare with Oldhamia.*

All the figures are of the natural size.

a. Sertularia argentea, *upper portion.*
b. Cellularia avicularia.
c. *d*. Cellularia plumosa.

* Journ. Geol. Soc. of Dublin, vol. iv., p. 20 (1848).
† Trans. Royal Irish Acad., vol. xxiii. (1858).
‡ Johnston's British Zoophytes, vol. i., pl. xiv., *f*, 3; and vol. ii., pl. xv., xvi.
§ Ibid., pl. lxiii., figs. 7, 8.
‖ Ibid., pl. lxi., figs. 1-5.

case the probability is, that the impressions left by such readily decomposing vegetable organisms would not have appeared so sharp and clearly defined as that of the *Oldhamia* presents in the fine sandstones, in which they occur so abundantly in certain situations.

The remaining Fossils from the Irish Cambrians were discovered by Dr. Kinahan, who collected similar tracks and burrows to those described by Mr. Salter (Plate ii., fig. 3), as well as very large tubular burrows; some of which since obtained by the Geological Survey of Ireland, passing vertically through the grit beds, are several inches in length, (fig. 4, *c*); this fossil Dr. Kinahan named *Histioderma Hibernicum** (Plate ii., fig. 4); describing it as "a tentacled sea worm, evidently cephalo-branchiate, and not very dissimilar from the common Lugworm (*Arenicola*) of our present seas."

From this brief sketch of the Cambrian Fossils, it will be seen that in the great series of strata composing this, the oldest of the fossiliferous deposits in England and Wales, the earliest evidence of life indicates only the existence of marine animals referrible to Annelids, with a doubtful Crustacean. In Ireland similar tracks and burrows (*Arenicolites*), with a larger and more evident form (*Histioderma*), also Annelidan, occurs, and in addition the well-marked Sertularian-like Zoophytes (*Oldhamia*).

It has been argued, and with reason, that this apparent paucity of organic remains may have arisen from the nature of the deposit; arenaceous or sandy beds being generally bad preservatives of organic structure; and that there may have been a more varied assemblage of life during this epoch, including marine plants, and some of the softer kinds of Zoophytes, Mollusca, or other invertebrate animals, of which no record remains, either from the perishable nature of their structures, or from their obliteration during the process of change, or consolidation of the deposit in which they were imbedded: as this, however, is necessarily conjectural, much importance cannot be attached to it.

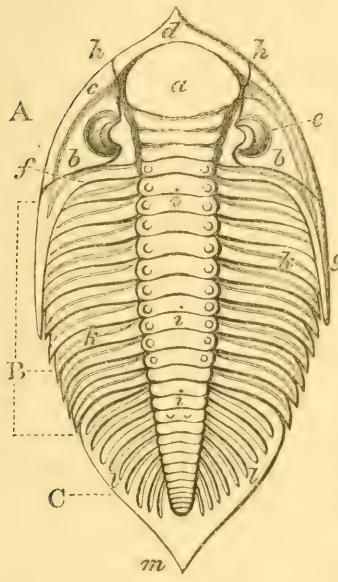
We have not thought it necessary to allude more particularly to the *Eozoön* of the Laurentian Rocks of Canada, described by Sir William Logan and others, as the presence of that questionable Fossil has not been yet satisfactorily established in the British Islands.

* Journ. Geol. Soc. of Dublin, vol. viii., p. 71.

Fossils of the Silurian Rocks.

The succeeding Formations of the next Fossiliferous epoch, the Silurian, disclose a considerable and rapidly increasing addition to the assemblage of Fossils found in them, especially in those deposits which were evidently favourable to their preservation; Corals, Mollusca, Crustacea, and Echinodermata being the classes of animals represented. We do not meet with any remains of a higher character than Invertebrata, until we arrive at the very uppermost beds of the Silurian strata, when we get the first evidence of vertebrate animals in the remains of fish.

Fig. 2.—*Parts of a Trilobite.*



Phacops caudatus.

A. Head, or Cephalic shield.
a. Glabella.
b. Sides, or cheeks.
c. Cheek margin.
d. Front margin.
e. Eyes.
f. Posterior margin.
g. Posterior angles, or cheek spines.
h. Facial sutures, or divisions of the head.

B. Thorax; thoracic rings, or segments of the body.
i. Axis, or central portion.
k. Pleura, or side lobes.

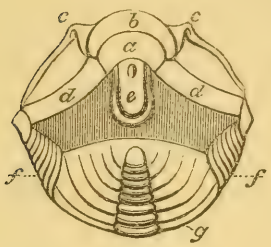
C. Pygidium, or tail—Caudal shield.
l Margin.
m. Mucro.

The extinct order of Crustacea called Trilobites, from their being three-lobed, are amongst the most important of Palæozoic Fossils, especially in the lowest division of these strata, the Lower Silurian, and the most highly organized of the Invertebrata occurring in them. To assist in their study, an outline sketch of a common Upper Silurian species, *Phacops caudatus*, with a definition of the principal parts, is shown in the woodcut, fig. 2; also the under side of the head, with the labrum at fig. 3 (on the following page), from a specimen of *Calymene tuberculosa*.

No trace of feet or swimming appendages has yet been observed on the under surface of the Trilobite, although both sides of the hard crust of these animals has been found, and their remains occur in every condition of rock favourable to the preservation of such organs, if sufficiently endurable to have become fossilized. Mr. Salter, therefore, concludes they were destitute of any such appendages, and that the ventral surface had not even membranous feet. It appears, however, scarcely possible that they were without locomotive organs of some kind; probably these were soft, and unpreservable, like those of some of the Crustacea, and other allied marine animals of the present day. Professor Burmeister gives an

ideal figure of the under surface of a Trilobite, with such an arrangement of soft parts, but which, although interesting as the opinion of so eminent an authority, is necessarily extremely conjectural.*

Fig. 3.



Calymene tuberculosa, showing under side of the head.
a. Rostral shield.
b. Rostral suture.
c. Part of the facial suture.
d. Margin of head.
e. Labrum, epistome, or hypostome.
f. Ends of pleuræ.
g. Tail, or pygidium.

With respect to their relations with existing Crustacea, they are believed to occupy a distinct group by themselves, presenting, however, such a resemblance to some recent forms of the Pœcilopoda and Phyllopoda, as to induce some authors to consider them to be intermediate, or closely allied to those orders of the Entomostraca or lower division of the Crustacea.

The range of this important group, as shown by Mr. Salter,† is from the lowest beds of the Palæozoic series, the Lingula Flags, to the upper, or Carboniferous Formation, its greatest abundance being in the Llandeilo and Caradoc Formations of the Lower Silurian; gradually lessening in importance to the upper part of the Carboniferous series, when they became extinct.

Fossils of the Lower Silurian Rocks.

To the labours of the Rev. Professor Sedgwick, and Sir Roderick Murchison, we are mainly indebted for the elucidation of the great series of strata known as the Lower Palæozoic Rocks.

This series of rocks, for the most part consisting of calcareous and argillaceous deposits, alternating with limestones, sandstones, and crystalline slates, are principally developed in North and South Wales, Shropshire, and the North-west of England; also to a considerable extent in the South of Scotland, and distributed over several counties in various parts of Ireland.

The principal and most of the minor divisions in the order of succession of Silurian strata adopted by the Geological Survey (and which we have followed)‡ are, as Professor Ramsay informs us, almost identical with those published in 1839 by Sir R. Murchison in the Silurian System; "the chief differences consisting in additions to our knowledge, due either to the discovery since that period of new and subordinate divisions, or to the better understanding of the precise stratigraphical re-

* Organisation der Trilobiten, by Dr. H. Burmeister; pl. vi., fig. 8.
† British Trilobites, Palæontographical Society (1864), pp. 6, 7.
‡ See Table of Fossiliferous Strata, *ante*, pp. 7, &c.

lations of members of the series; all the modifications of which have been recognised in the last edition of Siluria."*

Although the remains of organic life exhibit but little increase in the lower divisions of strata, immediately superimposed upon the Cambrian, yet there is a marked difference in their character, and they become much more evident as to their relations in the animal series; rapidly adding to their numbers and variety of forms towards the upper portion of the series; the following classes, all confined to the Invertebrata being represented:—

Zoophyta, or Corals, few; *Mollusca*, especially Brachiopod shells, abundant; of the *Echinodermata*, Crinoids few, Cystidea more numerous; *Annelida* few; and of *Crustacea*, the extinct group of Trilobites abundant.

Fossils of the Lingula Beds.

The designation "Lingula Flags" was first applied to those rocks, by Professor Sedgwick, in consequence of the discovery by Mr. Davis in rocks near Tremadoc, in 1845, of the shell named after him *Lingula Davisii* (since called *Lingulella* by Mr. Salter), which was found to be so characteristic and abundant as to give the name to the formation. These beds, divided into upper and lower by the Geological Survey, occur in North and South Wales, above the Cambrian Grits, near Bangor; near Bala, in Merionethshire; and at St. David's Head, Pembrokeshire; also in Shropshire; the series of strata occurring there being described by Sir R. Murchison, as "a great mass of dark coloured schistose shale, or consolidated mud, reposing upon the Cambrian Rocks of the Longmynd Mountains;" and, as forming the base of his system, since observed to be the equivalents in position of the Welsh Lingula Flags, although not yet found to contain Fossils.† At Malvern, black shales with Trilobites, first described by Professor John Phillips,‡ are also believed to belong to the same series.

On Plates iii. and iv. are figured the principal Fossils from these beds. They consist of what is supposed to be worm tubes or burrows (*Annelidan?*) named *Cruziana semiplicata*, Plate iii., fig. 1, and *Chondrites*, occurring, as Mr. Salter informs us, in matted masses, on the largely exposed surfaces of the arenaceous flags; the remarkable net-like Fossil, *Dictyonema sociale*, Plate iii., fig. 2, described by him as a Bryozoan or Polyzoan, and as forming a connecting link between the Graptolites and Fenestellidæ; abundant in the uppermost Lingula Flags near Tremadoc, and very generally distributed; occurring also in Shropshire and the Malverns. This fossil (identified by the author) has been also collected by the Geological Survey in Ireland. It certainly appears to be intimately related to Fenestella—a genus so prevalent in the Carboni-

* Memoirs Geological Survey, vol. iii., p. 1.
† Introduction to British Silurian Brachiopoda, Pal. Soc., 1866.
‡ Memoirs of the Geological Survey, vol. ii., part i., p. 54.

ferous limestone—but does not, in our opinion, present any special characters connecting it so much with the Graptolites as Mr. Salter considers it to do: the projecting corneous cells, alluded to by him as a distinctive character,* are quite as evident in some species of Fenestella, resembling very closely *F. frutex*, M'Coy. The Fossils called Callograptus and Dendrograptus by Professor Hall appear to exhibit more closely an intermediate stage, and to connect these net-like forms with the branching Graptolites. It is of considerable interest, however, as the oldest known form of Polyzoa in British strata, and as characterizing the "Primordial Zone" of Barrande; the equivalent of the Lingula Flags of Britain.†

The Brachiopod shell, *Lingulella Davisii*, Plate iii., fig. 3 (formerly called *Lingula*), said to be the commonest of all the Lingula Flag Fossils, belongs to a family of which the following genera are represented in British Silurian Rocks, viz., Lingula, Lingulella, Obolus, and Obolella.‡

It is widely distributed, and very abundant throughout the Tremadoc district of North Wales, some of the slaty beds being full of these shells, in which, however, their true shape is rarely preserved, being more or less flattened and distorted; it has been also found near St. David's Head, Pembrokeshire.

The small *Orthis lenticularis*, Plate iii., fig. iv., the earliest known in British rocks (believed by Mr. Salter to be identical with a Swedish species), is found in the Upper Lingula Flags, near Tremadoc; the Welsh specimens are described as occurring in myriads in some of the shales.

The Crustacea of the Lingula Flags, with one exception, are all Trilobites, that of *Hymenocaris vermicauda*, Plate iv., fig. 1, described as belonging to the Phyllopoda, and said to be abundant in the fine slaty layers at the upper part of the Lower Lingula Flags, near Portmadoc, in North Wales. The lowest and most rudimentary form of Trilobite, *Agnostus*, furnishes a species—*A. princeps*, fig. 2—met with in the greatest profusion in some of the beds of the Lower Lingula Slates, associated with others of a higher character.

The remarkable Trilobite *Paradoxides Davidis*, fig. 3, the largest of all British species, first discovered by Mr. Salter at St. David's Head, Pembrokeshire, South Wales, is also included by him amongst the Fossils of the Lower Lingula Flags, as occurring at Dolgelly, North Wales.§

The gems *Olenus*, which includes *Paradoxides*, is the most characteristic and abundant of all the Trilobites of the Lingula Flags. We

* Memoirs of the Geological Survey, vol. iii., p. 332.

† Siluria, third edition, p. 562.

‡ The genus Lingula ranges from the oldest strata up to the present time; as a recent genus, it is few in number of species. Mr. Davidson enumerates fifteen fossil species of British Silurian Lingulæ, and ten additional, not yet sufficiently made out, several of which, when better known, may prove to be synonyms. British Silurian Brachiopoda, pp. 33, 34.

§ Memoirs of the Geological Survey, vol. iii., pp. 247, 248, and Decade xi., Description to Plate x., p. 4.

have figured on Plate iv., three species—*O. micrurus*, fig. 4; *O. cataractes*, fig. 5; and *O. humilis*, fig. 6; the two former species both occurring in the black shales of the Lower Lingula Flags, North Wales; and the latter, a small species first described by Professor Phillips, common in the black shales of the Upper Lingula Flags, Malvern. The *pygidium* or tail of a Trilobite called *Dikelocephalus* (?) *Celticus*, fig. 7, and portions of the head and tail of another, *Conocoryphe invita*, fig. 8, both from Upper Lingula Flags, North Wales, complete the illustrations of the Crustacea given on Plate iv., which form an important and peculiar group in the strata of this Formation.

Fossils of the Tremadoc Slate.

These strata, as we are informed by Professor Ramsay,* were first described by the Rev. Professor Sedgwick, on special lithological grounds, as long ago as 1846; Mr. Salter having since, from the study of their Fossils, considered them entitled to rank as a distinct formation—a claim now acknowledged by the Geological Survey. They are described as a very local formation, immediately succeeding the black Lingula slates, and as being at present only recognised in certain parts of Merionethshire and Caernarvonshire, North Wales; and in Pembrokeshire, South Wales. The general range and character of these beds are shown by Professor Ramsay in his "Memoir on the Geology of North Wales," before referred to, and the Fossils, separated into two zones, described by Mr. Salter, and figured in the Appendix to the same volume; a selection from these has furnished us with the materials for Plate v., Trilobites being the most abundant; of these sixteen different kinds are enumerated in the list of species.† The most characteristic, according to Mr. Salter, are *Niobe Homfrayi*, fig. 4; and *Psilocephalus innotatus*, fig. 5 in the lower division; and *Angelina Sedgwicki*, fig. 2, and *Asaphus affinis* (or *A. Homfrayi*), in the upper. The remaining Fossils are almost entirely Mollusca—*Lingulella Davisii* (Plate iii., fig. 3), and a smaller shell, *Lingula lepis* (pl. v., fig. 7), also called Lingulella by Mr. Salter. Mr. Davidson, however, considers it to possess characters so similar to that of Lingula proper, that he places it provisionally with the last-named genus.‡ Both these species are noticed as occurring in the Lingula Flags, and are stated by Mr. Salter to be the only Fossils which ascend from that lower horizon. The other shells are *Bellerophon Arfonensis*, fig. 8; *Theca operculata*, fig. 9; and *Conularia Homfrayi*, all frequent Fossils in these beds, the genus *Theca* being very predominant; *Orthoceras* and *Cyrtoceras* are also said to occur, appearing for the first time in these deposits in Britain.

* Mem. of the Geol. Survey, vol. iii., p. 7.
† Ibid., p. 253.
‡ British Silurian Brachiopoda, p. 54.

Fossils of the Llandeilo Flags.

The strata next in order of superposition are what are called the Llandeilo Flags, a series of deposits consisting of black earthy slates, and interstratified sandy flagstones, with occasional calcareous bands, which sometimes become regular limestones. Some of these beds contain a great abundance of Fossils, particularly in the neighbourhood of the town from which it derives its name—Llandeilo Fawr, in Caermarthenshire; and near Builth, in Brecknockshire; similar rocks occupying parts of both North and South Wales. This Formation also occurs in the Silurian region on the western flank of the Stiper stones of Shropshire, as well as in Cumberland; the Skiddaw slate, its representative, forming the lowest band in that slaty region.* Fossils indicating strata belonging to this Formation have also been collected at various places in the south and central parts of Ireland, and probably also in the north: there is, however, from the absence of continuous sections, much difficulty in determining their relative positions at present. The advancement of the Geological Survey, combined with a more extended examination of the Fossils, will doubtless afford a better clue as to the equivalents of the various members of the Silurian Formation in that country.

This group of strata has been separated into two series—Upper and Lower—and the Fossils enumerated in the Appendix to the Geology of North Wales,† as well as in the Appendix to Siluria, third edition.

The fossils of the Llandeilo Formation are more varied as to the classes represented, as well as more numerous, than in any of the preceding Formations; they consist of a few Corals, very few Crinoidal remains; and a peculiar group of organisms, called Graptolites—which first make their appearance in the lower division, attaining their maximum development in the upper series of these strata. As these remarkable Fossils are entirely confined to the Silurian Rocks, they become very important indicators of Lower Palæozoic strata. Of Molluscous shells, Brachiopods are the most numerous, particularly the Orthidæ and Lingulæ; we have in these strata the earliest evidence of Lamellibranch bivalves. The Gasteropoda, or univalves, were mostly of the Euomphaloid type; both these classes, most abundant at the present day, having been but poorly represented in these ancient strata. On the contrary, shells referred to Nucleobranchiata, as Heteropoda, the class Pteropoda, and the now almost extinct class of Cephalopods, were the prevailing forms.

The group of Trilobites existed in great numbers during this epoch, several new genera first making their appearance, such as Æglina, Trinucleus, Ampyx, and Calymene.

The Fossils figured on Plate vi. are of a miscellaneous character. *Palæochorda major*, fig. 1, is believed to be a plant belonging to the sea-weeds or Algæ; *Pyritonema fasciculus*, fig. 3, *Protovirgularia dichotoma*,

* Introduction to Brit. Sil. Brachiopoda, by Sir R. I. Murchison, Pal. Soc. p. 25.
† Memoirs of the Geological Survey, vol. iii., pp. 256, 258.

fig. 4, and *Nebulipora favosa*, fig. 2, are Zoophytes or Corals, the two former considered to belong to the Gorgonidæ, the latter to the Favositidæ, a group of the division Zoantharia tabulata of Professor Milne Edwards; it resembles very closely some of the varieties of *Stenopora* (Favosites), *fibrosa*, small Corals, generally branching, and composed of an aggregation of basaltiform corallites belonging to the same family; first appearing in this Formation, and continuing throughout the remainder of the Silurian rocks, but most abundant and characteristic of the next or superimposed Formation, that of the Caradoc or Bala, with the Fossils of which we have figured it, Plate x., fig. 1.

It is not until we reach the Upper Silurian that we meet with many of the larger kinds of Corals, those which secrete a calcareous framework, and are in consequence so easily preserved as Fossils; they are abundant in the Wenlock limestone. There may have been, however, during the period of these earlier deposits, softer kinds, such as the Actiniæ (Sea Anemones), and allied forms, which would have been unpreservable, and of which, therefore, no traces remain.

The portion of an Encrinite stem, fig. 5, referred to *Cyathocrinus* by Mr. Salter, is stated by him to be the earliest British record of the order Crinoidea, which afterwards became so abundant throughout the Palæozoic strata.

The singular markings called *Nereites Cambrensis*, fig. 6, with others of a somewhat corresponding character, have been usually described, from their resemblance to marine worms, as Annelidan; but, as we are now aware that some of the shell-bearing, as well as soft Mollusca, and other marine animals, during their locomotion produce sinuous tracks over the smooth surface of sand, as well as burrow through it, and even excavate cavities in the hard rock, it would not be safe to rely too confidently on such markings as exact evidences of the class to which they have been referred; they are nevertheless useful as characterizing particular sandy and flaggy beds, in this and more recent Formations in which there are often no other remains perceptible. We have in figures 7 and 8 more tangible evidence of the Annelida. Fig. 7 is referred by Mr. Salter to *Arenicolites*, fig. 8 to *Scolites:* the latter he believes to be the ordinary fillings up of worm tracks in the sandy mud, and for such he proposes to retain the name of *Scolites;* for those which show double vertical burrows, such as fig. 7, that of *Arenicolites.*

The Trilobites figured on Plate vii. consist of examples of those genera which are most frequent, as well as characteristic of this Formation; a small species of *Agnostus*, named *A. M'Coyii*, fig. 1, belonging to a genus before alluded to (*ante*, p. xvi.), as being the most rudimentary form of the group; and, on the contrary, one of the largest and well developed of these Crustacea is that of *Asaphus tyrannus*, of which fig. 2 is a reduction; it is said to be eminently characteristic of the Upper Llandeilo, not ranging above that Formation, and limited to the British area. *Ogygia Buchii*, fig. 3, is another very important Trilobite, particularly abundant in the Llandeilo shales, near Builth, and believed to be also confined to the same Formation. A small Trilobite, *Æglina binodosa*,

fig. 4, remarkable for its globular head and large eyes, also by having two nodular prominences on the third segment, and a triangular tail, is abundant in the black slates of the Lower Llandeilo, west of the Stiper stones, Shropshire.

The most easily recognised, as well as perhaps the most characteristic genus of Trilobites in this Formation, is that of *Trinucleus*, moderately small in size, but important in point of numbers, as some of the species are; the expanded border to the head, usually ornamented with radiating lines or perforations, its stunted form and long cheek spines readily distinguish it. We have included two species on Plate vii. *Trinucleus fimbriatus*, fig. 5, originally figured in the 'Silurian System' (head only), pl. xxiii., fig. 2 (as Mr. Salter informs us), is not the same Fossil as that figured so long ago as 1698, by Dr. Llhwyd in the "Philosophical Transactions" as *Trinucleum fimbriatum*, that being the common Llandeilo species, *T. concentricus* or *T. Caractaci*.* The fossil from which our figure was taken was collected at Builth, in Radnorshire, where it is very plentiful. *Trinucleus Lloydii*, fig. 6, is a species also originally figured in the Silurian System, pl. xxiii., fig. 4, and since by the Geological Survey in Decade vii., pl. vii. The figure in the Silurian system, as remarked by Mr. Salter, "although characteristic, was taken from a specimen having but five body, or thoracic rings;" he supposes the deficiency due to accidental growth. It is said to be confined to Caermarthenshire and the mining district of Shropshire, where it is frequent. Belonging to the same small group is *Ampyx nudus*, a species remarkable for its extremely developed cheek spines and pointed frontal spine. It affords a good illustration of the caution necessary in naming and describing, having been originally figured in the 'Silurian System' as a species of Trinucleus, in consequence of its imperfect character, from being deprived of its spines, and under the supposition that it had lost the expanded margin peculiar to that genus; specimens in a more perfect condition were afterwards collected at Builth, where it is not uncommon, proving it to belong to the genus Ampyx; and it was again described by Professor E. Forbes, then Palæontologist to the Geological Survey, in Decade ii., Plate 10, the drawings to illustrate it being executed by the Author, who has repeated the principal figure on Plate vii., fig. 7. No facial suture has been observed in this genus, and it is said to be without eyes.

The remaining Trilobite, *Calymene duplicata*, belongs to a genus which ranges through the whole of the Silurian strata from the Lower Llandeilo to the Ludlow, and is, according to Mr. Salter, one of the most typical forms of Trilobite, and not known beyond the British Isles. It is abundant at Builth, and occurs also in South Wales and Shropshire.

Various classes of the Mollusca, some of which appear for the first time in this Formation, are represented on Plate viii., most numerous amongst them being the shells of *Brachiopoda*, which includes several species of *Orthis;* of these *Orthis alata*, fig. 4, is confined to the Llandeilo

* Memoirs of the Geological Survey, Decade vii., Explanation to Plate vii., p. 5.

rocks. *O. calligramma*, fig. 5, a common shell throughout the Lower Silurian, most characteristic of Caradoc or Bala strata, and *Orthis striatula*, fig. 1, are figured, not for their abundance, but to complete the group of Llandeilo Fossils. The Lingulæ selected from amongst the half dozen or more species of this genus occurring in this Formation is *Lingula attenuata*, fig. 1, *a*, small shell, originally described and figured in the 'Silurian System;' and *L. plumbea*, fig. 2, a more orbicular form, referred to Obolella by Mr. Salter, with respect to which Mr. Davidson, in his monograph on British Silurian Brachiopoda, observes that "it is not perfectly certain that any of our hitherto discovered British species agree with Mr. Billings' genus, although two or three have been referred to it."

The very small orbicular Brachiopod, *Siphonotreta micula*, fig. 3, first described by Professor M'Coy, is remarkable for its gregarious habits, as shown by the profusion in which it occurs; one hundred of these little shells having been counted on a fragment of shale four or five inches square from Pen Cerrig, Builth.

The ordinary Bivalves, or Lamellibranchiata, are but few in number in these ancient deposits, as it is here only we observe the first certain evidence of their appearance. Examples of these are given on Plate viii., figs. 7, 8, and 9, under the names of *Palæarca*, *Redonia*, and *Ribieria*. The Univalve or Gasteropod shells were likewise, but feebly, represented in this Formation, in which they also first make their appearance. *Euomphalus*, fig. 10, is a genus of the Turbinidæ, very frequent in Palæozoic strata, ranging from these Llandeilo beds to the Trias; *Ophileta*, fig. 11, being apparently a closely allied shell.

To the Nucleobranchiata, which include the Heteropoda, shells, the animals of which swim at the surface, instead of creeping on the bed of the sea, *Bellerophon*, fig. 12, a convoluted shell, with a notched aperture, resembling somewhat that of the recent *Atlanta*, is believed to have belonged; a genus ranging from this formation through the entire series of Palæozoic strata. This class of the Mollusca was developed to a much greater extent, anciently, than at the present day, particularly during the Silurian epoch. The *Maclurea*, fig. 13, a large discoidal shell resembling Euomphalus, with a solid operculum, fig. 14, corresponding with a species named *M. Logani*, which abounds in the Chazy limestone of the United States and Canada, is doubtfully included with Bellerophon in the family Atlantidæ, as a Nucleobranch shell.* It is also alluded to as probably belonging to Pteropoda, although the occurrence of this group in the older rocks is very obscure.†

The Pteropoda, a group of small animals, which appear in incredible numbers in the tropical seas, are, it is thought, represented Palæontologically by much larger forms, such as *Theca*, species of which are figured on Plate v., fig. 9; and Plate viii., fig. 15; and *Conularia*, Plate v., fig. 10.

The highest and most important class of Mollusca, that of the Ce-

* Manual of the Mollusca, by S. P. Woodward, p. 202 (Weale's Series).
† Palæontology, by Prof. R. Owen (1860), p. 72.

phalopoda, is represented in this Formation by *Orthoceras*, fig. 16; these straight shells, divided by "septæ," and externally striated, are the most abundant and widely distributed of the Mollusca in Palæozoic strata, and attained a larger size than any other fossil shell.

Next in Palæontological importance to the Trilobites, are the remarkable bodies called *Graptolites*, their name being derived from two Greek words, signifying written stone, or writing on stone. Various kinds of these Fossils are represented on Plate ix. This group of anomalous marine animals, so abundant in these ancient strata, wherever the condition of the sediment (such as a fine muddy deposit, converted into argillaceous shale) was favourable to their existence, has, like the Trilobites, entirely passed away; their representatives at the present day being most probably the compound Asteroid Zoophytes, such as *Virgularia*, in which the polypidoms are arranged on either side of a rod; and other elongated forms of the *Pennatulidæ*, or sea pens, and the *Sertularian Zoophytes* or *Corallines*, belonging to the *Hydrozoa*, so abundant on our sea shores. To illustrate these, and for comparison, see woodcut, fig. 4.

Fig. 4.—Graptolites, and probable allied recent Hydrozoa, and other Zoophytes.

a. b. Virgularia mirabilis; (recent), *a.* nat. size; *b.* enlarged. Die Graptolithen, &c., pl. 22, *a*, *b*, by Prof. Geinitz.
c. d. Sertularia fallax; (recent) *c.* nat. size; *d.* enlarged portion. British Zoophytes (Johnston), pl. xi., figs. 5, 6.
e. f. Diplograpsus pristis; (fossil), *e.* nat. size; *f.* enlaged portion. Die Grap. pl. i., fig. 23.
g. h. Plumularia pennatula; (recent), *g.* nat. size; *h.* enlarged portion. Brit. Zooph., pl. xxii., figs. 1, 2.
i. k. Graptolithus sagittarius; (fossil), *i.* nat. size; *k.* enlarged portion. Journ. Geol. Soc., vol. viii., pl. xxi., fig. 8, *c*, *d*.
l. Graptolithus priodon; (fossil), restored, after Forbes.

Their exact relations are still, however, the subject of discussion, notwithstanding the discovery of so many extraordinary forms in Canada; some naturalists believing their alliance to be more with the Polyzoa.

The forms represented on Plate ix. are examples of the various genera met with in British strata; in *Graptolithus*, a single row of cellules are arranged on the axis or *stipe*, of which G. sagittarius, fig. 1, may be considered the type; G. Nilssoni, fig. 2, being another example of these single Graptolites, which are not confined to Lower Silurian strata, like the double forms; one of the single Graptolites, *G. priodon*, being almost as abundant and generally distributed as *D. pristis*, ranging from Caradoc or Bala rocks through all the stratigraphical divisions of the Upper Silurian. Those having a central axis, on which a double line of cellules are arranged, are well shown in *Diplograpsus pristis*, and its variety *scalariformis*, fig. 3. To this species the living Zoophyte, *Virgularia mirabilis* (woodcut, fig. 4, *a*, *b*), presents perhaps the nearest resemblance: it is the most frequent of all the Graptolites in the Llandeilo Formation, of which it is eminently characteristic, and, as far as at present known, confined to Lower Silurian strata, as are all the double forms.

D. teretiusculus, fig. 4, also a double form, is a smaller and less abundant Graptolite, although a characteristic one of the Llandeilo series, to which it is said to be entirely confined.

In the double Graptolite, *Didymograpsus Murchisoni*, fig. 5, the axis diverges from a "radicle," or point, the cell serratures being arranged in a single series on the inside of each branch. Another and smaller diverging form of Graptolite is that of *Didymograpsus sextans*, fig. 6; it has the cell serratures arranged on the outer edge of the axis, and is very characteristic of this Formation. Some of the specimens collected by Mr. C. Galvan, of the Geological Survey of Ireland, from near Dungarvan, show the "initial points," or "radicles," exactly resembling the original figures of this species given by Professor James Hall, in the Palæontology of New York, vol. i., pl. lxxiv., fig. 3, *d*, *e*.*

As an example of a coiled form, *Rastrites peregrinus*, fig. 7, is not an uncommon one in the black shales of the upper division of this Formation in Dumfriesshire. This elegant little Graptolite differs from all the preceding ones alluded to in the narrow and delicately curved axis, from which proceed, at regular intervals, the elongated narrow tubular cellules peculiar to this species, and developed on one side only of the axis or stipe.

In concluding this account of the Fossils of the Llandeilo Formation, it will be important to remember, that Graptolites, according to our present knowledge, wherever detected, will be found to present a *certain* indication of Silurian strata. This fact, in connexion with the merest rudiments of geology, if properly known, might have saved

* Those who wish to study this interesting and important group of Fossils should consult Decade ii. of the Geological Survey of Canada, under the direction of Sir Wm. Logan, the Graptolites, by Professor James Hall, 1865.

many thousand pounds in the fruitless search for coal, which has in several cases been made through these black shales containing Graptolites, under the impression that they were coal shales with plants.*

* Mistaken ideas, such as these, which have led to 'vain' trials for coal, have often fallen under the notice of the Geological Surveyors. They are alluded to by Professor John Phillips, in the Memoirs of the Geological Survey, vol. ii., part i., p. 54, in his account of the black shales of the Silurian district of Malvern; and by Mr. J. Beete Jukes, Director of the Geological Survey of Ireland, in his address delivered before the Lord Lieutenant, at the Museum of Irish Industry, December 21st, 1866. The author also has recorded similar mistakes in his 'notice of Fossil localities near Drogheda,' read before the Geological Society of Dublin, January 12th, 1859; as, for instance, at the Commons of Slane, there are places which are marked on the Ordnance 6-inch Maps as coal pits, where fruitless trials have been made through black slates of the Silurian Formation, containing Graptolites, under the impression that they were plants, involving necessarily the same barren results and loss of capital.

Fossils of the Caradoc or Bala Rocks.

This group of strata derives its name of Caradoc from the range of hills in Shropshire, of which Caer Caradoc is the highest, as on its flanks the strata are well exposed. In this county the beds consist mostly of sandstones with impure shelly limestone and shales: in consequence of a fault, this formation is separated from the underlying Llandeilo Flags by the intervention of the Cambrian Rocks of the Longmynd. In North Wales, in the neighbourhood of Bala, Merionethshire, these strata consist of hard slaty rocks, occasionally sandy, with bands of a similar impure fossiliferous limestone, which in that district immediately overlie the Llandeilo formation, and extending westward in undulations, constitute the slates of the summit of Snowdon. In Caermarthenshire and Pembrokeshire, South Wales, the same relative order of superposition prevails, with a similar distinction between the organic remains of the Llandeilo and Caradoc groups of strata; the Llandeilo beds near Llandovery being regularly overlaid by slaty and arenaceous beds full of characteristic Caradoc fossils, these being again covered by the conglomerates at the base of the Llandovery series.

In the north-west of England the Skiddaw slates of Cumberland are proved to be of Lower Llandeilo age; and to the south of these lofty mountains of the Lake District, the Coniston limestone, with its overlying flagstones or grits, by comparison of its organic remains, is clearly shown to be a representation of the Caradoc formation.

In Ayrshire, Scotland, the limestones on the Stincher and Girvan rivers contain fossils of Caradoc types, the beds in which they occur being covered by conglomerates, sandstones, and shales of the Llandovery formation.

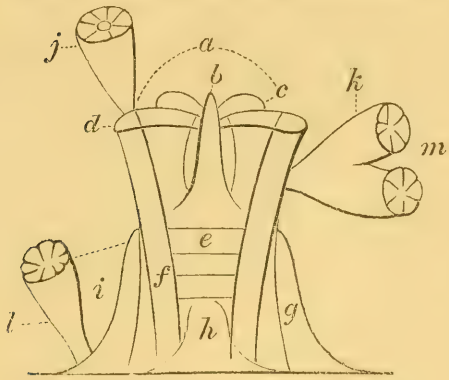
In the north of Ireland, the shales and sandy strata of Tyrone, parts of Meath, with the Silurian limestones and shales of the county of Dublin, and that known as the Chair of Kildare, as well as large districts in Wicklow, Wexford, and Waterford, in many places abound with fossils also of Caradoc age.

Plates x. to xiii. contain a selection of some of the most characteristic fossils. It is, however, obvious that amongst such a profusion of the remains of organic life as have been obtained from this formation, a comparatively small number only can be figured in a work like the present.

Corals, always more prevalent in the limestones, are but feebly represented in argillaceous, sandy, or calcareous deposits, and although sometimes abundant, are of doubtful character. Whilst treating of this important class of fossils, the following diagram (fig. 5) will serve to

explain the terms used in describing these various elements of the calcareous structure, the only part preservable in a fossil state:—

Fig. 5.—Parts of a Coral (after Forbes).



a. Calice, or cup.
b. Columella.
c. Pali.
d. Lamella, or septa.
e. Dissepiments, or tabulæ.
f. Theca.
g. Epitheca.
h. Endotheca.
i. Cœnenchyma.
j. Calycial budding.
k. Lateral and superior budding.
l. Lateral and inferior budding.
m. Fission.

Such forms as *Petraia æquisulcata*, Pl. x., fig. 2, although sometimes abundant, are of doubtful character. In the explanation to that Plate, p. 28, I have remarked on the probability of this coral and others belonging to Cyathophyllum, a genus of turbinated corals arranged under the sub-order Zoantharia rugosa, by Professor H. Milne Edwards and Jules Haime. Entirely agreeing with these eminent authors of "British Fossil Corals" that the species which constitute the genus *Petraia* or *Turbinolopsis* are merely internal casts of simple turbinated corals, having characters undistinguishable from that of *Cyathophyllum*,* I propose to include in that genus the above-named species and others common to the Llandovery rocks, characteristic examples of which are figured amongst the fossils of that formation on Plate xiv., figs. 1, *a*, *b*, *c*.

The most universally distributed of the corals is *Favosites*, (*Stenopora*) *fibrosus*, branching and hemisphærical varieties of which are shown on Pl. x., figs. 1 *a–d*. It is most abundant (especially the branching variety) in Lower Silurian rocks, ranging through all the Silurian strata from the Llandeilo to the Ludlow formation; its occurrence in the Upper Llandeilo rocks of Wales being recorded in Mem. Geol. Surv., vol. iii., p. 258.

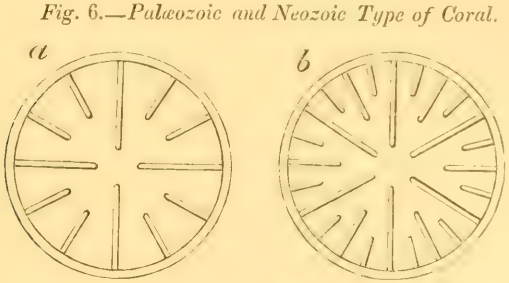
Accompanying it in these Lower and Upper Silurian strata is the remarkable "chain coral," *Halysites catenularius*, figured amongst the fossils of the Wenlock rocks, Pl. xvii., figs. 3 *a–d*, as being most abundant in that formation. *Heliolites interstinctus* on the same Plate, fig. 1 *a*, *b*, *c*; and *Favosites Gothlandicus*, fig. 2 *a*, *b*, *c*; all these corals

* Monograph of Brit. Fossil Corals, Palæontographical Society, 1850–4, pp. 226 and 286.

having a very similar structure, being composed of an aggregation of radiating tubes, and belonging to the same division *Zoantharia tabulata*, of Milne Edwards and Haime, flourished in the greatest profusion during the period of the Wenlock formation. The first of these species, *Halysites catenularius*, commencing in the Llandeilo formation, continued on, through the intermediate formations to the Wenlock; the second, *Heliolites interstinctus*, first appearing in the Caradoc, continuing on through the intermediate formations to the Ludlow rocks; the third, *Favosites Gothlandicus*, having the same geological range, according to the Table of British Silurian Fossils in Siluria, 4th ed., p. 510; about twenty other species of corals are recorded from the Caradoc formation in the same Table. "The true corals," as Sir R. I. Murchison observes, "are far more characteristic of the upper than of the lower members of the Silurian rocks; and they are more abundant in them both as to species and individuals." *Ibid.*, p. 217.

The discovery by MM. Milne Edwards and Haime of a *Palæozoic* or ancient and *Neozoic* or modern type is of considerable importance; the former constituting for the most part their sub-orders or divisions *Zoantharia rugosa* and *tabulata*, the latter embracing the majority of the Oolitic and recent species comprised in that of *Zoantharia aporosa*. The corals belonging to *Z. rugosa*, which include the *Cyathophyllidæ*, *Lithodendroninæ*, and *Cystiphyllidæ*, are characterized by having transverse tabulæ, *dissepiments*, and a quadrupartite arrangement of the septæ into four, or multiples of that number, fig. 6 *a*.

Fig. 6.—*Palæozoic and Neozoic Type of Coral.*



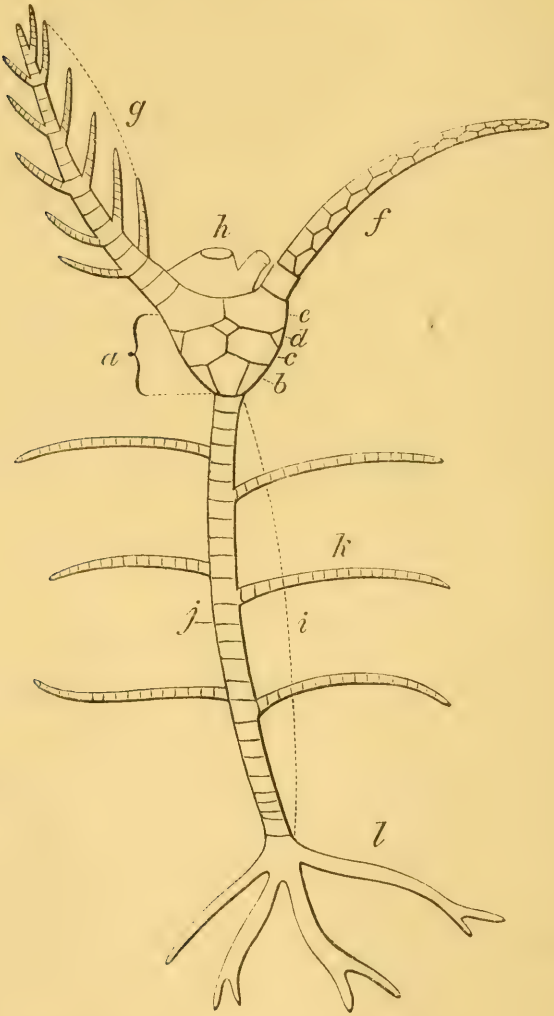
In *Z. tabulata*, which includes *Favosites*, *Heliolites*, *Halysites*, &c., the tabulæ or *dissepiments* are present; the septal arrangement is, however, rudimentary.

In contradistinction to these, the division *Z. aporosa*, which constitutes the Neozoic type, and includes the principal Oolitic and recent corals, such as the *Turbinolidæ*, *Oculinidæ*, *Astreidæ*, and *Fungidæ*, the septal apparatus is highly developed, being composed of six elements or multiples of that number (fig. 6, *b*); and there are no tabulæ or *dissepiments* like those which characterize the older or Palæozoic corals.

Crinoids are those forms of the Echinodermata, having a more or less globular body, composed of series of calcareous plates, from which

proceed rays, and provided with a jointed stem, terminating in root-like processes, for the purpose of attachment to submarine bodies.

Fig. 7.—*Parts of a Crinoid* (after Forbes).



a. Calyx, or cup.
b. Basal plates, "Pelvis."
c. Primary radial plates.
d. Intermediate and accessory plates.
e. Brachial plates.
f. Arms.
g. Pinnules, or fingers.
h. Mouth, or proboscis.
i. Stem, or column.
j. Joints.
k. Ramules, or side arms.
l. Root, or base of attachment.

The diagram, fig. 7—an ideal representation or typical example of the order—is intended to show the various parts entering into its composition and their designation. Like the corals, the "Stone Lilies" attained their maximum in Upper Palæozoic strata, their remains being especially abundant in the Wenlock and Carboniferous Limestone.

In the older Silurian strata they are comparatively rare, except as fragments; we have figured amongst the Llandeilo fossils (Pl. vi., fig. 5) a portion of them referred to *Cyathocrinus*, which is said to be the oldest crinoid known in British strata. A nearly complete example, named *Glyptocrinus basalis* is shown on Pl. x., fig. 7, as a Caradoc fossil, although they are seldom met with in so perfect a state in beds so low in the series.

The Cystidea.—Sphæronites of old authors, are plentiful in British strata, first appearing in Caradoc shales and limestone; they abound in the Lower Silurian strata of Scandinavia and Russia. This group of the Echinodermata, allied to the crinoids by a resemblance of some parts of their structure, are mostly rounded bodies formed of a number of closely united polygonal plates, the stem or column being short or rudimentary. In some the arms and tentacles are only obscurely indicated (as in Pl. xviii., fig. 6) or entirely absent. The "pectinated rhombs" and "pyramids," or ovarian openings, such as are figured on the same Plate, figs. 6, *b* and *c*, are characteristic peculiarities of this group. The principal genera found in this formation are shown on Pl. x.—*Sphæronites*, fig. 4; *Echinosphærites*, fig. 5; and *Hemicosmites*, fig. 6.; they include sixteen species, and probably represent in these older deposits the sea urchins or Echinidæ of modern seas.

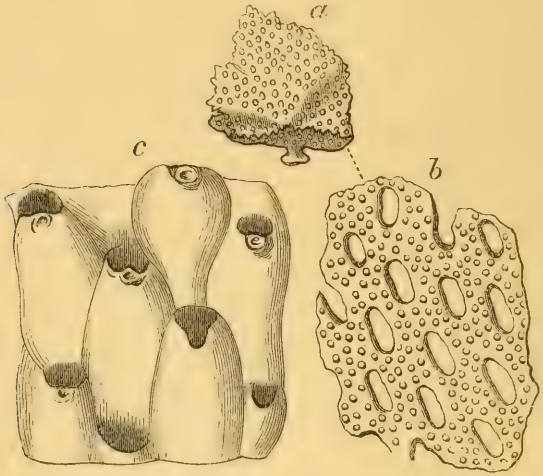
Starfishes not very unlike those of the present day occur for the first time, although not frequent, in Caradoc strata. *Plœaster obtusus* resembles so much the living Uraster as to have been originally referred to that genus; another smaller species, doubtfully named *Protaster*, and figured on the same Plate (9, *a b*), appears to be allied to *Ophuira*, the brittle star. Sixteen species of starfishes are recorded from British strata—six in Lower, ten in Upper Silurian.

The net-like Polyzoa, now considered as belonging to the lowest group of the Mollusca, but formerly classed with corals to which they certainly bear a close relationship, are more abundant in Upper Silurian strata.

Fenestella assimilis, pl. xi., fig. 1, which is also a common Wenlock species, is a good example of this class of fossils, and is not unlike some modern forms at present existing in the seas of Europe; it occurs abundantly in the Caradoc limestone of the Chair of Kildare.

For comparison with this fossil and that of *Dyctyonema*, figured on Pl. iii., fig. 2, which appears to be more closely connected with the Reteporidæ than to Graptolites, I have introduced a figure (woodcut fig. 8) of a small but well-marked recent species with enlarged portions, showing the arrangement and form of cells in this British species of network coral: from Johnston's British Zoophytes, 2nd ed., woodcut 67, p. 354; and enlarged view of cells from Busk's Polyzoa; Pal. Soc., Pl. xii., fig. 2.

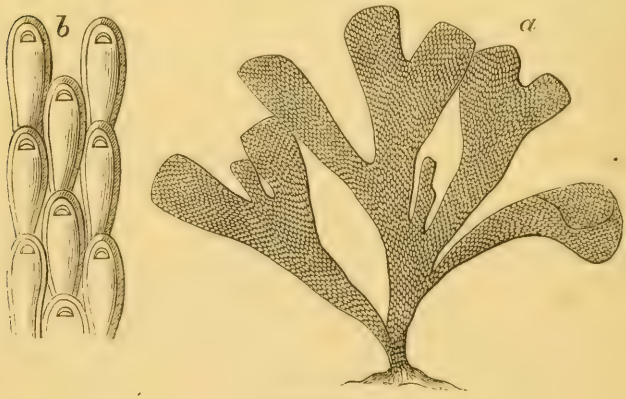
Fig. 8.—*Retepora Beaniana, or net-work coral, a recent Polyzoan.*
Hab. Deep Water, British Seas.



a. Natural size.
b. Portion of the surface enlarged, showing celluliferous spaces and openings.
c. A few of the cells highly magnified; showing the openings.

Other forms flattened and sometimes branched, are more generally distributed in Lower Silurian strata, such as *Ptilodictya acuta* on the

Fig. 9.—*Flustra carbasea, or "Sea Mat," a recent Polyzoan.*
Hab. on Shells from Deep Water, British Seas.



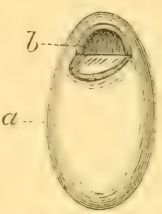
a. Natural size.
b. Cells enlarged.

same Plate, fig. 2; this species may be compared with the recent *Flustra carbasea* (woodcut, fig. 9); from Johnston's British Zoophytes,

2nd ed., pl. lxiii., figs. 1, 2, to which it is closely allied, being included in the same family Escharidæ.

To illustrate this group of fossils, which are formed of a number of cells arranged in several series and of various shapes, the small woodcut, fig. 10, reduced from Busk's Polyzoa (Pal. Soc.), will serve to show the normal form of a cell with its orifice or aperture and lid. The margins of this opening, from which the "polypes" protrude in the living examples, are either smooth, provided with spines, or valvular.

Fig. 10.—*Cell of Polyzoan* (after Busk).



a. Cell.
b. Orifice or aperture.

Brachiopoda are the most numerous of the Molluscan shells in Caradoc strata; characteristic forms of *Lingula*, *Discina*, and *Crania*, are represented on pl. xi., figs. 3, 4, and 5. *Leptæna sericea*, fig. 6 of the same plate, a common fossil throughout Lower Silurian strata, is most numerous in strata of this formation. *Orthis Actoniæ*, fig. 7, characteristic also of the Llandeilo rocks, *O. flabellulum*, fig. 8, and *O. calligramma*, especially the latter, is remarkably abundant in Caradoc rocks, as also is *Strophomena expansa*, Pl. xii., fig. 1.

Conchifera, or ordinary bivalve shells, are less numerous in these older strata, except in special localities; *Modiolopsis*, Pl. xii., figs. 2 and 3, resembling the recent Modiola; and *Ctenodonta*, fig. 4, small shells with hinge teeth, like the recent Nucula, are examples of some of the most frequent.

Gasteropoda.—Univalve shells are still fewer in the number of species, although some of them, such as *Holopea concinna*, fig. 5, and *Murchisonia turrita*, fig. 6, abound in strata of this age at certain localities in Ireland; the former species, although resembling much the recent *Natica*, is believed to represent the Ianthinæ, or oceanic floating snails; and *Murchisonia*, the Pleurotomariæ of Upper Palæozoic and secondary strata, and the recent Cerithia with notched apertures.

Of the Nucleobranchiata, univalve shells resembling the nautilus in external form, but without possessing air chambers, eight species are recorded from Caradoc strata. *Bellerophon bilobatus*, fig. 7, is a common fossil of this formation in Britain, being "equally characteristic of the same deposits in North America, Spain, and Bohemia.—Sil., 4th ed., p. 198.

Theca reversa, fig. 9, is believed to be a Pteropod, with which the delicate shell of the recent Clio borealis offers a comparison. The fossil named ? *Theca triangularis*, fig. 8, and to which I have prefixed a query in the explanation of Plate xii., was figured by Portlock as a doubtful Orthoceratite, and has since been referred to Theca. Having had the opportunity of examining his original specimens, I have come to the conclusion that it is nothing more than the pointed termination of an Orthoceras, such as the species he figures from the same locality as elongato-cinctum or subundulatum; it was unfortunately introduced into the Plate before I discovered it had characters incompatible with that of

Theca; such as a thick shell showing lines of septæ at regular intervals, which are independent of the fine transverse striæ with which the surface is marked, these characters being identical with that of Orthoceras.

The small tapering and tubular shell, ornamented at regular intervals with rings, *Tentaculites Anglicus*, Pl. x., fig. 3, is remarkably frequent in some beds of the Caradoc sandstone, particularly at the locality from which the examples figured were obtained, in a buff-coloured sandstone from Cheney-Longville, Shropshire; it is also plentiful in Llandovery strata.

Minute bivalved Crustacea belonging to the *Ostracoda*, such as those figured on Plate xiii. *Cytheropsis umbonata*, fig. 1, and *Primitia Maccoyii*, fig. 2, are not uncommon in some of the Caradoc deposits; the latter species being remarkably abundant in the limestone of this age at the Chair of Kildare.

Beyrichia, fig. 3, and *Agnostus*, fig. 4, are other small crustaceans; the former, a bivalved *Phyllopod*, the latter, one of the rudimentary forms of the extinct group of Trilobites, a class of fossils largely represented in these rocks; some of the most common species being figured on the same Plate, such as *Illænus Bowmanni*, fig. 5; very plentiful in the Bala limestone of North Wales, and that of the Chair of Kildare in Ireland; it also ranges into Llandovery strata. *Trinucleus concentricus*, fig. 5, "has a very extensive Lower Silurian range both in Europe and America." Sil., 4th ed., p. 204. *Lichas laxatus*, fig. 7, a perfect example of which is given in the above edition of Siluria, p. 204; Fossils (46, fig. 5), frequent in North Wales, is not uncommon in Caradoc or Bala limestone of the Chair of Kildare; this species also ranges into the Llandovery rocks. *Calymene brevicapitata*, fig. 8, is a variety of the well-known Dudley fossil occurring in Lower Silurian strata of this age in Tyrone. This species, under the name of *C. senaria*, is included in the list of Caradoc fossils of North Wales as occurring at several localities in that district. Mus. G. S., vol. iii., p. 263. *Homalonotus bisulcatus*, fig. 9, is plentiful in the Caradoc sandstone of Shropshire. *Sphærexochus mirus*, fig. 10, a very common fossil at the Chair of Kildare, is found perfect in the Wenlock limestone near Dudley; and *Phacops Brongniarti*, confined to Caradoc strata, is found in North Wales, and occurs in profusion, often in a perfect state, in the slaty rocks of Tyrone, Waterford, and Wexford.

Fossils of the Llandovery Rocks.

The Llandovery formation, described as a distinct group of strata by Sir R. I. Murchison, is named from the district in South Wales to the north and west of Llandeilo, particularly near Llandovery, where the passage from the underlying Caradoc rocks into the lowest member of

this formation is well shown. This intermediate group of strata, connecting the Lower and Upper Silurian, was formerly called Upper Caradoc; it is now divided into a lower and an upper series—the lower and larger portion of the formation being related by its fossils to those of the Lower Silurian; the higher series, although containing some Lower Silurian species, is more evidently connected with the Upper Silurian.

At the hills of Noeth Grüg and Cefn-y-garreg, north-east of Llandovery, the whole formation is admirably exposed; it is remarkable as being the only tract in England and Wales where the lower and upper portions have hitherto been observed in a continuous series; showing clear relations to the Caradoc beneath and the overlying Wenlock and other Upper Silurian strata.

In Radnorshire, Shropshire, Herefordshire, the Malverns, &c., only the upper portion of the Llandovery series is present, forming, as Sir R. Murchison informs us, the natural base of the Upper Silurian rocks.

About nine miles south of the Malvern range the Upper Llandovery or May Hill sandstone of Professor Sedgwick reappears, upon which the Wenlock and other Upper Silurian rocks are superimposed. At Tortworth also, in Gloucestershire, still more to the south, the Upper Llandovery sandstone, with much trap rock, occupies a large area, and is surmounted by the Wenlock formation, with two courses of limestone, and feeble representatives of the Ludlow rock. Siluria, 4th ed., p. 100.

The most eastern tracts in England where the Upper Llandovery rock appears are the Lower Lickey Hills, in Worcestershire, and near Barr, in Staffordshire, at both which places that rock supports the base of the Upper Silurian deposits of the adjacent tracts of Dudley and Walsall (*ibid.*).

In Scotland, on the banks of Girvan Water, Ayrshire, besides Caradoc, and perhaps Llandeilo strata, there are in certain beds of fine micaceous dark grey sandstones an abundance of fossils of Llandovery type; and also, as in England and Wales, rocks in which typical Upper and Lower Silurian fossils are mingled together; these Silurian deposits of Ayrshire are covered towards the north by the Old Red and Carboniferous formations.

In the west of Ireland, in Connemara and the adjacent tracts, near Cong, in the Co. Galway, and extending to Uggool, in Mayo, equivalents of the Llandovery rocks, consisting of conglomerate, sandstone, and schists, occur in patches, containing in some places a profusion of fossils, the strata resembling both in its lithological and palæontological character some of the upper fossiliferous beds described as occurring on the banks of the Girvan Water in Ayrshire.

The organic remains from these rocks, though exhibiting on the whole a peculiar facies, and containing some distinctive species, show an evident continuity and passage from beds in which Lower Silurian typical forms prevail, into others, at its higher portion, where Upper

Silurian fossils predominate; thus forming a connecting link between the two great divisions of Silurian strata, clearly proving it to be one continuous series of deposits.

From the difficulty of selecting species sufficiently distinct to characterize the lower and upper members of this formation, it has been found necessary to include them all in the same Plates (xiv. to xvi.). In the explanation to these Plates, where practicable, the position each fossil occupied in the series is however mentioned.

Graptolites, the alliance of which with the *Hydrozoa* is now the received opinion, so abundant in the argillaceous slates of the older rocks, are rare in these sandy strata; and, excepting *G. priodon*, Pl. xix., fig. 1, a species which ranges from the Caradoc to Ludlow strata, are entirely absent.

Corals are not uncommon; the most plentiful consist of a few well-known species which, commencing in Lower Silurian strata, continued on during the formation of these deposits into that of the Upper Silurian, such as *Favosites fibrosus*, figured amongst the Caradoc fossils, Pl. x., fig. 1. *F. Gothlandicus*, Pl. xvii., fig. 2; *Halysites catenularius*, fig. 3; and *Heliolites interstinctus*, fig. 1, also on the same Plate, and all included with the Wenlock fossils, as being most characteristic of that period. The simple turbinated corals called *Petraia* are the most abundant and characteristic of the class in these deposits; as before remarked, in alluding to the fossils of the Caradoc rocks (*ante*, p. xxvi.), in accordance with the views of the eminent authors of British Fossil Corals, the proper position for these fossils, which are mostly internal casts, is with Cyathophyllum, to which genus I have referred them. There are eight species of Petraia included in the list of British Silurian fossils from Llandovery strata (Siluria, 4th ed., p. 511). Some of these, however, appear to me identical with *P. elongata* (Plate xiv., fig. 1, *a*, *b*, *c*), particularly *P. subduplicata*, and probably *P. bina;* this will, I think, be evident on comparison with the figures from the same slab of *P. elongata*, showing different ages and conditions of this coral.

Echinodermata are comparatively rare either as Cystideans or Crinoids, except disconnected stems and joints; no entire specimens have yet been collected from these strata.

Polyzoa are also poorly represented in these rocks; the species known, three only, all belong to *Ptilodictya*, a genus more numerous in species during the preceding Caradoc formation; one of the most frequent of these being figured on Pl. xi., fig. 2.

Of all the fossils occurring in Llandovery strata Brachiopod shells are in the greatest profusion; *Lingula parallela*, Pl. xiv., fig. 2, and *L. crumena*, fig. 3, are examples of a genus at present existing on the shores of the Indian Ocean. *Atrypa hemisphærica*, fig. 5, a species confined to Llandovery beds, abundant in the Abberley, Tortworth, and Malvern districts, but rare in Wales, is also the common fossil in the Upper Llandovery rocks of Galway, and the equivalent rocks of Scotland. *Atrypa reticularis*, frequent in the Wenlock formation, amongst the fossils of which it is figured (Plate xx., fig. 4), appears to

have commenced in this formation ranging up through all the overlying Silurian groups. *Meristella angustifrons*, Plate xiv., fig. 9, and *Rhynchonella angustifrons*, fig. 10, are remarkably abundant, particularly in the equivalent rocks of Ireland and Scotland. Of *Strophomena* ten species are recorded from these strata; one of them, *S. compressa*, fig. 6, occurring in the upper beds and the overlying Wenlock formation; *S. depressa*, plentiful in Wenlock strata, amongst the fossils of which formation it is figured (Plate xx., fig, 9), and *S. antiquata* are frequent in the Lower Llandovery; *S. euglypha*, also a common Wenlock fossil (Plate xx., fig. 8), being more scarce. Several species of *Leptæna*, including the well-known Lower Silurian fossil, *L. sericea* (Plate xi., fig. 6), and *L. transversalis* (Plate xiv., fig. 7), as well as *Orthis calligramma* (Plate xi., fig. 9), and *O. elegantula* figured with the Wenlock fossils (Plate xx., fig. 7), are not unfrequent in the Llandovery rocks. *Pentamerus*, including *Stricklandinia*, are the most characteristic fossils of the class in these rocks, both in Shropshire and South Wales; they are so numerous as to have given the name of Pentamerus rock or limestone to the zone in which they occur; five or six species of these remarkable shells are known, four of the most typical being represented on Plate xv.

Bivalve Shells.—*Conchifera*, are not unfrequent; thirty species of these are recorded, belonging, for the most part, to the Mytiloid and Aviculoid groups; a species referred to the recent genus *Mytilus* (Plate xvi., fig. 1), one also of *Modiolopsis*, six species of *Orthonota*, and seven of *Pterinea*; the small *Anodontopsis bulla*, fig. 2, and other shells with hinge teeth resembling the recent *Nucula*, are common at Malvern; *Ctenodonta Eastnori* (fig. 3) and *C. lingualis* are typical fossils showing this character.

Univalve Shells.—*Gasteropoda*, are slightly in excess of the conchiferous bivalves, thirty-four species being catalogued from these strata; five of them belong to *Euomphalus*; a similar number to the more elongated spiral shells *Holopella*, a typical form, *H. cancellata*, being represented on Plate xvi., fig. 5 (this shell is alluded to in Siluria, 4th ed., p. 212, as "our largest British species, often three inches long, common to the Lower and Upper Llandovery"); eight to *Murchisonia*, a characteristic genus named in honour of Sir R. Murchison, which is also an elongated many-whirled shell, allied to Pleurotomaria, and peculiar to Palæozoic strata, ranging from the Llandeilo to the Ludlow formations inclusive, of the lower division, and continuing through the Upper Palæozoic strata into the Permian. *M. angulata* (fig. 6), a large spiral shell, with another and still larger species; *M. Prycei* (Siluria, 4th ed., Pl. x., fig 11) occurs throughout the Lower Llandovery rocks of Wales. A flattened trochiform shell, *Raphistoma lenticularis* (Siluria, 4th ed., Pl. x., fig. 10), also allied to Pleurotomaria, is said to be of frequent occurrence in Llandovery rocks; *ibid.*, p. 212. A shell with seven or eight whirls resembling in shape the recent top shell, *Trochus*, is doubtfully referred to that genus by the name of *T. multi-*

torquatus (fig. 7); it is very plentiful in the Upper Llandovery rocks of Galway, and is believed also to occur in Ayrshire and Pembrokeshire.

Of *Bellerophon* as many as eight species are already enumerated from these strata; one of these, *B. trilobatus* (Pl. xvi., fig. 8), is selected as a small species, commencing in Llandovery strata, and ranging upwards to the Ludlow and Tilestone series; it occurs both in Gloucestershire and Galway.

Two kinds of a thin curved discoidal shell, with widely separated whirls, named *Ecculiomphalus* and *Conularia Sowerbyi* (Siluria, 4th ed., Pl. xxv., fig. 10), a Pteropod which commences in the Caradoc, ranges through the intermediate strata to the Ludlow rocks.

Cephalopod shells, although not numerous in this formation, are present in considerable variety; of the straight forms, as in *Orthoceras*, several species have been collected; one of these, *O. subgregarium* (Plate xvi., fig. 11), is found with others in the Llandovery rocks of Galway. A curved shell of this class, *Cyrtoceras approximatum*, represented on the same Plate, fig. 9, is, like the preceding one, confined to Llandovery rocks. A coiled discoidal shell, *Lituites cornu-arietis*, fig. 10, found in the lower division of these rocks, is also a Caradoc species, and an example of the extreme variability in form of the shells of this class of the Mollusca.

Fossils referred to the Annelida are not uncommon at certain localities, being most plentiful in the strata of the upper division. The prevalent species is *Tentaculites Anglicus*, a small fossil figured with those of the Caradoc (Plate x., fig. 3), in which formation, as in Llandovery strata, it occurs in considerable abundance.

Of Trilobites the most frequent is *Encrinurus punctatus* (Plate xvi., fig. 12). *Calymene Blumenbachii* (included with the Wenlock fossils) is not uncommon; few species are, however, peculiar; certain Lower Silurian forms range into these rocks, such as *Illænus Bowmanni*, figured with the Caradoc fossils (Plate xiii., fig. 5), and *Lichas laxatus*, which is also a Caradoc species; *Phacops Stokesii* and the characteristic *P. caudatus*, with others, being Upper Silurian types, first appearing in this formation.

Fossils of the Upper Silurian Rocks.

No very striking change from those of the Lower Silurians is observable in the general character of the assemblage of fossils contained in the upper division of Silurian strata, until we arrive at its uppermost portion, when the first evidence of vertebrata is obtained, by the discovery of the remains of fish in the Ludlow formation; there is, however, a considerable difference in the relative numbers of some of the classes of organic remains prevalent in Upper Silurian deposits.

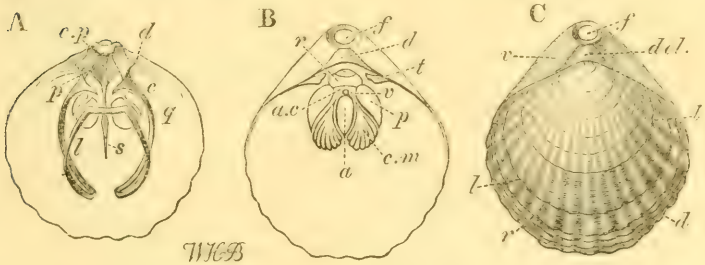
The following figures of recent typical examples of some of the classes of Molluscan shells, prevalent as fossils, are introduced for comparison, and to assist in explaining their various parts and the terms used in describing them:—

Fig. 1.—A Brachiopod Shell.

Genus Terebratula.—Sub-genus Waldheimia. W. Australis (recent).

(Reduced to two-thirds of natural size).

Figs. A and B copied by permission of Dr. J. E. Gray—Fig. C original.



A.—*Interior of Dorsal valve.*

c. p. Cardinal process.
d. Dental sockets.
p. Hinge plate.
s. Septum.
c. Crura of the loop.
l. Reflected portion of loop.
q. Quadruple adductor impression.

B.—*Interior of Ventral valve.*

f. Foramen.
d. Deltideum.
t. Teeth.
a. Single adductor impression.
c. m. Cardinal muscles.
a. c. Accessory muscles.
p. ePdicle muscles.
v. Vent.
r. Attachment of pedicle sheath.

C.—*Exterior of both valves.*

d. Dorsal valve.
v. Ventral.
f. Foramen.
r. Ribs, or plaits.
l. Lines of growth.

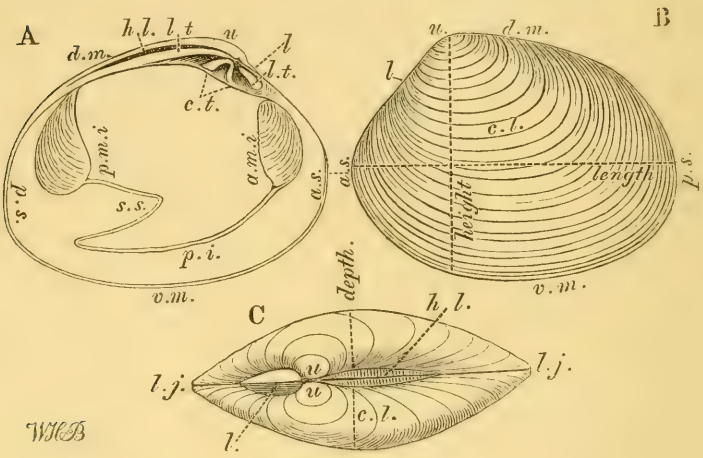
The Brachiopoda are bivalve Molluscoida, inæquivalve, and all having marine habitats. In the living examples the interior cavity of the shell is provided with two long oral processes, ciliated on one side, termed "arms," from which the name of the class has been derived.

FIG. 2.—A BIVALVE SHELL.

Class CONCHIFERA, *Cytherea chione* (recent).

Original reduced to two-thirds of natural size.

Interior of left valve. Exterior of ditto.



Both valves united.

A.—*Interior of left valve.*

u. Umbo.
d. m. Dorsal margin.
v. m. Ventral margin.
a. s. Anterior side.
p. s. Posterior side.
c. t. Cardinal teeth.
l. t. Lateral teeth.
h. l. Hinge ligament.
l. Lunule.
a. m. i. Anterior muscular impression.
p. m. i. Posterior " "
p. i. Pallial impression.
s. s. Siphonal sinus.

B.—*Exterior of left valve.*

u. Umbo.
l. Lunule.
d. m. Dorsal margin.
v. m. Ventral margin.
a. s. Anterior side.
p. s. Posterior side.
c. l. Concentric lines of growth.

C.—*Right and left valves united.*

u. Umbo.
l. Lunule.
h. l. Hinge ligament,
l. j. Line of junction of valves.

The dotted lines on figure B, marked "length" and "height," also that on fig. C, marked "depth," are intended to show the directions in which measurements should be taken in describing fossil shells.

It would be desirable if a uniform system of measurement were adopted, by lines, reckoning 12 to the inch.

Bivalve shells are all aquatic, and, excepting a few fresh water genera, all marine.

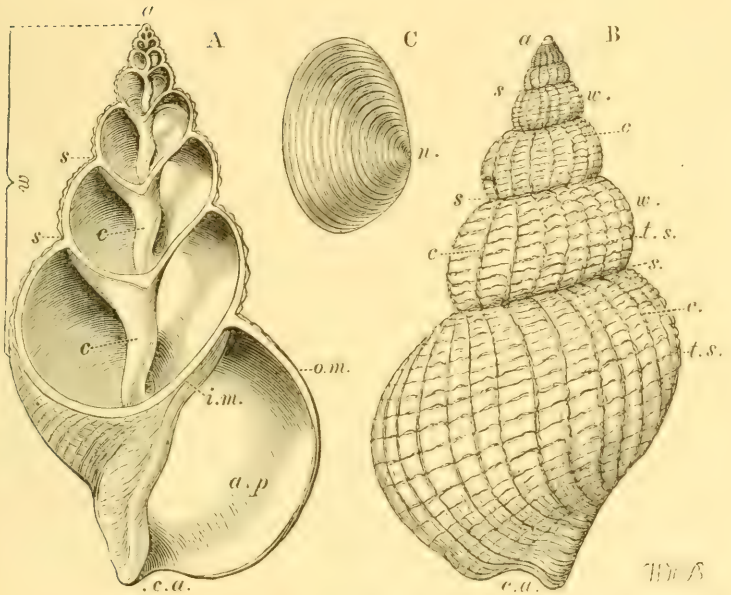
Fossil Bivalves are frequent in all sedimentary rocks; in the oldest, or Palæozoic strata, they are few, but gradually increase through the secondary and tertiary, attaining their maximum development in the present seas.

FIG. 3.—A UNIVALVE SHELL.

Class GASTEROPODA, *Buccinum undatum* (recent).

The Whelk.

Original reduced to two-thirds of natural size.



A.—*Section of under side.*

a. Apex.
w. Whirls of spire.
s. s. Sutures.
c. c. Columella.
o. m. Outer, or right margin.
i. m. Inner, or left margin.
a. p. Aperture.
c. a. Canal.

B.—*Upper side-back.*

c. c. Costæ.
t. s. Transverse striæ.

C.—*Operculum*, lamellar.

n. Nucleus (external).

The Gasteropoda are of land, fresh water, and marine habitats. They are usually called "univalves," such as land snails, whelks, limpets, &c. The shell is, however, sometimes composed of several pieces, and is then termed multivalve, as in chiton; in many cases there is noshell, or merely a rudimentary one, as in the slugs.

Fossils of the Wenlock Rocks.*

The Upper Silurian rocks are arranged by Sir R. Murchison into two groups—a Lower or Wenlock, and an Upper or Ludlow group. The lower division includes the Tarannon and Denbighshire slates, the Woolhope shale and limestone, and the Wenlock shale and limestone.

Tarannon Shales and Denbighshire Sandstones, Shales, and Slates.—These are local formations, occupying an intermediate position between the Llandovery rocks and the true Upper Silurian. The Tarannon shales at Tarannon, in Montgomeryshire, form a band of great persistence and considerable thickness, extending from Llandovery and Montgomery into North Wales. In these deposits fossils are rare, and not sufficiently characteristic to determine with certainty whether these strata should be classed with the Upper Llandovery rocks or those of the Wenlock formation. The Denbighshire sandstones, &c., rest conformably upon the Tarannon slates in the same counties of Radnor and Montgomery, and in North Wales; the fossils in the Denbighshire flags being unquestionably of the Wenlock type.

The Lower Wenlock or Woolhope series of strata derives its name from its occurrence at Woolhope, near Hereford, where it is superimposed upon the Upper Llandovery formation; the same general order of succession is also exhibited in the Malverns, May, and Huntley Hills, Gloucestershire. The Wenlock shale is of considerable thickness, and occurs both below and above the Woolhope or lower limestone; in the Malvern and Woolhope districts it is occasionally very fossiliferous. In some parts of Wales it occurs as shale, but in Denbighshire it is represented by hard, slaty sandstones and schists. The Wenlock limestone, or upper member of the group, is usually of a lighter grey colour than the lower or Woolhope. In the districts of Malvern, Woolhope, May Hill, and Usk, as well as in Shropshire, it is largely developed; though very thick near Wenlock, it thins out rapidly to the south-west.

In the north-western part of England, especially in the counties of Westmoreland and Cumberland, and the adjacent tracts of Lancashire and Yorkshire, the Silurian rocks are extensively developed; towards the south and south-east, the Lower Silurian strata are succeeded by newer deposits, which, although of very different mineral characters, clearly represent, by position and fossils, the Wenlock and Ludlow formations.

Silurian rocks, particularly those belonging to the lower division, are spread over a very large area in the south of Scotland; whilst in

* In the Table of Fossiliferous Strata (*ante*, p. viii.), the Upper Llandovery Beds or May Hill Sandstone is included with the Upper Silurian Rocks, as forming its natural base.

the Pentland Hills, near Edinburgh, the fossils exhibit clear evidence as to the Upper Silurian character of the deposits, representing, in all probability, a Wenlock, surmounted by a Ludlow series.

In Ireland, Upper Silurian rocks, abounding in typical Wenlock and Ludlow fossils, occur in the Dingle promontory, county Kerry, and in occasional tracts in the counties of Galway and Mayo.

Although certain fossils, by their abundance, larger proportions, or other peculiarities, may be said to characterize some of these subdivisions, the whole assemblage agree so much in general character as to render it difficult to select a series of typical forms for each; the characteristic fossils for each group of strata are therefore combined, those of the Wenlock rocks being illustrated on Plates xvii. to xxiii.; those of the Ludlow rocks on Plates xxiv. to xxvii., both inclusive.

In the Woolhope Limestone at Woolhope, amongst the principal fossils are the Trilobites *Homalonotus delphinocephalus*, Plate xxiii., fig. 7; *Illænus Barriensis*, the Barr Trilobite, fig. 4, and *Phacops caudatus*, fig. 5; The Annelide *Cornulites serpularius*, Plate xix., fig. 2; Brachiopod Mollusca, *Orbiculoidea Forbesii*, fig. 7; *Spirifera elevata*, Plate xx., fig. 2; *Atrypa reticularis*, fig. 4; *Strophomena depressa*, fig. 9; *Rhynchonella Wilsoni* (figured with the Ludlow fossils), Plate xxi., fig. 8), and less frequently *Orthis elegantula*, Plate xx., fig. 7; also the Cephalopod, *Orthoceras annulatum*, Plate xxii., fig. 4. Siluria, 4th ed., p. 111.

Wenlock Shale.—The fossils of this stratum are generally similar to those of the overlying limestone; the prevailing forms, exclusive of Corals and Trilobites, which are chiefly of species unknown in the lower deposits, are Brachiopods, of the genera *Leptæna, Orthis, Strophomena, Atrypa*, and *Rhynchonella;* among them are several common to this deposit and the Lower Silurian rocks, such as *Orthis elegantula*, Pl. xx., fig. 7; *Strophomena depressa*, fig. 9; *Atrypa reticularis*, fig. 4; *Spirifera plicatella*, fig. 1; *Meristella tumida*, fig. 3, &c. Most of these Lower Silurian forms have a much greater vertical range, continuing upwards through the Wenlock high into the Ludlow formation. *Obolus Davidsoni*, a species recognized by Mr. T. Davidson in the Wenlock shale, also occurs in the limestone, and is recorded in "Siluria" as a Llandovery fossil. *Avicula, Ctenodonta*, and some other bivalve shells, occur frequently; but few of them are characteristic, except *Cardiola interrupta* (figured with the Ludlow fossils), Pl. xxv., fig. 5. Of the spiral or univalve shells, *Euomphalus funatus*, Pl. xxi., fig. 9; *E. alatus*, fig. 7; *Aeroculia haliotis*, fig. 12; and of Heteropods, *Bellerophon Wenlockensis*, Pl. xxii., fig. 2, with *B. dilatatus*, fig. 1, are the most common. Pteropoda are not so plentiful as in the lower rocks. *Theca Forbesii* (figured with the Ludlow fossils), Pl. xxvi., fig. 6, and *Theca anceps*, Pl. xxii., fig. 3, are Wenlock shale species. Amongst the Cephalopoda, *Orthoceras annulatum* (previously cited), Pl. xxii., fig. 4, *O. filosum*, and *O. angulatum* (figured in "Siluria)" are rare; but many of the smooth and thin-shelled species, such as *O. subundulatum, O. primævum*, &c., are frequent in these muddy sediments; they are almost the

only shells in this formation, as it is exhibited in Denbighshire and other parts of North Wales, occurring there in the greatest abundance; *Phragmoceras* of one or two species, and *Lituites articulatus, Biddulphi*, and occasionally *L. giganteus* (figured with the Ludlow fossils), Pl. 26, fig. 7, are conspicuous fossils in this stratum.

The Trilobites, *Encrinurus punctatus*, Pl. xxiii., fig. 2,* *E. variolaris*, fig. 3; and *Calymene Blumenbachii*, fig. 1, are characteristic. *Cornulites serpularius* (before cited), Pl. xix., fig. 2, and other Annelides, are sometimes found, as well as stems and portions of Encrinites, complete fossils of this class being rare in this formation. Corals are in general similar to those of the Wenlock limestone, but fewer in number; the cup corals, *Cyathophyllum* and *Omphyma*, Pl. xvii., fig. 4, with *Favosites alveolaris* and *F. fibrosus*, Pl. x., fig. 1, ranging from the Llandeilo rocks to the Ludlow, being the most conspicuous; the single form of Graptolite, *G. priodon*, Pl. xix., fig. 1, although commencing in Caradoc strata, is a most abundant and characteristic fossil of the Wenlock shale, continuing on into the Ludlow rocks.

Wenlock Limestone.—The profusion of Corals in this rock distinguishes it from all the other Silurian strata, so that it resembles, in some districts, a coral reef. Some of the typical forms are figured on Pl. xvii. *Heliolites interstinctus*, fig. 1; *Favosites Gothlandicus*, fig. 2; *Halysites catenularius* (the chain coral), fig. 3; and *Omphyma turbinata*, fig. 4; other common species are also mentioned in "Siluria," p. 120, viz., *Cyathophyllum truncatum* and *C. articulatum*, *Favosites cristata* and *F. asper*, *Syringopora bifurcata*, *Alveolites Labechii*, *Acervularia luxurians*, &c. This limestone is also rich in Crinoids, *Periechocrinus moniliformis*, Pl. xviii., fig. 4; an Encrinite with a bead-like stem, and occasionally five feet in length, is very abundant, covering large surfaces of the rock at Dudley, and occurring in detached fragments at other localities; *Cyathocrinus goniodactylus*, fig. 1; *Taxocrinus tuberculatus*, fig. 2; *Ichthyocrinus pyriformis*, fig. 3; and *Crotalocrinus rugosus*, are common Wenlock fossils. Cystideans, although rare, are characteristic; four genera only occur in the Wenlock rocks, including eight species, all distinct from those of the Lower Silurian. Examples of two of the most frequent species are figured on Pl. xviii., viz., *Pseudocrinites quadrifasciatus*, fig. 6, and *Echino-encrinus armatus*, fig. 7.

The Graptolites, so numerous and varied in form, in the slaty rocks of the Lower Silurian are reduced to but a few species in the upper division; for although in many districts the Wenlock shale and Lower Ludlow are crowded with them, it is only one species, *Graptolithus priodon*, before mentioned, Pl. xix., fig. 1, that is so abundant in this upper division. The Annelides, *Cornulites serpularius*, fig. 2, and *Tentaculites ornatus*, fig. 3, are very frequent, especially in the limestone of Dudley, both having a considerable stratigraphical range. Polyzoa, although not so numerous in species in the upper as in the lower division, are not unfrequent in the Wenlock limestone; a large species,

* The Tail of this Trilobite is also figured with the Llandovery fossils, Pl. 16, fig. 12.

Ptilodictya lanceolata, fig. 4, is abundant; *Fenestella subantiqua*, fig. 5, and *F. Milleri*, are common fossils at Dudley, &c., in the limestone. Brachiopod Shells, though not so plentiful (either in number or species) as in Lower Silurian rocks, are still very abundant. Four species of *Pentamerus* and one of *Stricklandinia* (formerly included with Pentamerus) are recorded as Wenlock fossils; only two of these, *P. linguifer* and *S. lirata*, Pl. xv., fig. 4, continued from the Llandovery strata, the remainder being all distinct; *P. galeatus*, Pl. xx., fig. 5, as mentioned in the Explanation of the Plates, p. 59, is common to the Wenlock and Ludlow, continuing into the Devonian formation. The characteristic Brachiopods alluded to in the description of the fossils of the Wenlock shale (*ante*, p. xii), as ranging from the Lower to the Upper Silurian, such as *Orthis elegantula*, Pl. xx., fig. 7, which is equally abundant in both divisions, *Strophomena depressa*, fig. 9 (now referred by Mr. T. Davidson to *S. rhomboidalis*, "Brit. Sil. Brach." p. 281), ranging from Caradoc to Ludlow, passing up into the Devonian, and continuing during the Carboniferous period (according to Mr. Davidson), the greatest range of any known shell; *S. euglypha*, fig. 8, ranging from Llandovery to Ludlow rocks, and *Atrypa reticularis*, fig. 4, are also very frequent in the limestone; the last-named species commencing in Lower Llandovery strata, ranges through all the Upper Silurians to the Upper Devonian. *Spirifera plicatella*, fig. 1, *S. elevata*, fig. 2, and *Meristella tumida*, fig. 3, are also very common shells in the limestone, having a corresponding range from the Llandovery to the Ludlow rocks; *Rhynchonella borealis*, fig. 6, also recorded as a Llandovery species, is exceedingly plentiful in Wenlock limestone. *Obolus Davidsoni*, Pl. xix., fig 6 (before referred to, p. xli.), and *Orbiculoidea Forbesii*, fig. 7 (formerly Orbicula), are rarer limestone species.

The *Conchifera* consist for the most part of shells allied to the recent Mytilus, Arca, Nucula, and Avicula; to the latter belongs *Pterinea orbicularis*, Pl. xxi., fig. 1, abundant in the Dingle District, Co. Kerry; the small shell doubtfully referred to the same genus, *P. planulata*, fig. 2, is frequent in the Wenlock rocks. The Mytiloid shells are also an important group: *Modiolopsis antiqua*, fig. 3, and *M. gradata*, fig. 4, are common Wenlock fossils, the latter being also a Ludlow species. *Grammysia cingulata*, fig. 5, belongs to a genus of shells remarkable for the deep furrows on its valves; it has been found in South Wales, Westmoreland, and in Ireland; and *Pleurorhynchus æquicostatus*, fig. 6, a Wenlock fossil, is a small species, belonging to a genus representative of the Cardiacea, which commenced existence in the Caradoc series of the Lower Silurian strata.

Univalve Shells, *Gasteropoda*, occur throughout the Upper Silurians, and is not unfrequent in the Wenlock limestone; amongst the common forms are the spiral shells, *Euomphalus alatus*, fig. 7, a Wenlock and Ludlow species, abundant in the Dingle District of Ireland; *E. rugosus*, fig. 8 (with its probable variety, *E. discors*), and *E. funatus*, fig. 9, which is the most common, and has the greatest vertical range; its concentric operculum, fig. 9, *b*, is often found fossil, and assists in

the conclusion as to the near relation of the genus to the recent Delphinula. Of the more elevated spiral shells, *Murchisonia balteata*, fig. 10, is a common Wenlock form; *Acroculia prototypa*, fig. 11, and *A. haliotis*, fig. 12, are very abundant in the Wenlock limestone, particulary the latter species.

Of the Heteropoda, *Bellerophon dilatatus*, Pl. xxii., fig. 1 *a*, is one of the largest examples, commencing in Caradoc strata, and continuing into the Llandovery and Wenlock rocks. *B. Wenlockensis*, fig. 2, is another large species, very characteristic of Wenlock strata, as implied by its name.

Of Pteropod Shells but few species are known in Upper Silurian strata, besides *Theca anceps*, fig. 3, and *T. Forbesii*, Pl. xxvi., fig. 6, before mentioned as Wenlock shale species; *Conularia Sowerbyi*, fig. 5, is often found in Wenlock limestone, and occurs, with a rarer species, *C. subtilis*, in the Ludlow rocks of Westmoreland.

Of the Cephalopoda as many as fifteen species are enumerated as occurring in the Wenlock series, *Orthoceras annulatum*, fig. 4, previously cited, and its variety *fimbriatum*, although commencing in Caradoc strata, and continuing into the Llandovery, is most characteristic of the Wenlock limestone. There are many other species, some of them also ranging from Caradoc strata, through the whole of the Upper Silurian series, such as *O. filosum*, *O. ibex*, and *O. subundulatum*. The genera *Phragmoceras* and *Lituites* are represented by a few and nearly equal number of species.

The *Cirrhipedia*, now classed with the Crustacea—a group which includes the barnacles or acorn shells—had its earliest representative in the Wenlock limestone, in a pedunculated form, resembling Loricula, named *Turrilepis Wrightianus*, and described by Mr. Henry Woodward from the limestone of Dudley.

Trilobites* of certain species are very abundant, especially *Calymene Blumenbachii*, Pl. xxiii., fig. 1; a species ranging from Caradoc to Ludlow strata, *Encrinurus punctatus*, fig. 2, and *E. variolaris*, fig. 3, are very common both in the limestone and shale; *Phacops caudatus*, fig. 5, ranging from Llandovery to Ludlow, is most frequent in the Wenlock rocks. *P. Downingiæ*, fig. 6, having the same stratigraphical range, is one of the most characteristic Trilobites. *Proetus latifrons*, fig. 8, with another species, *P. Stokesii*, are not uncommon in Wenlock strata; *Illænus Barriensis*, fig. 4, ranging from Llandovery to Wenlock strata, most frequent in the latter; and *Homalonotus delphinocephalus*, fig. 7, before cited, as also occurring in the lower Wenlock or Woolhope limestone. The small bivalve crustaceans (belonging to the Phyl-

* Since writing the remarks on page xiii, relative to parts of a Trilobite, the discovery of a series of eight pairs of jointed legs attached to an equal number of thoracic segments in a Trilobite (*Asaphus platycephalus*) found in Canada, was announced to the Geological Society of London, May 17th, 1870, by Mr. E. Billings, Palæontologist to the Geological Survey of Canada. Other organs, believed to be the palpus of one of the maxillæ, were recognised by Mr. H. Woodward, in additional specimens of Trilobites from Canada, exhibited at the same meeting.

lopod tribe), Beyrichia and Primitia, are very numerous. *Beyrichia Klædeni*, fig. 9, is the most abundant Upper Silurian species, its range being from the Llandovery to the Passage beds of the Upper Ludlow; one other species of Beyrichia only is catalogued, *B. siliqua;* whilst *Primitia* includes nine Wenlock species.

Fossils of the Ludlow Rocks.

The *Lower Ludlow Rocks* of the Silurian region of England and Wales, as Sir R. Murchison states, must be looked upon merely as a continuation of the argillaceous beds of the underlying Wenlock formation: these strata consist of dark-grey shales with small calcareous concretions. The central portion of the Ludlow rocks at several places, particularly at Aymestry, is an argillaceous dark-grey limestone (called the *Aymestry Limestone*): over this are more sandy and somewhat calcareous beds, forming for the most part an imperfect thin bedded grey earthy building stone, termed the *Upper Ludlow Rock*, the highest stratum being occasionally composed of light-coloured sandy freestones and tilestones, called *Passage Beds*, through which the formation graduates lithologically and conformably into the lowest beds of the Old Red Sandstone or Devonian rocks; this being the general order near the town of Ludlow, which stands upon the higher strata of the formation. In following the formation from the Ludlow tract on its strike or direction to the north-west, its included limestone thins out and disappears.

Lower Ludlow Rocks.—In these shales the single form of Graptolite *G. priodon*, before alluded to as commencing in Caradoc strata of the Lower Silurians, figured on Pl. xix., fig. 1, is a very abundant fossil.

At Leintwardine, Shropshire, where the ascending strata become somewhat more sandy, large Orthoceratites, many Crustacea, and Starfishes have been discovered.

The Starfishes belong to genera, and probably to families, distinct from any living forms. *Palæasterina primæva*, Pl. xxiv., fig. 2, is a Westmoreland fossil somewhat resembling the recent Palmipes roseus. *Palæocoma Marstoni*, fig. 3, may be compared with the living genus Pteraster. *Protaster Miltoni*, fig. 4, has the general form of the Ophiuræ or Brittle stars: the two last mentioned are Leintwardine fossils. As many as ten species of Starfishes have already been found at this locality; and Professor Wyville Thomson has described two species of Echinoderms from the same place, under the name of *Echinocystites*, which he considers to be allied to Sphæronites of the Lower Silurians, and Palæchinus of the Carboniferous, although possessing intermediate characters. Many Brachiopod shells have been obtained from this stratum which are also common to the Wenlock series, such as *Pentamerus galeatus*, Pl. xx., fig. 5; *Strophomena depressa*, fig. 9; and *S. euglypha*, fig. 8;

Atrypa reticularis, fig. 4 ; and *Rhynchonella Wilsoni*, Pl. xxiv., fig. 8. *Lingula lata*, Pl. xxv., fig. 1, is perhaps the only Brachiopod peculiar to this division of the Upper Silurians.

Of the Conchifera, *Cardiola interrupta* (before alluded to), Pl. xxv., fig. 5, is the most common; this species has also been found in the Caradoc, not yet in Llandovery strata ; characteristic in the Wenlock shale, and more particularly so in the present division of the Ludlow rocks. Another bivalve, doubtfully referred to the same genus, [?] *Cardiola striata*, fig. 6, is equally characteristic, and up to the present time only known in Upper Silurian rocks, occurring in all the fossiliferous localities of Shropshire and the neighbouring regions.

Amongst the Cephalopoda the largest and probably the most common is *Orthoceras Ludense*, of which a much reduced figure is shown on Pl. xxvi., fig. 8, and *O. filosum*, Sil., Pl., xxvii., fig. 1. The only common species of Lituites is *L. giganteus*, Pl. xxvi., fig. 7 (reduced to half natural size). *Phragmoceras pyriforme*, fig. 6, is a remarkable pear-shaped shell having the mouth or opening contracted into a key-hole form.

A large species of the singular crustacean *Pterygotus* has been found in these rocks at Leintwardine, and described by the late Mr. Salter as *P. punctatus;* Mr. Henry Woodward has since referred this form to Eurypterus.*

Fish remains of the genus *Pteraspis* has also been discovered in this Lower Ludlow locality, being the first evidence of Vertebrata, which had been hitherto only known from Upper Ludlow strata.

Aymestry or Ludlow Limestone.—This central portion of the Ludlow formation was named by Sir R. Murchison after the village of Aymestry. The Aymestry limestone is principally developed in Herefordshire and Shropshire, and again at Sedgeley, in Staffordshire. It is a dark-grey limestone passing into a highly calcareous flagstone, and may generally be recognised by its well-defined joints and predominant fossils ; in some parts of South Wales, where the calcareous matter is absent, it is difficult to trace even the place of this band in the Ludlow rocks.

The large Brachiopod, *Pentamerus Knightii*, Pl. xxv., fig. 2,† is one of the predominant fossils of the Aymestry limestone, together with *Lingula Lewisii* (Pl. xxiv. fig. 5) ; *Rhynchonella Wilsoni*, fig. 8 ; *Strophomena euglypha*, Pl. xx., fig. 8 ; *Atrypa reticularis*, fig. 4 ; *Bellerophon dilatatus*, Pl. xxii., fig. 1, and many other Corals, Shells, and Trilobites common to the Wenlock limestone.

Upper Ludlow Rocks.—This series of strata is the most diversified

* "Quart. Jour. Geol. Soc.," 1868, vol. xxiv., p. 290.

† The name applied to the genus of shells to which this species belongs relates to its capability of division into five parts, in consequence of its possessing thin septæ—two attached to the ventral, and one to the dorsal valve. The facility with which the shell separates on applying a chisel, and giving it a smart tap where one of these lines are visible, defining the longitudinal septa, is remarkable, as a section is disclosed through both valves similar to that shown by fig. 2 c, on the same Plate.

in structure and contents of the three subdivisions of the highest Silurian formations, being also remarkable for exhibiting a transition into the next overlying series, the Old Red Sandstone or Devonian formation. The lowest stratum is a calcareous shelly band, which contains a small Brachiopod shell, *Rhynchonella navicula*, (Sil., Pl. xxii., fig. 1, 2,) in profusion; over this are grey argillaceous beds, which are sometimes spheroidal and concretionary, and from their incoherent character easily decompose into a kind of mud. The upper and principal portion is usually a thin bedded calcareous stone, slightly micaceous, and of a bluish-grey colour, and remarkable for its symmetrical transverse joints: these upper beds are full of the following, with other fossils: *Discina rugata*, Pl. xxiv., fig. 7; *Rhynchonella nucula*, fig. 9; *Orthis lunata*, fig. 10; *Chonetes lata*, fig. 11; *Pterinea retroflexa*, Pl. xxv., fig. 4; *Orthonota amygdalina*, fig. 9; *Goniophora cymbæformis*, fig. 11; *Cyclonema corallii*, Pl. xxiv., fig. 1; the curved Annelid-tube, *Serpulites longissimus*, Pl. xxvi., fig. 10; *Cornulites serpularius*, Pl., xix., fig. 2, and the minute *Beyrichia Klædeni*, Pl. xxiii., fig. 9. Very few corals occur except the small incrusting species, *Alveolites fibrosus*, which is frequently found covering small univalve shells, such as *Cyclonema corallii*, Pl. xxiv., fig. 1; and *Murchisonia corallii* (Sil. Pl., xxiv., fig. 7). Orthocerata (occasionally of large size) of similar species to those of the Lower Ludlow rock are not unfrequent. Of Trilobites *Phacops caudatus*, Pl. xxiii., fig. 5; *Encrinurus punctatus*, fig. 2, and *Calymene Blumenbachii*, fig. 1, pass through the series, but are not abundant: the most prevalent Trilobite is *Homalonotus Knightii*, Pl. xxvii., fig. 1, found throughout the whole range of this formation from Pembrokeshire to Westmoreland, and sometimes of large size. The highest member of the Ludlow rocks is most interesting, as until recently it was described by Sir R. Murchison as being the oldest rock in which fossil fish had been found; the only exception being that already alluded to—the discovery of a fragment of *Pteraspis* in the central part of the same formation. The uppermost Ludlow rock also contains the earliest remains of land plants ("Siluria," p. 133).

The largest, if not the most highly organized Crustacean in Silurian strata is the *Pterygotus problematicus*, Pl. xxvii., fig. 3; this characteristic species of the order Eurypterida* has a greater stratigraphical range than any of the others, commencing in Wenlock strata, and continuing to the Passage beds or Uppermost Ludlow. The size of this species, from a comparison of its parts discovered at Ludlow, with that of others found nearly entire in Scotland is estimated as being not much less than five or six feet in length, whilst *P. Ludensis*, also found near Ludlow, in the Passage beds, and *P. gigas*, from the Tilestones† of

* Professor Huxley includes Pterygotus and Eurypterus under this order.

† The Tilestones (formerly included with the Old Red Sandstone, but now classified by Sir R. Murchison, with the Silurian rocks, as containing species common to the Upper Ludlow formation), in their range from Shropshire, through Herefordshire, Radnor, Brecon, and Caermarthen, are characterized by the following, amongst other fossils:

Kington, Herefordshire, were probably of still greater dimensions. In the uppermost Ludlow rocks at Lesmahago, Lanarkshire, these remarkable Crustacea are very prevalent in the dark clay slate; *P. bilobus*, of which a reduced figure from a young specimen is shown, Pl., xxvii., fig. 5, is one of the species from this locality, by which it will be seen that the entire form of Pterygotus was very simple; a small semi-oval, or sub-quadrate head (or carapace), followed by twelve convex body-rings (segments), the last forming a pointed, truncate, or bilobed tail-joint (telson); two large compound eyes on each side of the carapace, beneath which the mouth is situated, protected by a large heart-shaped labrum (metastoma). Five pair of appendages are arranged round the mouth, and attached to the under surface of the carapace, including anteriorly a pair of large jointed antennæ, with massive pincers (chelæ), furnished with sharp cutting teeth; next to these, one or two pairs of mandibles with serrate edges (endognaths), and posteriorly a pair of swimming feet (ectognaths).*

The genus Pterygotus commences in Upper Llandovery strata, ranging through all the overlying Upper Silurian rocks into the Cornstones of the Old Red Sandstone. Nine species are included in the list of Fossils appended to Siluria, 4th ed., p. 521. Seven of these occur in Ludlow rocks, three of them continuing to the Passage beds.

Eurypterus, though resembling Pterygotus, differs from it in several particulars, especially in the absence of the great pincer-like claws; also in having the eyes within the cephalic shield, and not upon the border, as in Pterygotus. They have similar scale-like markings, though less conspicuous than in Pterygotus. Eight species have been found in Britain; seven of these occur in Ludlow rocks, two of them continuing into the Passage beds, and one other being peculiar to that uppermost division of the Ludlow rocks.

E. pygmæus, Pl. xxvii., fig. 4, a small and abundant species in the Tilestones at Kington and Ludlow, accompanies other species at the latter place; the genus continuing through the Old Red Sandstone into the Lower Beds of the Carboniferous rocks. Fragments of similar large Crustacea have also been found in the Tilestones of Westmoreland, and in these localities they are accompanied, as in Scotland, and at Ludlow, Kington, &c., by the small *Lingula cornea*, Pl. xxiv., fig. 6.

Of the shrimp-like forms, *Ceratiocaris papilio*, Pl. xxvii., fig. 2, is a characteristic species peculiar to the uppermost Ludlow rocks of Lesmahago, in Lanarkshire. This genus, which commenced in the Llandeilo rocks, with two species, is represented by eleven species in

Lingula cornea, Pl. xxiv., fig. 6; *Chonetes lata*, fig. 11; *Bellerophon expansus*, Pl. xxvi., fig. 5; *Platyschisma helicites*, fig. 3; *Holopella obsoleta*, fig. 2.

* Although these remarkable Crustacea are related to the *Pœcilopoda* to which the recent Limulus or King Crab belongs, Professor Huxley has shown their affinities to be closer to the *Copepoda*, and some points of structure to be comparable with the living forms of *Calanus*, *Sappharina*, &c. Mem. Geol. Surv. Monograph 1.

the Ludlow rocks of Ludlow, Kendal, and the south of Scotland. *Hymenocaris vermicauda*, Pl. iv., fig. 1, characteristic of the Lingula Flags (Primordial Silurian), as already noticed (*ante*, p. xvi.), being the earliest representative of the order of bivalve Crustaceans, the Phyllopoda, to which Ceratiocaris is also referred.

Fish Remains are most frequent at the uppermost portion of the Ludlow formation, in what is called the Bone-bed, although, as before remarked, the first indication of this class of the Vertebrata has been met with in the lower part of the same Ludlow formation, in which was found one of those remarkable heads called *Pteraspis*—a ganoid fish allied to Cephalaspis, of which there are two species in the Ludlow rocks—*P. truncatus*, Pl. xxvii., fig. 6, and *P. Banksii*—both from the Passage beds of Kington, in Herefordshire, as well as from the Bone bed of Ludlow. In the same bed other fish remains have been found; *Onchus tenuistriatus*, Pl. xxvii., fig. 7., and *O. Murchisoni*, fig. 8, bony fin-spines resembling those of placoid fishes of the present day. The very small cushion-like bodies called *Thelodus parvidens*, fig. 11, which occur so abundantly in the stratum as often to constitute large portions of its thin layers, are believed to be the granules of the skin or shagreen of one or other of these two common species. The remarkable jaws and teeth, *Plectrodus mirabilis*, fig. 9, and *P. pustuliferus* (figured in "Siluria"), probably belonged to some small ganoid fish.

Fish and Crustacean remains have also been found near Ludlow in strata, proved to be at a higher level than the original Bone-bed; the fish remains consisting of fragments of *Plectrodus*, fig. 10; the *Onchus Murchisoni*, fig. 8, with two species of *Auchenaspis*, buckler-headed fish, also allied to Cephalaspis. "It may therefore," as the author of "Siluria" remarks, "be naturally suggested that this band constitutes the last link in the chain of Silurian life."

The following Table of the number of species of British Silurian Fossils found in each formation is compiled from "Siluria," fourth edition, 1867, pp. 508–536.

Total Species.		Primordial Silurian.	Llandeilo.	Caradoc.	Llandovery.	Wenlock.	Ludlow.	Passage Beds.
9	Plantæ (some doubtful), . .	0	0	0	1	1	6	1
17	Protozoa, Class Amorphozoa, .	2	2	4	1 & 1?	2	4	1
139 & 4?	Cœlenterata, Class Actinozoa, .	0	3	24 & 2?	31 & 1?	70 & 1?	11	0
55 & 1?	,, Graptolitidæ, Hydrozoa (Dictyonema is included with Polyzoa), . . .	0	40	9	0	5 & 1?	1	0
85 & 1?	Annulosa, Echinodermata, .	0	0	24	7 & 1?	37	17	0
46	Annulata, Annelida, . .	4	14	10	4	6	8	0
366 & 2?	Articulata, Crustacea, . .	37	75	103	29 & 1?	52	61	9 & 1?
1	,, Cirripedia, . .	0	0	0	0	1	0	0
45	Mollusca, Molluscoida, Class Polyzoa, .	2	3	15	3	22	0	0
309 & 7?	,, Molluscoida, Class Brachiopoda,	13	25	75	74 & 3?	88 & 4?	33	1
44 & 1?	,, Lamellibranchiata, Asiphonida,	0	0	7 & 1?	7	15	15	0
131 & 4?	,, Siphonida, . .	0	5	36 & 2?	25 & 1?	16 & 1?	48	1
123 & 1?	,, Class Gasteropoda, .	0	7	34	34 & 1?	17	30	1
35	,, Heteropoda, (Nucleobranchiata),	0	9	8	9	4	5	0
34 & 1?	,, Class Pteropoda, .	3	10	9 & 1?	3	3	6	0
107 & 3?	,, Class Cephalopoda, .	0	5 & 1?	31	20	22 & 1?	29 & 1?	0
14 & 1?	Vertebrata, Class Pisces, . .	0	0	0	0	0	8	6 & 1?
1560 & 26 ?	Total number of species, 1586, including 26, the relations of which are doubtful.							

The list of Primordial Silurian fossils has now been considerably augmented by the labours of Mr. H. Hicks, the late Mr. Salter, Mr. Thos. Belt, F. G. S., Mr. John Plant, F. G. S., and Mr. E. Williamson, F. G. S. In the neighbourhood of St. Davids, in South Wales, and near Dolgelly and Maentwrog in North Wales, immediately beneath the Lingula flags, is a series of dark-grey and black flags, alternating with some beds of sandstone, the whole comprising a thickness of from 500 to 600 feet: these strata were formerly considered to be the base of the Lingula flags, solely on lithological grounds. Messrs. Hicks and Salter have, however, shown that the fossils, of which more than 40 species have been found in them, are distinct from those of the Lingula flags. The Trilobites described by those gentlemen included *Paradoxides Davidis*, Pl. iv., fig. 3, the largest example known in Britain; they propose to place these strata at the top of the Lower Cambrian, under the term "Menevian," Menevia being the classical name of St. Davids.

Note.—In the Explanation of the Plates, p. 10, *Olenus humilis*, Pl. iv., fig. 6, is stated to be only known in the black shales (Lingula beds) of Malvern; Mr. John Plant has since obligingly informed me that he has several hundred specimens which he collected in Lower Lingula Beds, at Tyddyngwladis, North Wales, with many new species.

Fossils of the Old Red Sandstone and Devonian Rocks.

The gradual transition from the uppermost grey Silurian strata into that of the red deposits, or Old Red Sandstone, has been clearly described by Sir R. Murchison and other Geologists as occurring near Ludlow where the thin beds or "Tilestones," partly of a reddish colour, with Ludlow fossils, clearly indicate the passage from one series of strata to the other.

Additional examples of this succession have been also observed along the eastern edge of the Upper Silurian rocks in Hereford, Radnor, and Brecon, on the west flank of the Malvern and May Hills, and around the valley of Woolhope.

In Shropshire this series of red sandstones with concretionary bands of impure arenaceous limestone, called "cornstone," green and red clays and marls, and red conglomerates, resting conformably upon the Upper Ludlow rocks, are estimated at a thickness of 3,700 feet, being covered by the Carboniferous rocks of the Clee Hills; whilst in the counties of Monmouth and Brecknock it attains the great thickness of at least 10,000 feet, forming mountains nearly 3,000 feet high. The uppermost beds of this series of strata being conformably overlaid by the Carboniferous Limestone of the South Welsh coal basin.

In the north of England the Old Red Sandstone so extensively developed in the counties alluded to, rests unconformably on the Silurian rocks principally as a single band of coarse conglomerate lying between the Silurian and Carboniferous formations of the lake district of Cumberland.

The Old Red Sandstone of Scotland covers an extensive area. It has been described as exhibiting two different types, north and south of the Grampian range. That of the south is abundantly developed between the Grampians and the Cheviot Hills, and according to Professor A. Geikie is divisible into three groups.

The *Upper* division, consisting of red and yellow sandstones, and conglomerates in Berwickshire and Haddingtonshire, resting unconformably upon the Lower Silurian strata, passes gradually up into the base of the Carboniferous series; the strata of Dura Den, in Fifeshire, with its numerous fish remains, is also assigned to this group.*

The *Middle* division consisting of red, green, and grey sandstones, flagtones, and conglomerates, includes the bituminous flagstones of Caithness and the Orkneys, strata in Elgin and Banff, and in the south-west of Ayrshire, where it is associated with contemporaneous volcanic rocks; *Pterichthys major* has been found in the upper part of the series.

The *Lower* division, consisting of red, reddish-brown, and grey sandstones and shales, with large masses of intercalated contemporaneous volcanic rocks, is exhibited in the Sidlaw and Ochil Hills, Pentland

* The genera of fossil fish *Holoptychius*, *Pamphractus*, *Glyptopomus*, &c., with *Palæopteris* (Cyclopteris) *Hibernicus*, occurs in this group.

Hills, and the tract of hilly country stretching thence by the head of Nithsdale into Ayrshire. In the Lesmahago district this group of strata rests conformably upon the Upper Silurians, between the basin of the Clyde at Lanark and the Ayrshire Coal-fields; fish remains are abundant in Forfarshire; *Cephalaspis Lyelli* and the crustacean *Pterygotus anglicus* occur in this group of strata.

The northern type has also been grouped into three divisions; the *Upper*, consisting of light red and yellow sandstones of Dunnet Head, north of Caithness, and the Orkney and Shetland Islands, with plant remains, *Calamites* (?).

The *Middle* composed of grey flagstones occasionally calcareous and bituminous, covers a large area in Caithness, and extends into the Orkney Islands. These beds contain numerous fossil fish, *Pterichthys*, *Coccosteus*, &c., *Estheria*, a crustacean, and land plants, *Lepidodendra* (?), *ferns*, &c.

The *Lower*, consisting of red sandstones and conglomerates, rests unconformably upon the metamorphic rocks of the Highlands, in Rossshire, Sutherland, and Caithness. *Pteraspis* has been found in these beds at Lybster, in Caithness.*

The Old Red Sandstone of Scotland has been graphically described by the late Hugh Miller; this designation, therefore, which, as Sir R. Murchison observes, "has been thus rendered classical, may well be retained as a synonym for the great group of intermediate age between the Silurian rocks beneath, and the Carboniferous formation above it, which in those countries where it assumes more calcareous, schistose, and slaty characters is termed Devonian."

In the south of Ireland, counties of Cork and Kilkenny, a fine grained sandstone occurs, which from its fossil contents is considered to be an equivalent of the Upper Old Red Sandstone of Scotland.

The term Devonian is applied in Devonshire to rocks which cover a large part of the county, and adjacent districts in Cornwall, consisting of clay slates (locally called Killas), and grey limestone; these strata occupy a similar position between the Silurian and Carboniferous formations, although lithologically and palæontologically these deposits are unlike the Old Red Sandstone of Hereford, the South Welsh counties, and Scotland.

The late Professor Jukes, in alluding to these strata which contain an abundant marine fauna, observes that "it is quite possible that the slates and limestones of South Devon and the Red Sandstone of South Wales, although each deposited within the same great period, are not strictly contemporaneous, but were formed at different parts of the period; or it is possible that the Red Sandstone series of South Wales is not a continuous series; that the lower part of it, at all events, is older than any of the Devon series, while the upper part may be newer than much of that series."†

* Jukes and Geikie, Manual of Geology (1872), p. 570.
† Manual of Geology (1862). p. 491.

These rocks of Devon and Cornwall have, like the true Old Red Sandstone, been classified into three groups, and an attempt has been made to correlate them with the typical Old Red; so much difference of opinion, however, prevails as to their exact relations, that it will be preferable to consider them as a distinct series, some of the lower elements of which (as pointed out by Mr. Jukes), may probably have been contemporaneous with the Old Red Sandstone and other strata of the upper division with the Carboniferous Limestone.

The order of succession has been ascertained to be as follows:—

Upper Devonian,	Pilton and Marwood beds, N. Devon, Petherwin and Tintagel, Cornwall.
Middle do.	Torquay, Plymouth, Newton, Bushel, and Ilfracombe, S. Devon.
Lower do.	Lynton, N. Devon; Meadsfoot, S. Devon; Looe and Fowey, Cornwall.

The fossils of the typical Old Red Sandstone of Herefordshire, Wales, Scotland, and the south of Ireland, are in their general character quite distinct from those of Devon and Cornwall. Whilst in the former series of strata fishes, peculiar crustacea, a single Molluscan shell, and plants, all indicating a fresh water habitat, are the predominant fossils; in the latter, which consists, for the most part of limestone and slaty rocks, Corals, Crinoids, and Mollusca, undoubtedly of marine origin, are the prevailing organisms.

Our knowledge of the vegetation of the Old Red Sandstone is still very imperfect, and has only been derived from collections made at a few localities. It bears a considerable resemblance to that of the succeeding Carboniferous formation, all being clearly of terrestrial origin. In the lowest division fragments of land plants only have been discovered. Ferns, Lycopodiaceous plants, Lepidodendra with roots, described as resembling Stigmaria of the coal, also stems and roots of Coniferous trees have been found at Wick, in the central portion of the Caithness Flags, in the Orkneys, and at Thurso. In higher strata fossil plants of large size, belonging either to Calamites or an allied genus, have been discovered in the Orkney and Shetland Isles. Whilst in the uppermost division in Ireland, at Kiltorcan in the county Kilkenny, and other places in the county Cork, numerous plant remains have been found in the Upper Old Red Sandstone, accompanied at some of the localities by a large freshwater bivalve Molluscan shell, and fish remains, corresponding with those found in the Old Red Sandstone of Scotland.

The Upper Old Red Sandstone occurs extensively in the south-eastern parts of Scotland, the highest beds of the series are of yellow sandstone, upon which rests the Coal strata of Fife; this is well shown at Dura Den, near Coupar. The beautiful fossil fern, so abundant in the south of Ireland, *Palæopteris* (*Cyclopteris*) *Hibernicus*, is also found in the Upper Old Red Sandstone of Berwickshire, at Jedburgh, associated with the Fossil Fish, *Holoptychius*, *Coccosteus*, and *Pterichthys*. On

the authority of Mr. Etheridge this plant, under the name of *Adiantites Hibernicus*, is also stated to occur in the Upper Devonian, Baggy and Pilton groups, North Devon, as well as in the Coomhola rocks of Ireland* (its occurrence in the latter rocks is not, however, authenticated). In the fine-grained and evenly-bedded yellowish sandstone of Kiltorcan, county Kilkenny (before alluded to), remains of plants are the prevailing fossils, which, from the condition of the deposit, are in most beautiful preservation. The fronds of the magnificent fern *Palæopteris Hibernicus* a much reduced figure of which is shown on Pl. 28, fig. 1, is the most abundant of all the fossils; some of its fronds measure five feet in length, and are perfectly preserved, from its scaly base to the extremity; it was formerly called *Adiantites*, when named by Forbes, and *Cyclopteris* by Ad. Brongniart; the possession of an intermediate pair of leaflets between each pinnule, and its peculiar fructification are characters which induced Professor Schimper to constitute it the type of a new genus, named by him *Palæopteris*. Fig. 1 *a*, pl. 28, is reduced to one-sixth of the natural size; 1 *b*, shows some of the leaflets of the natural size, in which the venation is distinctly visible.

Another abundant plant at this prolific locality has been named by the same eminent Botanist, *Sagenaria* (Knorria) *Bailyana*. A portion of this plant is figured on the same plate, fig. 2 *a*, reduced to one-third of the natural size, and 2 *b*, a portion of the surface of the natural size. This specimen shows the central axis and characters of a Lepidodendriod plant evidently allied to Sigillaria of the Coal Measures, and like it having punctated roots with attached rootlets. At 2 *c*, is represented a portion of the upper branches of a similar plant, also reduced in size; 2 *d*, of the natural size, shows the regularly arranged surface markings. On a late visit to this place we were fortunate enough, in quarrying, to expose one of these plants, tree-like in size, which measured over twenty feet in length, the upper portion branching, and again subdividing.

The plants named *Cyclostigma* by the Rev. Professor Haughton, M. D., are also abundant at Kiltorcan, but are generally more fragmentary; it is probable they all belong to one species to which the name of the typical form *Cyclostigma Kiltorkense* may be applied. This plant differs essentially from the previously named species, both in the finely striated (not fluted stem as in Sagenaria), and in the widely distant cicatrices to which the leaves were attached as well as in other particulars.

Dr. J. W. Dawson, Principal of M'Gill College, Montreal, has described some analogous plants from the Devonian and Lower Carboniferous formations of Canada.†

The only Molluscan shell yet discovered in beds considered to be

* Journal, Geological Society of London, vol. xxiii., p. 616.

† See Reports and Papers in Journal, Geological Society of London, 1862-63, 1871, &c.; and Report to Geological Survey of Canada, on the Fossil Plants of the Lower Carboniferous and Millstone Grit Formation of Canada, 1873.

equivalents of the true Old Red Sandstone, at Kiltorcan, is the large bivalve before alluded to *Anodonta Jukesii Forbes;* this shell is figured on Plate 31, fig. 5, reduced to two-thirds of natural size; its close alliance with the large fresh water mussel, *Anodon, cygnæus* of our lakes, its association with numerous land plants and fish of a type analogous to those inhabiting inland lakes and rivers, favour the theory of the fresh water origin of the Old Red Sandstone.

Small bivalved Carapaces of Crustacea belonging to the order Phyllopoda, named *Estheria membranacea* (Plate 32, fig. 5, *a*, *b*, *c*), have been found abundantly in the central or Caithness flags near Wick. Another form *Beyrichia Klædeni*, belonging to the order *Ostracoda* has also been met with in the Old Red Sandstone of Shropshire.*

Crustacea of the Eurypterida, an order which includes some of the largest examples of the class,† commencing in the Uppermost Silurian, are also found in the Basement beds of the Old Red Sandstone, represented by one of the largest species, *Pterygotus anglicus*, of which figures of some of the parts, reduced to one-fourth the natural size, is given on Plate 32, figs. 7, *a–e*, from the monograph by Messrs. Huxley and Salter.‡ This species is found in strata called the Perth and Forfarshire Paving Stones, at Balruddery Den, Perthshire. A second species of *Pterygotus* occurs plentifully in the Yellow Sandstone of Dura Den.

These remarkable Crustacea, allied to the recent King Crab, *Xiphosura*, and the Copepoda, are composed of a number of moveable segments, usually about eleven or twelve; the anterior portion (*carapace* or head), being square shaped, and provided with a pair of eyes, generally at the upper edge, but in some species more central; to the under part of the head are attached three or four pair of moveable swimming feet and antennæ, the latter armed with powerful pincers as in the lobster; the tail, or *telson*, usually terminates in a pointed spine, but is sometimes lobed or rounded; the surface of the integument is ornamented with semicircular plications or markings of a half moon shape.

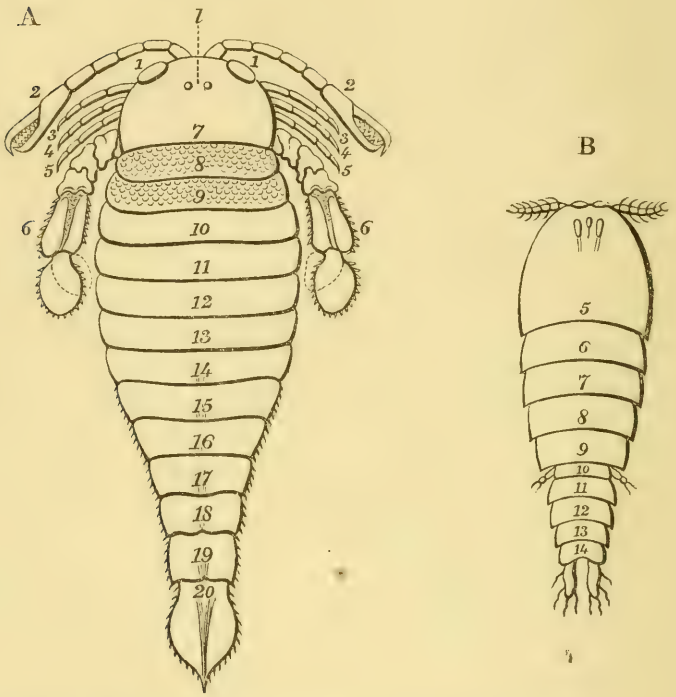
Figure 14 is a restored outline of *Pterygotus*, with a recent allied crustacean, *Sapphirina*, the former considerably reduced in size, from the monograph by Mr. Woodward, Palæontological Society, 1865, Plate viii., fig. 1, and Plate ix., fig. 4.

* Chart of Fossil Crustacea, by Salter and Woodward, p. 19, fig. 47.

† Descriptive remarks, *ante*, p. xlvii., &c

‡ Memoirs of the Geological Survey of the United Kingdom, Monograph 1, 1859.

FIG. 14.—FOSSIL AND RECENT CRUSTACEAN FOR COMPARISON, EURYPTERIDA.



A.—*Pterygotus anglicus* (*fossil*) *restored* (*after Woodward*).

1. The eyes.
2. Chelate antennæ.
3. Mandibles (endognaths).
4. First maxillæ do.
5. Second do.
6. Maxillipeds (ectognaths).
7. Head shield bearing the ocelli (*l*) and large compound eyes (*i i*).
8—14. Thoracic somites.
15—19. Abdominal do.
20. The Telson or terminal segment,

B.—*Sapphirina ovato-lanceolata* (*recent*) *Atlantic.*

5. Head shield.
6—9. Thoracic somites.
10—14. Abdominal do.

Some of these Crustaceans, particularly the species we have selected for illustration, *Pterygotus anglicus*, or "Seraphim," as certain portions of it are termed by the quarrymen, must have been of great size; it is estimated, from some of its remains, that it attained a length of fully five feet, and was more than a foot in breadth. There are sixteen species recorded, twelve of them in British strata, their Geological

range being from Upper Llandovery to Middle Devonian strata.* The characteristic examples are *P. anglicus*, and *P. gigas*.

Of the genus *Eurypterus* (according to the same authority), about twenty-two species are known, eleven of them in British strata, the Geological range of this genus being from the uppermost Silurian (Downton Sandstone and Passage Beds) to the lowest Carboniferous strata.

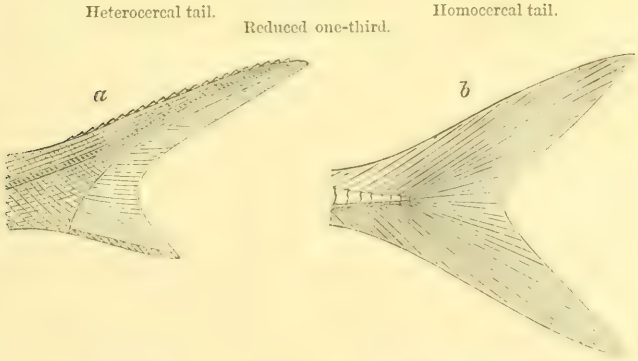
Other Crustacea of this order belonging to the genus *Stylonurus*, including six species, of which *S. Symondsii* (formerly called *Eurypterus*), figured on Plate xxxii., fig. 8, is an example, reduced to one-third of natural size, from "Cornstones" of the Old Red Sandstone, Rowlestone, in Brecknockshire; the Geological range of the genus being from Uppermost Ludlow to the Lower Devonian of Forfarshire.

Several forms of Crustacea allied to some of those just mentioned have also been collected from Upper Old Red Sandstone at Kiltorcan.†

The true Old Red Sandstone period may correctly be termed the age of fish, their remains being the predominant fossils; they principally belong to the great order of *Ganoids*, a few only to *Placoids* (to which division the recent Sharks and Rays belong), as these orders are defined by the late Professor Agassiz, whose magnificent and extensive works on Fossil Fish have so largely benefited science.

The fossil fish of the Palæozoic Rocks all belonged to the division with *heterocercal* tails, being unsymmetrical, with a prolongation of the vertebral column into the upper lobe, as in the Permian genus *Pygopterus* (Fig. 15 *a*), and in the recent *Lepidosteus*, Sharks, Rays, and Sturgeons; whilst the majority of living fish have the *homocercal* or symmetrical form of tail in which the vertebral column terminates

FIG. 15.



Pygopterus (*fossil*). *Clupea*, *Herring* (*recent*).

* Monograph by H. Woodward, F. G. S., &c., in Palæontographical Society, Vol. xix., 1866, p. 19.

† British Association Reports, 1868 and 1869.

at an equal distance between the two lobes as in the Herring (Fig. 15 *b*).

A remarkable group, the *Cephalaspides* includes in Britain alone, fifteen species, a number which have been since increased. This group, commencing in the Upppermost Silurian with the genus *Pteraspis*,* Plate xxvii., fig. 6, was extensively developed in the Old Red Sandstone.

With regard to these fossil fish Sir R. Murchison remarks, "It follows, therefore, that as the grey flag-like strata which pass up into reddish beds may either be viewed as the termination of the Silurian or the commencement of the Old Red, the genera *Cephalaspis* and *Pteraspis* are typical both of the uppermost Silurian and the lowest zone of the Old Red or Devonian group."†

The lowest division of the Old Red Sandstone is characterized in Ludlow, &c., and Forfarshire by fish of the genera *Onchus*, *Pteraspis* (two species), and *Cephalaspis* (two species), including *C. Lyelli*, Plate xxxiii., fig. 2, *a–c*.

In the Middle Division of Herefordshire and part of Shropshire, Caithness flags, Orkneys, &c., Scotland, the characteristic fish are *Coccosteus*, including *C. decipiens*, Pl. xxxiii., fig. 3, *a*, *b*. *Asterolepis*, *Pterichthys*, including *P. cornutus*, Pl. xxxiii., fig. 1, *a*, *b*. *Diplopterus Dipterus*, *Glyptolepis*, including *G. leptopterus*, Pl. xxxiii., fig. 5, *a*, *b*. *Osteolepis*, including *O. major*, Pl. xxxiii., fig. 4, *a*, *b*; and *Holoptychius nobilissimus*, Pl. xxxiii., fig., 4, *a*, *b*. From strata belonging to this division in Britain upwards of seventy species have been already obtained.

The Upper Division has been observed at Dura Den, in Fife, the Orkneys, &c., and at Kiltorcan, Co. Kilkenny. The characteristic fish are *Holoptychius Flemingi*, *Dendrodus*, *Pterichthys minor*, &c., *Onchus*, and *Glytopomus minor*; fifteen species referred to eleven genera have been obtained from British strata.

The majority of these Old Red Sandstone fishes, including the figured examples on Pl. xxxiii. of *Osteolepis*, *Glyptolepis*, and *Holoptychius*, with the exception of the anomalous genera *Cephalaspis*, *Pterichthys*, and *Coccosteus*, have been arranged by Professor Huxley into a sub-order established by him under the name of *Crossopterygidæ*‡ (fringed fin), of which the recent *Polypterus* of the Nile and other African rivers is the living representative.

The genus *Cephalaspis* (Buckler-headed), so named from the peculiar shield covering the head, is represented by a remarkable fish which first occurs in the Passage beds from the Silurian rocks into the Old Red Sandstone described as *C. Murchisoni*, from the uppermost bone bed near Ludlow. The species we have figured *C. Lyelli*, Pl. xxxiii., fig. 2, is from the Arbroath Paving stone, Glammiss, in Forfarshire.

* Descriptive remarks, *ante* p. xlix. † Siluria, fourth edition, p. 260.
‡ Mem. Geo. Survey, Decade x., p. 24.

Coccosteus decipiens, Pl. xxxiii., fig. 3, is another extraordinary fish, which was provided with a cuirass of bony plates encasing the head and body, the vertebral column and other bones being cartilaginous.

Pterichthys (winged fish) is perhaps still more remarkable, and less fish-like. Five species of this genus have been found in the Old Red Sandstone of Scotland; its body was also encased in hard bony plates, and was provided with spine-like jointed appendages which sometimes spread out at right angles and were probably connected with the pectoral fins.

These three genera, with some others, are grouped in the family *Cephalaspidæ;* but as Professor Huxley remarks, the position it should occupy in the classification of fish is not readily determinable.

The belief as to the fresh-water origin of the typical Old Red Sandstone is greatly strengthened by the character of the fish remains; the closest affinity to these fossils, amongst living examples, being found in certain fishes inhabiting the rivers and lakes of North America and Africa.*

We now arrive at the consideration of the Devonian type of fossils as observed in parts of Devonshire and Cornwall. Allusion has already been made to the tripartite division of this group (*ante* p. liii.), and to the question whether some of the strata of the upper division should not be incorporated with the lower portion of the Carboniferous series.

These fossils in several respects show an intermediate character between the Silurian and Carboniferous group; in the lower beds of the series they are closely allied to those of the Silurian formation, and in the upper strata to that of the Carboniferous, yet they are believed to be sufficiently distinct to constitute an independent group. According to Mr. Etheridge† "there are 383 species of fossils known to occur in the Devonian rocks of North and South Devon and Cornwall."

In the uppermost division at Pilton, Barnstaple, &c. (according to Sir C. Lyell), "thirty-six species out of 110, that is, more than one-fifth, are common to the overlying Carboniferous rocks."‡

The plant stems called *Knorria* of North Devon appear to be identical or closely allied to the *Sagenaria* of the South of Ireland; according to Professor Goeppert, the genus *Knorria* of Sternberg is only a form of *Sagenaria* or *Lepidodendron*, and his opinion is, that *Knorria imbricata* of the Lower Carboniferous rocks is identical with *Sagenaria Veltheimiana* of Sternberg; the species to which we originally referred the plant from Kiltorcan, which has been since named by Professor Schimper, *S. Bailyana*. The plants occurring in such profusion in more shaley beds, at Tallow Bridge, county Waterford, were also referred to *S. Veltheimiana*, a determination which has been con-

* Huxley, Mem. Geol. Survey, Dec. x.
† Journal Geological Society of London, Vol. xxiii., p. 679.
‡ Student's Elements of Geology (1871).

firmed by Professor Heer; they were originally described by Professor Haughton under the name of *Knorria dichotoma*. The strata in which they are found although lithologically resembling the Carboniferous state, was considered by the late Professor Jukes to belong to the Upper Old Red Sandstone series.*

Although several of the Silurian and Devonian genera are the same, the species are for the most part distinct; *Stromatopora concentrica*, Pl. xxix., fig. 1. and *S. placenta*, fig. 2, characteristic fossils of the Middle Devonian (Torquay group), were formerly classed with Corals, but are now included under the class *Amorphozoa* in the order Foraminifera.

Corals (*Actinozoa*), are very frequent in the Middle Devonian limestone of South Devon, especially at Torquay, Plymouth and Newton Bushel; when cut and polished, the structure is clearly shown, and they are frequently used for ornamental purposes. Professors Milne, Edwards, and M. Jules Haime, whose learned and beautifully illustrated Monographs on this class of fossils in the volumes of the Palæontographical Society we have frequent occasion to quote from, observes that nearly all the Devonian are distinguished from the Silurian Corals. Some of the most characteristic of these Devonian Corals are figured on Pl. xxix.

In the Monograph on British Devonian Corals,† the authors state that "the Corals of the Devonian formation in different parts of the world belong to about 150 well defined species, forty-six of which have been met with in England. The Corals belonging to the family *Cyathophyllidæ* are very predominant, and form thirty-three of the forty-six above mentioned species. The family of *Favositidæ* is represented by ten species, and the three remaining species belong one to each of the three families *Stauridæ; Milleporidæ* and *Poritidæ*, with the exception of one species all these fossils belong, therefore, to the two sub-orders, *Zoantharia tabulata* and *Z. rugosa*, one of which has no representatives in the actual Fauna, nor in the Tertiary and Secondary Formations. Three of these Devonian fossils exist also in the Silurian rocks, but all the others appear to be peculiar to the Devonian period."

The family *Milleporidæ* is represented by *Heliolites porosa*, figured on Plate xxix., 4 *a*, *b*, a characteristic Coral of the Middle Devonian limestone at the localities specified in the explanation of the Plates.

The *Favositidæ* includes *F. polymorpha* (fig. 5, on the same plate), one of the most frequent of all the Devonian Corals.

The remarkable Coral *Pleurodictyum problematicum* of Goldfuss, we have also figured on the same plate, fig. 3, *a–d*. It is referred by the

* In the Table of Old Red Sandstone and Devonian fossils, by Mr. Etheridge, before referred to, plants under this name of *Knorria dichotoma* (Haughton), are stated to occur in the Baggy and Pilton groups of the Upper Devonian, North Devon. Possibly they are like the specimens figured and described by Professor Haughton, the upper branches of *Sagenaria Veltheimiana* or *S. Bailyana*.

† Palæontographical Society, 1853, p. 211.

Authors of British Fossil Corals to the *Poritidæ*,* and is a frequent fossil at Braunton, Devon, as well as in the Carboniferous Slate and "Coomhola" grit near Bandon, in the county of Cork, it appears to be, as suggested by the late Professor Phillips, allied to *Michelinea*, but presents structural differences which are pointed out in a notice of this Coral by the Author in the Explanation of the Maps of the Geological Survey of Ireland, Sheet 187, &c., p. 24.

Of the *Cyathophyllidæ* we have figured *Cyathophyllum cæspitosum*, fig. 6, *a*, *b*, a fasciculate or branching coral. *Acervularia pentagona*, fig. 7, *a*, *b*, and *Arachnophyllum* (Smithia), *Hennahi*, fig. 8, *a*, *b*, both astreiform or compound aggregations of corallites.

The singular fossil called *Calceola sandalina*, fig. 9, *a*, *b*, *c*, formerly considered to be a Brachiopod shell, is now satisfactorily shown by Professor Lindström† to be a coral of the division Zoantharia rugosa, and allied to *Goniophyllum*, a Silurian genus which is also operculiferous.

The Echinodermata of the Devonian rocks, as enumerated in Mr. Etheridge's list of fossils, include two Starfishes, referred to the genera *Protaster* and *Palæaster* (both however specifically unnamed), from the Upper or Pilton group of North Devon eighteen Crinoids and one Pentremite, *P. oralis*. The Crinoids, according to their present unsatisfactory determination, belong for the most part to the genus *Cyathocrinus*, of which there are eight species named. Of the whole number eight species are said to continue into the Carboniferous rocks. The species we have figured are *Cyathocrinus geometricus*, Pl. xxx., fig. 2. *Hexacrinus interscapularis*, fig. 1., *a*, *b*; of this genus there are three species, all being confined to Middle Devonian, and *Taxocrinus macrodactylus*, fig. 3, *a*, *b*, the only representative of the genus occurring in Upper Devonian of North Devon.

The Devonian Polyzoa number about twelve species, all the genera except one occurring in Carboniferous rocks, and several of the species also continuing into that formation such as *Ceriopora gracilis*, *Fenestella antiqua* (figured amongst the Carboniferous Fossils, Pl. xxxvii., fig. 1, *a*, *b*), of which *F. plebeia* and other species are believed to be synonyms. *F. prisca*, *Glauconome hipinnata*, *Polypora laxa*, and *Ptylopora flustriformis*. This group of Fossils, like that of the Echinodermata, are in consequence of their condition in these rocks, which are mostly decomposing slates, very difficult of determination, the definition of the species cannot therefore be entirely relied on.

The Devonian Brachiopoda, like those of older and newer strata, have been ably treated and elaborately figured by Mr. Thomas Davidson, F. R. S., in his excellent monographs on this class of animals in the volumes of the Palæontographical Society. From his descriptions and results, it appears there are above twenty genera, including upwards of ninety species; twelve only of these pass into the Carboniferous

* Op. cit., p. 221.

† Geol. Mag. (1866), Vol. iii., p. 356, &c., Pl. xiv.

rocks. This class of the Mollusca are with the Actinozoa or Corals the most abundant and typical of all the fossils of these rocks, and especially of the Middle Devonian series.

Some of the purely Devonian species are figured on Pl. xxx., amongst them *Stringocephalus Burtini*, fig. 4, *a*, *b*, a remarkable shell, having a very prominent beak ; *Spirifera disjuncta*, fig. 6, a very abundant species in the Middle and Upper Devonian of N. and S. Devon and Cornwall, although apparently not very distinct from some of the varieties of *S. striata* of the Carboniferous rocks. *Cyrtina heteroclita*, fig. 7, *a*, *b*, a sub-genus of Spirifera, according to Woodward, having a very prominent beak. *Atrypa desquamata*, fig. 9, is a frequent fossil, especially in the Middle Devonian, occurring also in the Upper or Petherwin group, and allied to the common Silurian species *Atrypa reticularis*, which is also not uncommon in Devonian strata. *Pentamerus brevirostris*, fig. 11, belongs to a genus which attained its maximum in Upper Silurian rocks; a shell remarkable for its five divisions (from which its generic name is derived), caused by the dental and septal plates attached to each valve ; and *Chonetes Hardrensis*, fig. 14, a small flattened shell having the hinge margin of the ventral valve provided with a series of tubular spines. This shell occurs in Middle and Upper Devonian, continuing on into Carboniferous strata.

The Devonian Conchifera (bivalve shells), or Lamellibranchiata, according to Mr. Etheridge's able summary in the Journal of the Geological Society (before quoted), p. 673, comprises twenty-eight genera, including fifty-eight species; of these five genera, including seven species only, continue into the Carboniferous series. Some of the most characteristic of these are figured on Pl. xxxi., viz., *Aviculopecten transversus*, fig. 1. *Avicula Damnoniensis*, fig. 2, and *Cucullæa Hardingii*, fig. 3, all Upper Devonian species, the two latter being abundant in the sandy strata of that division in the Barnstaple series. Both of these bivalve shells are also found plentifully in the "Coomhola" grits and shales of the Lower Carboniferous strata in the county of Cork.* The remarkable shell *Megalodon cucullatus*, fig. 4, *a*, *b*, is a typical Middle Devonian species having an enormous development of the hinge teeth, a characteristic fossil in the limestone of the Torquay and Ilfracombe series, also occurring in the Lynton group of the Lower Devonian. The large freshwater bivalve *Anodonta Jukesii*, fig. 5, (*ante* p. lv.), has hitherto only been observed in the Upper Old Red Sandstone of Ireland, in the counties of Kilkenny, Cork, and Waterford.

Of the Gasteropoda (Univalves), forty-seven species are included in Mr. Etheridge's list, two only of these occur in the Lower Devonian, the Lynton group; thirty-seven occur in the Middle Devonian (Torquay group), and four only of these in the Ilfracombe group, also Middle Devonian. In the Upper Devonian nine species occur in the Petherwin group, three in the Baggy, and nine in the Pilton groups, three of the latter continuing into this group from the Middle De-

* Explanation to Map 187, &c., Geol. Survey Ireland, pp. 16, 17, & 28.

vonian. We have figured on the Pl. xxxi., *Murchisonia bigranulosa*, fig. 6, and *Euomphalus annulatus*, fig. 7, both Middle Devonian species, Torquay group.

The Cephalopoda of the Devonian rocks, number according to the same authority, six genera including fifty-two species. Of the four principal genera *Clymenia* contains eleven species, *Cyrtoceras* thirteen, *Goniatites* ten, and *Orthoceras* fifteen. All the species of *Clymenia* occur in the Upper or Petherwin group, one of them only, *C. lævigata*, appearing in the Middle Devonian, Torquay group. Of *Cyrtoceras* out of the thirteen species recorded, all of them except one, and that of doubtful occurrence, are found in the Torquay group. *C. nodosum*, Pl. xxxi., fig. 8, is a species confined to Middle Devonian. *Clymenia striata*, fig. 9, *a*, *b*, is a genus belonging to the *Nautilidæ* in which the septa, 9 *b*, is simple or slightly lobed, it is almost entirely confined to the Upper Devonian. The genus *Orthoceras* is represented by one species in the Lower Devonian, six in the Middle Division (Torquay group), four of them continuing to the Carboniferous, ten in the Upper Devonian; one of these also continuing to the Carboniferous. The genus Nautilus is represented by two species, one of them in the Torquay group (Middle Devonian), the other in the Petherwin group (Upper Devonian).

The Nucleobranchiata or Heteropoda of the Devonian rocks are of two genera, *Bellerophon* and *Porcellia*, the former include five species, three of them continuing into the Carboniferous rocks.

The Pteropoda of the Devonian rocks have only one representative, a species of *Conularia* not specifically named, it occurs in the Ilfracombe group of the Middle Devonian.

The Annelida are represented in Devonian rocks by the genus *Tentaculites* only, of which there are two species, both Middle Devonian.

The Crustacea of the Devonian rocks consist of six genera including thirteen species. The small bivalve Carapaces of *Entomis serratostriata*, Pl. xxxii., fig. 6, *a*, *b*, belonging to the *Ostracoda*, a very characteristic fossil of the Middle Devonian rocks of the Rhine, and the Upper Devonian of Belgium, is also found in the Petherwin group of the Upper Devonian in Cornwall.

The Trilobites number twelve species included in five genera; *Phacops latifrons*, fig. 1, *a*, *b*, is the most frequent in Middle and Upper Devonian strata. The remarkable form of *Harpes macrocephalus* is shown at fig. 2, this fossil is in Britain confined to the Torquay group of the Middle Devonian, it also occurs in the same division on the Rhine. The large species *Homolonotus armatus*, fig. 3, is another remarkable Trilobite, more abundant on the Continent than in Britain; it has been found in the Meadsfoot group of the Lower Devonian, and characterizes the Lower and Middle Devonian of the Rhine, and Lower Devonian of Belgium. *Bronteus flabellifer*, fig. 4, is a Middle Devonian type, in Britain confined to the Torquay group, occurring also in the

Middle Devonian group of the Rhine, and the same division in Belgium and France.

The Devonian CRUSTACEA are, in their general aspect, allied to those of the Silurian, the genera being nearly all similar.

Whilst there are over 100 species of fossil fish in the Old Red Sandstone proper, in the Marine Devonian, three only are known, viz.: 1. *Phyllolepis concentricus*, from the Meadsfoot group, Lower Devonian Slates of Cornwall.* 2. *Holoptychius*, from the same group, and Baggy, Upper Devonian. And 3. *Onchus* (?), fish bones and defence spines in Middle Devonian strata, east side of Ilfracombe Harbour.†

FOSSILS OF THE CARBONIFEROUS ROCKS.

The series of strata included in the Carboniferous formation are in Britain usually grouped into four divisions; the lowest being the Lower Limestone shale, or Carboniferous slate, which is occasionally interstratified with ferruginous sandstones about 200 feet in thickness, these strata graduate downwards into the Upper Old Red Sandstone; over this is the Carboniferous or Mountain Limestone, an aggregation of compact thick and thin bedded limestones, of various shades of red and grey, occasionally interspersed with shales, its thickness ranging from 500 to 1,500 feet. These two divisions form the lower portion of the series. Over them is the Millstone Grit, locally called *Farewell rock*, which usually consists of hard quartzose sandstones having a maximum thickness of 1,000 feet. Superimposed upon this is the Coal Measures, consisting of an Upper and Lower series, between which in the Somersetshire and South Welsh districts are the Pennant Sandstones.

The total thickness of the whole Coal Measure group in the first named district is estimated at 5,000 feet, and in some parts of South Wales at as much as 12,000 feet.

The Carboniferous rocks are clearly exhibited in the great South Welsh Coal basin of Caemarthen, Glamorgan, and Monmouth; and on a smaller scale in that of the Forest of Dean, and with certain mineral changes and an expansion of the lower shale in the county of Pembroke.

Towards the north, as observed in Shropshire and Flintshire, the lower portion of the series is more developed, a change which becomes still more evident in the range of strata from Derbyshire into Yorkshire and Northumberland, and especially so in the great central Carboniferous depression of Scotland.

* Pengelly, Report Royal Geological Society, Cornwall, 1860–65.
† Etheridge, Journal Geological Society, Vol. xxiii., pp. 606, 617, 677.

In the North of England the limestone is much divided by beds of grit or sandstone, clays and shales; in Yorkshire the Upper Limestone shale, and top of the Carboniferous Limestone, has been named by the late Professor John Phillips, the Yoredale series, and the thick Limestone below the Scar limestone.

In some of the Coal districts which are within or contiguous to the Silurian formation, as at Dudley and Wolverhampton, the lower and central portions of the series, the Carboniferous Limestone and Millstone Grit are absent, the upper productive Coal Measures resting directly on Silurian rocks.

The Carboniferous formation in Scotland is well exhibited along the great midland valley, from the shores of the Clyde to the mouth of the Frith of Forth. The lower part of the system, as before alluded to, instead of the usual thick mass of limestone, consists for the most part of sandstones and shales, with comparatively few and thin limestone bands.

In Ireland the lower portion only of this formation is extensively developed. The Carboniferous slate and *Coomhola* grits, forming its base in the county of Cork, has a maximum thickness of at least 5,000 ft. The Carboniferous Limestone of the South is of great thickness, usually forming low and gently undulating ground; it is covered by the Lower Coal Measures, consisting of black shales and grits, containing at their upper portion thin beds of Coal. The limestone spreads over a great extent of the central part of the country

In the north of Ireland the Coal Measures differ from that of the south by the development of thick sandstones, forming a group like the Millstone grit of Derbyshire, and the separation of the Carboniferous Limestone by the introduction of a set of shales and sandstones called the *Culp*, with the entire absence of the Carboniferous slate group. The character of the Coal is also different, that of the north being Bituminous, whilst in the south it is Anthracitic.*

In England the lowest division of the Carboniferous formation is known as Lower Limestone Shale; in Scotland, as the Lower Calciferous Sandstone; and in Ireland, Carboniferous Slate and Coomhola grit.

Although the arenaceous and schistose Lower Carboniferous strata, "have" as Sir R. Murchison observes,† "a strong mineral and zoological affinity to the upper portion of the underlying Devonian, or Old Red Sandstone rocks, into which they graduate," yet the fossils are sufficiently distinct to enable us to separate these formations, and more especially as we ascend in the series.

The Plants of the Lower Carboniferous strata in Scotland are numerous in some districts, and resemble those of the true Coal Measures, such as the genera *Sphenopteris Lepidodendron, Stigmaria,* &c.‡

* Jukes, Manual of Geology, 1862, p. 515.

† Siluria, fourth edition, p. 295.

‡ Prestwich, Geol. of Coalbrookdale, Geol. Trans., 2nd series, Vol. v., p. 463.

In Ireland the Lower Carboniferous slate and grits, except at particular localities, contain but few fossil plants; *Knorria* like stems with simple branching forms, *Filicites lineatus*, are the prevailing kinds which have been hitherto noticed.

The great central mass of Limestone is purely marine, and contains still fewer traces of vegetable remains; the intermediate shales occasionally display Fucoidal like forms and rarely anything like terrestrial plants.

It is only when we arrive at the upper division, or Coal Measures, the superabundant remains of a primæval vegetation becomes apparent; changes from a marine or estuary condition to that of a terrestrial one are observable in many of our Coal fields, such as that of Coalbrookdale, where at least five decided alternations in the character of the strata from marine to terrestrial have been observed. In South Wales, where the Coal Measures are estimated to contain the great thickness of 12,000 feet, and 100 Coal beds are, it is said, intercalated at various levels, we have also positive evidence of alternating marine conditions; marine shells having been found associated with some of the lowest beds of coal.* Each of these Coal seams rests immediately upon a band of clay or sandy shale, called *Underclay* or *Seat rock*, which abounds with the plants called *Stigmaria*, or roots of *Sigillaria*, one of the most abundant plants in the Coal series, and one which must have contributed largely to the production of Coal.

From this series of strata, principally in the shales immediately above and below the Coal seams, more than 300 different kinds of fossil plants have been described, belonging, for the most part, to the class of *Cryptogamia*, Ferns or *Acrogens* being the most prevalent. One of the most universally distributed of these is *Alethopteris lonchitica*, Plate xxxiv., fig. 2, *a*, *b*. *Sphenopteris Hæninghausii*, fig. 3, *a*, *b*, is another abundant fern of a different character. A very important and numerous class of plants named *Calamites*, probably allied to the *Equisetaceæ*, occur in profusion in almost every Coal field. *Calamites cannæformis*, fig. 1, being one of the most characteristic species. *Lepidodendron Sternbergii*, fig. 4, *a*, *b*, *c*, is considered to be allied to the Club Mosses, although of gigantic proportions, being referred with them to the *Lycopodiaceæ*.

Another group of important Coal Plants are the *Sigillaricæ*, of these *Sigillaria tessellata*, fig. 5, *a*, *b*, showing trunk and roots *Stigmaria*; the stumps of this plant often passes through the shale and coal, and its roots traverse the underclay. These stumps, when unobserved by the workmen on excavating the coal which supported them, fall through, causing frequent accidents. They are locally termed *Bell moulds*, from their rounded extremity.

The three last named genera contained plants, several of them of very large size, resembling in that respect some of our Forest Trees,

* Bevan, Brit. Assoc., Rep. Trans. Sect., 1858, and Salter's Appendix to the Iron Ores of S. Wales, Geol. Surv. Mem., 1861.

and with the large variety of Ferns, many of which may have been Tree-ferns, evidently formed the principal supply from which our valuable Coal-seams have been derived.

The Carboniferous or Mountain Limestone in certain parts of the series abounds in Corals or true Polypi; CŒLENTERATA, the majority of these, as well as the Silurian Corals, belong to the division *Zoantharia rugosa*.* Some of the most frequent varieties are figured on Pl. xxxv., viz.: *Michelinea favosa*, fig. 1, especially characteristic of the Lower Limestone shale. *Calamopora tumida*, fig. 2, *a*, *b*, *c*, *Syringopora reticulata*, fig. 3, *a*, *b*, a small tubular branching and reticulated species occuring in hemispherical bunches. *Zaphrentis cylindrica*, fig. 4, a large simple or turbinated Coral, very frequent in the Lower Limestone shales of the North of Ireland. *Amplexus coralloides*, fig. 5, *a*, *b*, also a large simple cylindrical Coral, very characteristic of the Irish Carboniferous Limestone. *Lithostrotion striatum* (formerly named *L. basaltiformis*), fig. 6, *a*, *b*, a compound species, in which the corallites, from their close proximity, assume a hexagonal form, like a basaltic column, hence the name by which it was first known. *L. Portlocki*, fig. 7, *a*, *b*, is also a compound Coral, with a more irregular hexagonal arrangement and smaller corallites; their astreiform surfaces, caused by the radiation of the *septæ* from the prominent *columella*, are beautifully preserved in some examples from the Limestone of the North of Ireland. *Lithodendron junceum*, fig. 8, *a*, *b*, *c*, a group of small branching corallites occurring in bunches, is common in the Lower Limestone shales; and *L. affinis*, fig. 9, an aggregation of much larger branching corallites is remarkably abundant in some beds of the Carboniferous Limestone, where it occurs in radiating masses with *Lithostrotion striatum*, several feet in diameter; one of these *Lithostrotion* "stools" is described in the explanation to Sheet 145, Geol. Survey of Ireland, p. 28, fig. 10, as being 9 feet in diameter.

As there is some confusion in the definition of the genera *Lithodendron* and *Lithostrotion*, we have arranged those species in which the corallites are rounded and separate under the former; for example, *Lithodendron affinis* and *L. junceum;* and those which are more compact, having the corallites in close proximity, or pressed together, under the latter, such as *Lithostrotion striatum*, *L. Portlocki*, &c,

The remains of ECHINODERMATA in the Carboniferous rocks are referred to three orders only. The *Blastoidea* is represented in our figures by *Pentremites Derbiensis*, Pl. xxxvi., fig. 1, *a*, *b*, *c*. This elegant little fossil we found to be plentiful at the picturesque limestone cliff of Ben Naughlin, in the demesne of the Earl of Enniskillen, Florence Court, county of Fermanagh, some of the specimens exhibiting the arrangement of *ambulacra* and *ovarian* apertures with great distinctness. *P. inflatus*, fig. 2, is a larger species in which the short stalk and petaloid ambulacra are well shown.

* See Descriptive Remarks, *ante* p. xxvii.

The CRINOIDEA occur in profusion; some masses of Limestone being almost entirely composed of their separated joints, is therefore called *Crinoidal Limestone*. *Platycrinus lævis*, fig. 3, affords a good idea of one of those "stone lilies," showing a portion only of the column or stem,* composed of jointed rings, above which is the head *calyx* or "cup," built up of large plates from which spring double pairs of arms, which again subdivide, and are covered by the fingers, *pinnulæ*. *P. mucronatus*, fig. 4, is an allied species showing the *proboscis*. *Woodocrinus macrodactylus*, fig. 5, is one of a series of remarkable Crinoids, named in honour of Edward Wood, Esq., J. P., F. G. S., &c., of Richmond, Yorkshire, to whom, in conjunction with Professor De Koninck, of Liége, we are much indebted for their discovery and elucidation;† they occur in a most perfect condition, and in great profusion, in certain beds of the Yoredale series, in Carboniferous Limestone at Swaledale, near Richmond. *Poteriocrinus crassus*, fig. 6, *a*, *b*, *c*, is portion of a large stem and separated joints, and *P. conicus*, fig. 7, represents a large part of the head of another species. *Actinocrinus* is a very abundant genus; fig. 8 shows a portion of the column from which proceed the *ramules* or side arms. *Actinocrinus polydactylus*, fig. 9, is a frequent fossil in the Lower Limestone shale, especially at Hook Head, county of Wexford, some of the radiated plates of the cup and a portion of the stem only are shown in the figure. *A. amphora*, fig. 10, is a large *head* common in the limestone at Derryvullan, county of Tyrone.

The ECHINOIDEA, or Sea Urchins, include some remarkable bodies called *Palæchinus*. One of these beautiful fossils, *P. elegans*, fig. 11, *a–d*, shows a much larger number of plates entering into its composition than is possessed by its recent analogues, together with other peculiarities in the *ambulacral* arrangement, and *ovarian* or *genital* disk. *Archæocidaris Urii*, fig. 12, *a*, *b*, is a species of which the detached plates and large spines only have yet been observed.

The discovery of a new species of this genus by Wm. Harte, Esq., C. E., and County Surveyor of Donegal,‡ lately redescribed and named by the author.§ *Archæocidaris Harteiana* is the only known instance where the general form of this peculiar Carboniferous Urchin has been preserved.

The genus *Archæocidaris* may be considered as the prototype of the *Cidaris;* whilst *Palæchinus* foreshadowed that of *Echinus*.

All the classes of Mollusca except the *Tunicata* which have no hard shell, are well represented, and of full size in the Carboniferous Limestone.

The POLYZOA are more numerous in the Carboniferous Limestone and shales than in any other formation; the shales between the beds

* See diagram of Crinoid, Descriptive Remarks, *ante* p. xxviii., fig. 7, for designation of parts.

† "Geologist," 1858.

‡ Journal Royal Geological Society, Ireland, Vol. i., p. 67.

§ *Ibid.*, Vol. v, p. 40, Pl. iv.

of limestone, especially that of the Lower Limestone, generally exhibit their beautiful lace work structures in the greatest beauty and profusion. There is perhaps no spot where they may be better studied than on the promontory of Hook Head, in the county of Wexford, where the beds of limestone are almost horizontal, and large surfaces exposed, which are covered with a variety of Corals, Crinoids, Polyzoa, and Brachiopoda.

The most frequent in the Lower Limestone and Carboniferous slate is *Fenestella antiqua*, Pl. xxxvii., fig. 1, *a*, *b*. This species first appears in the Devonian. *F. membranacea*, fig. 2, *a*, *b*, is a funnel-shaped form with regularly arranged *fenestrules*, which, with others, are in such profusion in some limestone localities in Ireland as to give from their convolutions quite a character to the rock, which has in consequence been termed "Fenestella" limestone. *Polypora fastuosa*, fig. 3, *a*, *b*, is a species having numerous pores; and *Retepora undata*, fig. 4, *a*, *b*, a form closely related to that of existing species,* *Ceriopora rhombifera*, fig. 5, *a*, *b*, a small branching Polyzoan of great beauty commencing in the Upper Devonian, is a common fossil in the Lower Limestone shale of Ireland.

The Brachiopoda are the most frequent and characteristic of all the Mollusca in the Carboniferous Rocks; the accurate delineation and description of the numerous species, with their varieties, by Thomas Davidson, Esq., F. R. S., in the Volumes of the Palæontographical Society, lightens the labour of the Palæontologist in their identification. Of this class of fossil Bivalve shells more than 150 species are enumerated.

Of recent species, according to Woodward,† only seventy species were then known, whilst more than 1,000 extinct species had been described. For description of the parts of a Brachiopod shell see Descriptive Remarks, p. xxxvii., fig. 1, A, B, C. *Lingula*, *Discina*, *Crania*, *Terebratula*, and *Rhynchonella*, are genera which have lived on to the present day.

Lingula squamiformis, Plate xxxvii., fig. 6, *a*, *b*, *c*, belongs to a genus the most persistent of all fossils, commencing in the lowest fossiliferous rocks, it has continued through all the strata to the present day. This species commences in the Upper Devonian and continues to the Coal Measures.

Discina (formerly Orbicula) *nitida*, fig. 7, *a*, *b*, is an orbicular shell common in the Clay Ironstone of Coalbrook Dale. It commences (according to Mr. Etheridge) in the Upper Devonian continuing on to the Coal Measures.

Crania quadrata, fig. 8, *a*, *b*, *c*, is a less common fossil; it is, however, one of the genera which continues to the present day, and has been found in English, Scottish, and Irish strata. *Terebratula hastata*, fig. 9, *a*, *b*, is a common fossil in the limestone, of which *T.*

* See Descriptive Remarks, *ante* p. xxx, fig. 8.
† Manual of Mollusca, 1854.

sacculus., fig. 10, *a*, *b*, *c*, may be merely a variety, as suggested by Mr. Davidson. *Rynchonella pleurodon*, fig. 11, *a*, *b*, is a very abundant shell, especially in Lower Limestone; and *R. pugnus*, fig. 12, a larger form not so frequent, but nevertheless a characteristic shell. *Spirifera striata*, Pl. xxxviii., fig. 1, *a*, *b*, belongs to a genus which includes many Carboniferous species. This species is remarkably prevalent through all the divisions of Carboniferous strata from the lowest to the highest. *Spirifera cuspidata*, fig. 2, is another form not so frequent as the last named species, but still abundant in England and Ireland. *Anthyris ambigua*, fig. 3, *a*, *b*, *c*, an intermediate form between *Terebratula* and Spirifer, differs from the former in having an internal spiral arrangement like the latter. *Orthis resupinata*, fig. 4, *a*, *b*, is one of the most frequent fossils in the Carboniferous Limestone. *Productus semireticulatus*, fig. 5, *a*, *b*, *c*, also occurs in profusion. The *Productidæ* are exclusively Palæozoic and attained their maximum during the Carboniferous Limestone period; entire beds are made up of the large shell *Productus giganteus*. *Chonetes papilionacea*, fig. 6, *a*, *b*, belongs to a genus which also attained its maximum during the Carboniferous period. *Streptorhynchus crenistria*, fig. 7, *a*, *b*, is frequent in the Lower Limestone.

The Conchifera, or Bivalve shells of the Carboniferous Rocks, include a considerable number of genera and species. Of *Aviculopecten*, which contain a large variety of forms, we have selected *A. papyraceus*, Pl. xxxix., fig. 1, a shell found associated with *Goniatites* in the black shales (marine deposits) of the Coal Measures, both in England and Ireland. *A. granosus*, fig. 2, common in the Limestone, and *A. Sowerbii*, also abundant in the Limestone, especially of Ireland, and showing colour markings. An allied shell *Posidonomya Becheri*, fig. 4, also a marine species, is a fossil which in Ireland occurs in abundance, and marks a particular horizon between the Upper Carboniferous and the Lower Coal Measures; it is also frequent in the Culm of Devonshire, and thus a clue is obtained as to the true position the beds in which it occurs occupies in the Carboniferous series. *P. membranacea*, fig. 5, is a smaller and transverse form common in the Lower Coal Measure shales in the south and central parts of Ireland. *Modiola Macadami*, fig. 6, is especially characteristic of the Lower Limestone shale in Ireland. *Pleurorhynchus Hibernicus*, fig. 7, *a*, *b*, is abundant, and attains a large size in the Carboniferous Limestone of Ireland. *Anthracosia centralis*, fig. 8, is a unio-like shell, indicating a brackish water deposit, frequent in the Coal shale of the Midland counties. *Myacites Omaliana*, fig. 9, is not unfrequent in the Carboniferous Limestone of Ireland. *Cardiomorpha oblonga* is another characteristic species in the Carb. Limestone of Ireland. *Curtonotus elegans*, fig. 11 *a*, *b*, are smaller bivalves, frequent in Lower Carboniferous strata, "Coomhola Grit" of the South of Ireland.

The Gasteropoda are also represented by a considerable number of forms in the Carboniferous Limestone; *Natica plicistria*, fig. 1, is a frequent species; *Loxonema impendens*, fig. 2, is a species common in

the Carboniferous Limestone of Ireland; *Euomphalus pentangulatus*, fig. 3, is particularly abundant in the Limestone, especially in Ireland. *Pleurotomaria carinata*, fig. 4, is one of a number of species included in this genus, common to the Carboniferous Limestone.

The Heteropoda or Nucleobranchiata of the Carboniferous rocks are of considerable size, if the genus *Bellerophon*, which is supposed to belong to this class, is correctly assigned to it. *B. hiulcus*, fig. 5, is a frequent species in the limestone of England and Ireland. *B. Urii*, fig. 6, a much smaller species, has a considerable range from Upper Devonian strata to the Coal Measures.

In continuation of the examples already given of some of the leading classes of Mollusca, we here introduce (Figure 16) recent and fossil *Heteropod* shells.

Fig. 16.

Heteropoda.

Atlanta Peronii (*recent*) *S. Atlantic.* (Woodward's Mollusca).

Bellerophon tenuifascia (*fossil*) *one-half natural size.* Carb. Limestone. (De Koninck).

Plate 14.

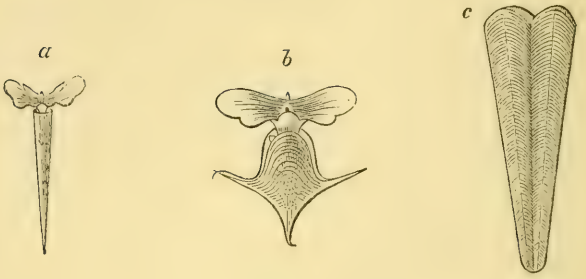
In the Pteropoda, also an order of pelagic and swimming Mollusca, is included the Palæozoic genus *Conularia*, which occurs in the Limestone and Coal Measures of Coalbrook Dale; it is believed to have been allied to the recent *Cleodora*, species of *Conularia*, have been found in Silurian, Devonian, and Carboniferous strata.

In the woodcut on the following page (Figure 17), of recent and fossil Pteropoda-*Creseis*, a small living species found in the Atlantic, in the form of its shell, may be compared with the fossil genus *Theca*, several species of which have been alluded to in previous pages, and figured on the Plates.*

* See Descriptive Remarks, *ante*, pp. xxi., xxxi., & xliv., also Plates v., viii., xii., and xxvi.

Fig. 17.

Pteropoda.



Creseis aciculata (*recent*) *Atlantic.* (Woodward's Mollusca.)

Cleodora pyramidata (*recent*). *Atlantic.* (Woodward's Mollusca.)

Conularia quadrisulcata (*fossil*), *reduced to one-fourth of natural size.* Carboniferous Limestone, and Coal Measures. (Woodward's Mollusca.)

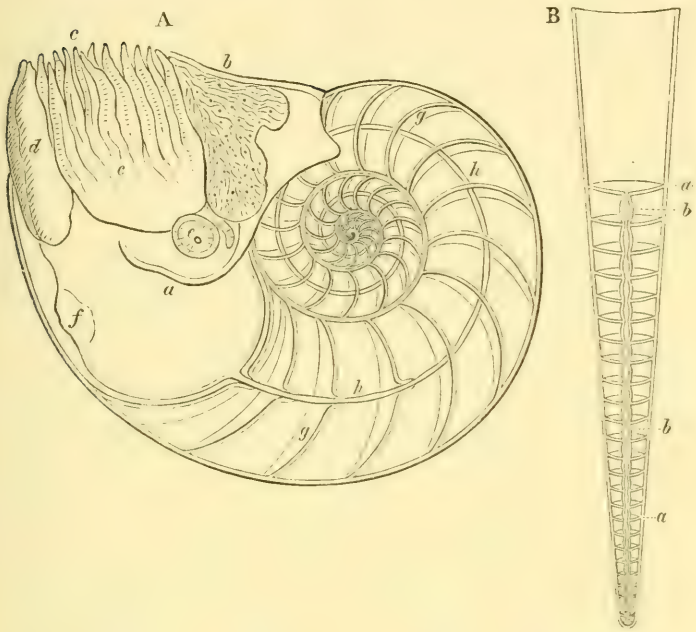
Cephalopoda were at their maximum development during the Carboniferous Limestone period. *Nautilus dorsalis*, fig. 7, is a large and frequent Carboniferous Limestone species in England and Ireland; there are several other species of this genus in the Limestone; some of them being flattened forms were named *Discites* by Professor M'Coy. The straight and curved forms of the *Orthoceratidæ* are well represented in the Carboniferous Limestone by many species of the genera *Orthoceras*, *Gomphoceras*, and *Cyrtoceras*. *Orthoceras cinctum*, fig. 8, *a*, *b*, ranges from Middle Devonian to the Carboniferous Limestone.

Recent and fossil examples of spiral and straight forms of Cephalopod shells are shown on the next page at fig. 18. A. The pearly *Nautilus* (recent); and B. *Orthoceras* (fossil) both being sections of the shell to show septal divisions and siphuncle.

Goniatites belonging to the Ammonitidæ also attain their maximum development in Carboniferous strata; many species are enumerated both in the Limestone and Coal Measure shales. The one we have selected for illustration, *Goniatites sphæricus*, fig. 9, *a*, *b*, believed to be identical with that named *G. crenistria*, occurs in profusion both in the Limestone and the Coal Measure shales, more especially in Ireland. As far as British strata are concerned, Orthoceras and Goniatites disappear with this formation.

FIG. 18.

CEPHALOPODA. Order TETRABRANCHIATA. Shell external.



NAUTILUS POMPILIUS (*recent*), *reduced to one-third of natural size. Section of Shell, with the animal occupying the outer chamber.*

a. The Mantle.
b. The Hood.
c. The Tentacles.
d. The Funnel.
e. The Eye.
f. Nidamental gland.
g. Septa.
h. Siphuncle.

ORTHOCERAS (*extinct*). *Section showing:*

a. Septa.
b. Siphuncle.

(After Woodward.)

The CRUSTACEA of the Carboniferous formation show a considerable declension from that of the Lower Palæozoic, especially with regard to the extinct order of Trilobites, of which only three genera remain, *Phillipsia*, *Griffithides*, and *Brachymetopus*. *B. Ouralicus*, Pl. 41, fig. 1, *a–d*, is a small species found in Carboniferous Limestone, Derbyshire, and at several localities in Ireland. *Phillipsia pustulata*, fig. 2, *a–c*, is a frequent fossil in Carboniferous strata from the lowest division to the Coal Measures; *Griffithides globiceps*, fig. 3, *a*, *b*, is also

a Carboniferous Limestone species frequent in Ireland. The group of Trilobites entirely disappear at the close of the Carboniferous period. Many Crustacea of other orders make up for the small number of Trilobites. Limuloid forms of the Order *Pœcilopoda* are represented by the *Belinurus trilobitoides*, fig. 7, from the Coal Measures of Coalbrook Dale, and *B. Reginæ* from Coal shale, Queen's County, and county Clare; they differ from the modern Limulus in the moveable condition of the body segments. Of the *Phyllopoda*, *Leaia Leidyi*, has been described from the Coal strata of Ardwick; and small forms of *Ostracoda, Leperditia subrecta,* fig. 4, *a–c*, are abundant in the Lower Limestone shale of Ireland, and a larger genus *Entomoconchus Scouleri*, fig. 5, *a*, *b*, in the Irish Carboniferous Limestone. To the Macrurous Crustacea it is believed that *Palæocrangon* from Carboniferous strata, Fifeshire, and *Palæocarabus dubius* from the Coal strata of Shropshire, belong.

Fish remains are abundant in Carboniferous strata—placoid fishes being at their maximum development. In the order *Plagiostoma* the defence spines, or Ichthyodorulites, are included, such as the Silurian *Onchus*, Pl. xxvii,, figs. 7, and 8, and *Oracanthus* of the Carboniferous Limestone. *Tristychius*, Pl. 41, fig. 8, Carboniferous shale, and *Gyracanthus* of the Coal Measures.

The family *Cestraciontidæ*, of which the Port Jackson Shark (Cestracion) is a living example, includes numerous palatal and other teeth found in the Carboniferous Limestone of Farlow, Shropshire, Bristol, and Armagh; *Psammodus porosus*, Pl. 41, fig. 9, *a*, *b*, is one of the largest and most abundant of these peculiar crushing teeth, in the Bristol and Armagh Limestone; *Orodus ramosus*, fig. 10, is another large tooth of a different form occurring in the Lower Limestone; *Helodus gibberulus*, fig. 11, a smaller tooth of variable shape, is frequent in the Armagh limestone. *Pœcilodus Jonesi*, fig. 12, is a peculiar form of tooth also found in the Armagh limestone; and *Petalodus Hastingsiæ* occurs in Yorkshire and in the Carboniferous Limestone shale at various localities in the north of Ireland. Large Sauroid fishes are prevalent in the Coal Measure strata of Scotland and Ireland. In the Lepidoganoid, named by Agassiz *Holoptychius Hibberti*, but which Professor Owen has placed in the genus *Rhizodus*, fig. 14, the jaws are armed with formidable teeth The fish *Palæoniscus Robisoni*, fig. 15, *a*, *b*, also from the Coal Measures of Burdie House, Edinburgh, belongs to the same group of Lepidoganoids, a family which increases in number during the Carboniferous epoch. The genera, *Amblypterus* and *Cœlacanthus*, also Coal Measure fish, continuing with it into the Permian strata.

The Labyrinthodont type of Reptiles (Amphibians) are abundantly represented in Upper Carboniferous strata. *Apateon* and *Archægosaurus*, Sauro-Batrachian, or Salamandroid reptiles, found in Coal Measure strata in Germany; and *Dendrerpeton*, described by Principal Dawson, from the Coal field of Nova Scotia, belong to the order *Ganocephala*. The order *Labyrinthodontia* include *Baphetes*, from

Pictou Coal, Nova Scotia; *Brachiops*, and *Anthracosaurus* from Lanarkshire Coal field; *Loxomma* and *Pholidogaster* from the Edinburghshire Coal field.

The largest assemblage of these remarkable Reptilia have been found at one colliery in the county of Kilkenny, that of Jarrow, in the Castlecomer district, from which place eight genera of Labyrinthodont Amphibia have been described by Professor Huxley. Three of these *Keraterpeton Galvani*, Pl. 41, fig. 16, *Urocordylus* and *Lepterpeton*, are stated to be Salamandroid animals, having long tails and well developed fore and hind limbs; whilst in two other genera, *Ophiderpeton* and *Dolichosoma*, the greatly elongated and eel-like body appears to have been devoid of limbs.*

The largest fossil of this class, which must have been five or six feet in length, has since been obtained from the same colliery, and is now in the collection of the Geological Survey of Ireland, through the liberality of the proprietor, Samuel Bradley, Esq. The author having compared it with a group of ribs and vertebræ, in the former series of fossils from Jarrow, now in the British Museum, referred by Professor Huxley to *Anthracosaurus*, but not specifically named, felt convinced they belonged to the same species, and with the additional material at his disposal, believing it to be distinct from *A. Russelli* (Huxley), of the Scotch Coal field, named it *Anthracosaurus Edgei*, in honour of Benjamin B. Edge, Esq., J. P., to whom the Geological Survey is indebted for much information and many specimens from the district.

Fossils of the Permian Rocks.

This term was proposed by Sir R. Murchison, to include strata, next in the order of superposition above the Coal Measures, and called in England Lower New Red Sandstone, Marlstone, Magnesian Limestone, &c. The name being derived from the ancient kingdom of Perm, in Russia, where similar rocks occur, but which are much more largely developed.

The Permian rocks in Britain consist at its base of Lower red and yellow Sandstones, and Conglomerates equivalents of the *Roth liegende* of Germany; Marl Slate and Magnesian Limestone, equivalents of the *Kupfer Schiefer* and *Zechstein;* and Red Sandstone and Marl at its upper part.

The best examples of the series, especially of its calcareous or central portion are visible in the counties of Durham, York, and Nottingham.

At Manchester Red Marls and Shale occupy the position of the Magnesian Limestone; these strata include some thin beds of Limestone, containing a characteristic assemblage of Permian fossils;

* Siluria (4th edition), p. 303.

E. W. Binney, Esq., F. R. S., estimates the maximum thickness of the group in Lanchashire at 1,160 feet.

In Westmoreland, strata ascribed to this formation by Sir R. Murchison, and Professor Harkness, F. R. S., are stated to be of great thickness in the valley of the Eden.

In Scotland Red Sandstones referred to the Permian series are found in Dumfriesshire resting unconformably upon Lower Silurian and Carboniferous rocks. Their lower beds are sometimes breccias of the underlying rocks, and in some of the sandstones abundant reptilian foot prints have been found. Similar Red Sandstones and Marls overlye the Coal of Ayrshire.*

In the north of Ireland, at Cultra, near Holywood, on the south side of Belfast Lough, and at Tullyconnell, near Ardtrea, in the county Tyrone, there are small patches of Permian strata containing fossils similar to those of Durham and Yorkshire.

It is the opinion of some of our leading Geologists and Palæontologists that the Permian cannot be viewed in the light of a formation, but should merely be considered as a group rather than a system; some authors would even consider this series of strata as a division only of the Carboniferous system of which great period it is evidently the natural termination.

The Plants and Animals of Permian strata are of a decided Palæozoic type, and bear a considerable resemblance to those of the Carboniferous group. The Plant remains are but few in British strata. In other countries the Permian strata contain many more plants; in certain districts in Germany they are numerous, and the results of their examination by M. Adolphe Brongniart, Colonel Gutbier, and Professor Göppert, show that they are to a great extent composed of the same families and genera as those of the Carboniferous epoch, although only about eight per cent. are said to be specifically identical with Carboniferous forms.

One species only, *Voltzia heterophylla*, is known to have lived on into the succeeding Triassic formation, or base of the Secondary rocks.

The Corals (Cœlenterata) of the Permian are but few, only five British species being recorded by the authors of British Fossil Corals.† *Calamopora*, *Stenopora*, and *Alveolites* of Professor King, they refer to the genus *Chætetes;* the two other species are believed to belong to the *Stauridæ*.

The Echinodermata are barely represented in these strata, consisting only of a few Crinoid stems and remains of *Achæocidaris*, a genus which first appears in the Carboniferous Limestone, being with *Palæchinus* the earliest known representative of the modern Echinoidea or Sea Urchins.

The Polyzoa, as well as the Corals and Echinoderms, bear the aspect of the Palæozoic types, *Synocladia virgulacea*, Pl. 42, fig. 1, *a–c;* is a

* Jukes and Geikie, Student's Manual of Geology, 3rd edition, p. 609.

† Palæontographical Society, 1852.

species which appears to be confined to Permian strata. The fossil named *Fenestella retiformis* has been found by Mr. J. W. Kirkby* to be identical with a characteristic Carboniferous species *Fenestella plebeia* M'Coy, a species the author believes to be a synonym of *Fenestella antiqua*, figured on Pl. xxxvii., fig. 1.

With respect to the *Brachiopoda*, Mr. Davidson enumerates but seventeen species as occurring in British Permian strata; of these we have figured some of the most characteristic forms on Pl. xlii., *Camaraphoria crumena*, fig. 2. *C. Humbletonensis*, fig. 3, *a*, *b*. *Strophalosia lamellosa*, fig. 4, and *Productus horridus*, fig. 5, *a*, *b*.

Eight of the Permian species are shown by Mr. Thomas Davidson, Mr. J. W. Kirkby and others to be synonyms of Carboniferous fossils; one of them as stated by Mr. Davidson is a recurrent species appearing in the Devonian as *Spirifera unguicula;* in Carboniferous strata *as Spirifera Urii*, and in the Permian as *Spirifera Clannyana*.

The *Conchifera* are also few and of small size, *Monotis* (*Avicula*) *speluncaria*, Pl. xlii., fig. 6. *Bakewellia antiqua*, fig. 7. *Axinus truncatus*, fig. 8, and *Pleurophorus costatus*, fig. 9, are some of the most frequent fossils.

The *Gasteropoda* likewise decrease considerably in number and size from those of the Carboniferous Limestone. *Turbo Marcuniensis*, fig. 10, *a–c*, and *Pleurotomaria antrina*, fig. 11, *a*, *b*, are the only examples figured.

Of the Cephalopoda, a group so abundant in Carboniferous strata, one species only, *Nautilus Frieslebeni*, is recorded.

The Trilobites, a group of Crustacea which commenced in the lowest fossiliferous rocks, attaining their maximum development during the Silurian period, decreasing considerably in Devonian deposits, and still more in the Carboniferous strata, appears to have entirely died out with that formation, no species having yet been discovered in Permian strata.

Fossil fish are not unfrequent, more than forty species having been described from Permian deposits; all of them, like those of more ancient strata, belonging to a division called by M. Agassiz, *Heterocercal*, from having their tails unequally lobed like the recent Shark and Sturgeon; the vertebral column continuing along the upper caudal lobe (see fig. 15, *a*, p. lvii.). In the *Homocercal* fish, which include almost all the species (about 9,000) living at the present day, the tail-fin is either single or unequally divided, and the vertebral column is not prolonged into either lobe, as in the herring, mackerel, &c. (see fig. 15, *b*). The fish selected for illustration, *Platysomus striatus*, Pl. xlii., fig. 12, *a–c*, is a characteristic example of the first named division.

Most of the genera of fish found in Permian deposits are also known in Carboniferous strata; the species are, however, for the most part distinct. The prevailing genera are *Palæoniscus*, *Pygopterus*, *Cœlacan-*

* Annals and Mag. Nat. Hist., 1862.

thus, Platysomus, and *Acrolepis* (the same forms being frequent in England, Germany, and Russia).

These fossil fish are chiefly found in the division of the Permian called *Kupfer-Schiefer,* underlying the *Zechstein* in Germany; and in England they are met with in the equivalent deposit, the Marl slate. Some small examples of *Palæoniscus* and *Acrolepis* have also been described from the Upper beds of the Magnesian Limestone of Durham.*

The Reptilia discovered in British Permian strata include two species of *Proterosaurus,* from the Marl slate, Durham, referred to the Lacertian order, and allied to *P. Speneri* of Von Meyer, from the Kupfer-Schiefer of Thuringia; also two species of Labyrinthodont Reptiles, named *Leptosaurus Duffii,* from similar slate near Durham; and *L. dasyceps* from Permian Sandstone, Kenilworth.

In closing this brief sketch of the Permian fossils, we cannot do better than quote the following appropriate remarks of the late Sir R. Murchison, in his last edition of Siluria: "The mass of the organic remains of the Permian group constitute a remnant only of the earlier animals whose various developments we have followed in the preceding pages. They exhibit the last of the successive changes which these creatures underwent before their final disappearance. The dwindling away and extinction of many of the types which were produced and multiplied during the anterior epochs already announce the end of the long Palæozoic period."†

The following Table, showing the number of species belonging to the various classes of Plants and Animals in the Palæozoic Rocks of Great Britain, is copied from Mr. Etheridge's elaborate communication to the Geological Society of London in 1867.‡

(Certain discrepancies between the numbers of species in the Silurian column of this Table and that before given at page l., may, perhaps, be accounted for by the difference of time at which they were respectively published.)

* Siluria, 4th edition, p. 342,

† *Ibid.* p. 344.

‡ "On the Physical Structure of West Somerset and North Devon, and on Devonian Fossils," &c., Journ. Geol. Soc., vol. xxiii., p. 615.

Classes.		Silurian.	Old Red Sandstone.	Devonian.	Sp. Common to Dev. and Carb.	Carboniferous.	Permian.
Plantæ,		10	12	4	2	308	20
Amorphozoa,		19	...	9	...	...	5
Rhizopoda,		...	...	...	...	...	6
Cœlenterata,		93	...	53	1	119	5
Echinodermata,		83	...	21	4	129	2
Annelida,		37	1	2	...	19	6
Crustacea,		267	21	13	...	59	20
Insecta,		...	...	...	...	3	...
Polyzoa,		79	1	13	6	55	6
Brachiopoda,		208	...	99	15	157	20
Lamelli-branchiata,	Monomyaria,	30	...	22	3	140	6
	Dimyaria,	99	1	36	6	194	20
Gasteropoda,		96	...	46	7	174	25
Nucleobranchiata,		22	...	9	3	29	1
Pteropoda,		27	...	1	...	1	...
Cephalopoda,		77	...	52	9	145	2
Pisces,		7	113	3	...	202	21
Reptilia,		...	...	...	...	7*	2
		1,154	149	383	56	1,741	167

Having now passed briefly in review the assemblage of Animals and Plants characterizing the several groups of the great Palæozoic division (the most ancient in the stratigraphical series), in ascending order, it may now be useful to give here a shorter summary.

Commencing with the oldest Fossiliferous rocks (at least in Britain), the CAMBRIAN formation. In this series of strata organic remains are few, marine worm tracks, and supposed Hydrozoan animals, plant-like in form, being the chief fossils.

The more interesting and largely developed SILURIAN rocks contain an abundance of certain classes of fossil animals; the most prominent being *Graptolites*, now generally believed to belong to *Hydrozoa* rather than *Polyzoa;* the extinct order of *Trilobites* with other forms of *Crustacea; Mollusca* of several classes, that of *Brachiopoda* being most prevalent; *Corals* of a peculiar type and *Crinoids* are also abundant in the Upper Silurian; and the first evidence, although but slightly, of *Vertebrata*, in the presence of *Ganoid* fish, is obtained from the very uppermost beds.

We next arrived at the consideration of the OLD RED SANDSTONE and DEVONIAN series of rocks. In the first named of these the remains of *Fish* (probably fresh water forms), are abundant, and almost the only fossils; *Ganoids* being the most prevalent, with a few *Placoids*. The

* At least twelve species of *Labyrinthodont Amphibia* (Reptilia) are now known from Coal Strata, eight of them having been found at Jarrow Colliery, county Kilkenny (See Descriptive Remarks, *ante* p. lxxiv-v.). W. H. B.

Devonian, a marine series, containing *Corals*, *Mollusca*, and *Trilobites*, bearing a Silurian aspect.

The great and important Carboniferous formation at its lower and central portion is composed of marine strata with numerous *Corals*, *Crinoids*, and *Mollusca*, especially *Brachiopods* and *Cephalopods*; but few forms of *Trilobites* pass into this formation with which they entirely cease. *Fish* remains are plentiful in the Limestone belonging chiefly to the *Placoids*. The upper portion of this formation is characterised by an abundant terrestrial *Flora*, the remains of which constitutes the valuable Coal seams.

The uppermost group of the Polæozoic strata, that of the Permian, completes the series; in these deposits the *Fauna* and *Flora*, although presenting certain peculiarities and many specific differences to that of the Carboniferous, are apparently but a continuation of that varied and extensive series of strata.

In concluding this volume, we again quote the eloquent author of Siluria* in the following expressive passage: We have here "a History of those types of former life which by the labours of Geologists have been found to occupy distinct stages in the oldest deposits composing the crust of the earth. In all this there is no theory but simply an accumulation of positive data. The order of such successive generations is indeed much more clearly proved than many a legend which has assumed the character of history in the hands of man; for the Geological record is the work of God."

* Siluria, 4th edition, p. 476.

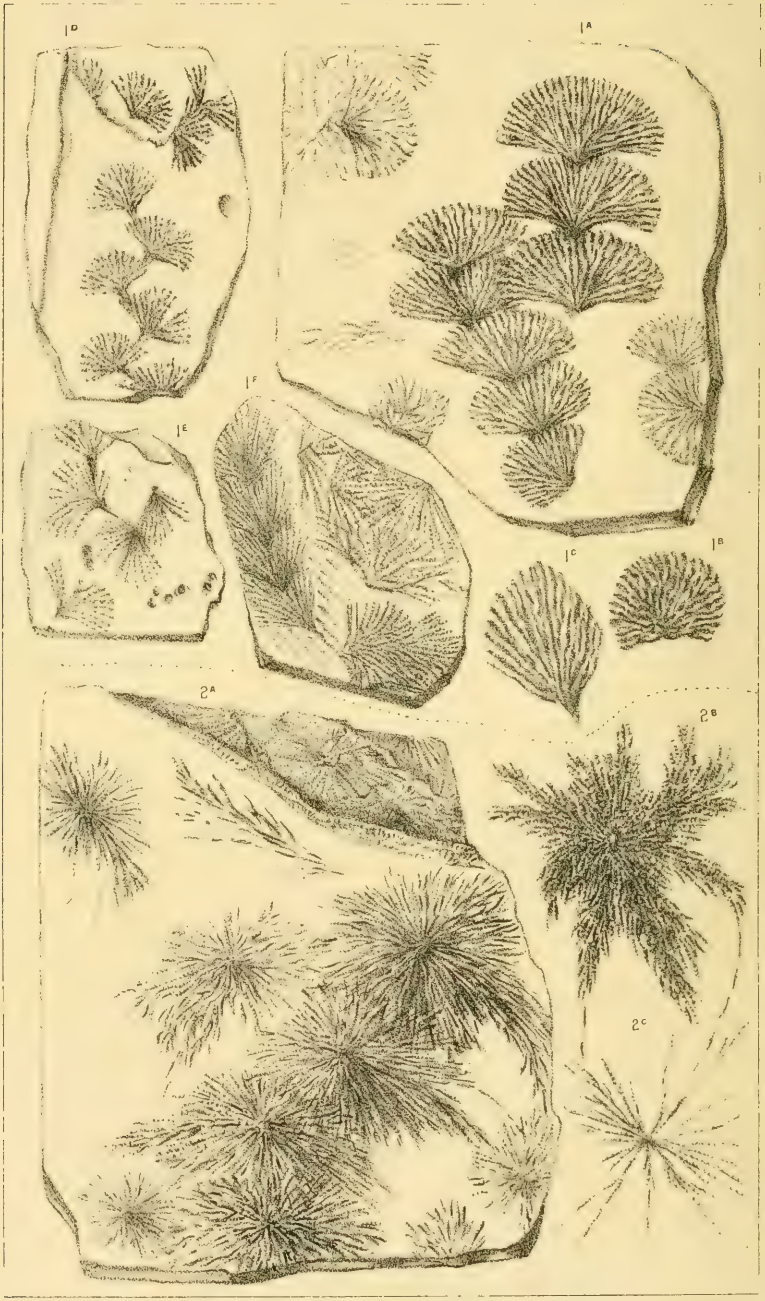


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Fig. 1-A-F *Oldhamia antiqua, Forbes.*

2-A-C " *radiata,* "

All the figures natural size.

EXPLANATION OF THE PLATES.

PLATE I.

FOSSILS OF THE CAMBRIAN ROCKS.

[All the Figures on this Plate are original.]

HYDROZOA or POLYZOA. (?)

FIG. 1.—*a*, *f*. OLDHAMIA ANTIQUA, *Forbes*.

O. antiqua.—Journal Geological Society of Dublin, vol. iii., p. 60, 1844; *Ibid*., vol. iv., p. 20, 1848; Transactions of the Royal Irish Academy, vol. xxiii., 1858; Siluria, third edition, p. 28, Fossils, 2; Geological Magazine, vol. ii., p. 385, 1865.

a. A series of fan-like branchlets, in which the axis is barely perceptible. From a specimen collected by the Geological Survey of Ireland, in buff-coloured shales, Carrick Mountain, county of Wexford; in the Museum, 51, Stephen's-green, Dublin.

b. A single branchlet, in which the fasciculi, or branches, repeatedly divide and become more dense; var. *O. discreta*, Kinahan, from the same locality.

c. A single branchlet, elongated, probably from the effects of cleavage; same locality.

d. An alternating series of branchlets, showing impression of axis in green grit, weathering brown with tracks and burrows of *Arenicolites*; from rocks on shore at Bray Head; in the Museum, Geological Survey of Ireland.

e. An alternating series of a few branchlets, showing a kind of division into two branches, and a bead-like or nodular condition of the fasciculi. On the same slab are double burrow holes of *Arenicolites didymus*, Salter; from green and red argillaceous slaty beds, rocks on shore at Bray Head, county of Wicklow; in the Museum, Geological Survey of Ireland.

f. Rigid variety; a series of fan-like branchlets in succession, and impressed upon each other, showing nodular character, from red and more argillaceous beds, Kilruddery Demesne, Bray Head; Museum, Geological Survey of Ireland.

FIG. 2.—*a*, *b*, *c*. OLDHAMIA RADIATA, *Forbes*.

a. Portion of rock, the surface of laminæ being altered in colour by chemical action, upon which are grouped well-defined stellate examples of *O. radiata*, showing the radiation of each from a common centre, their division and subdivision into branches and branchlets, some of them assuming a plumous appearance. The rock, a closely laminated, fine grained, greenish grit, shows every layer to be more or less covered by these remarkable fossils. From the rocks exposed at low water, called "Periwinkle Rocks," Bray Point.

b. An example of *O. radiata*, selected from amongst others as showing a more dense, plumous, and irregular branching appearance; also, very conspicuously, the jointed or intermittent character of the several branches, some of which are extended into a single thread-like filament, an inch or more in length; in purple laminated fine-grained grits, from rocks on shore at Bray Head; collected by the Geological Survey of Ireland.

c. An isolated star, doubtfully referred to this species, in which the branches are very few, and much lengthened out; collected by the Geological Survey of Ireland from the same beds with *O. antiqua* (fig. 1, *f*) at Kilruddery Demesne, near Bray Head.

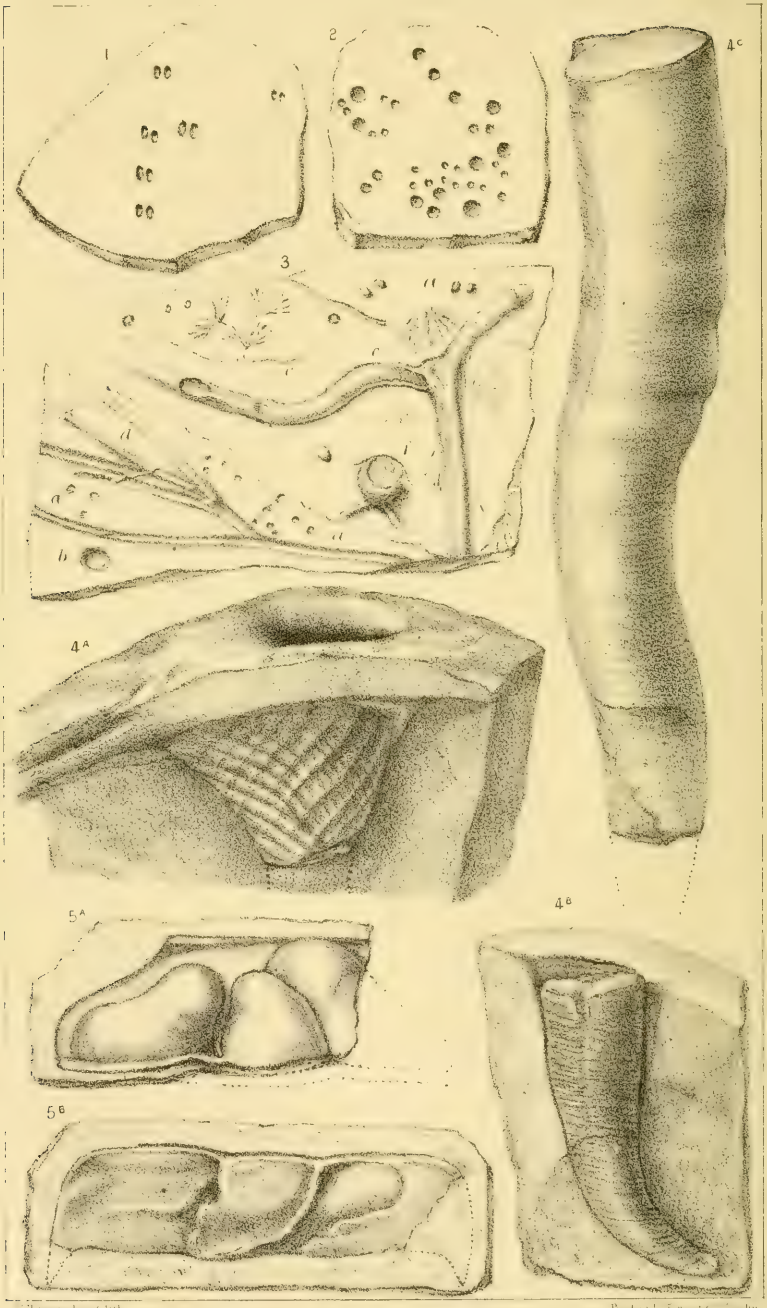


Fig. 1. *Arenicolites didyma, Salter.*
2. " *sparsus.*
3. " " *? with tracks & burrows.*
4 A C *Histioderma Hibernicum, Kinahan*
5 A-B *Palæopyge Ramsayi, Salter.*
All the figures natural size.

PLATE II.

FOSSILS OF THE CAMBRIAN ROCKS.

ANNELIDA.

FIG. 1.—ARENICOLITES DIDYMUS, *Salter*.

From the original figure in the Journal of the Geological Society, vol. xii., pl. iv., fig. 1, showing surface openings in pairs, "the burrows of Annelides, allied to the recent lobworm."
Longmynd, near Church Stretton, Shropshire.

FIG. 2.—ARENICOLITES SPARSUS, *Salter*.

From the original figure in the Journal of the Geological Society, vol. xiii., pl. v., fig. 3, showing raised casts of openings to burrows, in pairs of different sizes, and more numerously grouped than in the former species.

FIG. 3.—ARENICOLITES SPARSUS, *Salter*.

Original. With surface tracks and burrows of different kinds and sizes, accompanying *O. antiqua*; from slabs of laminated fine-grained green shaly grits; collected from rocks on shore, near Bray Point, by the late Dr. J. R. Kinahan, and presented by him to the Museum, Geological Survey of Ireland.

FIG. 4.—*a*, *b*, *c*. HISTIODERMA HIBERNICUM, *Kinahan*.

a. *Original*. Opening of burrow, and commencement of tube, showing crossing ridges or wrinklings produced by a "tentacled sea worm." From the original specimen, collected and described by the late Dr. J. R. Kinahan, Journal Geological Society of Dublin, vol. viii., pl. vi., fig. 2; and presented by him to the Geological Survey of Ireland.

From thicker bedded and coarser green grit than that containing the *Oldhamia*, believed to be from rocks on shore near Bray Point, the exact locality not having been given by Dr. Kinahan.

b. *Original*. Lower portion, or curved extremity of tube, marked with fine transverse lines or wrinklings. From the original specimen, collected and described by Dr. J. R. Kinahan in the Journal of the Geological Society of Dublin, vol. viii., pl. vi., fig. 1, and presented by him to the Geological Survey of Ireland.

In a similar rock, and probably from the same beds as the previous specimen, fig. 4, *a*.

c. *Original.* Large tubular cast, showing irregular deep corrugations, and finer wrinklings, separated by a longitudinal ridge. Collected by Mr. T. Mayne, and presented by him to the Geological Survey of Ireland

From a compact bed of greenish grit, containing many mounds of *Histioderma*, discovered by Mr. T. D. Falkner in rocks, exposed at low water on the shore between the Brandy Hole and Periwinkle Rocks, Bray Point.

CRUSTACEA(?)—*TRILOBITA.*

Fig. 5.—*a*, *b*. Palæopyge Ramsayi, *Salter*.

a. Enlarged to correspond with 5 *b*. From the chart of Fossil Crustacea by Messrs. J. W. Salter and H. Woodward, fig. 32. Locality not given.

b. From the original figure in the Journal of the Geological Society, 1856, vol. xii., pl. iv., fig. 3.

Callow Hill, Longmynd.

With respect to this obscure fossil Mr. Salter observes :—"I do not very strenuously maintain it to be a Trilobite ; but it is either a caudal shield of one, or else a broad body segment of a phyllopod, allied to *Hymenocaris*. I feel persuaded of its being a Crustacean, and hope to have further evidence when the description of the Longmynd district shall be ready." M. G. S., vol. iii., p. 244.

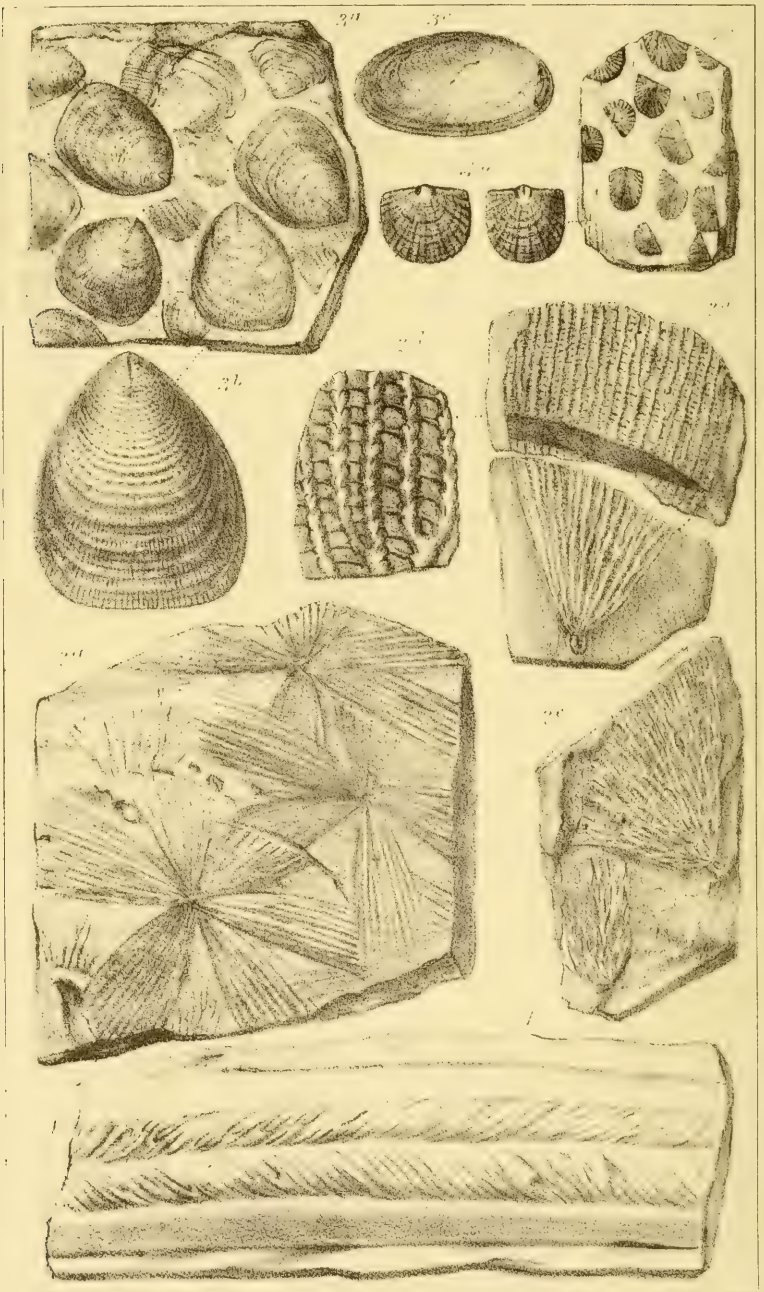


PLATE III.

FOSSILS OF THE LINGULA BEDS OR FLAGS.

ANNELIDA.

FIG. 1.—CRUZIANA SEMIPLICATA, *Salter.*

Proceedings of the British Association, 1852, p. 58; Siluria, third edition, p. 45, Foss., 4, f. 53.

From the figure in the Memoirs of the Geological Survey, vol. iii., pl. iii., fig. 1. These peculiar markings show a series of irregular folds or ridges, proceeding from a central furrow and bordered on both sides by a smooth and bevelled edge. They are, as Mr. Salter observes, generally considered to be fucoids, or seaweeds; he is, however, inclined to the opinion that they are filled-up worm tubes, or burrows. M. G. S., vol. iii., p. 292.

LOWER LINGULA FLAGS.—Carnedd-y-Filiast, near the Penrhyn slate quarries, Bangor, Maentwrog, North Wales: also beneath the Stiper Stones, Shropshire; or an allied species.

FIG. 2.—*a–d.* DICTYONEMA SOCIALE, *Salter*, sp.

Professor J. Hall, Palæontology of New York vol. ii., p. 174. *Graptoporæ.* Siluria third ed., p. 47; Foss., 7; f., 3. Memoirs Geological Survey, vol. iii., p. 331, pl. iv., fig. 1.

a. From the figure in Memoirs Geological Survey, vol. iii., pl. iv., fig. 1. Portion of slate, with "fronds" grouped together, and radiating from the base.

b. From the figure in Memoirs Geological Survey, vol. iii., pl. iv., fig. 1 *a*. A single example, showing the attachment, or "radicle," from which proceed the diverging branches bearing the cells, and united by processes or dissepiments.

c. *Original.*—A smaller example, showing ring-like process of attachment, and the dividing or dichotomizing branches, with crossing dissepiments pressed upon each other. From a specimen in the collection of the Geological Survey of Ireland, obtained from the railway above Plas Oakley, Maentwrog, Merionethshire, North Wales.

d. From the figure in Memoirs Geological Survey, vol. iii., pl. 4, fig. 1 *b*. Enlarged view, to which, however, no special reference is made in the text or list of plates. It shows a slightly projecting row of cells arranged on each side of the branches, as in Fenestella, a character which is alluded to by Mr. Salter at p. 332 of the same volume.

UPPERMOST LINGULA FLAGS.—In black slate, at Bron Foel slate quarries, S. W., of Tremadoc, abundant. In beds at the railway above Plas Oakley, Maentwrog, rare; Brampton Bryan Park, Pedwardine, Shropshire;

Key's End Hill, Malvern—Memoirs Geological Survey, vol. iii., p. 333.

Other localities given in list of Upper Lingula Flag fossils, at p. 250. Gellifwyog, Ffestiniog; Borthwood, Portmadoc; west side of Moel-y-gest, North Wales.

Irish Localities.—Cooksgrove, near Duleek, county of Meath, collected by the Geological Survey of Ireland. A closely allied fossil, which appears to be identical with *Callograptis elegans*, or *Salteri*, Hall, was also obtained by Mr. C. Galvan, of the Geological Survey of Ireland, with several other interesting forms of the *Graptolitidæ*, resembling those figured by Professor Hall in the Palæontology of New York, and Decade 2, Geological Survey of Canada; from dark grey sandy and micaceous shales at Lady Elizabeth's Cove, Tramore Bay, county of Waterford. (See Explanations to Sheets 167, &c., of the Maps of the Geological Survey of Ireland; Palæontological Remarks, by the author, p. 28.)

MOLLUSCA.—*BRACHIOPODA.*

Fig. 3.—*a*, *b*, *c*. Lingulella Davisii, *M'Coy*, sp.

Lingula Davisii, M'Coy, British Palæozoic Fossils, 1 L., fig. 7; and when distorted, *Tellinomya lingulæcomes*, *ib.*, pl. 1 K., fig. 18.

Lingulella Davisii, Salter. Memoirs Geological Survey, vol. iii., p. 333, pl. ii., figs. 7–12; and pl. iv., fig. 14.

Lingulella Davisii. British Silurian Brachiopoda, by Thomas Davidson, Esq.; Palæontographical Society's Memoirs, 1866, p. 56, pl. iv., figs. 1–16.

a. Original. A fragment of slate, full of these thin flattened shells. From a specimen in the Museum of the Geological Survey of Ireland; from *Lingula Beds*, Penmorfa, Tremadoc.

b. Original. Enlarged view of one of the shells from fig. 3 *a* (interior?), showing the numerous concentric striæ, or "lines of growth," which assume a granulated or bead-like appearance towards the upper part of the shell, gradually passing into smooth ridges, crossed by fine longitudinal lines or "striæ," which become stronger towards its lower edge.

c. Original. A distorted example of the same species formerly referred to *Tellinomya*, to show the effect of pressure from cleavage. From a specimen in the Museum, Geological Survey of Ireland. From Ffestiniog, North Wales.

This Lingula, first discovered by Mr. Davis in 1845, from its abundance has given the name of Lingula Flags to the formation which it so eminently characterizes.

Lingula Flags.—Everywhere in the middle band, rare in the lowest and highest portions; but, as remarked by Mr. Salter, "of nearly full size again in the sandy beds of the *Upper Tremadoc* slate. Memoirs Geological Survey," vol. iii., p. 334.

Localities mentioned in list of *Lower Lingula Flag* fossils:—Carnedd Filiast, Bangor; Marchlyn-Mawr, Llanberis; Tremadoc; Ffestiniog; Dolgelly; rare in the lower black slates at Maentwrog, North Wales; Whitesand Bay, near St. David's Head, Pembrokeshire, South Wales. Memoirs Geological Survey, vol. iii., p. 247.

This Lingula has not yet been identified with certainty in Ireland, although specimens collected some time since by the Geological Survey at Bellewstown, near Duleek, county of Meath, were doubtfully referred by the author to this species. With regard to these specimens, Mr. Davidson, to whom they were submitted, makes the following remarks:—"In the Lower Silurian shales of Bellewstown, county of Meath, Ireland, we find some flattened, distorted Linguläe, which may perhaps belong to Davisii. We have given a figure of them in our plate."—Brit. Sil. Brach. Pal. Soc., p. 58, pl. iv., fig. 12.

FIG. 4.—*a*, *b*. ORTHIS LENTICULARIS, *Dalman*.

J. W. Salter in Memoirs Geological Survey, vol. iii., p. 339, pl. iv., figs. 8–10.

a. From Memoirs Geological Survey, vol. iii., pl. iv., fig. 9 *a*. A portion of rock, with several examples of this small species of Orthis, the earliest known in British rocks.

b. Enlarged figures of the same species, from Memoirs Geological Survey, vol. iii., pl. iv., fig. 9 *b*.

UPPER LINGULA FLAGS.—Penmorfa Church, Tremadoc; near Criccieth, at Ogof-ddu Cliffs, North Wales. Memoirs Geological Survey, vol. iii., p. 340.

PLATE IV.

FOSSILS OF THE LINGULA BEDS OR FLAGS.

CRUSTACEA.—*PHYLLOPODA.*

FIG. 1.—*a*, *b*. HYMENOCARIS VERMICAUDA, *Salter*.

Proceedings of the British Association, 1852, p. 58; Memoirs Geological Survey, vol. iii., p. 293, pl. ii., &c.

a. From Memoirs Geological Survey, vol. iii., pl. ii., fig. 2, representing several of these remarkable Crustacea, somewhat altered by pressure.

b. Restored outline, from the same plate, fig. 4, reduced in size, showing the large carapace; abdomen, consisting of nine transverse segments, the last being furnished with three pairs of unequal lanceolate appendages, or tail spines.

With respect to its occurrence, Mr. Salter remarks:—"Hymenocaris appears to be a far more plentiful fossil than at first supposed; it evidently affected sandy shallows, rather than a deeper and muddier sea bottom." Memoirs Geological Survey, vol. iii., p. 248.

LINGULA FLAGS.—Abundant in the upper portion of the true Lingula Flags.

LOWER LINGULA FLAGS.—In fine grey sandstones, with *Lingulella Davisii;* Gwern-y-barcud, Moel-hafod-owen, and other places near Dolgelly; at Tremadoc, Ffestiniog; and at Pont Seiont, Caernarvon, fragments, apparently of this species, occur.—Memoirs Geological Survey, vol. iii., pp. 293-4. Other localities mentioned in list of Lower Lingula Flag fossils:—Pentrefelen, west of Penmorfa; Borth, west of Portmadoc; *Ibid.*, p. 247.

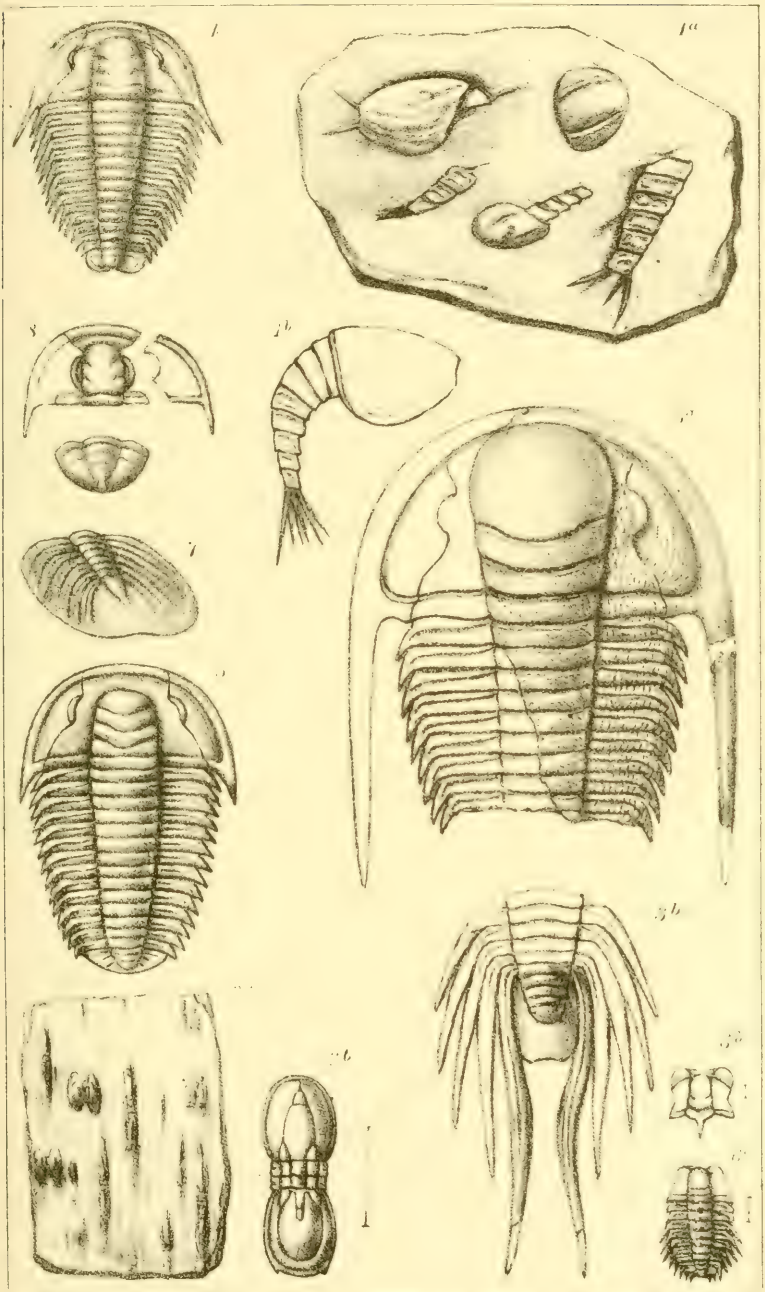
CRUSTACEA.—*TRILOBITA.*

FIG. 2.—*a*, *b*. AGNOSTUS PRINCEPS, *Salter*.

A. pisiformis, Salter, in Siluria, third edition, pp. 45, 53; Foss, 4, f. 4; Do., 9, f. 9; Decade Geological Survey, No. 11, pl. i., figs. 1-5; Memoirs Geological Survey, vol. iii., p. 296, pl. iv., figs. 2-11, pl. v. fig. 1.

a. *Original.* In highly cleaved and crumpled slate, the fossils being curiously distorted and elongated in opposite directions. From the collection of the Geological Survey of Ireland; Lower Lingula Flags, Maentwrog, near Ffestiniog, North Wales.

b. Enlarged view of an entire specimen of these small and remarkable Trilobites, in which the *cephalic* (head) and *caudal* (tail) shields are nearly equal; the body rings are two only, and they have no eyes or facial suture. These fossils are, as Mr. Salter remarks, the lowest and most rudimentary form of Trilobite, and amongst the oldest of known fossils. "Memoirs Geological Survey," vol. iii., p. 296.



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Upper Lingula Flags.—Penmorfa Church, and Carreg-wen farm, near Portmadoc, North Wales; also in the shales of White-leaved Oak, &c., Malvern. In certain beds of the Lower Lingula Slates, which are full of iron, and contain some volcanic ash, the *Agnostus princeps* occur in millions. *Ib.*, p. 248. Tremadoc Slate.—Portmadoc. Lower Llandeilo.—St. David's Head, Pembrokeshire?

Other localities mentioned in list of Lower Lingula Flag fossils: Maentwrog Waterfall, and other places near Ffestiniog. *Ib.*, p. 247.

Fig 3.—*a*, *b*. Paradoxides Davidis, *Salter*.

Journ. Geol. Soc., vol. xix., p. 275; and xx., pl. xiii., figs. 1-3. Decade Geol. Survey, No. 11., pl. x., figs. 1-8.

a. Reduced to half natural size from Journ. Geol. Soc., vol. xx., pl. xiii., fig. 1. The number of body rings is not complete.

b. The tail, reduced to the same proportions; from fig. 2 on the same plate (the restored parts are drawn in outline).

The discovery of this large and well-developed Trilobite as a British fossil by Mr. Salter in strata so low in the series as the Lowest Lingula Flags is of the greatest interest, especially as the range of the genus, so extensive abroad, had been until lately limited in this country to a single specimen only, it being only a few years since it was found in any considerable numbers, at a single locality in South Wales, as we are informed by Mr. Salter, in Decade 11, p. 2; that palæontologist observing that some of the fragments collected indicate a fossil of 16 or 18 inches in length. The broad club-shaped *glabella* (central portion of head), long spines proceeding from each side of the head, and numerous (17 to 20) body rings, readily distinguish this group, which includes the largest known Trilobites, from all others, and yet is the earliest type, or nearly so, of the whole Trilobite family. *Agnostus* accompanies it in all countries where it has been observed. Decade 11, Text to pl. x., p. 2.

Lowest Lingula Flags.—Port Rhraw and Solva Harbour, both near St. David's Head, South Wales; also north of Dolgelly, North Wales. Decade 11, Text to pl. x., p. 4: M. G. S., vol. iii., p. 247.

Fig. 4.—Olenus micrurus, *Salter*.

Mem. Geol. Survey, Dec. 2, pl. 9; Siluria, 3rd Edition, p. 45; Foss. 4, fig. 2; Mem. Geol. Survey, vol. iii. p. 300, pl. 2, fig. 5, 6, repeated from Dec. 2, pl. 9, fig. 1, 3.

From the original figure in Decade 2, pl. 9, fig. 1. This Trilobite is the first described British example of the genus *Olenus*, and is more familiar to us from its figures than the following species, *O. cataractes*, although, as Mr. Salter observes, it is by no means a common fossil, as the latter appears to be the ordinary form in the lower black shales of North Wales. Decade 11, Text to plate 8. *Olenus* and *Paradoxides* in Britain, as well as on the Continent, are among the most ancient genera of Trilobites in the lowest Silurian rocks.

Lower Lingula Flags.—Trawsfynydd; Cwm-y-Swm, gold mine; Dolgelly, Merionethshire; Marchllyn-mawr, near Llanberis, Caernarvonshire; Treflys; Borth, Portmadoc; Tremadoc, &c., North Wales.

FIG. 5.—OLENUS CATARACTES, *Salter*.

Decade 11, pl. viii., fig. 14; Mem. Geol. Surv. vol. iii., p. 300. pl. v., fig. 23.
From the original figure in Decade 11, pl. viii., fig. 14. In the description of this species in the Decade cited, Mr. Salter observes that the number of body rings should be 15, distinguishing it in that respect from the preceding species, *O. micrurus*, which has 14: as the figure from the Decade is here copied, the error, if such it be, is also repeated.
LOWER LINGULA FLAGS.—Maentwrog Waterfall, Merionethshire; in black shales full of Agnostus princeps; Treflys, east of Criccieth, Caermarthenshire, North Wales.

FIG. 6.—*a*, *b*. OLENUS HUMILIS, *Phillips*.

Memoirs Geological Survey, vol. ii., part I., p. 55, figs. 4, 5, 6. Memoirs Geological Survey, Decade 11, pl. viii., figs. 9-11.
a. From Memoirs Geological Survey, vol. iii. pl. v., fig. 12; this figure being apparently reduced from that in the Decade above cited, fig. 9. The natural size of this very minute Trilobite is shown by the line drawn near it.
b is reduced in the same proportion from the head figured in the same Decade, pl. viii., fig. 10. The author well remembers the difficulty experienced in making out the drawings of these very minute Trilobites for Professor J. Phillips' Memoir, now nearly twenty years ago; since then much better specimens have been procured, some showing the entire animal, as in the figure we have copied at 6 *a*.
UPPER LINGULA FLAGS.—Only known in the black shales of Malvern at Fowlet's Farm, and White-leaved Oak Farm, &c., where it occurs in considerable abundance with other species of the same genus.

FIG. 7.—DIKELOCEPHALUS (?) CELTICUS, *Salter*.

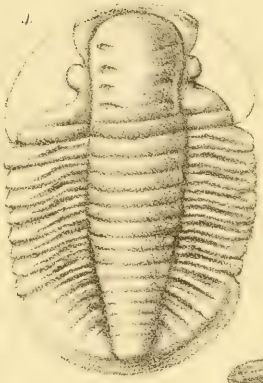
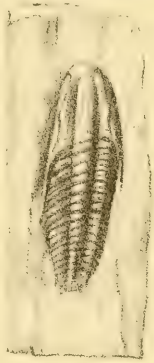
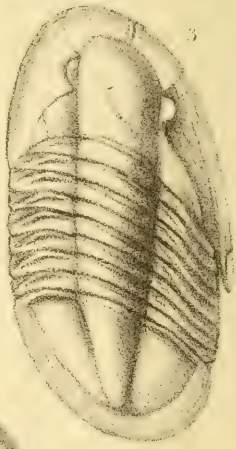
Mem. Geol. Surv. vol. iii., p. 304, pl. v., fig. 21, 22.
From figure 22 in the work above cited, representing the tail or *pygidium*. only.
UPPER LINGULA FLAGS.—Ogof-ddu, east of Criccieth, North Wales, in black slate.

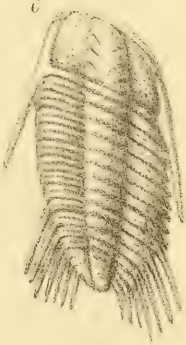
FIG. 8.—CONOCORYPHE INVITA, *Salter*.

Geological Survey, Decade 11, pl. vii., fig. 6. *Conocephalus invitus*, Siluria, third edition, p. 47, Foss. 7, fig. 1. Memoirs Geological Survey, vol. iii., pl. iv., figs, 5, 6, 7, pl. vii. fig. 6.
From the original figure, Decade 11, pl. vii., fig. 6, portions of the head and tail only of this species have been collected, the figure is completed in outline.
UPPER LINGULA FLAGS.—Penmorfa Church, and Carreg-wen, Tremadoc; Ogof-ddu, near Criccieth, North Wales.

Characteristic British Fossils. Plate 5.





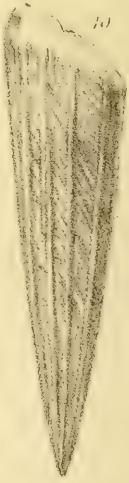




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PLATE V.

FOSSILS OF THE LOWER LLANDEILO OR TREMADOC SLATES.

CRUSTACEA.—*TRILOBITA.*

FIG. 1.—CONOCORYPHE DEPRESSA, *Salter.*

Memoirs Geological Survey, vol. iii., p. 307, pl. vi., fig. 1. *Ellipsocephalus? depressus*, Siluria, third edition, p. 47, Foss. 7, fig. 2. The head of this Trilobite is remarkably broad; the eye is small: the *axis*, or central portion of the body, is wide, and the whole animal much depressed or flattened.

Position and Locality. LOWER TREMADOC. Wern, Penmorfa; and above Penmorfa Church.

FIG. 2.—*a*, *b*. ANGELINA SEDGWICKII, *Salter.*

Geol. Surv. Decade 11, pl. vii., fig. 1–5. *A. Sedgwickii*, Siluria, third edition, 1859; p. 53. Foss. 9, fig. 2. *A. subarmatus*, *Ibid.* fig. 3, specimens distorted by cleavage.

a. From the original figure in Decade 11, pl. vii., fig. 2.

b. *Original.*—From a specimen in the collection of the Geological Survey of Ireland. Locality, Garth, opposite Portmadoc, in grey slate.

This Trilobite is distinguished by its long head spines; the *glabella* is smooth, and without lobes; the body segments are provided with an *angular fulcrum*, so constructed as to enable it to roll up. The tail is small, and sometimes bordered with spines.

Both figures show distortion in different directions, the effects of mechanical action, or what is termed *cleavage*, upon the rock in which these fossils are imbedded, and are introduced to show the caution and amount of judgment necessary in the determination of fossils affected in a similar manner, where there is so great a departure from the original form.

UPPER BEDS OF THE TREMADOC SLATES.—Garth Hill, east side of the Traeth Bach, Tremadoc; Portmadoc quarries; Tuhwnt-yr-bwlch; Under Garth, &c.; Dendraeth; Ynys-Tywyn. Mem. Geol. Surv., vol. iii., pp. 253, 310.

FIG. 3.—ASAPHUS AFFINIS, *M'Coy*, sp.

Isotelus affinis, M'Coy, Synopsis, Brit. Pal. Foss., pl. i. F, fig. 3. *A. affinis*, Memoirs Geological Survey, vol. iii., p. 310, pl. viii., fig. 15,

British Trilobites, Pal. Soc., p. 164, pl. xxiv., figs. 13, 14. With respect to this fossil Mr. Salter remarks, that "it is not certain that this is identical with Professor M'Coy's very imperfect specimen; but I wish to keep that species in mind, as it may eventually be included with *A. Homfrayi*."

Position and Locality.—Upper Tremadoc. Pen-y-Clogwyn, south of Portmadoc, in flinty slate, much compressed by cleavage, Garth, Penrhyn; near Llanerch, by the roadside towards Treflys; Tyddyn-diewm above Penmorfa.

Fig. 4.—Niobe Homfrayi, *Salter*.

British Trilobites, by J. W. Salter, Esq., Pal. Soc., 1865, p. 143, pl. xxii. figs. 3-12; Memoirs Geological Survey, vol. iii., pl. vi., fig. 5.

Reduced one-third from the figure in Memoirs Geological Survey, vol. iii., pl. vi., fig. 5.

Lower Tremadoc Slate.—Penmorfa Church, Tremadoc; Castle Dendraeth, near Maentwrog; Ogof-ddu; Borthwood; Tyn-y-llan.

Passage beds.—Llanerch; North Wales. Memoirs Geological Survey, vol. iii., pp. 253, 315.

Fig. 5.—Psilocephalus innotatus, *Salter*.

Memoirs Geological Survey, vol. iii., p. 315, pl. vi., figs. 9-12; Brit. Trilob. Pal. Soc., 1866; p. 175, pl. xx., figs. 13-19.

This small Trilobite rarely more than an inch, although sometimes an inch and a half long, described by Mr. Salter as the most abundant fossil in the Lower Tremadoc beds, in company with *Niobe Homfrayi*, a much less common species. The form is very convex, especially in the head, which is but slightly lobed, the tail more strongly so; and the body, or *thorax*, is strongly trilobed throughout.

Lower Tremadoc.—Penmorfa, Tremadoc; and the neighbourhood of Borth and Moel-y-gest; *e. g.* Borthwood, Tyn-y-llan, Tyddyn-llwyd Farm, &c., North Wales.

Fig. 6.—Cheirurus Frederici, *Salter*.

Memoirs Geological Survey, vol. iii., p. 322, pl. viii., fig. 1; Brit. Trilob., Pal. Soc., 1866; p. 74, pl. v., figs. 18-21.

This Trilobite, Mr. Salter remarks, only found as yet in the upper part of the Tremadoc Slates, is a member of a genus more characteristic of higher beds of the Lower Silurian. It is occasionally as much as three and a half inches long, rather wide and much compressed.

MOLLUSCA.—*BRACHIOPODA*.

Fig. 7.—*a*, *b*. Lingula lepis, *Salter*, sp.

Lingulella lepis, Salter, Memoirs Geological Survey, vol. iii., p. 334, woodcut, fig. 11. *Lingula lepis*, Davidson, Silurian Brachiopoda, Pal. Soc., 1866, p. 54, pl. iii., figs. 53-9.

Our figures are taken from the two upper ones in the woodcut, Memoirs Geological Survey, p. 334, fig. 11. Mr. Salter describes it as a smaller and rounder form than L. Davisii, the beak being pointed, and the surface

sharply marked with fine concentric striæ. Mr. Davidson observes:—"Almost every specimen I have seen of this shell is more or less distorted, and subsequently but little can be said with certainty of its specific characters:" from a specimen of the interior he had examined, he believed it to be so similar to those of *Lingula* proper, that he had provisionally placed it with that genus.

Lower and Upper Lingula Flags of the Portmadoc district.

Lower Tremadoc.—Wern, Borthwood; Trwyn-y-lago; Cefn-Cyfarnedd, east of Pontnant-y-lladron, near Taihirion, on the Bala road, from Ffestiniog, &c., where it is a common species. Upper Tremadoc.—Under Moel-y-gest, and Garth, opposite Portmadoc.

HETEROPODA.

Fig. 8.—*a*, *b*. Bellerophon Arfonensis, *Salter*.

Memoirs Geological Survey, vol. iii., p. 349, pl. x., figs. 6, 7.

a. From Memoirs' Geological Survey, pl. x., fig. 6. View showing inflated mouth: the form is, however, much altered by pressure.

b. From the same plate, fig. 7. Back view.

Upper Tremadoc.—Moel-y-gest, Garth, Penrhyn, Penclogwyn, Tu-hwnt-yr-bwlch, Portmadoc. *Passage beds*, Llanerch.

PTEROPODA.

Fig. 9.—*a*, *b*. Theca operculata, *Salter*.

Memoirs Geological Survey, vol. iii., p. 351, pl. x., figs. 22-24.

a. From pl. x., fig. 22. View of flattened or dorsal side, showing operculum.

b. From fig. 22. With point restored.

Lower Tremadoc.—Abundant in all the localities near Portmadoc, Borthwood, Tyn-y-dre, Tyn-y-llan, North Wales.

Fig. 10.—Conularia Homfrayi, *Salter*.

Memoirs Geological Survey, vol. iii., p. 354, pl. x., figs. 11-13.

From Memoirs Geological Survey, pl. x., fig. 12. This large Pteropod shell is stated by Mr. Salter to occur four inches and a half long, and three quarters of an inch wide at the larger end, from which it gradually tapers to the point or *apex*; the surface being ornamented with double ridges, eight in number.

Upper Tremadoc.—Garth Hill, abundant; Tuhwnt-yr-bwlch, Portmadoc, North Wales.

PLATE VI.

FOSSILS OF THE LLANDEILO ROCKS.

PLANTÆ?—*ALGÆ.*

FIG. 1.—PALÆOCHORDA MAJOR, *M'Coy.*

From the original figure in Brit. Pal. Foss., pl. i. A., fig. 3 (reduced to half natural size).
LLANDEILO.—Skiddaw slate, Kirkfell, near Scawgill, Cumberland.

ZOOPHYTA.

FIG. 2.—*a*, *b*. NEBULIPORA FAVULOSA, *Phillips*, sp.

Nebulipora favulosa.—Memoirs Geological Survey, vol. ii., pl. i., pl. xxx., figs. 3, 3 *a*; vol. iii., p. 282, pl. xix., fig. 10 and *a*. (the same figures having been transferred). *Nebulipora lens*, M'Coy.—Brit. Pal. Foss., pl. i. C., fig. 7.
a. Natural size.
b. Portion of the surface enlarged.
UPPER LLANDEILO.—Lann Mill, near Llandeilo, South Wales.

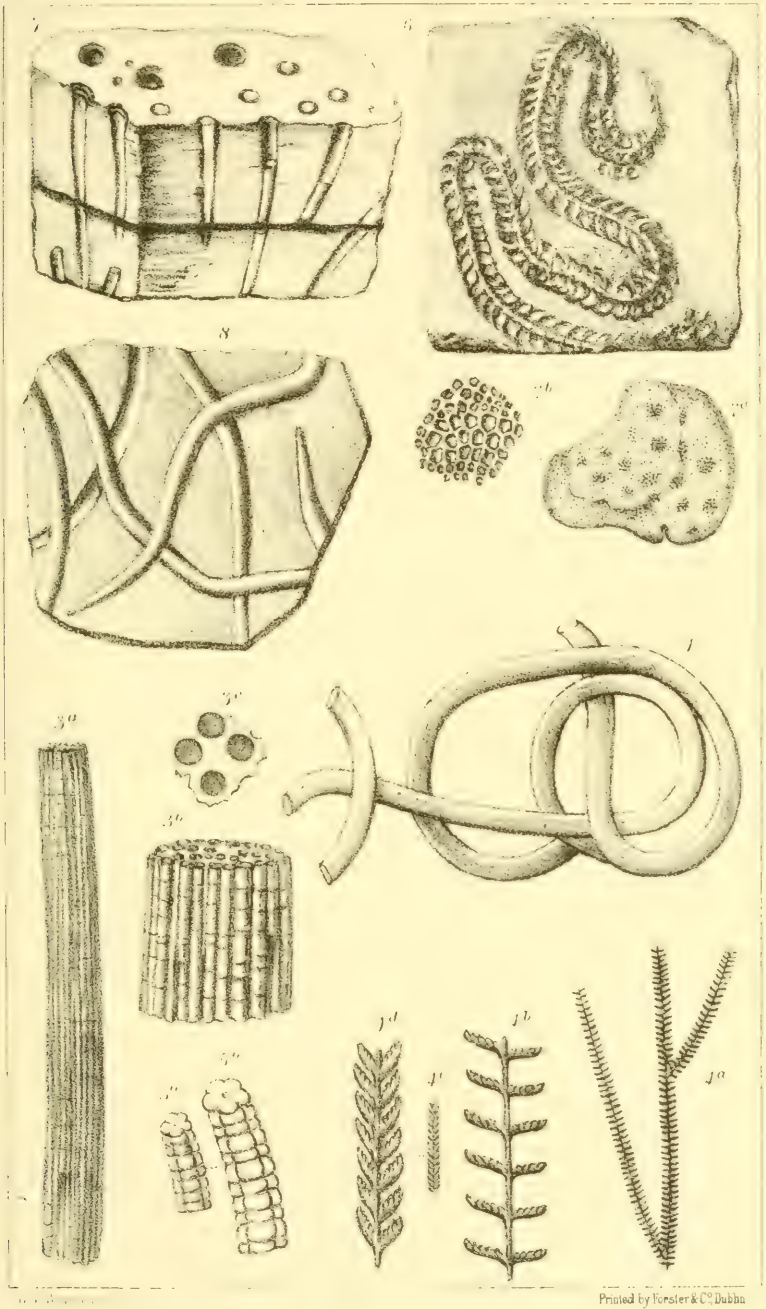
FIG. 3.—*a*, *b*. *c*. PYRITONEMA FASCICULUS, *M'Coy.*

From the original figures in Brit. Pal. Foss., pl. i. B., fig. 13.
a. Natural size.
b. Portion of the same, enlarged three diameters, showing the external surface of the bundle of tubes.
c. Portion of horizontal surface of tubes, more highly magnified.
LLANDEILO.—Limestone of Tre Gil.

HYDROZOA OR POLYZOA.

FIG. 4.—*a-d*. PROTOVIRGULARIA DICHOTOMA, *M'Coy.*

From the original figures, Brit. Pal. Foss., pl. i. B., fig. 11.
a. Part of a branched specimen (natural size), from Lockerby.
b. Portion of the same, enlarged six diameters.
c. A fragment, with the pinnules contracted.
d. Portion of the same, enlarged six diameters.
LLANDEILO.—Lockerby, Dumfriesshire.



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ECHINODERMATA.—*CRINOIDEA.*

FIG. 5.—*a*, *b*. CYATHOCRINUS, species undetermined.

Mr. Salter, in Memoirs Geological Survey, vol. iii., p. 284, pl. xi. B., fig. 9.

a. Portion of stem, natural size.

b. The same, enlarged.

The figures above are reproduced here, as it is believed to be the oldest Crinoid known in the British rocks, and is stated by Mr. Salter to be clearly distinct from *Glyptocrinus*, the Caradoc fossil.

LOWER LLANDEILO.—West of Stiper stones, Shropshire.

ANNELIDA.

FIG. 6.—NEREITES CAMBRENSIS, *Murchison.*

Reduced from the original figure in the Silurian System, 1839, vol. ii., p. 709, pl. xxvii., fig. 1.

Locality.—Llandeilo, Lampeter, Caermarthenshire, South Wales.

FIG. 7.—ARENICOLITES LINEARIS, *Hall* (Scolithus), *Salter.*

From the original figure in Memoirs Geological Survey, vol. iii., p. 292, pl. x. B., fig. 27, representing small tubular burrows of nearly corresponding size in a sandy rock.

LOWER LLANDEILO OR UPPER TREMADOC.—Stiper stones, Shropshire.

FIG. 8.—SCOLITES, *Salter.*

Annelide tracks or burrows; reduced one-third, from the original figure in Memoirs Geological Survey, vol. iii., p. 292.

"The ordinary fillings up of worm tracks in the sandy mud, common in all Lower Silurian rocks."

Hard Sandstones at the base of LOWER LLANDEILO Shales above Penmorfa, near Tremadoc.

PLATE VII.

FOSSILS OF THE LLANDEILO ROCKS.

CRUSTACEA.—*TRILOBITA.*

FIG. 1.—*a*, *b*, *c*. AGNOSTUS M'COYII, *Salter*.

Geol. Surv., Dec. 11, pl. xiii., fig. 8; Siluria, third edition, pl. iii., figs. 7, 8; Memoirs Geological Survey, vol. iii., p. 297, pl. xiii., figs. 8 and 8 *a* being transferred from figs. 6 and 6 *a* of the plate in the Decade above cited.

a. *Original.* The head only; in Museum, Geological Survey of Ireland, from black shales of the upper Llandeilo, Builth; on the same slab is a fragment of the *cheek* margin of *Ogygia Buchii*.

Our figure, taken from the specimen named as above, is somewhat different from that in the Decade before referred to; the collection in Ireland did not possess a tail, which is therefore copied from the Decade. It is stated by Mr. Salter to be a frequent fossil in the black Llandeilo Flags of Builth, in Radnorshire, and Shelve, in Shropshire, accompanying the *Ogygia Buchii* and *Ampyx nudus*.

UPPER LLANDEILO FLAGS.—Builth, Radnorshire; Llandeilo, Caermarthenshire; Marrington, Wilmington, and Shelve, Shropshire.

FIG. 2.—ASAPHUS TYRANNUS, *Murchison*.

Siluria, third edition; pl. i., figs. 4 and 5, pl. ii., fig. 1; Memoirs Geological Survey, Dec. 11, pl. v., fig. 1; and vol. iii., p. 312, pl. xiii., figs. 1-5. British Trilobites, J. W. Salter, in Pal. Soc., 1866, p. 149, pl. xxi., xxii., figs, 5-12.

Reduced one-third from fig. 1, pl. v., in the above Decade. (The parts wanting in this specimen, as in other figures, are restored in outline where practicable.) Respecting this fine Trilobite Mr. Salter remarks—"It is a truly characteristic species of the Upper Llandeilo age, as common at Llandeilo as *O. Buchii*," Decade 2, p. 3; and Memoirs Geological Survey, vol. iii., p. 312.

LLANDEILO FLAGS.—Abundant in South Wales; Llandeilo, and many localities in Caermarthenshire; in Pembrokeshire; Musclewick Bay; Llampeter, Felfrey; Narberth; Mydrim; and Lann Mill. In Shropshire, Meadowtown, Shelve, &c.; in North Wales, Craig-y-glyn, near Llanhaiadr in the Berwyns. Pal. Soc., p. 152.

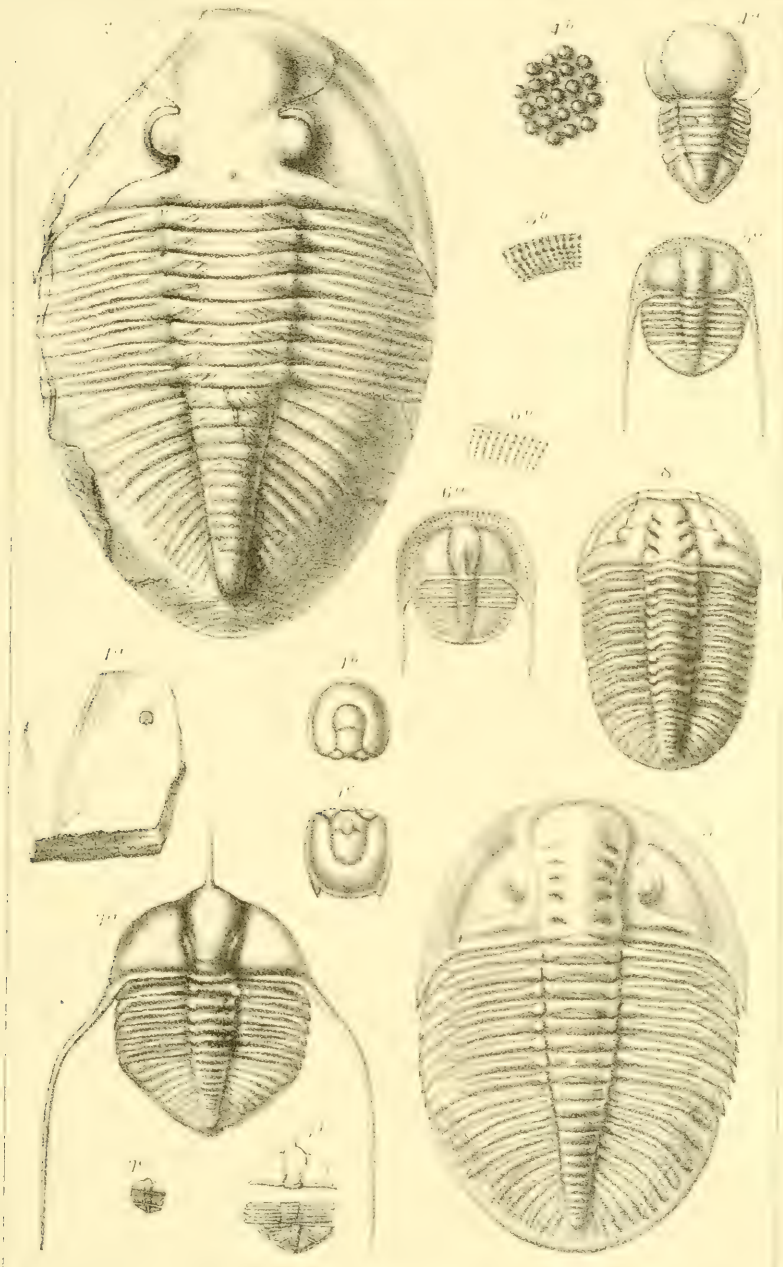

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FIG. 3.—OGYGIA BUCHII, *Brongniart.*

Siluria, third edition, 1859, pl. iii., figs. 1, 2, 3; Memoirs Geological Survey, Dec. 2, pl. vi., fig. 1. Mon. Brit. Trilob., p. 125, pl. xiv., figs. 1–7, and pl. xv., figs. 1-6.

Reduced one-third from the figure in Decade 2, pl. vi., fig. 1, and British Trilobites, pl. xv., fig. 1, aided by specimens in Museum, Geological Survey of Ireland, from Tre Coed, north of Builth.

LLANDEILO FLAGS only. "It abounds in the distorted slates at Shelve and Hope Mill, Rorington, Middleton, and Meadowtown, Shropshire; Builth, Radnorshire; Llangadoc and Llandeilo, Caermarthenshire; near Haverfordwest, Musclewick Bay, Pembrokeshire; and Abereiddy Bay, Cardiganshire; not hitherto found out of South Wales." J. W. Salter, Mon. Brit. Trilob., p. 128.

In examining the large collection of fossils made by the Geological Survey of Ireland at Dunabrattin Head, Co. Waterford, the author believed he had correctly identified several of them with this very characteristic Trilobite: Mr. Salter, however, appears disposed to consider them to belong to a distinct species.

FIG. 4.—*a*, *b*. ÆGLINA BINODOSA, *Salter.*

Siluria, third edition, p. 50; Foss. 8, fig. 6. Memoirs Geological Survey, Dec. 11, pl. iv., figs. 1–6; and vol. iii., p. 317, pl. xi. B, figs. 3, *a–c*.

a. From Memoirs Geological Survey, vol. iii., pl. xi. B, fig. 3.

b. From Decade 11, pl. iv., fig. 3 *a*, representing a portion of the eye, enlarged, which occupies nearly the whole cheek, as seen by the shaded part on one side of fig. 4 *a*.

LOWER LLANDEILO.—Abundant in black slate; Cefn Gwynlle, in the district west of the Stiper stones, Shropshire.

FIG. 5.—*a*, *b*. TRINUCLEUS FIMBRIATUS, *Murchison.*

Siluria, third edition, p. 55; Foss. 10, fig. 6, and pl. iv., fig. 7; Geol. Surv., Dec. 7, p. 8.

a. *Original.*—From a specimen in Museum, Geological Survey of Ireland. *Locality.*—Tre Coed, Builth, in black slates.

b. *Original.* Portion of border or expansion of head, enlarged, from the same specimen.

UPPER LLANDEILO.—"Only yet found at Builth, in Radnorshire. It is exceedingly abundant in the lane leading to the farm-House, called Pen-cerrig, on the west side of the hill, where it occurs with *Ampyx nudus* and *Agnostus M'Coyii*." Dec. 7, p. 8.

FIG. 6.—*a*, *b*. TRINUCLEUS LLOYDII, *Murchison.*

Siluria, third edition, p. 55; Foss. 10, fig. 7, and pl. iv., fig. 6; Geol. Surv., Decade 7, pl. vii.

a. From Decade 7, pl. vii., fig. 1.

b. Portion of border, or expansion of head, enlarged, from the same figure.

LLANDEILO FLAGS.—"Abundant in Caermarthenshire, Dynevor Park, and Maerdy Bach, Llandeilo; Blaen-dyffryn-garn and Coed Sion quarries,

Llangadock; frequent in Shropshire, Middleton, and the country about Cherbury and Shelve." Dec. 7, description of pl. vii., pp. 1 and 4.

FIG. 7.—*a*, *b*, *c*. AMPYX NUDUS, *Murchison*, sp.

Siluria, third edition, p. 225; Foss. 46, fig. 7, and pl. iv., figs. 9, 10. Memoirs Geological Survey, Decade 2, pl. x.

a. From the original figure by the author, in the above Decade, fig. 1, aided by specimens from Pen Cerrig, Builth, in Museum Geological Survey, Ireland.

b, *c*. *Original*. Young dislocated specimens, showing commencement of spines; from the same locality and Museum.

FIG. 8.—CALYMENE DUPLICATA, *Murchison*.

Siluria, third edition, p. 55; Foss. 10, fig. 10, and pl. iii., fig. 6; Memoirs Geological Survey, vol. ii., part 1, p. 236; and vol. iii., p. 327, pl. xvii., figs. 15-20; Mon. Brit. Trilob., p. 100, pl. ix., figs. 19-24.

LLANDEILO FLAGS.—Near Shelve, and Wilmington, Shropshire; Builth, Radnorshire, abundant; Lann Mill, near Narberth, Abereiddy Bay, Pembrokeshire, abundant.

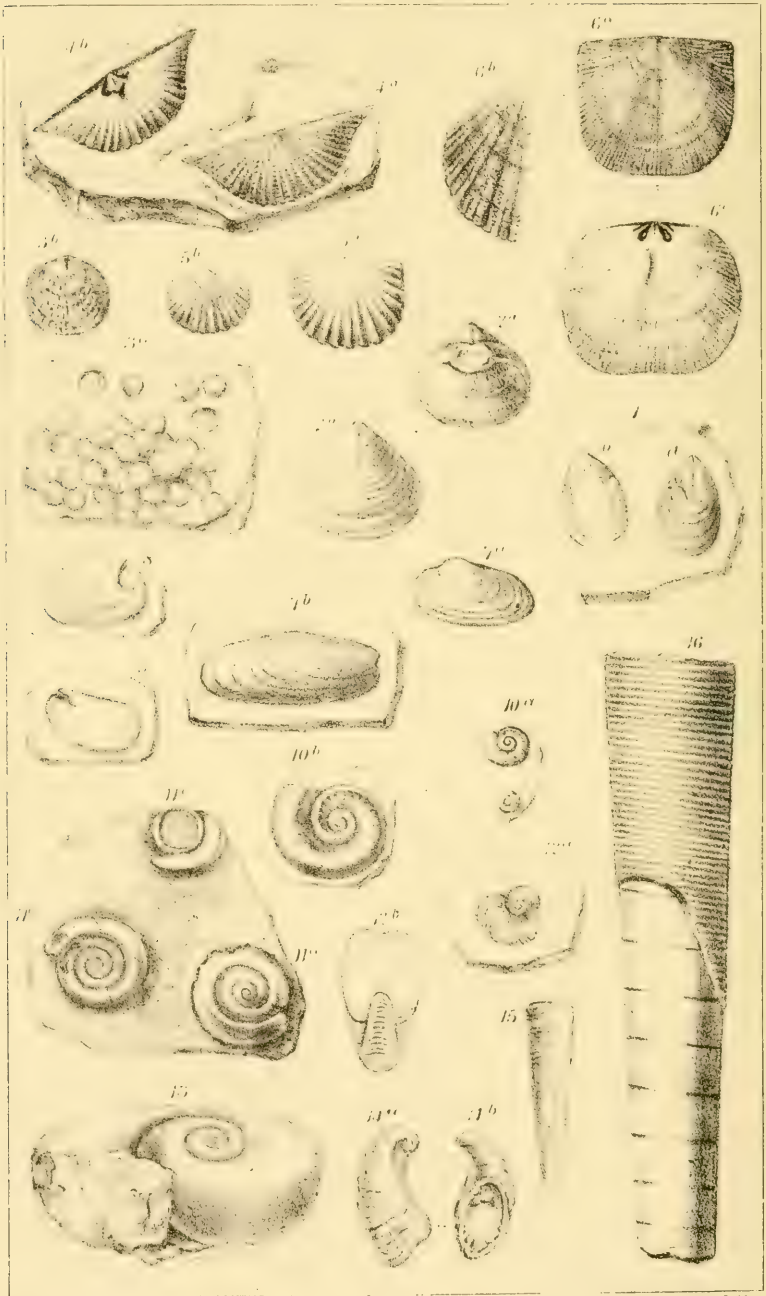

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PLATE VIII

FOSSILS OF THE LLANDEILO ROCKS.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 1.—*a*, *b*. LINGULA ATTENUATA, *Sowerby*.

Silurian System, pl. xxii., fig. 13, 1839; and Siluria, third edition, p. 55; Foss. 10, fig. 18, and pl. v., fig. 16; British Silurian Brachiopoda, by Thomas Davidson, Esq., Pal. Soc., 1866, p. 44, pl. iii., figs. 18-27.

a, *b*. From the original figures in the Silurian System above cited, aided by specimens in the Mus. Geol. Surv. of Ireland, from Pont Ladies, Llandeilo, and Panteg, Caermarthenshire.

LLANDEILO FLAGS.—It occurs in the Llandeilo Flags only, according to Mr. Salter. Very characteristic examples, are found at Llandeilo and Shelve; also at Coed Sion, Llangadock; Middleton, east of Cherbury; Rorington, Salop; Carneddau, Builth district, &c.; Brit. Sil. Brach. pp. 44, 45.

FIG. 2.—*a*, *b*. OBOLELLA? PLUMBEA, *Salter*, sp.

Lingula plumbea, Salter, Siluria, third edition, p. 50; Foss. 8, fig. 1. *Obolella plumbea*, Id. Memoirs Geological Survey, vol. iii., p. 334, pl. xi. B, fig. 10; Brit. Sil. Brach., p. 61, pl. iv., figs. 20-27.

a, *b*. From the original figures in Memoirs Geological Survey, vol. iii., pl. xi. B, figs. 10, 10 *a*.

LOWER LLANDEILO.—West of the Stiper stones, Shropshire, abundant, particularly at White Grit Mine, Shelve; it is also found at Ty-Obry, two miles east of Portmadoc. Brit. Sil. Brach., p. 60.

FIG. 3.—*a*, *b*. SIPHONOTRETA MICULA, *M'Coy*.

Brit. Pal. Foss., p. 188, pl. i. H, fig. 3; Siluria, third edition, p. 212; Foss. 35, fig. 3; Brit. Sil. Brach., p. 76, pl. viii., figs. 2-6.

a. *Original.* A group of these minute Brachiopod shells from a slab of black shale, Wyeford, Builth; Museum, Geological Survey of Ireland.

b. *Original.* One of these shells, enlarged three diameters, showing perforated beak, and the irregular spiny surface; the longitudinal fissure, as suggested by Mr. Davidson, being probably due to pressure.

LLANDEILO FLAGS.—"It abounds at Wyeford, near Builth, also at Conway Castle; in Scotland it was found by Professor Harkness in the Graptolite shales at several localities about nine miles east of Dumfries, also near

Moffat and Girvan, in Ayrshire. In Ireland it occurs in Lower Silurian shales (? *Llandeilo Flags*) at Bellewstown Hill, county of Meath." Brit. Sil. Brach., p. 77.

These Brachiopod Shells from the county of Meath, alluded to by Mr. Davidson, associated with *Didymograpsus Murchisonii*, *Diplograpsus pristis*, &c., were amongst the old collections made by the late Mr. Flanagan, of the Geological Survey, and since examined by the author; they are very important fossils, as indicating strata of Llandeilo age; but, although the neighbourhood from which they were said to have been obtained has been searched on several occasions, corresponding specimens were not met with, although others equally interesting were collected.

FIG. 4.—*a*, *b*. ORTHIS ALATA, *Sowerby*, sp.

Spirifer alata. Silurian System, pl. xxii., fig. 7.

Orthis alata. Siluria, third edition, p. 55; Foss. 10, fig. 15, and pl. v., fig. 11.

a, *b*. From the original figure in the Silurian System above cited.

LLANDEILO FLAGS.—Mount Pleasant, Caermarthen. The author collected this species from black carbonaceous shales with *Diplograpsus pristis*, *Dictyonema sociale*, &c., at Cooksgrove, Bellewstown Hill, near Dulcek, County of Meath—the locality from which the specimens previously alluded to were believed to have been obtained; the lithological character of the rock, in which they are imbedded, differs however considerably.

FIG. 5.—*a*, *b*. ORTHIS CALLIGRAMMA, *Dalman*, variety.

From the figures in Mem. Geol. Surv., vol. iii., pl. xi. B, figs. 11, 12.

LOWER LLANDEILO.—Cae-glyd, a locality rich in fossils, under the traps of Manod Bach, Ffestiniog; also in the arenaceous mudstones of Lord's Hill and other places, west of the Stiper stones, Shropshire. Mr. Salter, in Mem. Geol. Surv., vol. iii., p. 337.

Corresponding specimens were obtained by the author in the black shales, mentioned in the description of the preceding figure, at Cooksgrove, County Meath.

FIG. 6.—*a*, *b*, *c*. ORTHIS STRIATULA, *Conrad*, sp.

O. testudinaria, Hall, Pal. New York, vol. i., pl. xxxii., fig. 1; Mem. Geol. Surv., vol. ii., Part I., pl. xxvii., figs. 6-8, and vol. iii., p. 340, pl. xiii., figs. 10-14.

a, *b*. From the figures in Mem. Geol. Surv., vol. iii., pl. xiii., figs. 11, 12.

c. *Original*. Enlarged view of portion of the surface of a shell, from a slab in Mus. Geol. Surv., Ireland.

LOWER LLANDEILO.—[Lord's Hill, Shelve?] Sutherlandshire.

UPPER LLANDEILO.—South Wales.

CARADOC?

LOWER LLANDOVERY.—North of Llandovery, Mem. Geol. Surv., vol. iii., p. 340.

CONCHIFERA.

FIG. 7.—*a*, *b*. PALÆARCA SOCIALIS, *Salter*.

From Mem. Geol. Surv., vol. iii., p. 344, pl. xi. A, fig. 13, 13 *b*.
The form, as in fig. 7, *a*, is that of an *Arca*; when distorted, as at 7 *b*, it resembles *Modiola*, and in such state is very likely to be mistaken for that or some other genus.
LOWER LLANDEILO.—Ty-obry, Penrhyn, opposite Tremadoc, abundant.

FIG. 8.—REDONIA ANGLICA, *Salter*.

Mem. Geol. Surv., vol. iii., p. 345, pl. xi. B, fig. 15.
Cucullella? Siluria, third edition, p. 50; Foss. 8, fig. 2.
From Mem. Geol. Surv., vol. iii., pl. xi. B, fig. 15 *a*, upper figure; both figures being marked with the same letter; the lower one should probably have been 15 *b*.
LOWER LLANDEILO.—Lord's Hill, Shelve.

FIG. 9.—RIBEIRIA COMPLANATA, *Salter*.

Mem. Geol. Surv., vol. iii., p. 346, pl. xi. B, fig. 16.
Redonia? Siluria, third edition, p. 50, Foss. 8, fig. 3.
Ribeiria. Ibid., p. 549.
From Mem. Geol. Surv., vol. iii., pl. xi. B, fig. 16.
LOWER LLANDEILO.—Lord's Hill, Shelve.

GASTEROPODA.

FIG. 10.—*a*, *b*. EUOMPHALUS CORNDENSIS, *Sowerby*.

Silurian System, pl. xxii., fig. 16; Siluria, third edition, pl. vii., fig. 5, 5 *a*.
From original figure in Silurian System, pl. xxii., fig. 16.
LLANDEILO ROCKS.—Corndon Hills.

FIG. 11.—*a*, *b*, *c*. OPHILETA COMPACTA, *Salter*.

Journ. Geol. Soc., vol. xv., p. 378, pl. xiii., fig. 12.
Siluria, third edition, p. 217; Foss. 38, fig. 4.
From the original figure in Journ. Geol. Soc., cited.
a. Lower surface. *b*. The convex cast. *c*. Upper concave surface.
LLANDEILO ROCKS.—Durness, in Sutherland, North-western Highlands.

HETEROPODA.

FIG. 12.—*a*, *b*. BELLEROPHON PERTURBATUS, *Sowerby*.

Euomphalus. Silurian System, pl. xxii., fig. 15.
Euomphalus furcatus, M'Coy, Sil. Foss., Ireland, p. 13, pl. i., fig. 11.

Bellerophon perturbatus, Siluria, third edition, p. 218; Foss. 39, fig. 6, and pl. x., fig. 5. Mem. Geol. Surv., vol., iii., p. 350, woodcut, fig. 16.

a. From the original figure in Silurian System, pl. xxii., fig. 15.

b. From the woodcut in Mem. Geol. Surv., vol. iii., fig. 16, p. 350. "One of the very best and most characteristic species for the Llandeilo Flags, being common in British localities in North and South Wales, and very rarely met with (in Ireland only) in rocks, supposed to be of the Caradoc era." Mr. Salter, in Appendix to Mem. Geol. Surv., vol. iii., p. 350.

The author has identified this species from cleaved slates, supposed to be of Caradoc or Bala age, at Slieveroe, near Rathdrum, Co. Wicklow; and it occurs plentifully in the collections of fossils made by the Geological Survey of Ireland, at Newtown Head, Waterford Harbour.

Upper Llandeilo.—Bath House, Bangor; abundant in Upper Llandeilo Rocks in North and South Wales; and in Caradoc? S. E. Ireland. Locality mentioned in Catalogue of British Fossils, by Prof. Morris, under the name of *Euomphalus perturbatus*. Pensarn, Caermarthen.

PTEROPODA.

Fig. 13. Maclurea Logani, *Salter*.

Journ. Geol. Soc., vol. vii., pl. viii., fig. 7. Siluria, third edition, p. 215; Foss. 37, fig. 1. Geological Survey of Canada, Dec. 1, pl. i., fig. 6.

From Journ. Geol. Soc. (above cited), pl. viii., fig. 7 *b*, reduced to half natural size.

Llandeilo.—In Limestone, Aldeans, Ayrshire.

Fig. 14.—*a*, *b*. Maclurea Peachii, *Salter*.

Journ. Geol. Soc., vol. xv., pl. xiii., figs. 4, 5; Siluria, third edition, p. 217; Foss. 38, figs. 1, 2.

a, *b*. Reduced figures of the operculum, or plate for closing the mouth of the shell; from Journ. Geol. Soc., above cited. *a*, inner view; *b*, exterior.

Llandeilo.—Limestone, Durness, Sutherlandshire.

Fig. 15.—Theca simplex, *Salter*.

Siluria, third edition, p. 50; Foss. 8, fig. 5.

From Mem. Geol. Surv., vol. iii., p. 352, pl. xi. B, fig. 24. The pointed end being restored in outline.

Lower Llandeilo.—White Grit Mine, Shelve, Shropshire; abundant.

CEPHALOPODA.

Fig. 16.—Orthoceras Avelinii, *Salter*.

Siluria, third edition, p. 50; Foss. 8, fig. 4.

From Mem. Geol. Surv., vol. iii., p. 356, pl. xi. B, fig. 18.

Lower Llandeilo.—Cefn Gwynlle Mine, Shelve, Shropshire.

Characteristic British Fossils. Plate 9.

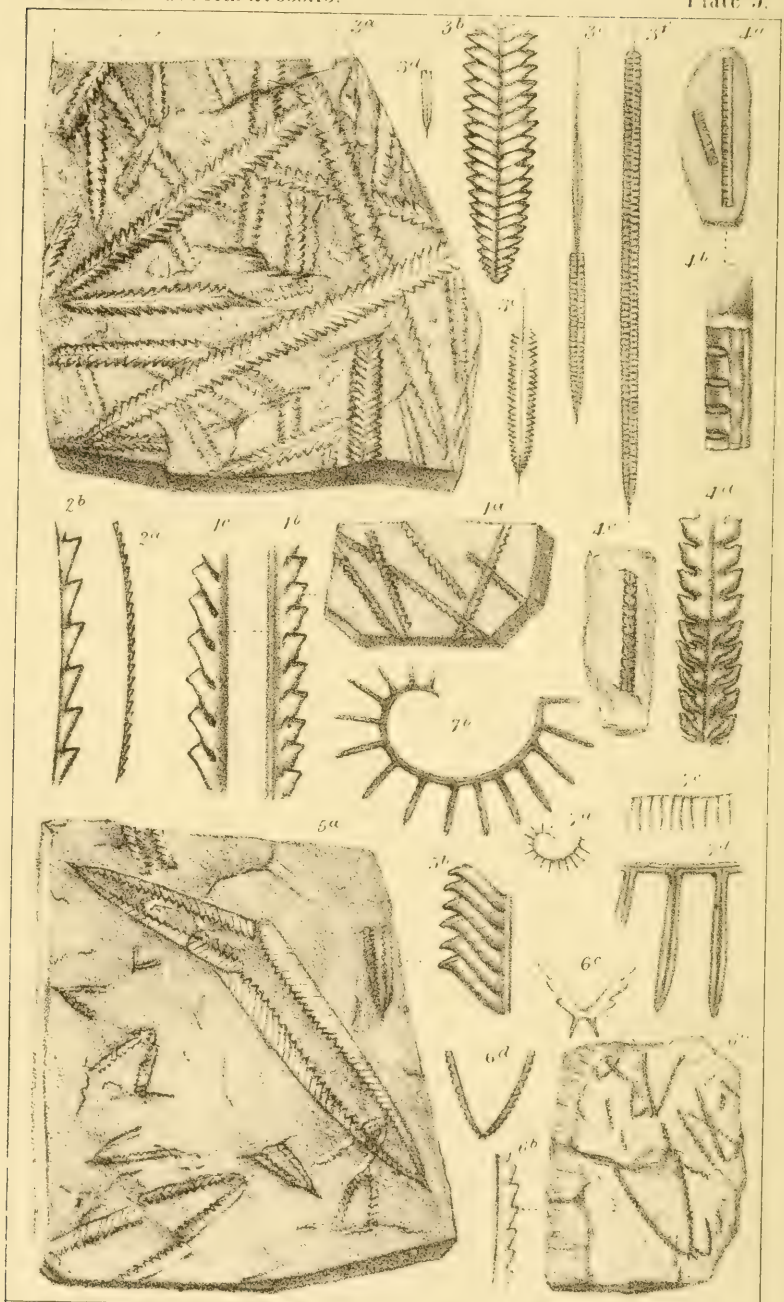

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PLATE IX.

FOSSILS OF THE LLANDEILO ROCKS.

HYDROZOA OR POLYZOA.—*GRAPTOLITIDÆ.*

FIG 1.—*a*, *b*, *c*. GRAPTOLITHUS SAGITTARIUS, *Linnæus.*

Hisinger, Leth. Suec,, pl. xxv., fig. 6, *Monograpsus sagittarius*, Prof. Geinitz, Die Graptolithen (1852), pl. ix., fig. 3.

G. incisus.—Harkness, Journ. Geol. Soc., vol. vii.. p. 6, pl. i., fig. 8; Memoirs Geological Survey, vol. iii., p. 329, pl. xi. *a*, fig. 2.

a. Original. From black argillaceous slates, collected by Professor Harkness, and presented by him to the Museum, Geological Survey of Ireland.

UPPER LLANDEILO.—"Graptolite shale," Duffkinnell, Dumfriesshire, south of Scotland, with *Diplograpsus pristis* on same slab.

b. Original. A portion of one of these Graptolites enlarged, showing double line of *canal*, and the closely set series of prominent serratures or *cellules.*

c. From the enlarged figure in Memoirs Geological Survey, vol. iii., pl. xi. A, fig. 2.

LOWER LLANDEILO.—Llanfaelrhys, South Caernarvonshire, *ib.*, p. 329.

FIG. 2.—*a*, *b*. GRAPTOLITHUS NILSSONI, *Barrande.*

Die Graptolithen, by Prof. Geinitz, 1852, p. 35, pl. ii., figs. 17-20, 24, 25, 28-32.

G. tenuis, Portlock, Geol. Report of Londonderry, &c., pl. xix., fig. 7.

G. Nilssoni, Harkness, Journ. Geol. Soc., vol. vii., p. 61, pl. i., fig. 7.

a. Original. Natural size.

b. enlarged; from black slates, Upper Llandeilo Flags. Little Queensberry Burn.

LLANDEILO FLAGS.—Dumfriesshire, Ayrshire (?) Scotland; black slates, (?) *Llandeilo*, Belvoir, Co. Clare (?) Balbriggan, Co. Dublin, in shales; (?) *Caradoc*, Kilnacreagh, near Six-mile Bridge, Co. Clare; Reafadda; Garrangreena, and other localities near Borrisoleigh, Co. Tipperary; also Desertcreat, Tyrone; as *G. tenuis*, Portlock, Rep. *cit.*

FIG. 3.—*a-f.* DIPLOGRAPSUS PRISTIS, *Hisinger*, sp.

Prionotus pristis and *scalaris*; His. Leth. Suec., p. 113, pl. xxxv., figs. 4, 5.

G. foliaceus, Harkness, Journ. Geol. Soc., vol. vii., pl. i., fig. 13.

a. Original. From a piece of black fissile slate, showing the abundance of these fossils, which are impressed upon each other throughout every layer. These Graptolites are generally white, and distinctly visible upon the black slate; in some of the beds they are stained pink, the cleavage joints in the

slate being of a ferruginous or yellow ochre colour; they are accompanied, at the same locality, by numerous and perfect examples of what appears to the author identical with *Graptolithus flaccidus*, Hall. Collected by the Geol. Surv. of Ireland, from cliffs, on the River Suir, a little north-west of the city of Waterford. See Palæontological Remarks, in Explanation of Sheets 167, &c., p. 25, &c., Geol. Surv. of Ireland.

b. *Original.* Portion of one of these Graptolites, enlarged; showing central axis, and closely arranged double series of cellules.

c-f. From original figures by the author, in Journ. Geol. Soc., of Dublin, vol. ix., pl. iv., figs. 2 *a*, *b*, *c*, and 3 *b*.

c. Small example, with fine central axis projecting beyond the cell serratures at both ends.

d. A very young specimen, upon which no serratures are visible, the outline being smooth, and the central axis projecting.

e and *f* are considered to belong to the same species, and to be pressed in an opposite direction to 3 *a*, and 3 *c*, a specimen from the same locality. Graptolites presenting this appearance were formerly described as distinct species, under the names of *scalaris* and *scalariformis*. Fig 3 *e*, in addition to the edge view, shows the axis prolonged at the upper part, above the compressed cells, to a considerable length; gradually swelling out in the centre, and provided with what appears to be a thread-like canal passing through it, and terminating in a small pointed filament.

f. An example of a similar variety to the previously described one, in which the mass of compressed cells bear a much greater proportion to the axis, which is but slightly prolonged beyond them; *c*, *d*, *e*, and *f*, are all from the same locality, on the north-west flank of the Slieve Bernagh Mountains, at Belvoir, between Sixmile Bridge and Broadford, in the county Clare, and were collected by the Geol. Surv. of Ireland, from black slates in which this species and variety are very abundant, accompanied by *Graptolithus? gracilis*, Hall, and a few other Graptolites. *Vide* Explanation to Sheet 133 of the Maps, Geol. Surv., Ireland. Pal. Notes by the author, p. 10, &c.

This species, the most abundant and characteristic of all the Graptolites of the Silurian rocks, especially marks the Lower Silurian division; no double Graptolite having hitherto occurred above the Caradoc or Bala.

Llandeilo.—Shropshire; North Wales; Dumfries. Catalogue of Brit. Foss., by Prof. Morris, second edition, 1854, p. 53.

Lower Llandeilo.—Tai-hirion; Arenig, west of Bala, North Wales; west of Stiper stones, Shropshire; and Upper Llandeilo, South Wales; Mr. Salter, in Mem. Geol. Surv., vol., iii., p. 256.

Caradoc or Bala Rocks.—In Bala schists in many parts of Wales; also in earthy beds, ascribed to this formation, at Church Stretton, Shropshire; Siluria, third edition, p. 73.

Localities in Ireland.—Black slates, ? *Llandeilo* Ballymoney, and Ballinatray Bridge, Courtown Demesne, near Gorey, and Tinnaglogh, Ballyhack, Co. Wexford; Belvoir, Co. Clare; Commons of Slane; Newtown Fortescue, Broomfield, and Cooksgrove, near Duleek, Co. Meath; also Balbriggan, Portraine, and Lambay Island, Co. Dublin; collected and determined by the author; also Lisbellaw, Fermanagh; and Desertcreat, Tyrone; specimens in the Portlock Collection, Mus. Geol. Surv. of Ireland.

Fig. 4.—*a-d*. Diplograpsus teretiusculus, *Hisinger*, sp.

Prionotus, Hisinger, Leth. Suec., pl. xxxviii., fig. 4.

Diplograpsus teretiusculus, Mr. Salter, in Journ. Geol. Soc., vol. viii., p. 329, pl. xxi., figs. 3, 4. Mem. Geol. Surv., vol. iii., p. 330, pl. xi. *a*, fig. 3.

a, *b*. From the original figures in the Journ. Geol. Soc., vol. viii., pl. xxxi., fig. 3, *a*, *b*.

a. Natural size (uncompressed).

b. Portion of do. enlarged four diameters, being the edge view, which shows the orifices of the cells.

c, *d*, *original*. Uncompressed fragment, showing the arrangement of cells on each side of the axis; the lower portion, having been removed, has left its impression, in which the interior of the cells and their connexion with the central canal may be observed. From a specimen collected and presented by Professor Harkness to the Museum, Geological Survey of Ireland; from black slates, *Upper Llandeilo*, Little Queensberry Burn, Dumfriesshire; other and well-preserved specimens in the same Museum were also collected by that gentleman from Glenkiln, Dumfries, in similar black shales.

Lower Llandeilo.—Ty-obry. Upper Llandeilo.—Conway, Mona Mine, Anglesea; Llanerchymedd, &c., N. Wales; Pembrokeshire, S. Wales; Mem. Geol. Surv., vol. iii., pp. 258, 330. Dumfriesshire, *Prof. Harkness*. In Ireland, at Lady Elizabeth's Cove, Tramore, Co. Waterford, and Ballymoney, near Gorey, Co. Wexford, *W. H. B.*

Fig. 5.—*a*, *b*. Didymograpsus Murchisonæ, *Beck*, sp.

Graptolithus Murchisoni, Beck, Sil. Syst., p. 695, pl. xxvi., fig. 4. *Cladograpsus*, Prof. Geinitz, Die Graptolithen, p. 30, pl. ii., fig. 40.

a. *Original*. Fragment of dark grey slate, on which several examples of this double Graptolite are impressed; some of them illustrate the remarkable effects of cleavage, which has separated and disturbed the relation of one part to another. Museum, Geol. Survey of Ireland, from Upper Llandeilo Flags, Abereiddy Bay, Pembrokeshire.

b. *Original*. Enlarged four diameters: view of some of the cells, from well-preserved specimens collected by the Geol. Surv. of Ireland, near Duleek, county of Meath, described by the author in the Journ. Geol. Soc. of Dublin, p. 300, vol. ix., pl. iv., fig. 1 *b*.

Llandeilo Flags.—Llandrindod Hill, Radnorshire: Siluria, third edition, pl. i., fig. 1 (description); Llanfair; Welchpool; Abereiddy Bay, Pembrokeshire; Catal. Brit. Foss., p. 52; ? *Llandeilo*, near Duleek, Co. Meath, *W. H. B.*

Fig. 6.—*a*–*d*. Didymograpsus sextans, *Hall*, sp.

Graptolithus sextans, Hall, Palæontology of New York, vol. i., pl. lxxiv., fig. 3. *Cladograpsus*, Prof. Geinitz, Die Grap. 1852. *D. sextans*, Salter, in Journ. Geol. Soc. 1848, vol. v., p. 17, pl. i., fig. 10, *b*, *c*.

a. *Original*. A group of these remarkable little diverging Graptolites, well preserved in dark grey shale, collected by Mr. C. Galvan, of the Geological Survey of Ireland, at Dalligan Bridge, five miles N. E. of Dungarvan.

b. *Original*. Enlarged portion of fig. 6 *a*, showing cell denticles.

c. *Original*. Enlarged portion of fig. 6 *a*, showing double radicles at the base, from which the two branches diverge.

d. *Original*. From a specimen in black fissile shale, collected and presented by Professor Harkness to the Geol. Surv. of Ireland, in which the double radicles and cell denticles are rather obscure: "Graptolite shales" (*Upper Llandeilo*); Glenkiln, Dumfriesshire.

Llandeilo Flags.—Black slate, west of Wigtownshire, *Salter;* Cairn Ryan, Ayrshire, Cat. Brit. Foss., p. 52. In Ireland, Dalligan Bridge, N. E. of Dungarvan; and Lady Elizabeth's Cove, Tramore Bay, Co. Waterford. Explanation of Sheets 167, &c., of the Maps, Geol. Surv. of Ireland, pp. 20, 33, Pal. notes by the author.

Fig. 7.—*a–d.* Rastrites peregrinus, *Barrande.*

Grap. Bohem., pl. iii., figs. 10–13. Prof. Harkness, Journ. Geol. Soc., vol. vii., p. 59, pl. i., fig. 1.

Monograpsus, Prof. Geinitz, Die Grap., p. 48.

a. Original. Small portion of this beautiful curved Graptolite, in finely laminated, black shale, Duffkinnel, Dumfries.

b. Original. The same, enlarged, showing central canal, communicating with the elongated cells.

c. Original. Another fragment, with longer cells, in dull earthy shale, from Little Queensberry Burn, Dumfriesshire.

d. Original. Portion of the same, enlarged; all collected by Professor Harkness, and presented by him to the Geol. Surv. of Ireland.

Upper Llandeilo.—Dumfriesshire, *Harkness*, Journ. Geol. Soc., above cited.

Characteristic British Fossils. Plate 10.

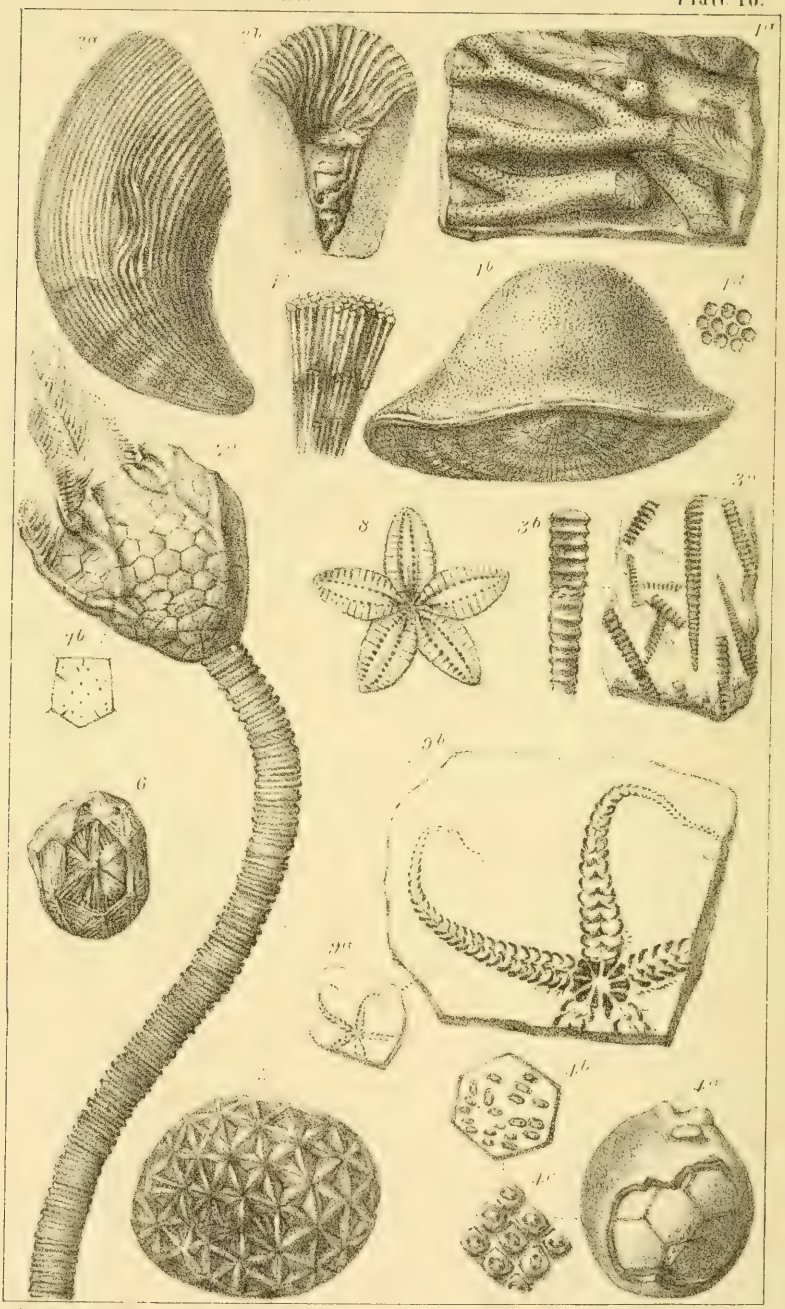

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PLATE X.

FOSSILS OF THE CARADOC OR BALA ROCKS.

ZOOPHYTA.—*ANTHOZOA.*

FIG. 1.—*a–d.* STENOPORA FIBROSA, *Goldfuss.*

Petrefacta Germaniæ, pl. xxviii., figs. 3, 4. *Stenopora fibrosa*, Silur. Syst., pl. xv., *bis*, fig. 6.

a. Original. Branching variety of this coral, natural size, showing punctated surface, and horizontal section of corallites, from calcareous beds, Lower Silurian, Tramore Bay; collected by Geol. Surv. of Ireland.

b, c, d. Variety *lycoperdon*, Hall. *Favosites lycopodites*, Hall, Pal. New York, pl. xxiii., figs. 1–3. *S. fibrosa*, var. *lycoperdon*, Siluria, third edition, p. 204; Foss. 28, fig. 2.

b. Original. Hemispherical variety, natural size.

c. Original. Fragment of the same variety, showing radiating group of corallites, where fractured.

d. Original. Portion of surface enlarged from 1 *b*, showing openings of the irregular hexagonal corallites. From Tramore Bay, where this variety is very abundant, in rocks believed to be of Caradoc or Bala age.

UPPER LLANDEILO ROCKS.—Garn, east of Arenig; south side of Arenig; one mile N. W. of Llanerchymedd, Treiorwerth; North Wales; and Pembrokeshire, South Wales; Mem. Geol. Surv., vol. iii., p. 258; Lancashire; Yorkshire; North and South Wales; Catal. of Brit. Foss., p. 64.

CARADOC OR BALA ROCKS.—Numerous localities in Caernarvonshire, Denbighshire, Montgomeryshire, and Merionethshire; ibid., p. 260.

From localities in Ireland, believed to be of the same age, at Knockmahon; Dunabrattan Head, Tramore Bay, Co. Waterford; Carrickadaggan, and near Gorey, Co. Wexford; Slieveroe, near Rathdrum, Co. Wicklow.

This coral is perhaps the most generally distributed of all the Silurian fossils both in time and space; ranging from the Llandeilo Rocks, through all the series of Lower and Upper Silurian, to the Ludlow formation (Appendix to Siluria, third edition, Table of Fossils, p. 534); and occurring at most of the fossil localities in these formations.

FIG. 2.—*a, b.* PETRAIA ÆQUISULCATA, *M'Coy*, sp.

Brit. Pal. Foss. p. 39, pl. i. B, figs. 23 and 24. *Aulacophyllum mitratum*, Milne Edwards and Haime. British Foss. Corals, p. 280, pl. lxvi., fig. 1.

a. From the original figure in Brit. Pal. Foss., pl. i. B, fig. 23; a single turbinated corallite, showing the equidistant "septa," or "lamellar" divisions.

b. From the original figure in Brit. Pal. Foss., pl. i. B, fig. 24, showing the "calice" or cup with the "septa," uniting towards the centre.

The corals referred to Petraia and Turbinolopsis, usually in the state of casts, appear many of them to belong to Cyathophyllum, Brit. Foss. Corals (Palæontographical Society), p. 286.

Caradoc or Bala Rocks.—Coniston, Westmoreland; Ayrshire; Lancashire; North Wales. Catal. Brit. Foss., p. 62. In the Appendix to Siluria, third edition, it is inserted as ranging into the Llandovery Rocks.

ANNELIDA.

Fig. 3.—*a*, *b*. Tentaculites Anglicus, *Salter*.

T. annulatus and *scalaris*, Silurian System, pl. xix., figs. 15, 16. *T. Anglicus*, Siluria, third edition, p. 74; Foss. 12, fig. 4.

a. *Original.* A piece of fine laminated sandstone, full of these small but very characteristic fossils, in Museum Geol. Surv. of Ireland. *Caradoc Sandstone*, Cheney Longville, Shropshire.

b. *Original.* Portion of one of these fossils, enlarged; the upper part being an impression, showing a regular series of rings or annular ridges, from which the cast which fills up the lower part has fallen out.

Caradoc or Bala to Llandovery Rocks.—Appendix to Siluria, third edition, p. 537. Localities: Shropshire; North and South Wales; Tortworth; Coniston; Malverns (Cat. of Brit. Foss., 2nd edition, p. 94). *Caradoc;* several localities in Caernarvonshire, Merionethshire, Montgomeryshire, and Denbighshire. Mem. Geol. Surv., vol. iii., p. 261. *Bala beds*, Slieveroe, Co. Wicklow, *W. H. B.*

This well-marked little fossil is very abundant, and eminently characteristic of strata of Caradoc or Bala age.

ECHINODERMATA.—*CYSTIDEÆ.*

Fig. 4.—*a*, *b*, *c*. Sphæronites Litchi, *Forbes*, sp.

Caryocystites Litchi, Forbes, Mem. Geol. Surv., vol. ii., part ii., p. 514, pl. xxi., figs. 2 *a–g*.

a. From the original figure in the volume above cited, pl. xxi., fig. 2 *b*, which is repeated in vol. iii., pl. xx., fig. 3. Part of the test or shell of this globular cystidean having been removed, shows it to be composed of large hexagonal plates; at the summit are two projections for the oral and anal orifices; traces of the ovarian aperture may be seen at the upper part of the body, near the mouth.

b, *c*. *Original.* Enlarged views of the external markings, from the natural impression of one of these bodies, labelled *Caryocystites Litchi* in the museum, Geological Survey of Ireland; fig. 4 *b*, showing the twin pores described by Professor Forbes, vol. ii., part ii., p. 514, is taken from the natural impression, and corresponds with 2 *e* and *f* of the original figures illustrating Professor Forbes' Memoir. 4 *c*. Enlarged markings from the surface of the cast, which came out of the impression, showing pairs of pores, enclosed by small irregular hexagonal spaces, corresponding with figure 2 *d* of pl. xxi., in the vol. before cited.

Caradoc or Bala.—Bala, Merionethshire, North Wales; Sholes Hook, Pembrokeshire, South Wales.

FIG. 5.—ECHINOSPHÆRITES BALTICUS, *Eichwald.*

Sphæronites Balticus, Eich. Forbes, in Mem. Geol. Surv., vol. ii., part ii., p. 518, pl. xxii., fig. 3, and vol. iii., p. 287, pl. xx., fig. 10, the same figure having been transferred.

From the original figure, drawn by the author, in the work above cited; "a round or oblong body, covered with polygonal plates, the surface being ornamented with a network of triangles, forming a number of star-like devices, which completely conceal the true disposition of the plates." Forbes, in Mem. Geol. Surv., before cited, vol. ii., pl. ii., p. 518.

CARADOC OR BALA ROCKS.—Bala, North Wales; Sholes Hook, South Wales.

FIG. 6.—HEMICOSMITES? OBLONGUS, *Pander,* sp.

Echinosphærites oblongus, Pander, Beitrage, pl. ii., figs. 22, 23?. *H. oblongus*, Forbes in Mem. Geol. Surv., vol ii., part ii., p. 511, pl. xx., fig. 6; and vol. iii., p. 288, pl. xx., fig. 11, the same figure having been transferred.

From the original figure, drawn by the author in the work above cited, pl. xx., fig. 6.

This fossil is composed of large plates, ornamented with fasciculi of radiating grooves.

CARADOC SLATES.—Sholes Hook, Haverfordwest.

CRINOIDEA.

FIG. 7.—*a*, *b*. GLYPTOCRINUS? BASALIS, *M'Coy.*

Brit. Pal. Foss., p. 57, pl. i. D, fig. 4; Silluria, third edition, p. 206; Foss. 29. *Cœlocrinus*, proposed n. g. Salter, in Mem. Geol. Surv., vol. iii., p. 283, pl. xxiii., fig. 4.

From the original figures in the Mem. Geol. Surv. just cited, pl. xxiii., figs. 4 and 4 *c* (there are two figures on the plate marked with this letter).

[The references to this figure, as in several other instances, are somewhat confused, and there is a great want of more complete explanations to the plates in this volume, some of the figures not being alluded to at all, and no information given as to enlarged representations. There is a list professing to give the contents of the plates at p. 379; but it is a very meagre one, and does not explain the whole of the figures, or mention even all the species.]

a. From Mem. Geol. Surv., pl. xxiii., fig. 4. This fossil shows the rounded stem, consisting of numerous rings or joints, connected with what is called the head or body, which was composed of numerous hexagonal plates, some of the lower ones being marked by small tubercles, and radiating ridges; from the upper portion of this body proceed the "arms and fingers," or tentacles, of a graceful and feather-like character, much longer than shown in our figure, to which we have added a small portion from another specimen in the Mem. Geol. Surv. of Ireland.

b. From Mem. Geol. Surv., pl. xxiii., fig. 4 *c*. A single plate, showing the radiating ridges, and scattered tubercles ornamenting the surface.

"CARADOC ROCKS.—Everywhere in Wales; Guilsfield, near Meifod; Montgomeryshire, near Llanwddyn, in Berwyn mountains; Bala, Merionethshire; Bettws-y-Coed, Caernarvonshire." Mr. Salter, in Mem. Geol. Surv., vol. iii., p. 284.

ASTERIADÆ.

FIG. 8.—PALÆASTER OBTUSUS, *Forbes*, sp.

Uraster obtusus, Forbes, Mem. Geol. Surv., vol. ii., part ii., p. 463: Decade 1, pl i., fig. 3; vol. iii., p. 289, pl. xxiii., fig. 1. *P. obtusus*, Siluria, third edition, p. 208; Foss. 31, fig. 1.

From the? restored figure in Mem. Geol. Surv., vol. iii., fig. 1, of the under side, the upper surface being unknown; ib. p. 289. Professor Forbes remarks that the contour of this fossil starfish strikingly reminds us of that of the living *Uraster hispidus*, but the structure of its dermal covering was very different. Decade 1, description of pl. i., p. 3.

CARADOC OR BALA ROCKS.—First found in ashy slates at Drumcannon, Co. Waterford, in 1846; since, by the Geol. Surv., at Moel-y-Garnedd, near Bala, North Wales; Professsor Forbes, Mem. Geol. Surv., vol. ii., part ii., p. 463; and Decade 1, description of pl. i., p. 3, and later, according to Mr. Salter, in ash beds, west of Bala Lake, Mem., Geol. Surv., vol. iii., p. 289.

FIG. 9.—*a*, *b*. PROTASTER? SALTERI, *Forbes*, sp.

Ophiura, Journ. Geol. Soc., vol. i., 1845, p. 20, pl. ix., fig. 45; Annals and Mag. of Nat. Hist., second series, vol. xx.

Protaster, Siluria, third edition, p. 208.

Tæniaster, Mem. Geol. Surv., vol. iii., p. 289, pl. xxiii., fig. 3.

From the figures in Mem. Geol. Surv., vol. iii., pl. xxiii., figs. 3–3 *a*, internal impression. This minute Ophiuroid Starfish, scarcely more than three-quarters of an inch broad, "differs in its slender whip-like arms from all the other species of *Protaster* or *Tæniaster*."

It was long lost in the drawers of the late Professor Forbes; was recovered some years since, and is now in the Woodwardian Museum, Cambridge.

CARADOC SLATE.—Pen-y-gaer, Cerrig-y-Druidion, North Wales; Mem. Geol. Surv., vol. iii., p. 290.

Characteristic British Fossils. Plate II.

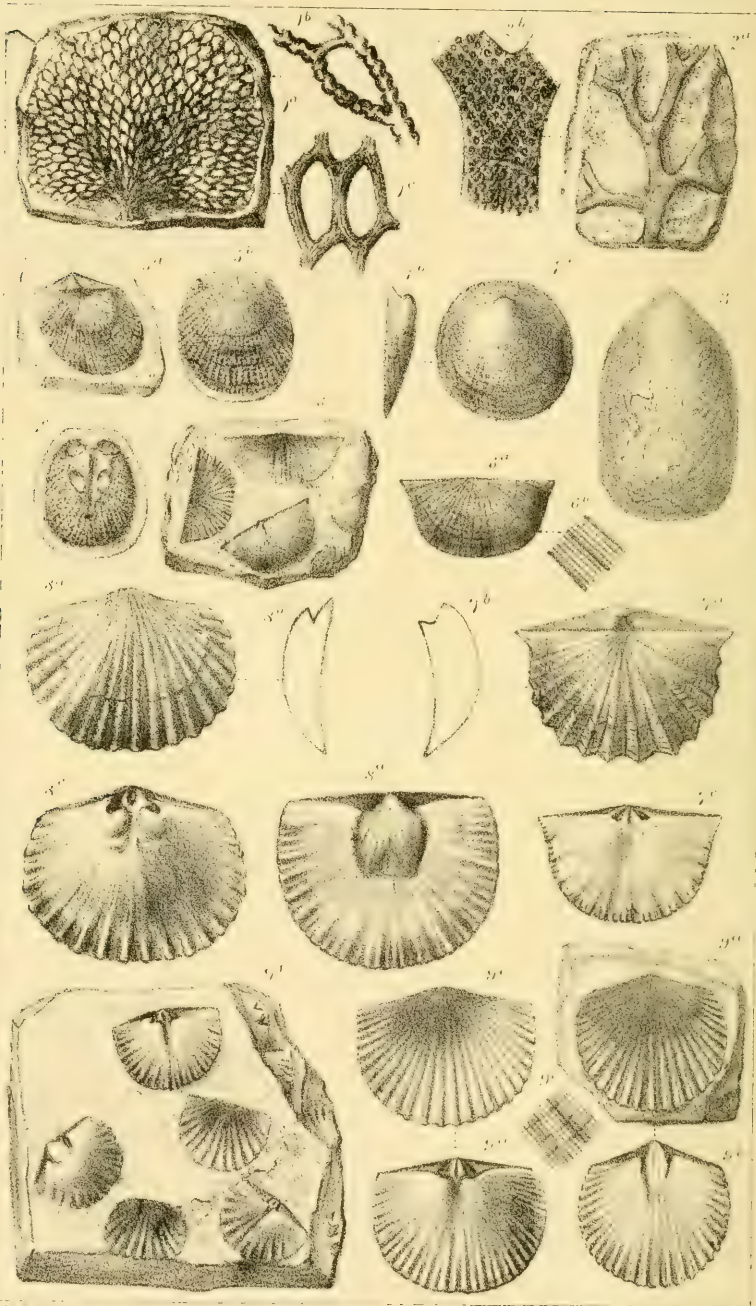

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PLATE XI.

FOSSILS OF THE CARADOC OR BALA ROCKS.

MOLLUSCA.—*POLYZOA.*

FIG. 1.—*a*, *b*, *c*. FENESTELLA ASSIMILIS, *Lonsdale*, sp.

Gorgonia, Sil. Syst., p. 680. *Fenestella*, Siluria, 4th ed., pl. xli., fig. 27.
a. *Original.* Showing fan-like form.
b. *Original.* Enlarged portion with cells.
c. *Original.* Enlarged portion of opposite surface, marked with irregular striations. All from grey limestone, Chair of Kildare, Co. Kildare. Mus. Geol. Surv. of Ireland.

CARADOC AND WENLOCK ROCKS.—Sil., fourth edition, p. 523. Frequent in the Caradoc-Bala limestone of the Chair of Kildare; it has also been collected by the Geological Survey from sandy shales of Caradoc age at Carriganeagh and Frankfort, Co. Wexford, and is not uncommon in grey slates of the same formation at Munmahoge, between Waterford and Tramore, as well as in rocks of similar character on shore at Tramore Bay and at Newtown Head, Waterford Harbour. Mus. G. S. I. In Siluria, fourth edition, p. 216, it is figured (Fossils 50) as "a common Wenlock species." It certainly is most characteristic of the Caradoc formation in Ireland.

NOTE.—In the Catalogue of British Fossils, by Professor Morris, second edition, p. 55, this species is said to occur in the county of Tyrone (I presume on the authority of Colonel Portlock); my examination of the specimens in the Portlock collection, Mus. Geol. Surv. of Ireland, leads me, however, to the belief, that he was mistaken in this supposed identification; and that the specimens alluded to are closely allied, if not identical, with *Callograptus elegans* or *Salteri* of the Quebec group, described by Professor Hall in Decade 2, pl. xix., of the Geological Survey of Canada.

FIG. 2.—*a*, *b*. PTILODICTYA ACUTA, *Hall*, sp.

Strictopora acuta, Palæontology of New York, vol. i., p. 74, pl. xxvi., fig. 3. *Ptilodictya*, Sil., fourth edition, pp. 188, 523.
a. *Original.* Showing the dichotomous character of the branches.
b. *Original.* Enlarged portion, showing alternating rows of cells, as in the recent *Eschara*, in grey limestone, Chair of Kildare. Mus. Geol. Surv. Ireland.

CARADOC.—Sil., fourth edition, p. 523. Localities in Denbighshire, at Glyn Ceirog, S. of Llangollen (M'Coy), in Montgomeryshire, at Llechweddwyd; and Llanfyllin. Mem. Geol. Surv., vol. iii., p. 266. Frequent in the grey limestone of the Chair of Kildare; it is also plentiful in dark grey limestone at Portraine, Co. Dublin.

BRACHIOPODA.

Fig. 3.—Lingula ovata, *M'Coy*.

Silurian Fossils of Ireland, p. 24, pl. iii., fig. 1.
From the figure in Brit. Sil. Brach. Pal. Soc., pl. ii., fig. 20.
Caradoc.—Sil., fourth edition, p. 525. *Localities*, Bala, N. Wales, Cat. Brit. Foss., p. 138. Slates of Penmorfa, M'Coy; not uncommon in the hard Caradoc grits of Grangegeeth, Co. Meath, Mus. G. S. I. Carrickanearla, Chair of Kildare, Mus. Sir R. Griffith; Caradoc beds, at Marshbrook, and Horderly, Salop; near Bala, and east of Bala Lake, Merionethshire; Llandwddyn and Meifod, Montgomeryshire; S. of Llangollen, Denbighshire; also in the *Lower Caradoc* or *Bala* shales of Westmoreland (Brit. Sil. Brach., p. 39). In the Mus. Geol. Surv., Irel. are specimens believed to be this species, in limestone, Chair of Kildare, and from Caradoc beds at Ballybro' and Carrickadaggan, Co. Wexford; Bellewstown, Co. Meath; and Desertcreat, Tyrone.

Fig. 4.—*a*, *b*. Discina oblongata, *Portlock*, sp.

Orbicula subrotunda, *lævigata*, and *elongata*, Geol. Rep. Londonderry, &c., p. 445, pl. xxxii., fig. 10–13. *Discina*, Brit. Sil. Brach., p. 66.
a, *b*. Front and side view of the upper or free valve. From Mr. Davidson's figures in Brit. Sil. Brach., pl. vii., fig. 1.
Caradoc.—Siluria, fourth edition, p. 524. *Caradoc schists*, Desertcreat, Co. Tyrone; Portlock collection, Mus. G. S. I. "Not uncommon in the sandy schists of Bardahessiagh, common in the slates of Tirnaskea, Pomeroy, Co. Tyrone." M'Coy, Sil. Foss. Irel., p. 24. It has also been collected from corresponding beds at Tramore, Co. Waterford, Mus. G. S. I. Mr. Davidson very properly considers D. *oblongata*, *lævigata*, and *subrotunda*, all from the same rock and locality, as "slight modifications of a single species." In England, on the authority of Mr. Salter, he states it to have been found in the *Upper Caradoc* beds of South Shropshire. In Mem. Geol. Surv., vol. iii., p. 266; the variety D. *subrotunda* is included in the list of *Caradoc* fossils from Llanfyllin, Montgomeryshire.

Fig. 5.—*a*, *b*. Crania divaricata, *M'Coy*, sp.

C. antiquissima (?) M'Coy (not of Eichwald), Sil. Foss. Irel., p. 25. *Pseudocrania divaricata*, M'Coy. Ann. Nat. Hist., second series, vol. viii., p. 388 (1851). *Crania catenulata*, M. S., name attached to specimens in Mus. G. S. I., Explanation to Map 119, p. 9, Geol. Surv. Irel.; Pal. notes by the author. *C. divaricata*, Sil., second edition, p. 212; and Brit. Sil. Brach., p. 78.
a. *Original.* From a slightly distorted specimen showing both valves, in dark grey slaty schist, Bala, Mus. G. S. I.
b. *Original.* Exterior, showing radiating striæ; from greenish grey slaty schist, Grange Hill, Kildare, Mus. G. S. I.
c. Cast of interior of dorsal valve, exhibiting the muscular impressions, described by Mr. Davidson in Brit. Sil. Brach.; explanation to pl. viii., fig. 11 and 11 *a*; taken from that figure and specimens in Mus. G. S. I.; from same locality as 5 *b*.

Caradoc.—"Common in the schists of the Caradoc or Bala limestone at several places near Bala, Merionethshire and Builth, Brecknockshire; also found in the shales of the Bala limestone, near Llanfyllin, Montgomeryshire; and south-east of Cerrig-y-Druidion, Denbighshire." Brit. Sil. Brach., p. 80; and Mem. Geol. Surv., vol. iii., p. 206. In Ireland it is frequent in slaty beds of Caradoc age, near Grange Hill, Kildare; occurring also in the hard calcareous beds of Grangegeeth, Co. Meath; and the Caradoc shales of Frankfort, Co. Wexford; and Newtown Head, Waterford. Mus. G. S. I.

Note.—In reference to Mr. Davidson's enumeration of the localities for this remarkable species, it may be desirable to observe that this fossil, and probably the specimens of *Lingula ovata*, noticed in his valuable monograph on British Silurian Brachiopoda, as having been collected at Carrickanearla, Chair of Kildare, is not from the very fossiliferous limestone (equivalent of Caradoc-Bala beds) known as that of the Chair of Kildare, which is situated on Grange Hill, about three miles north of the town of Kildare; but from a place near it, being found in distinct beds of a more shaly character (although believed to be of the same Caradoc age), a little east of the limestone knoll, known as the Chair, and at the base of the hill. From a third locality, about half a-mile north-east of the Chair, there are also shaly beds, but with a distinct set of Silurian fossils, considered to be the equivalents of Llandovery strata.

Fig. 6.—*a*, *b*, *c*. Leptæna sericea, *Sowerby*.

Silurian System, pl. xix., figs. 1, 2.

a. *Original.* Convex or ventral valve; in dark compact limestone, Lambay Island, Co. Dublin, Mus. G. S. I.

b. *Original.* Portion of surface of fig. *a*, enlarged, showing the widely distant and fine intermediate radiating striæ.

c. *Original.* A group of small examples of the flat dorsal, with interior and exterior ventral valves, on a slab of Caradoc sandstone, full of these fossils; from Cheney Longville, Shropshire. Mus. Geol. Surv. Irel.

Llandeilo to Llandovery and ? Wenlock, is the range of this species given in Siluria, fourth edition, p. 525. At p. 194 of the same work are the following remarks: "Of the two species of Leptæna, which are prevalent in the Lower Silurian Division, the most frequent is *L. sericea*, which, occurring in swarms among the slates of Snowdon, is also most abundant and characteristic in the Caradoc sandstone of Shropshire." In Ireland it is not uncommon in slaty Caradoc rocks, near Balbriggan; and in limestone at Portraine, and Lambay Island, Co. Dublin; as well as at several localities in rocks of the same age in Wicklow, Wexford, Waterford, and Tyrone.

Fig. 7.—*a*, *b*, *c*. Orthis Actoniæ, *Sowerby*.

Silurian System, p. 639, pl. xx., fig. 16; Brit. Sil. Brach., pl. xxxvi., figs. 5-17.

a. View of both valves. From Mem. Geol. Surv., vol. iii., pl. xxi., fig. 7.

b. Profile view; showing relative position of valves. *Ibid.*, fig. 8.

c. Interior of flat (dorsal) valve. *Ibid.*, fig. 6.

Llandeilo to Llandovery. Sil., fourth edition, p. 526. Abundant in the Llandeilo and Caradoc rocks of Shropshire, Wales, and Ireland. *Llandeilo Flags*, Garn, Arenigs; *Caradoc*, Bryn Bedwog, near Bala, &c. (Davidson).

Lower Llandovery rocks at Haverfordwest ; Mandinam, in Caermarthenshire ; Mathyrafal, in Montgomeryshire, &c. Mem. Geol. Surv., vol. iii., p. 339. Ireland ; in limestone of Caradoc-Bala age, Chair of Kildare.

FIG. 8.—*a–d.* ORTHIS FLABELLULUM, *Sowerby.*

Silurian System, p. 639, pl. xix., fig. 8, pl. xxi., fig. 8.

a. Original. Dorsal valve.

b. Profile view ; showing relative position of valves.

c. Original. Internal cast of dorsal valve.

d. Internal cast of ventral valve ; all from Boduan, Caernarvonshire ; in brown calcareous rock. Mus. G. S. I.

CARADOC.—Sil., fourth edition, p. 526. "Common in Caradoc sandstone." *Ibid.*, p. 193. "North Wales and Shropshire, everywhere in Caradoc rocks." M. G. S., vol. iii., p. 338. It occurs also abundantly in rocks of the same age in Ireland.

FIG. 9.—*a-f.* ORTHIS CALLIGRAMMA, *Dalman.*

O. virgata, Sil. Syst., p. 639. *O. calligramma*, Sil., fourth edition, pl. v., figs. 7, 8, 9.

a. Original. Impression of outer surface of ventral valve, from 9 *b.*

b. Original. Interior of ventral valve.

c. Original. Impression of exterior dorsal valve, from 9 *d.*

d. Original. Interior of dorsal valve.

e. Original. Enlarged portion of surface, showing proportion of "rib" to intermediate striæ, crossed by fine transverse lines ; all from Caradoc rocks, Grangegeeth, Co. Meath ; in hard dark green grit. Mus. Geol. Surv. Irel.

f. Original. Var. *virgata.* Internal casts and impressions of both valves, on a slab of coarse grey Caradoc grit, from Anglesea. Mus. G. S. I.

LLANDEILO TO WENLOCK is recorded in Sil., fourth edition, p. 526, as the geological range of this frequently recurring species ; it is stated to be one of the species of Orthis everywhere abundant in British Lower Silurian localities, as well as in North Wales and Ireland, occurring, though rarely, in the Wenlock limestone of Britain. *Ibid.*, p. 193. For special localities, *see* Memoirs Geol. Surv. and Brit. Sil. Brach., p. 245.

Characteristic British Fossils. Plate 12.

W. H. Baily del. et lith. Printed by Forster & Co. Dublin

PLATE XII.

FOSSILS OF THE CARADOC OR BALA ROCKS.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 1.—*a*, *b*. STROPHOMENA EXPANSA, *Sowerby*, sp.

Orthis expansa, Sil. Syst., p. 638, and *O. pecten*, *ibid.* (*Strophomena*, Cat. Brit. Foss., 1854, p. 137). Sil., fourth edition, pl. vi., fig. 4.

a. *Original.* Exterior of ventral valve, showing the strong radiating and intermediate fine striæ.

b. *Original.* Internal impression of fig. 1 *a*; both in fine-grained greenish sandstone, from Cheney-Longville, Shropshire. Mus. G. S. I.

CARADOC.—Sil., fourth edition, p. 528. Abundant in Shropshire and North Wales; also in Ireland at the following places in Caradoc rocks: Tramore Bay, Co. Waterford; Portraine, and Lambay Island, Co. Dublin; Grangegeeth, Co. Meath; and Desertcreat, Co. Tyrone. Mus. G. S. I.

CONCHIFERA.

FIG. 2.—MODIOLOPSIS EXPANSA, *Portlock*, sp.

Modiola, Geol. Rep. Londonderry, &c., p. 425. *Modiolopsis*, Sil., fourth edition, p. 530.

Original. In dark grey micaceous schist, Desertcreat, Tyrone (Portlock Collection). Mus. G. S. I.

CARADOC.—Co. Tyrone.

FIG. 3.—MODIOLOPSIS OBLIQUA, *Sowerby*, sp.

Avicula, Sil. Syst., p. 635. *Modiolopsis*, Sil., fourth edition, pl. vii., fig. 2. From Sil. Syst., pl. xx., fig. 4. Internal cast in Caradoc sandstone, Soudley.

CARADOC.—"This species occurs in clusters in the Caradoc sandstone, at Soudley, near Acton Scott; east flank of Caer Caradoc, Sil. Syst., p. 638. It is also included in the list of Caradoc fossils from North Wales, at Bettws-y-coed, Caernarvonshire, and east of Bala Lake, Merionethshire. M. G. S., vol. iii., p. 270.

FIG. 4.—*a*, *b*. CTENODONTA OBLIQUA, *Portlock*, sp.

Arca obliqua and *cylindrica*. Geol. Rep. Londonderry, pp. 428-9.

Ctenodonta obliqua, Sil., fourth edition, p. 529.

a. *Original.* In dark grey micaceous schist, Desertcreat, Tyrone. Mus. G. S. I.

b. Original. Enlarged outline, showing arrangement of hinge teeth.

CARADOC.—*Locality*, W. of Bala Lake, Merionethshire. M. G. S., vol. iii., p. 270, and County Tyrone.

GASTEROPODA.

FIG. 5.—HOLOPEA CONCINNA, *M'Coy*, sp.

? *Naticopsis*, Sil. Foss. Irel., p. 13. *Holopea*, Cat. Brit. Foss., 1854, p. 252.

Original. In grey and red Lower Silurian limestone; Chair of Kildare, Ireland. Mus. G. S. I.

CARADOC.—Very abundant in the limestone of the Chair of Kildare; it also occurs in dark grey limestone of corresponding age at Portraine, Co. Dublin; and at localities in Denbighshire and Merionethshire, N. Wales. M. G. S., vol. iii., p. 271.

FIG. 6.—*a*, *b*. MURCHISONIA TURRITA, *Portlock*, sp.

Pleurotomaria, Geol. Rep. Londonderry, &c., p. 413. *Murchisonia*, Sil., fourth edition, p. 532.

a, *b*. *Original.* Front and back view of the same shell. In dark grey slaty beds, Desertcreat, Tyrone. Portlock Collection, Mus. G. S. I.

CARADOC.—County Tyrone, N. of Ireland. It is also included in the list of Caradoc fossils (on the authority of Professor M'Coy), as occurring at Bala, Merionethshire. M. G. S., vol. iii., p. 271.

HETEROPODA.

FIG. 7.—*a*, *b*. BELLEROPHON BILOBATUS, *Sowerby*.

Sil. Syst., p. 643. *B. bilobatus*, *elongatus*, and *gibbus*, Geol. Rep. Londonderry, pp. 397-8. Cat. Brit. Foss., p. 287.

a, *b*. Front and side view. From Sil. Syst. pl. xix., fig. 13.

LLANDEILO TO LLANDOVERY.—Sil., fourth edition, p. 533. "One of the common fossils of the lower part of the Caradoc sandstone, and equally characteristic of the same deposits in North America, Spain, and Bohemia." *Ibid.*, p. 198. *Localities*, Horderly in Caradoc sandstone, also Llandeilo flags, N. Wales. *Ibid.* explanation to pl. vii., fig. 9. N. and S. Wales in Upper Llandeilo Rocks, M. G. S., vol. iii., p. 259; and in Caradoc rocks at several localities in N. Wales, *ibid.* p. 271. In Ireland it is abundant in rocks of the same age at Desertcreat, Tyrone, and in the counties of Wexford and Waterford.

PTEROPODA.

FIG. 8.—? THECA TRIANGULARIS, *Portlock*, sp.

? *Orthoceras*, Geol. Rep. Londonderry, p. 375. *Theca*, Cat. Brit. Foss. p. 232.

Original. In dark grey slaty beds, Desertcreat, Tyrone. Portlock Collection, Mus. G. S. I.

CARADOC.—*Localities*—S. of Cerrig-y-Druidion, Denbighshire. M. G. S., vol. iii., p. 271.

NOTE.—I have figured this fossil as a Theca on the authorities above-mentioned, although I am inclined to think, on further examination of the

original specimens, it is nothing more than the terminal end of an Orthoceras, such as those figured by General Portlock from the same place, as elongato-cinctum or subundulatum.

FIG. 9.—THECA REVERSA, *Salter*.

Siluria, second edition, p. 550. Mem. Geol. Surv. vol. iii., p. 353.
From woodcut 14, fig. 6, p. 347. M. G. S., vol. iii.
CARADOC.—*Localities*—S. of Cerrig-y-Druidion, North Wales; Bird's Hill, Llandeilo, South Wales; Horderly, Shropshire; S. Scotland, M. G. S., vol. iii., pp. 271, 353.
NOTE.—In the List of Fossils, Appendix to Siluria, third and fourth editions, it is catalogued as from Llandeilo rocks only.

CEPHALOPODA.

FIG. 10.—ORTHOCERAS ELONGATO CINCTUM, *Portlock*.

Geol. Rep. Londonderry, p. 372.
Original. In dark grey slaty beds, Desertcreat, Tyrone, Portlock Collection. G. S. I.
CARADOC.—Sil., fourth edition, p. 535. N. of Ireland.

FIG. 11.—*a*, *b*. ORTHOCERAS VAGANS, *Salter*.

Journ. Geol. Soc., vol. v., pl. vi., fig. 6. M. G. S., vol. iii., p. 356.
a, *b*. *Original*. A small example, showing septæ and siphuncle (*b*) in limestone, from Rhiwlas, Bala. Mus. G. S. I.
CARADOC and LLANDOVERY.—Sil., fourth edition, p. 536. "One of the very few Lower Silurian fossils common to the British and central European areas." *Localities*—Rhiwlas and other localities near Bala; Coniston limestone of Westmoreland. M. G., vol. iii., p. 357.

PLATE XIII.

FOSSILS OF THE CARADOC OR BALA ROCKS.

CRUSTACEA.—*OSTRACODA.*

FIG. 1.—*a*, *b*. CYTHERE ? UMBONATA, *Salter*.

Brit. Pal. Foss., Appendix A, p. ii. *Ceratiocaris*, M'Coy, p. 138, pl. 1 E, Fig. 6.

a. *Original.* Natural size; from a specimen from Bala, North Wales, in the Mus. Geol. Surv. Irel.

b. *Original.* Enlarged from 1 *a*.

CARADOC.—Siluria, fourth edition, p. 517. *Localities*—Bala; Corwen; Conway Falls; Llanfwrog, near Ruthin. Cat. Brit. Foss., p. 105. Various other localities in North Wales are enumerated in the list of Caradoc fossils in Mem. Geol. Surv., vol. iii., p. 265.

FIG. 2.—*a*, *b*, *c*. PRIMITIA MACCOYII, *Salter*, sp.

Cythere phaseolus, M'Coy (not of Hisinger); Sil. Foss. of Irel., p. 58. *Cythere Maccoyii*; Cat. Brit. Foss., second edition, p. 105. *Primitia;* Ann. and Mag. Nat. Hist., July, 1868; S. 4, vol. ii., pl. vii., figs. 1, 2, 3.

a. *Original.* Natural size. Fragment of grey limestone, showing the abundance of this minute bivalved Entomostracan; from the Chair of Kildare. Mus. G. S. I.

b. *Original.* Enlarged, right valve from a specimen on fig. 1 *a*.

c. *Original.* Enlarged, dorsal view of both valves.

CARADOC.—Very abundant at the Chair of Kildare, Co. Kildare, Ireland. Professor T. R. Jones, and Dr. H. B. Holl, also records its occurrence in rocks of similar age at Aldcans, Ayrshire; and at Keisley, in Westmoreland, where it was discovered by Professor Harkness.

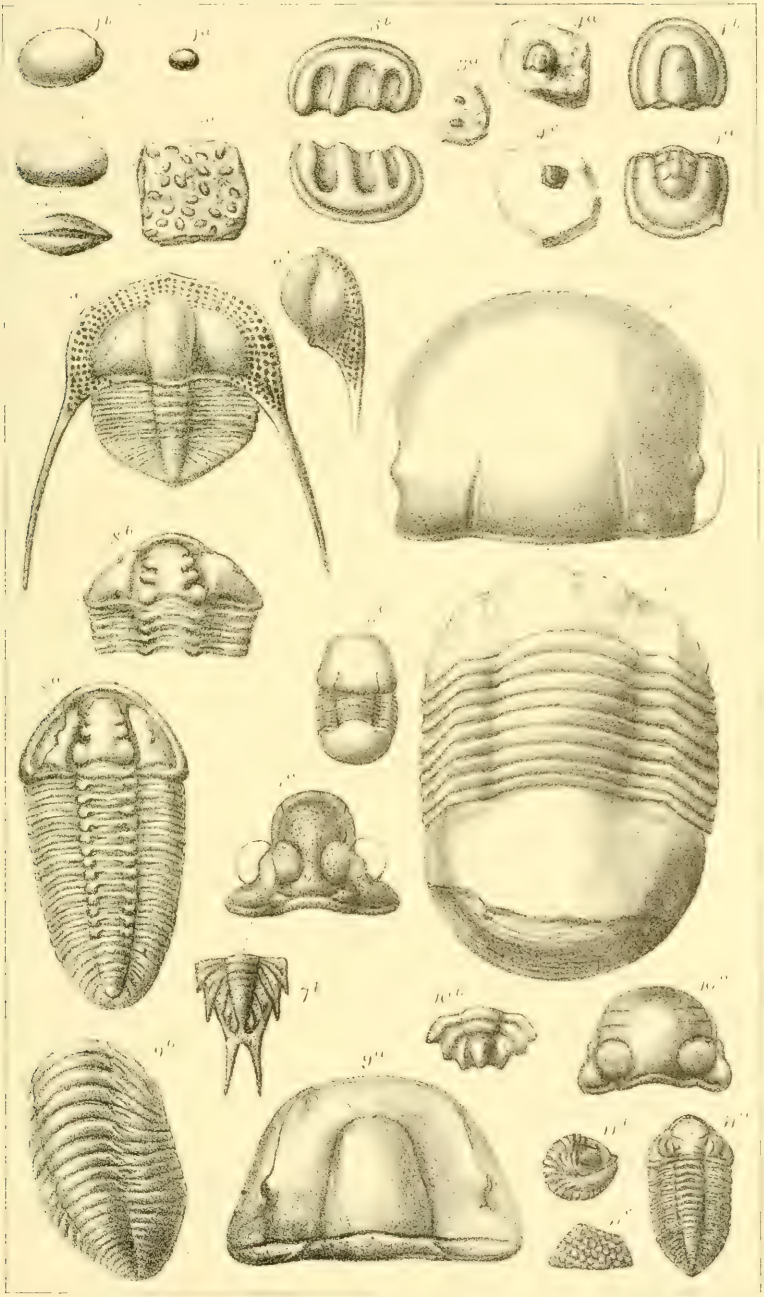
FIG. 3.—*a*, *b*, *c*. BEYRICHIA COMPLICATA, *Salter*.

Mem. Geol. Surv., vol. ii., pt. i., p. 352.

a. *Original.* Natural size; view of both valves. From Bala, in Mus. Geol. Surv., Irel.

b, *c*. *Original.* Enlarged figures of both valves from 3 *a*, and a wax impression taken from a specimen in Lower Caradoc sandstone, from Hopesay, Shropshire.

LLANDEILO and CARADOC.—Sil., fourth edition, p. 516. *Localities*—Llan Mill, Narbeth, Mus. Geol. Surv., Irel. Point-y-Meibion, M'Coy. For other localities in North and South Wales, *see* Cat. Brit. Foss., p. 101,



and Mem. Geol. Surv., vol. iii., p. 265. It has also been collected at Slieveroe, near Rathdrum, Co. Wicklow, by the Geol. Survey of Ireland.

TRILOBITA.

Fig. 4.—*a-d.* Agnostus trinodus, *Salter.*

Memoirs Geological Survey, vol. ii., part i., p. 351. B. *convexus*, pl. viii., figs. 12, 13, vol. iii., pl. xix., fig. 8. *Trinodus agnostiformis*, M'Coy, Sil. Foss., Irel., pl. iv., fig. 3.

a. Original. Natural size. Head; in light grey limestone, Chair of Kildare. Mus. Geol. Surv. Irel.

b. Original. Enlarged from 4 *a*.

c. Original. Natural size. Tail; in dark grey limestone, Portraine, Co. Dublin. Mus. Geol. Surv. Irel.

d. Original. Enlarged from 4 *c*.

Caradoc.—Sil., fourth edition, p. 515. *Localities*—Shineton, near Cressage, Shropshire; Haverfordwest, S. Wales; near Bala and Cerrig-y-Druidion, N. Wales; near Girvan, Ayrshire. Mem. Geol. Surv., vol. iii., pp. 263 and 298. Portraine, Co. Dublin; Annestown, near Waterford; and Chair of Kildare, Co. Kildare. Mus. G. S. I.

Fig. 5.—*a*, *b*, *c*. Illænus bowmanni, *Salter.*

Memoirs Geological Survey, vol. ii., part i., pl. viii., figs. 1-3.

Illænus centrotus, Portl. Geol. Rep., pl. x., figs. 3-6.

a. Original. Head; in light grey limestone, Chair of Kildare. Mus. Geol. Surv., Irel.

b. From Mem. Geol. Surv., vol. ii., part i., pl. viii., fig. 2; Tyrone; from a specimen in the Portlock collection. Geol. Surv.

c. From same plate, fig. 3, a small perfect specimen, and from the same collection.

Caradoc and Llandovery.—Sil., fourth edition, p. 518. *Localities*, near Haverfordwest and Llandeilo, M. G. S., vol. ii., part i., p. 339. "Everywhere in Britain." M. G. S., vol. iii., p. 317. Portraine and Lambay, Co. Dublin; Chair of Kildare; Carrickadaggan, near New Ross, Wexford; Newtown Head and Tramore Bay, Waterford; Desertcreat, Tyrone. Mus. G. S. I.

Fig. 6.—*a*, *b*. Trinucleus concentricus, *Eaton*, sp.

T. ornatus, Mem. Geol. Surv., vol. ii., part i., p. 349, pl. ix., figs. 1, 2. *T. Caractaci*, Sil. Syst., pl. xxiii., fig. 1.

a. From M. G. S., vol. ii., part i., pl. ix., fig. 1. Entire animal; locality not mentioned.

b. Original. Side view of the head; showing fringe, cheek spine, and prominent glabella, in dark grey micaceous schist, Desertcreat, Tyrone. From Portlock collection. Mus. G. S. I.

Llandeilo and Caradoc, Sil., fourth edition, p. 521. *Localities—Llandeilo Flags*, Dynevor Park, Llandeilo, Mus. G. S. I. *Upper Llandeilo*, Craig-y-glyn, S. Wales. M. G. S., vol. iii., p. 258. *Caradoc.* Several localities in N. Wales; *ibid.*, p. 265. "Caradoc rocks of Britain every-

where." *Upper Llandovery*, Shropshire; very rare, but certainly present; *ibid.*, p. 320. *Lower Llandovery*, Corston Farm, Hopesay, Mus. G. S. I. In Ireland it abounds in Caradoc rocks at several places in the counties of Wicklow, Wexford, and Waterford; also at Desertcreat, Tyrone.

FIG. 7.—*a*, *b*. LICHAS LAXATUS, *M'Coy*.

Silurian Fossils, Ireland, pl. iv., fig. 9; also *L. pumila*, ibid., fig. 8, and *Calymene? forcipata*, ibid., fig. 14. Mem. Geol. Surv., vol. ii., part i., p. 340, pl. viii., figs. 4, 5, 6.

a. Head; from M. G. S., vol. ii., part i., pl. viii., fig. 4. Sholes Hook, Haverfordwest.

b. *Original.* Tail; in limestone, Chair of Kildare. Mus. G. S. I.

CARADOC and LLANDOVERY.—Sil., fourth edition, p. 519. "Very common in N. and S. Wales, M. G. S., vol. iii., p. 324. *Localities*—in Ireland, near Duleek, and Grangegeeth, near Navan, Co. Meath; Portraine, Co. Dublin; Kildare; Rathdrum, Wicklow; Carrickadaggan, Frankfort, and Moyne, Wexford; Newtown Head, Pickardstown, and Tramore Bay, Waterford. Mus. G. S. I.

FIG. 8.—*a*, *b*. CALYMENE BREVICAPITATA, *Portlock*.

Geological Report, p. 286. Mem. Geol. Surv., vol. ii., part i., p. 341; vol. iii., p. 326.

a. From Brit. Trilob. Pal. Soc., pl. ix., fig. 3. (C. *Blumenbachii* var. *Caractaci*.) Entire animal; Acton Scott, Shropshire.

b. *Original.* From Desertcreat, Tyrone; Portlock collection. Mus. G. S. I.

CARADOC and LLANDOVERY.—Sil., fourth edition, p. 516. Caradoc rocks of Shropshire, of Bala, and North Wales. M. G. S., vol. iii., p. 326. Rathdrum, Wicklow; Carrickadaggan, Wexford; Newtown Head and Tramore Bay, Waterford; Desertcreat, Tyrone. Mus. G. S. I.

FIG. 9.—*a*, *b*. HOMALONOTUS BISULCATUS, *Salter*.

British Palæontological Fossils, Appendix, pl. 1 G, figs. 24-31.

a. Head; from Brit. Trilob., pl. x., fig. 9. Onny River, Shropshire.

b. Body and tail of young specimen; *ibid.*, fig. 5. Acton Scott.

CARADOC and LLANDOVERY. — Shropshire and Wales. "Everywhere in Caradoc rocks, but found rarely in Llandeilo, and even in Lower Llandovery beds." Mem. Geol. Surv., vol. iii., p. 327. Various localities in N. Wales, p. 264. Shropshire and Westmoreland Cat. Brit. Foss., second edition, p. 109. Near Rathdrum, Wicklow; Mus. G. S. I.

FIG. 10.—*a*, *b*. SPHÆREXOCHUS MIRUS, *Beyrich*.

Geological Survey, Decade 7, pl. iii. *S. calvus*, M'Coy, Sil. Foss., Irel., p. 44, pl. iv., fig. 10.

a. *Original.* Head; in limestone, Chair of Kildare. Mus. G. S. I.

b. *Original.* Tail; in limestone, Chair of Kildare. Mus. G. S. I.

CARADOC? LLANDOVERY, WENLOCK. Sil., fourth edition, p. 521. *Caradoc*, Chair of Kildare abundant; Mus. G. S. I. Carrickadaggan, Wexford,

Dec. 7, p. 4. *Wenlock* strata, Dudley Castle Hill; (entire)—Trindle, near Dudley; Walsall, Dec. 7, p. 4, and *Wenlock shale* (entire). Malvern, pres. by S. Allport, Esq. Mus. G. S. I.

FIG. 11.—*a*, *b*, *c*. PHACOPS BRONGNIARTII, *Portlock*.

Geological Report, p. 282, pl. ii., figs. 8, 9, 10. G. S., Dec. 7, p. 10.

a. *Original*. Entire animal; from Desertcreat, Tyrone. Portlock collection, Mus. G. S. I.

b. *Original*. Coiled specimen; from Tramore Bay. Mus. G. S. I.

c. *Original*. Eye enlarged, showing lenses; from 11 *a*.

Caradoc. Sil., fourth edition, p. 519. *Localities*—near Bala; Llanwddyn; Llanfyllin, Montgomeryshire. M. G. S., vol. iii., p. 264. Grangegeeth, Co. Meath; Rathdrum, Wicklow; Carrickadaggan, Wexford. Abundant at Quillia and Pickardstown, Co. Waterford; as well as at localities in Tramore Bay. Mus. G. S. I.

PLATE XIV.

FOSSILS OF THE LLANDOVERY ROCKS.

ZOOPHYTA—*ANTHOZOA.*

FIG. 1.—*a*, *b*, *c*. CYATHOPHYLLUM ELONGATUM, *Phillips*, sp.

Turbinolopsis. Pal. Foss., p. 6. *Petraia*, Sil., fourth edition, pl. xxxviii. fig. 6. *Cyathophyllum*. Brit. Foss. Corals, pp. 227 and 286.

a. *Original*. Casts of this simple turbinated coral of different ages; in Upper Caradoc sandstone; from the Malverns, Mus. G. S. I.

b. *Original*. Casts of a larger specimen in brown micaceous sandstone; from Mulloch Hill, Ayrshire. Mus. G. S. I.

c. *Original*. One of these corals in a more perfect state, showing the external surface (*epitheca*), as in Cyathophyllum; accompanied in the same block of greenish grit by other examples which, from partial weathering of the stone, exhibit casts of the interior only as in figs. 1 *a* and *b*.

LLANDOVERY.—This species is also included in the fossils of the Caradoc formation with a query; Sil., fourth edition, p. 511. It is said to be more frequent in the Upper than the Lower Llandovery. *Ibid.*, p. 208. *Localities*—Lickey Hill; Sil. Syst., p. 693; Horderly, May Hill, &c. Pal. Foss., p. 6; and Cat. Brit. Foss., p. 62. Presteign, Tortworth, Norbury, &c.; Haverfordwest and other localities in S. Wales; M. G. S., vol. iii., p. 359. Mulloch Hill, Ayrshire; Bardahassa, Pomeroy; and Desertcreat, Tyrone. Portl. Geol. Rep., p. 329; and Mus. G. S. I.

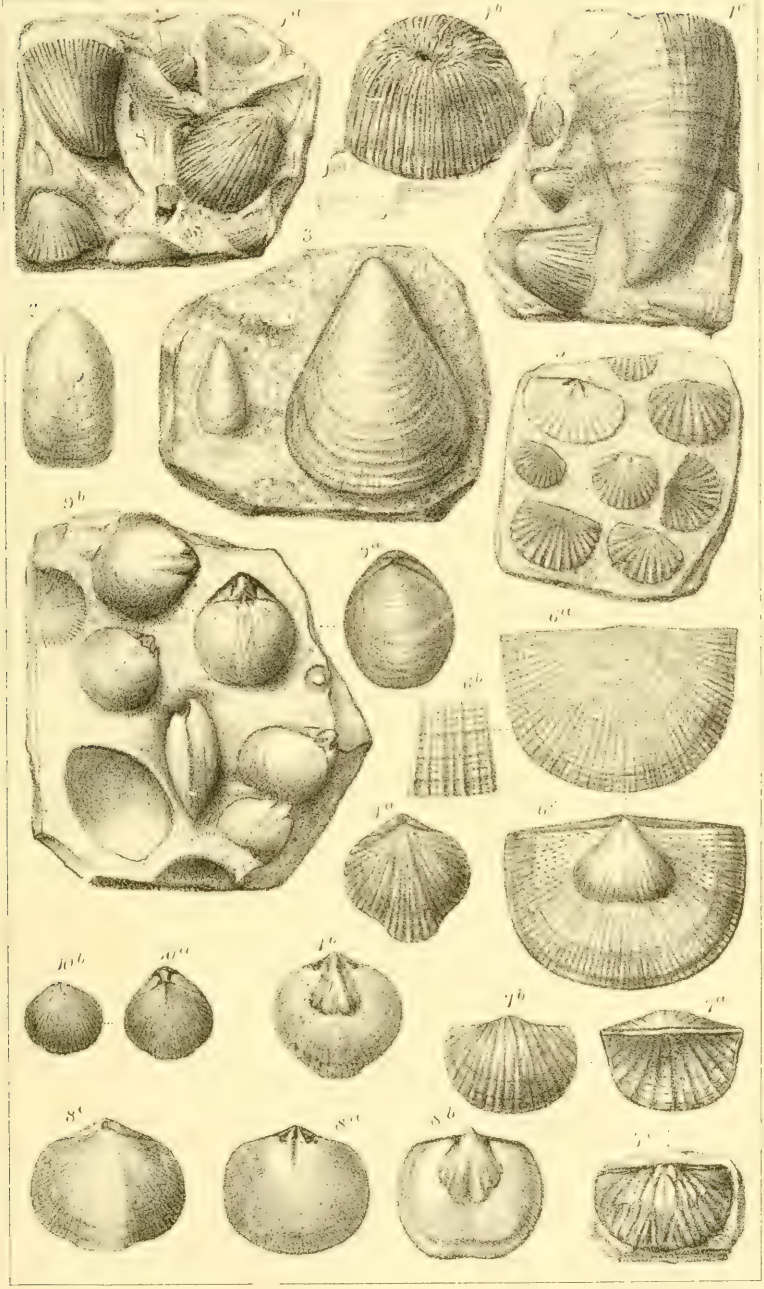
NOTE.—I have followed the authors of British Fossil Corals by including this coral in the genus Cyathophyllum to which it evidently belongs. The specimen from which fig. 1 *c* is taken shows both external and internal form; confirming the opinion of the authors of that work as to the fossils Turbinolopsis or Petraia, being merely casts of corals belonging to this genus. Brit. Foss. Corals, Silurian Formation, Palæontographical Society, pp. 226–7, and 286; see also note to p. 28.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 2.—LINGULA PARALLELA, *Phillips.*

Memoirs Geological Survey, vol. ii., part i., p. 370, pl. xxvi., fig. 1.
From Brit. Sil. Brach. Pal. Society, pl. ii., fig. 24. Upper Llandovery, Gunwick Mill, Malvern.

Characteristic British Fossils. Plate II



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LLANDOVERY.—Sil., fourth edition, p. 525. Mr. Davidson remarks on this species that it occurs in Upper Llandovery or May Hill sandstone only, and that it does not appear to be rare, being found, in addition to the above locality, at the Obelisk, Eastnor Park; as well as at the Wych; all three sections being in the Malvern district. Brit. Sil. Brach., p. 39.

FIG. 3.—LINGULA CRUMENA, *Phillips*.

Memoirs Geological Survey, vol. ii., part i., p. 369, pl. xxiv.

Original. Young and full-grown examples of this variable shell; in coarse, gritty, reddish sandstone; from Howler's Heath, Malvern district. Mus. G. S. I.

LLANDOVERY.—Sil., fourth edition, p. 525. Upper Llandovery, Howler's Heath; also Pentamerus-conglomerate, Kinley, Shropshire. Brit. Sil. Brach., p. 41.

FIG. 4.—*a*, *b*. ATRYPA MARGINALIS, *Dalman*.

Terebratula imbricata. Sil. Syst., p. 624. *Atrypa marginalis*, Sil., fourth edition, pl. ix., fig. 2.

a. Original. From impression of external shell.

b. Original. Internal cast of upper or ventral valve; both specimens from Lower Llandovery beds, Llandovery. Mus. G. S. I.

CARADOC to WENLOCK.—Sil., fourth edition, p. 524. "*Caradoc*, in North and South Wales; M. G. S., vol. iii., p. 266; and in Ireland in *Bala* shales and limestone. *Lower* and *Upper Llandovery* of many localities, especially in the Lower at Rhyader, Llandovery, Mandinam, &c. Upper Llandovery at Chirbury, and Llandovery. It is also found plentifully in *Wenlock limestone* at Dudley, Walsall, Wenlock, &c.; and in the *Woolhope limestones* of Malvern, Presteign, and east of Walsall." Brit. Sil. Brach., p. 135.

FIG. 5.—ATRYPA ? HEMISPHÆRICA, *Sowerby*.

Silurian System, p. 637, pl. xx., fig. 7.

Original. From a slab of sandstone containing impressions of both valves; external and internal. ? Upper Llandovery, Maume, Co. Galway. Mus. G. S. I.

LLANDOVERY.—Sil., fourth edition, p. 524. "This shell appears to be characteristic of the Upper and to be more rarely found in the Lower Llandovery beds; it is exceedingly abundant in certain localities." Brit. Sil. Brach., p. 139. It occurs in the Abberley and Malvern districts at several places, as well as in Gloucestershire and Shropshire; also at Wooltack Bay in the Marloes district; Brit. Sil. Brach., p. 139. Additional localities for this species in North Wales, &c., are given by Mr. Etheridge in the list of Upper Llandovery fossils; Mem. Geol. Surv., vol. iii., p. 361. Mr. Davidson also remarks that it is exceedingly plentiful in rocks of the Llandovery age, in the Girvan district of Ayrshire. Brit. Sil. Brach., p. 139. In Ireland, Professor M'Coy mentions several localities for this species in the county of Galway, at most of which it is very abundant. Sil. Foss., Ireland, pp. 39 and 40.

FIG. 6.—*a*, *b*, *c*. STROPHOMENA COMPRESSA, *Sowerby*, sp.

Orthis, Sil. Syst., p. 638. *Strophomena*, Sil., fourth edition, pl. ix., fig. 16.
a. *Original.* In yellow sandstone, from Harnage, S. E. of Shrewsbury. Mus. G. S. I.
b. *Original.* Portion of surface of 6 *a* enlarged.
c. Internal cast. From Sil., fourth edition, Fossils, 15, p. 90.
LLANDOVERY and WENLOCK.—Sil., fourth edition, p. 528. *Upper Llandovery*, Presteign; Marloes Bay; Norbury; Chirbury; Malverns; also Bogmine, near Shelve, Shropshire. M. G. S., vol. iii., pp. 361-2.

FIG. 7.—*a*, *b*, *c*. LEPTÆNA TRANSVERSALIS, *Dalman*.

Silurian System, p. 629, pl. xiii., fig. 2. *L. duplicata*, *ibid.*, p. 636, pl. xxii., fig. 2. *L. transversalis*, Sil., fourth edition, pl. ix., fig. 17; and pl. xx., fig. 17.
a. Upper or dorsal view; from Sil. Syst., pl. xiii., fig. 2.
b. Lower or ventral valve; from Sil. Syst., pl. xiii., fig. 2.
c. Internal cast; from Sil. Syst., pl. xxii., fig. 2.
CARADOC to WENLOCK.—Sil., fourth edition, p. 525. *Caradoc*. Glyn-ceiriog, Denbighshire; Bala, &c. M. G. S., vol. iii., p. 267. *Upper Llandovery*, Builth; N. of Llandovery; Pen-y-lan; Malverns; Longmynd; Norbury; Chirbury. M. G. S., vol. iii., p. 361. *Wenlock*, Walsall, Woolhope, Ledbury, &c. Sil. Syst., p. 629.

FIG. 8.—*a*, *b*, *c*. ORTHIS REVERSA, *Salter*.

Silurian Fossils, Ireland, *Addenda*, p. 72, pl. v., fig. 2.
a. *Original.* Internal cast of dorsal valve; Maume, Co. Galway. Mus. G. S. I.
b. *Original.* Internal cast of ventral valve; Maume, Co. Galway. Mus. G. S. I.
c. External surface of shell; var. *Girvanensis*, *Davidson*. From Brit. Sil. Brach., pl. xxix., fig. 18.
Llandovery. Sil., fourth edition, p. 527. *Lower Llandovery*, Mandinam, Caermarthenshire; Mus. G. S. I. ? *Upper Llandovery*, Girvan Water, Ayrshire; Mus. G. S. I. *Upper Llandovery*, Llandovery; Malverns; Tortworth; Chirbury; Norbury; Bogmine. M. G. S., vol. iii., p. 361. In Ireland it is not uncommon in (?) Upper Llandovery beds near Cong, Co. Galway.

FIG. 9.—*a*, *b*. MERISTELLA ANGUSTIFRONS, *M'Coy*, sp.

Hemithyris, Brit. Pal. Foss., p. 199, pl. 1 H., figs. 6-8.
a. External surface of shell; from Brit. Sil. Brach., pl. x., fig. 22.
b. *Original.* Impressions of the interior, showing various positions; in greenish and ferruginous sandstone, Mulloch Hill, Ayrshire. Mus. G. S. I.
Llandovery, Sil., fourth edition, p. 525. "This characteristic species of the Lower Llandovery rocks, first described from the sandstones of Mullock, Ayrshire, has also been detected near Builth and in the lower beds at Llandovery. Sil., fourth edition, p. 209. In Scotland it occurs by millions in a greenish and rusty-coloured sandstone at Mullock Hill,

Dalquharran, Craighead; as well as in other localities of the Girvan Valley, Ayrshire." Brit. Sil. Brach., p. 112.

FIG. 10.—*a*, *b*. RHYNCHONELLA LLANDOVERIANA, *Davidson*, sp.

Atrypa serrata, Sil. Foss., Irel., p. 41. *Rhynchonella*, Cat. Brit. Foss. (1854), p. 147. *R. Llandoveriana* (Dav.), Sil., 3rd ed., p. 527.

a. *b*. *Original*. Internal casts in greenish sandstone, weathering to a rusty brown; from Maume, Co. Galway. Mus. G. S. I.

LLANDOVERY.—Sil., 4th ed., p. 527. *Upper Llandovery*, Damory Bridge, Tortworth; Mus. G. S. I. In Scotland, it occurs at Saugh Hill, near Girvan, Ayrshire. In Ireland, it is abundant at several localities in the sandstones near Cong and other places in the county of Galway. Sil. Foss., Irel., p. 41. Brit. Sil. Brach., p. 184; and Mus. G. S. I.

PLATE XV.

FOSSILS OF THE LLANDOVERY ROCKS.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 1.—*a–d.* PENTAMERUS OBLONGUS, *Sowerby.*

Silurian System, p. 641, pl. xix., fig. 10 (not fig. 12). P. *lævis*, ibid., pl. xix., fig. 9.

P. *oblongus*, Brit. Sil. Brach., p. 151.

a. Showing both valves. From Sil. Syst., pl. xix., fig. 10.

b. Side view from the same figure.

c. Original. Internal cast of ventral valve; showing the "vertical median septum." In dark grey sandstone; from Tre Coed, Builth. Mus. G. S. I.

d. Original. Internal cast of dorsal valve; showing two similar long vertical septa; in *Upper Llandovery* sandstone, accompanied by *Atrypa hemisphærica* and *Petraia elongata;* from Nash Scar, Presteign. Mus. G. S. I.

LLANDOVERY.—Sil., 4th ed., p. 527. "This species would appear to be restricted to the *Lower* and *Upper Llandovery rocks*, and to be very much more abundant in the last-named formation." Brit. Sil. Brach., p. 154. Amongst the *Lower Llandovery* localities may be mentioned Wrexham, Denbighshire; Cefn, near Welshpool; also near Builth and Llandovery; and in *Upper Llandovery*, at Nash Scar, Presteign; Norbury, &c., in Shropshire, and Malvern; Pen-Cerrig, Builth; Llangadoc; and near Haverfordwest. In Scotland it abounds in the yellow (*Upper Llandovery*) sandstone of Saugh Hill, and Penwhapple Glen; and other places near Girvan, Ayrshire. In Ireland, Professor M'Coy mentions its occurrence in the (Llandovery) sandstone of Boocaun and Cappacorgue (where it is very abundant), Cong, Co. Galway; *ibid.*, p. 154.

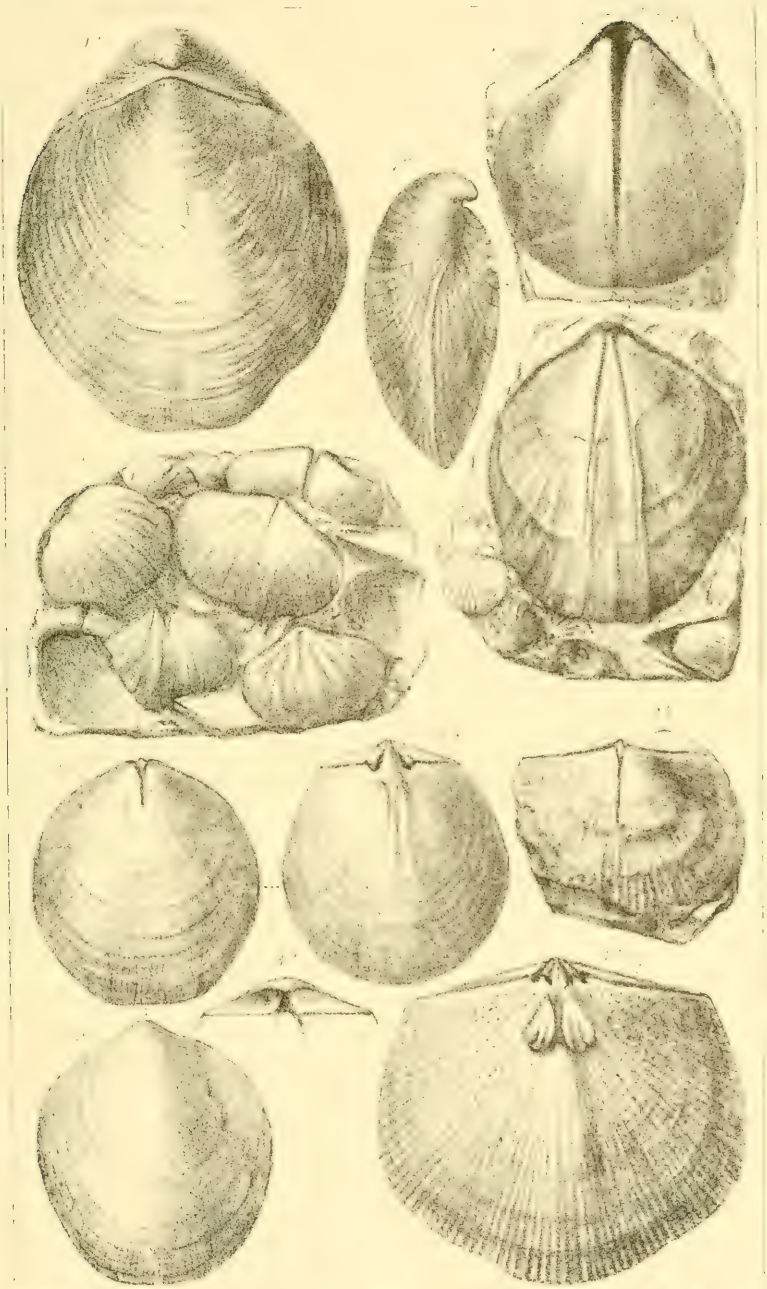
FIG. 2.—PENTAMERUS UNDATUS, *Sowerby*, sp.

Atrypa, Sil. Syst., p. 637. *Pentamerus*, Sil., 4th ed., pp. 90, 527, pl. viii., figs. 5, 6, 7; Brit. Sil. Brach., p. 155, pl. xix., figs. 4–9.

Original. Internal casts. In *Upper Llandovery* sandstone, Penlan, Llandovery. Mus. G. S. I.

LLANDOVERY.—Sil., 4th ed., p. 527. "Casts of this species occur abundantly in the Lower and Upper Llandovery, but especially in the former. Amongst the *Lower Llandovery* localities, it occurs near Welshpool, Llandovery, Builth, Haverfordwest, &c. In *Upper Llandovery*, at Mandinam, and Penlan, Llandovery; Builth, Llangadoc; Malverns; and Church Stretton. In *Woolhope beds*, at Buildwas." Brit. Sil. Brach., p. 156. In Ireland it has been collected by Mr. C. Galvan from *Upper Llandovery* sandstone, at Ballycar, Co. Clare, and near Cloonbur, Cong. Mus. G. S. I.

Characteristic British Fossils. Plate 15.



W.H.Bath, del. et lith.

FIG. 3.—*a–d.* STRICKLANDINIA LENS, *Sowerby*, sp.

Atrypa, Silurian System, p. 637. *Stricklandinia*, Siluria, 4th ed., pp. 90, 528; pl. viii., figs. 9–11. Brit. Sil. Brach., p. 161, pl. xix., figs. 13–23.

a. Internal cast of dorsal valve. From Brit. Sil. Brach., pl. xix., fig. 19.

b. Internal cast of ventral valve; from Brit. Sil. Brach., pl. xix., fig. 20. Both from Upper Llandovery, Avening Green, near Tortworth.

c. Ventral valve. From Brit. Sil. Brach., pl. xix., fig. 18. Upper Llandovery, Norbury, Bishops' Castle.

d. Hinge area. From Brit. Sil. Brach., pl. xix., upper part of fig. 15.

LLANDOVERY.—Siluria, 4th ed., p. 528. "This species occurs in the *Lower* and *Upper Llandovery rocks*, and is equally abundant in both. Amongst *Lower Llandovery* localities it has been identified from Mandinam and other places in the Llandovery district; Priory Mill, Haverfordwest; and other places in Caermarthenshire. In the *Upper Llandovery*, it occurs at Norbury, and other localities in the Malvern district; and near Tortworth; also at Mandinam, &c., Llandovery; Tre-Coed, Builth," &c. Brit. Sil. Brach., pp. 162, 3.

FIG. 4.—*a*, *b*. STRICKLANDINIA LIRATA, *Sowerby*, sp.

Spirifer, Silurian System, p. 638. *Stricklandinia*, Siluria, 4th ed., pp. 90, 528; Foss. 15, fig. 3. Brit. Sil. Brach., p. 159, pl. xx., fig. 1.

a. Original. Internal cast of dorsal valve. In sandstone, *Upper Llandovery*, Howler's Heath, Malverns.

b. Original. Internal cast of ventral valve from same locality and formation; both in Mus. G. S. I.

LLANDOVERY and WENLOCK.—Siluria, 4th ed., p. 528. *Upper Llandovery* or "May Hill sandstone," Howlers' Heath, south end of the Malverns; N. E. of Chirbury, Nash Scar, Presteign; Llangadoc, S. Wales, &c. *Woolhope beds*, Woolhope; *Wenlock shale*, Marloes Bay. Brit. Sil. Brach., p. 161. In Ireland it has been obtained from rocks of Llandovery age at Carrowkeel, Cong, Co. Galway. Mus. G. S. I.

PLATE XVI.

FOSSILS OF THE LLANDOVERY ROCKS.

MOLLUSCA.—*CONCHIFERA.*

FIG. 1.—MYTILUS MYTILIMERIS, *Conrad*, sp.

Memoirs Geological Survey, vol. ii., part i., p. 364, pl. xx., figs. 7, 8, 9. Sil., 4th ed. ; Foss. 61, fig. 6, p. 229.
From Memoirs Geological Survey, vol. ii., part i., pl. xx., fig. 7.
CARADOC ? LLANDOVERY to LUDLOW.—Sil., 4th ed., p. 530. "Caradoc sandstone (Upper Llandovery) of May Hill. *Wenlock limestone* of Dudley ; *Ludlow rocks* of Golden Grove, Llandeilo ;" M. G. S., vol. ii., part i., p. 365. Llandovery and May Hill, Sil., 4th ed., p. 211. "Plentiful in Wenlock rocks ;" *ibid.*, p. 229.

FIG. 2.—ANODONTOPSIS BULLA, *M'Coy*, sp.

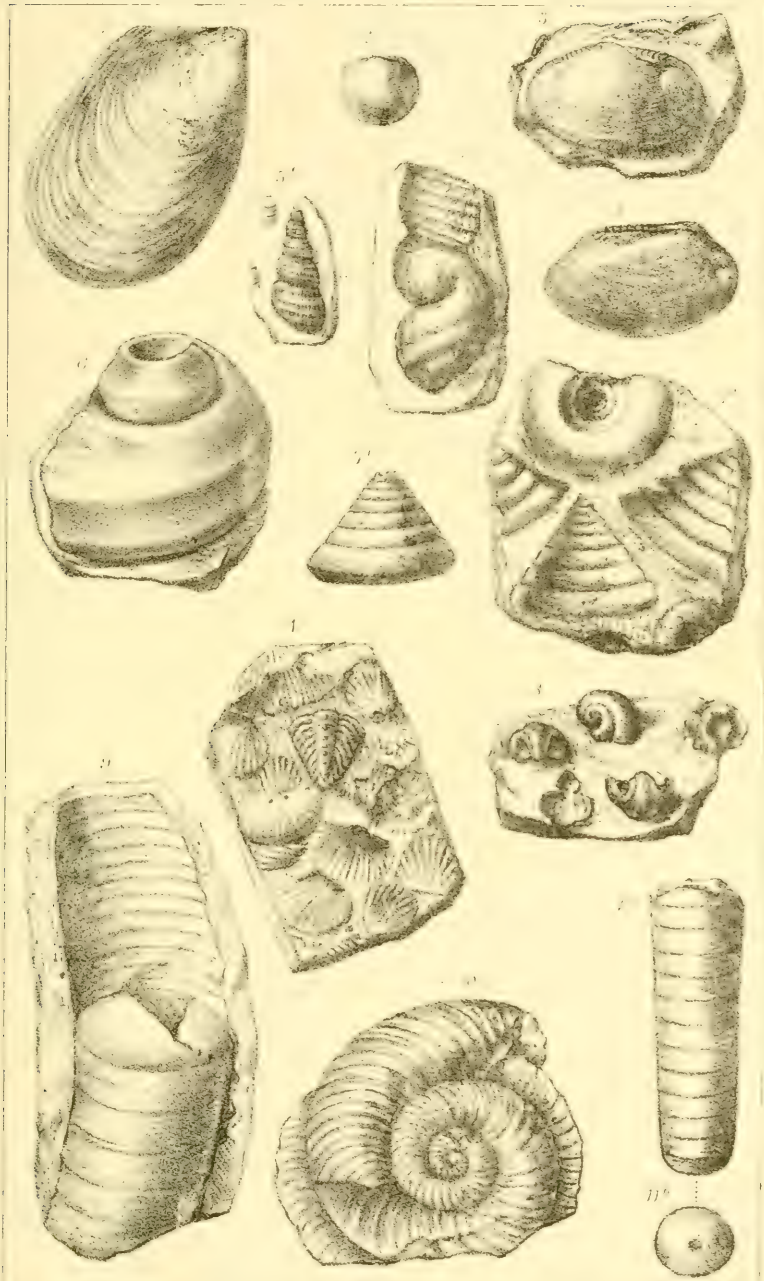
Lucina, Sil. Foss. Irel., p. 17, pl. ii., fig. 1. *Anodontopsis*, Brit. Pal. Foss., pl. 1 K, figs. 11-13. Sil., 4th ed., foss. 61, fig. 5, p. 229.
Internal cast. From Brit. Pal. Foss., pl. 1 K, fig. 13. ? Upper Llandovery rocks, Galway.
LLANDOVERY and LUDLOW.—Sil., 4th ed., p. 529. "A species first described by M'Coy from Galway ; lived on to the close of the Ludlow rocks." *Ibid.*, p. 211. "It abounds in the sandstone of Toulegee, Cong : in the state of casts." Sil. Foss. Irel., p. 17. *Upper Ludlow Rock*, Kirkby Moor, Kendal. M'Coy, Brit. Sil. Foss. (Explanation of Plate i. K).

FIG. 3.—CTENODONTA EASTNORI, *Sowerby*, sp.

Arca, Sil. Syst., p. 635. *Ctenodonta*, Sil., 4th ed., p. 529, pl. x., fig. 9.
Original. Internal cast in sandstone (Upper Llandovery) from Obelisk Lane, Malvern, Mus. G. S. I.
LLANDOVERY.—Sil., 4th ed., p. 529. *Upper Llandovery*—"It abounds with Ctenodonta subæqualis, near Malvern" ; *ibid.*, p. 211. Eastnor Park. Sil. Syst., p. 635.

FIG. 4.—CTENODONTA LINGUALIS, *Phillips*, sp.

Nucula, Mem. Geol. Surv., vol. ii., part i., p. 367. *Ctenodonta*, Sil., 4th ed., p. 529. From pl. xxii., fig 6, in the vol. cited.
LLANDOVERY.—Sil., 4th ed., p. 529. In sandstone ; Obelisk, Malvern.



W.H.Bond, Gr.et lith.

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GASTEROPODA.

FIG. 5.—*a*, *b*. HOLOPELLA CANCELLATA, *Sowerby*, sp.

Turritella, Sil. Syst., p. 642. *Holopella*, Sil., 4th ed., p. 532.
a, *b*. From the figures in Sil. Syst., pl. xx., fig. 18.
CARADOC, LLANDOVERY, and LUDLOW.—Sil., 4th ed., p. 532. *Localities* in *Lower Llandovery* rocks at Presteign; Malvern; and Mandinam; *ibid.* Explanation of Plate x., fig. 14. *Upper Llandovery rocks* at Chirbury, Norbury, and Bogmine. Mem. Geol. Surv., vol. iii., p. 362. In conglomerate "Pentamerus beds" at Golencoed, Pumsant. Mus. G. S. I. "This our largest British species, often three inches long, is common to the Lower and Upper Llandovery, and abounds in still higher beds at the Bogmine, near Shelve, in Shropshire." Sil., 4th ed., p. 212.

FIG. 6.—MURCHISONIA ANGULATA, *Sowerby*, sp.

Pleurotomaria, Sil. Syst., p. 641. Murchisonia, Sil., 4th ed., p. 532.
From the figure in Sil. Syst., pl. xxi., fig. 20.
LLANDOVERY.—*Locality*, Mandinam in *Lower Llandovery rocks*. Sil., 4th ed., Explanation of Plate x., fig. 13.

FIG. 7.—*a*, *b*. TROCHUS ? MULTITORQUATUS, *M'Coy*.

Silurian Fossils Ireland, p. 15.
a. *Original*. A group of internal casts in decomposing sandstone from Boocaun, Cong, Co. Galway.
b. External shell; showing its many whirls. From the figure in Sil. Foss. of Irel., pl. i., fig. 14.
LLANDOVERY.—Abundant at Boocaun and other localities near Cong, Co. Galway. *Ibid.*

I can confirm Professor M'Coy's remarks as to the abundance of this species from my own observation in rocks of Llandovery age, in the county of Galway, particularly at Ballyweeaun, near Lough Coolin, where bands of these shells may be seen weathered out by the decomposition of the hard sandstone.—W. H. B.

HETEROPODA.

FIG. 8.—BELLEROPHON TRILOBATUS, *Sowerby*.

Silurian System, p. 604.
From the figure in Sil. Syst., pl. iii., fig. 16. Loc. Felindre.
LLANDOVERY to LUDLOW.—Sil., 4th ed., p. 534. ? Upper Llandovery, Maume, Galway. Mus. G. S. I. Tortworth, and in Shropshire, Sil., 4th ed., pp. 90–213. *Upper Ludlow*, Felindre, ten miles W. of Knighton; *ibid.* Explanation to Plate xxxiv., fig. 9.

CEPHALOPODA.

FIG. 9.—CYRTOCERAS APPROXIMATUM, *Sowerby*, sp.

Orthoceras, Sil. Syst., p. 642.
From the figure in Sil. Syst., pl. xxi., fig. 22.

LLANDOVERY.—*Locality*, Eastnor Park, Malverns, in Upper Llandovery rocks. Sil., 4th ed., Explanation to Plate xi., fig. 4.

FIG. 10.—LITUITES CORNU-ARIETIS, *Sowerby*.

From the figure in Silurian System, pl. xx., fig. 20, var. *a*.
Silurian System, p. 643.
CARADOC and LLANDOVERY.—Sil., 4th ed., p. 535; var. *a. Upper Llandovery*, Corton, Presteign ; var *β Lower Llandovery rocks*, Cefn-y-Garreg, Llandovery ; *ibid.* Explanation of Plate xi., figs. 1, 2.

FIG. 11.—*a*, *b*. ORTHOCERAS SUB-GREGARIUM, *M'Coy*.

Silurian Fossils Ireland, p. 9.
From the figure in Sil. Foss. Irel., pl. i., fig. 4.
LLANDOVERY.—Sil., 4th ed., p. 536. *Localities*, Ardaun and Shanballymore, common at Boocaun, and very common at Tonlegee, Cong; also Munterowen, Leenane; all in the county of Galway. M'Coy in Sil. Foss. Irel., p. 9.

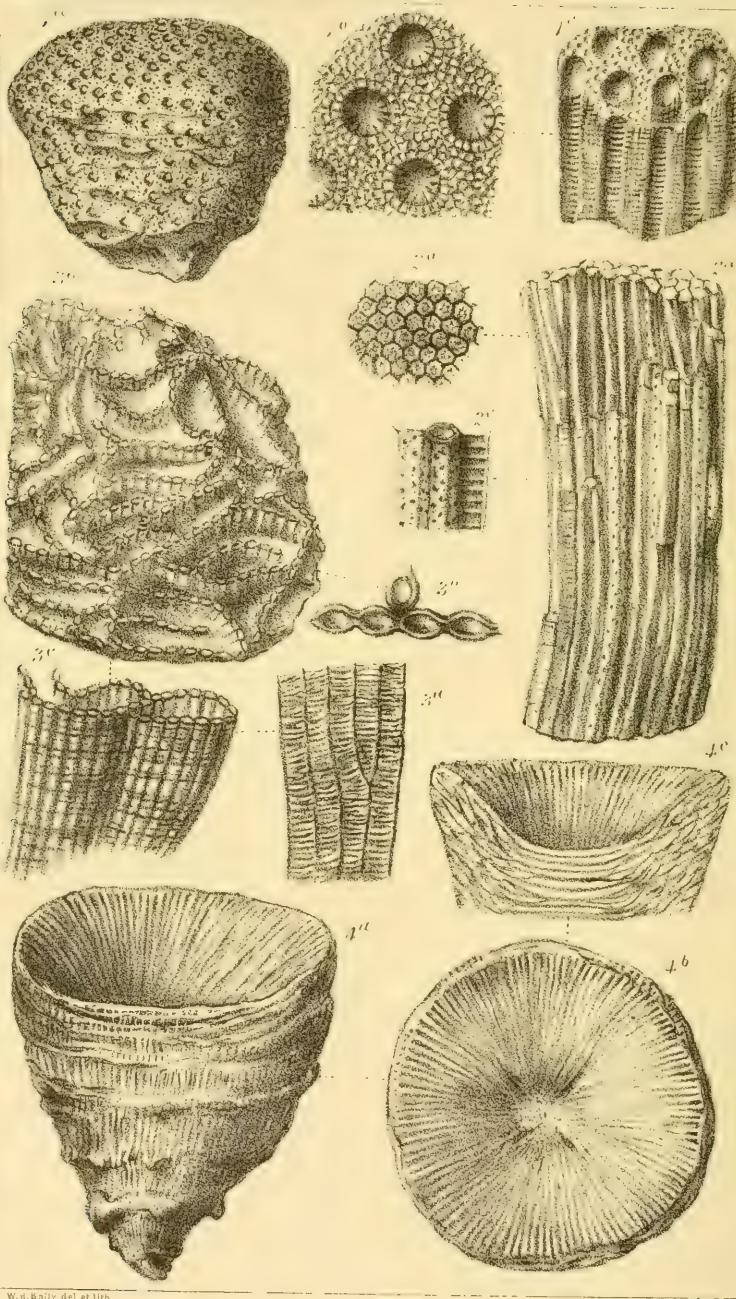
CRUSTACEA.—*TRILOBITA*.

FIG. 12.—ENCRINURUS PUNCTATUS, *Brunn*, sp.

Calymene, Sil. Syst., p. 661. *Encrinurus*, Sil., 4th ed.; Explanation to Plate x., fig. 5. *E. Stokesii*, Sil. Foss. Irel., p. 46, pl. iv., fig. 15.
Original. Tail only ; in Upper Llandovery sandstone ; full of *Atrypa hemisphærica*, shore of Lough Corrib, Co. Galway ; from a specimen collected by Mr. Joseph Nolan. Mus. G. S. I.
LLANDOVERY to LUDLOW.—Sil., 4th ed., p. 517. "This species is the most common of all the Trilobites in the Llandovery rocks." *Ibid.*, p. 214. I found it to be abundant at most of the localities where Llandovery fossils occur in the county of Galway.—W. H. B. See also M'Coy in Sil. Foss. Irel., p. 46.

Characteristic British Fossils.

Plate 17.



W. H. Bally del. et lith.

PLATE XVII.

FOSSILS OF THE WENLOCK ROCKS.

ZOOPHYTA.—*ANTHOZOA.*

FIG. 1.—*a*, *b*, *c*. HELIOLITES INTERSTINCTUS, *Linnæus*, sp.

Porites pyriformis, Sil. Syst., p. 686; Sil., 4th ed., pl. xxxix., fig. 2.

a. Hemispherical group of corallites in Wenlock limestone, Much Wenlock, Shropshire. From Brit. Foss. Corals, Pal. Soc., pl. lvii., fig. 5.

b. Portion of the surface enlarged from same plate, fig. 5 *b*.

c. *Original*. Vertical section; Wenlock limestone, Dormington Wood, Gloucestershire. Mus. G. S. I.

CARADOC to LUDLOW ROCKS.—Sil., 4th ed., p. 510. This widely-distributed and very abundant Silurian coral occurs in *Lower Silurian* rocks of Caradoc age at Coniston, Westmoreland; south of Llangollen, North Wales; and Portraine, Co. Dublin. In *Wenlock limestone* at Wenlock, Dudley, Aymestry, Ledbury, &c. In *Wenlock rocks* at Ballintemple and Doonquin, Kerry; Kilbride, Galway; and Uggool, Mayo.

NOTE.—It is very probable that H. megastoma M'Coy, sp., Pal. Foss., p. 16, pl. 1 *c*, fig. 4, will be found to be merely a variety of this species. —W. H. B.

FIG. 2.—*a*, *b*, *c*. FAVOSITES GOTHLANDICUS, *Lanarck*.

Silurian System, p. 682; Sil., 4th ed., pl. xl., figs. 3, 4. Brit. Foss. Corals, p. 256.

a. Side view of a vertical series of corallites; from Sil. Syst., pl. xvi. *bis*, fig. 3.

b. Impression of the surfaces of a group of corallites. From Brit. Foss. Corals, pl. lx., fig. 1 *a*; near Tortworth.

c. Enlarged portion; from Sil., 4th ed., Foss. 18, fig. 3, p. 119.

CARADOC to LUDLOW ROCKS.—Sil., 4th ed., p. 510. This equally abundant and widely-distributed species is found in many Lower and Upper Silurian localities. *Caradoc strata* S. of Llangollen. M. G. S., vol. iii., p. 260; *Llandovery*: several localities in Wales and Shropshire. In *Wenlock rocks* at Aymestry, Ledbury, Wenlock, Radnor, Dudley, and Tortworth; and from equivalent rocks in Ireland at Innishvickillane, South Blasket Island, Kerry; Bolingbroke, Tipperary; and Kilbride, Galway.

FIG. 3 *a-d*. HALYSITES CATENULARIUS, *Linnæus*, sp.

Catenipora escharoides, Sil. Syst., p. 685. *H. catenularius*, Sil., 4th ed., pl. xl., fig. 14. Brit. Foss. Corals, p. 270.

a. *Original.* Upper surface of a specimen in Wenlock limestone, from Dudley Tunnel; showing the chain-like appearance presented by the sections of tubular corallites. Mus. G. S. I.

b. *Original.* Section of some of the tubes enlarged.

c. *Original.* Side view of a series of corallites from Wenlock limestone, Dormington Wood. Mus. G. S. I.

d. "Vertical section in a specimen from Dudley." From Brit. Foss. Corals, pl. lxiv., fig. 1 *b* (a small portion of the figure only).

Llandeilo to Wenlock.—Sil., 4th ed., p. 510. This easily recognizable coral has a great vertical range and corresponding wide geographical distribution. In *Lower Silurian* rocks it occurs S. of Llangollen; and at Meifod, Montgomeryshire; M. G. S., vol. iii., p. 261. In *Caradoc* strata at Faynor Fach, near Narbeth, in rocks of the same age; at Portraine and Lambay, Co. Dublin; Mus. G. S. I. Desertcreat, Tyrone, Mus. G. S. I.; and many localities in the county of Galway (M'Coy); in *Lower Llandovery* at Cefn, near Buttington; Mathyrafal (M'Coy), &c., M. G. S., vol. iii., p. 276; also Robeston Wathen; Mus. G. S. I. In *Wenlock limestone* at Dudley; and several localities in Shropshire; and at Brand Lodge, Malverns; Mus. G. S. I. In *Wenlock rocks* at Doonquin, Ferriter's Cove, South Blasket Island, and Clogher Head, Kerry; Kilbride, Cong, Co. Galway; and Uggool, Co. Mayo.

Fig. 4.—*a*, *b*, *c*. Omphyma turbinata, *Linnæus*, sp.

British Fossil Corals, p. 287.

a. *Original.* A simple turbinated corallum; reduced to two-thirds of natural size; in Wenlock limestone, from Wenlock Edge. Mus. G. S. I.

b. Reduced in the same proportion as fig. 4 *a*; from Brit. Foss. Corals, pl. lxix., fig. 1 *a*.

c. *Original.* Portion of the vertical section of a specimen from the same locality as fig. 4 *a*.

Caradoc to Wenlock.—Sil., 4th ed., p. 511. In *Caradoc* rocks S. of Llangollen. M. G. S., vol. iii., p. 261. *Wenlock rocks*, Dudley, Wenlock; Ledbury, Ayrshire; Ballintemple and Ferriter's Cove, Dingle, Co. Kerry; Kilbride, Cong, and Uggool, Co. Mayo.

Note.—*Cyathophyllum turbinatum*, Sil. Syst., p. 690, pl. xvi., figs. 11, 11 *a*; and Sil., 4th ed., pl. xxxix., fig. 11, is *Omphyma subturbinata*; Milne, Edwards, and Haime, Brit. Foss. Corals, p. 288.

PLATE XVIII.

FOSSILS OF THE WENLOCK ROCKS.

ECHINODERMATA.—*CRINOIDEA.*

FIG. 1.—CYATHOCRINUS GONIODACTYLUS, *Phillips.*

From Silurian System, pl. xvii., fig. 1. A nearly perfect crinoid from Wenlock limestone, Dudley.
Wenlock.—Sil., 4th ed., p. 512.

FIG. 2. TAXOCRINUS TUBERCULATUS, *Miller*, sp.

Silurian System, pl. xviii., figs. 6, 7.
Original. From a specimen in Museum Geol. Survey of Ireland; *Locality*—Wren's Nest, Dudley. Presented by S. Alport, Esq., of Birmingham.
Wenlock.—Siluria, 4th ed., p. 513.

FIG. 3. ICHTHYOCRINUS PYRIFORMIS, *Phillips*, sp.

From Silurian System, pl. xvii., fig. 6.
Wenlock.—Siluria, 4th ed., p. 512. Localities—Dudley, Kendal. Cat. of Brit. Foss., p. 83.

FIG. 4. *a*, *b*. PERIECHOCRINUS MONILIFORMIS, *Miller*, sp.

a. Reduced to two-thirds of natural size; from Sil. Syst., pl. xviii., fig. 4.
b. Portion of column, or stem; natural size; from same figure.
Llandovery and Wenlock.—Sil., 4th ed., p. 513. Upper Silurian, Dudley, Staffordshire. Cat. of Brit. Foss., p. 86.

FIG. 5.—*a*, *b*. CROTALOCRINUS RUGOSUS, *Miller*, sp.

a. From Silurian System, pl. xviii., fig. 1. "Pelvic" plates.
NOTE.—*See* more perfect figures explanatory of this species in Siluria, 4th ed., woodcut 56, figs 4-7.
b. *Original.* "Root" or base of column; showing tubular processes of attachment; from specimen in Mus. Geol. Survey of Ireland; Wenlock limestone, Wenlock edge.
Wenlock.—Sil., 4th ed., p. 512. Locality—Dudley, Staffordshire. Cat. Brit. Foss., p. 75.

CYSTIDEÆ.

FIG. 6.—*a*, *b*, *c*. PSEUDOCRINITES QUADRIFASCIATUS, *Pearce*.

From Mem. Geol. Surv., vol. ii., part ii., pl. xiii., figs. 1, 5, 6.
a. Natural size; Cystidean; showing arrangement of stem and body (Forbes).
b. Ovarian pyramid.
c. Largest of the superior rhombs.
WENLOCK.—Sil., 4th ed., p. 513. Loc.—Dudley. Cat. Brit. Foss., p. 881.

FIG. 7. ECHINO-ENCRINUS ARMATUS, *Forbes*.

From Mem. Geol. Surv., vol. ii., part ii., pl. xviii., fig. 2; column restored from Siluria, 4th ed., p. 222, woodcut 55, fig. 6.
WENLOCK.—Sil., 4th ed, p. 512. Loc.—Dudley; *ibid.*, p. 222. Walsall, Cat. Brit. Foss., p. 78.

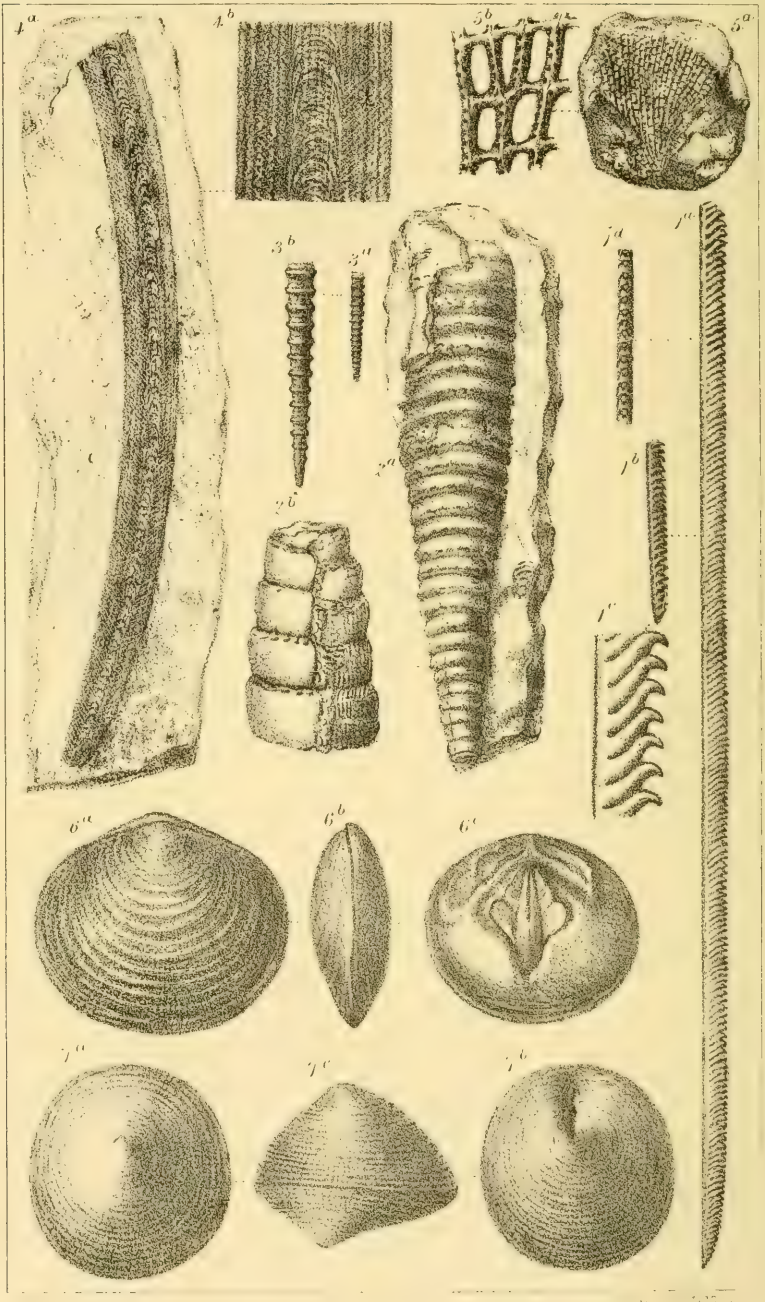

4a
4b
5b
5a
3b
3a
2a
2b
1a
1b
1c
6a
6b
6c
7a
7c
7b

PLATE XIX.

FOSSILS OF THE WENLOCK ROCKS.

HYDROZOA?—*GRAPTOLITIDÆ.*

FIG. 1.—*a-d.* GRAPTOLITHUS PRIODON, *Bronn*, sp.

G. Ludensis, Sil. Syst., p. 694, pl. xxvi., figs. 1, 2. *G. priodon*, Sil., 4th ed., p. 523.

a. Original. Compressed; in grey slate (Upper Silurian); from near Bird Hill, three miles S. of Killaloe, Co Tipperary. Mus. G. S. I.

b. Original. Uncompressed portion, in dark grey calcareous rock (Upper Silurian); from near Barnane House, four miles north-east of Borrisoleigh, Co. Tipperary. Mus. G. S. I.

c. Original. Enlarged portion of 1 *b*.

d. Original. View of uncompressed specimen; showing cell openings; from same locality as 1 *b*.

CARADOC to LUDLOW.—Sil., 4th ed., p. 523. At page 62 of the work cited the range of this very characteristic Upper Silurian fossil is stated to be from the Llandeilo to the Ludlow rocks inclusive. It is, however, the only species of graptolite which is abundant in the upper division of the Silurian formation occurring where argillaceous sediments prevail, at numerous localities in the British Islands.

ANNELIDA.

FIG. 2.—*a, b.* CORNULITES SERPULARIUS, *Schlotheim.*

Silurian System, p. 627, pl. xxvi., fig. 5.

a. From Sil. Syst., pl. xxvi.; and Sil., 4th ed., pl. xvi., fig. 6. Wenlock limestone, Ledbury; and specimen in Mus. G. S. I. from Malvern Hills.

b. Enlarged portion; from Sil. Syst., pl. xxvi., fig. 9.

LLANDOVERY to LUDLOW.—Sil., 4th ed., p. 514. This fossil is the principal Annelide in the Llandovery rocks, but more frequent in the Wenlock and Ludlow rocks. "The finest specimens are from the Wenlock limestone of Ledbury; but at Dudley, Cornulites are found attached to shells in groups of three or four together like Serpulæ; and they occur in profusion on the hard and sea-worn surfaces of the Ludlow rock at Marloes Bay in Pembrokeshire in masses a foot in diameter." *Ibid.*, p. 233. Localities—*Wenlock limestone*, Malvern Hills; Dudley; and *Upper Silurian* rocks, Westmoreland. Brit. Foss., p. 91.

FIG. 3.—*a*, *b*. TENTACULITES ORNATUS, *Sowerby*.

Sil. Syst., p. 628, pl. xii., fig. 25.
a. *Original.* Natural size; in dark grey shale; Wenlock rocks, Marloes Bay. Mus. G. S. I.
b. *Original.* Enlarged.
CARADOC to WENLOCK.—Sil., 4th ed., p. 514. It abounds in the Dudley limestone; *ibid.*, p. 233.

MOLLUSCA.—*POLYZOA*.

FIG. 4.—*a*, *b*. PTILODICTYA LANCEOLATA, *Goldfuss*, sp.

Sil. Syst., p. 676, pl. xv., fig. 11 *a-c*.
a. *Original.* From a specimen in Wenlock limestone, Malverns. Mus. G. S. I.
b. *Original.* Portion of do. enlarged.
CARADOC to LUDLOW.—Sil., 4th ed., p. 523. "This species is abundant in Wenlock strata, accompanied by *P. scalpellum*, a branching species; the former occurs also in the Ludlow rocks." *Ibid.*, p. 217. *Localities*—*Upper Silurian*, Malverns, Shropshire; Aymestry, Herefordshire; Montgomeryshire. Cat. Brit. Foss., 2nd ed., p. 127.

FIG. 5.—*a*, *b*. FENESTELLA SUBANTIQUA, *D'Orbigny*.

F. antiqua, Sil. Syst., p. 678. *F. subantiqua*, Sil., 4th ed., p. 523.
a. *Original.* In Wenlock limestone, Dormington Wood. Mus. G. S. I.
b. *Original.* Portion of do. enlarged; showing the net-work arrangement or fenestrules; spaces between the radiating or longitudinal ribs, on which are situated the pores or cellules; and the connecting transverse partitions.
CARADOC and WENLOCK.—Sil., 4th ed., p. 523. *Fenestella subantiqua* and *F. Milleri* are common fossils at Dudley." *Ibid.*, p. 217. *Upper Silurian*, Dudley; also in Denbighshire and Montgomeryshire. Cat. Brit. Foss., 2nd ed., p. 124. Dormington Wood, Gloucestershire. Mus. G. S. I.

BRACHIOPODA.

FIG. 6.—*a*, *b*, *c*. OBOLUS DAVIDSONI, *Salter*.

British Silurian Brachiopoda, p. 58, and varieties *transversus* and *Woodwardii*; *ibid.*, pp. 59, 60.
a, *b*. Bivalve example and side view of do. in Wenlock shale, Dudley. From Brit. Sil. Brach., pl. iv., fig. 30.
c. Internal cast of ventral valve from same plate, fig. 33; Wenlock shale, near Walsall.
LLANDOVERY and WENLOCK.—Sil., 4th ed., p. 526. *Wenlock shales*, near Walsall, Dudley; Malvern and Ledbury; and *Wenlock limestone*, Benthall Edge. In Ireland it occurs in decomposing Upper Silurian shales at Ferriter's Cove, Dingle, Co. Kerry (Mus. G. S. I.). Var. *transversus*

occurs in the same localities as the preceding, but is most abundant in the Wenlock shale of Parkes' Hall, near Dudley, at Walsall; and also in the *Woolhope limestone* of Malvern. Var. *Woodwardii* is found in the *Wenlock limestone* of Dormington Wood, *Woolhope*, and *Wenlock shales*, near Dudley. Brit. Sil. Brach., pp. 59, 60.

FIG. 7.—*a*, *b*, *c*. ORBICULOIDEA FORBESII, *Davidson*.

Orbicula Forbesii, Mem. Geol. Surv., vol. ii., part i., p. 371.

a. View of upper valve. From Brit. Sil. Brach., pl. vii., fig. 16. Wenlock limestone, Dudley.

b. Foraminated or lower valve. Wenlock limestone, Malverns; from the same plate, fig. 14.

c. View showing position of upper and lower valve; from same plate: fig. 16*a*.

WENLOCK.—Sil., 4th ed., p. 526. *O. Forbesii* has been found in the *Woolhope beds* and *Wenlock limestone* and *shales*. It occurs in the *Wenlock limestone* of Dudley, Dormington Wood, Woolhope; at Vinnals Farm, Malvern; and at Marloes Bay. Brit. Sil. Brach., p. 74.

PLATE XX.

FOSSILS OF THE WENLOCK ROCKS.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 1.—*a*, *b*, *c*. SPIRIFERA PLICATELLA, *Linnæus*, sp.

S. *interlineatus* and S. *radiatus*, Sil. Syst., pp. 614, 624.
S. *plicatella* and vars. *radiata* and *globosa*. Brit. Sil. Brach., pp. 84-89, pl. ix.
a, *b*, *c*. *Original.* Three views of the same shell; from *Wenlock limestone;* Dormington lime quarries, Woolhope district. Mus. G. S. I.
LLANDOVERY TO LUDLOW.—Sil., 4th ed., p. 528. *Sp. plicatella* occurs especially plentiful in the *Wenlock shales* in the neighbourhood of Dudley and Walsall, Staffordshire; and the *Wenlock limestone* of May Hill; of Woolhope, Ledbury, Herefordshire; Benthall Edge, &c.; and in the *Aymestry limestone*, of Aymestry. Brit. Sil. Brach., p. 86. Many other localities are given for this species with its varieties *Cyrtæna radiata* and *interlineata* in Mem. G. S., vol. ii., part i., p. 292, 3. The var. *radiata* is also stated, on the authority of Mr. Salter, to occur in the Lower Llandovery rocks of the Quakers' Burial Ground, near Welshpool; the only locality known in rocks below the Upper Silurian. Brit. Sil. Brach., p. 88.

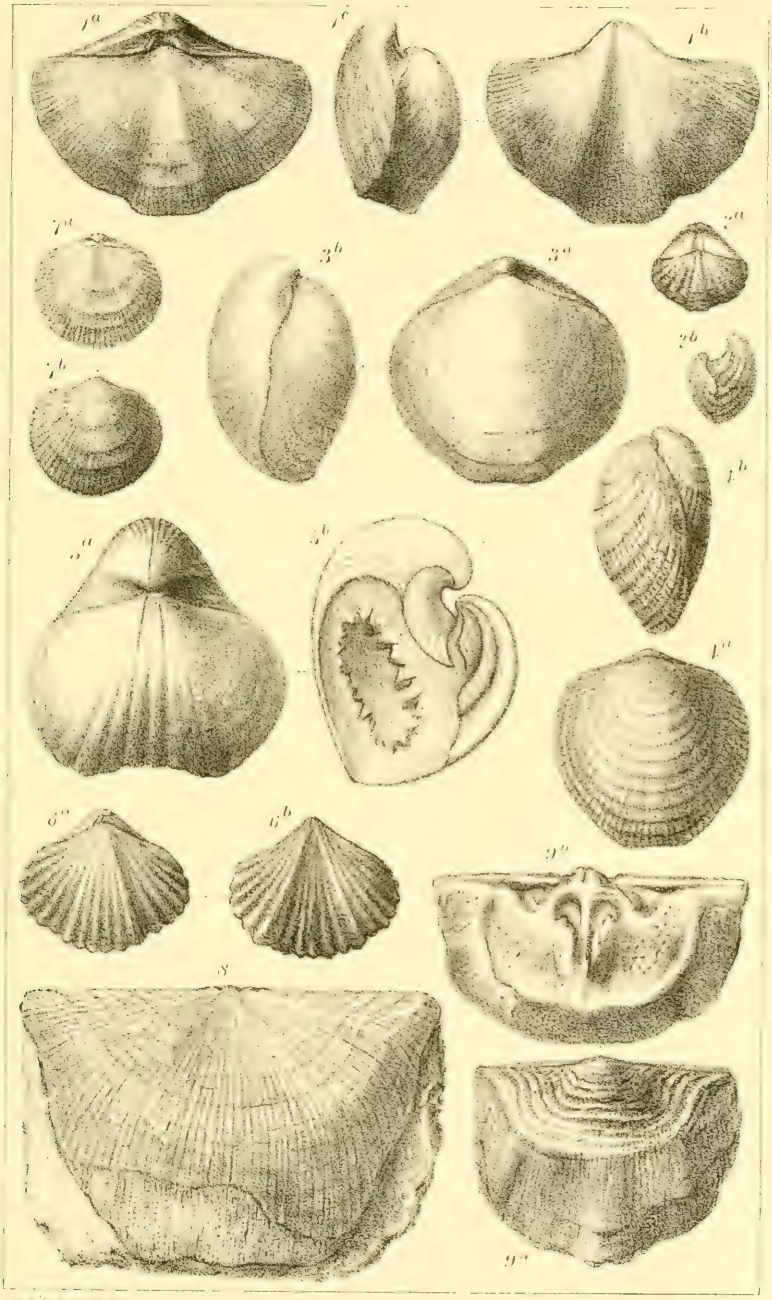
FIG. 2.—*a*, *b*. SPIRIFERA ELEVATA, *Dalman.*

S. *octoplicatus*, Sil. Syst., p. 624. S. *elevata*, Sil., 4th ed., pl. xxi., fig. 5, 6.
a, *b*. *Original.* Two views of the same shell. Wenlock limestone, Wenlock Edge. Mus. G. S. I.
LLANDOVERY to LUDLOW.—Sil., 4th ed., p. 528. "This shell is one of the most common in our Upper Silurian rocks; it varies considerably in shape and number of 'ribs.' It occurs in the *Upper Llandovery beds* at Damory Bridge, Tortworth; also not uncommonly in the *Llandovery beds* at May Hill and Huntley Hill, &c.; in the *Wenlock limestone* of Dudley; and numerous other localities in Shropshire, Herefordshire, and Gloucestershire; in the *Lower Wenlock* (or Denbigh) grit beds at several places in North Wales and *Wenlock beds* in South Wales and Dingle, Co. Kerry; in *Lower Ludlow*, Abberley, and Usk district; also in *Ludlow* beds at Kendal in Westmoreland," &c. Brit. Sil. Brach., pp. 96, 7.

FIG. 3.—*a*, *b*. MERISTELLA TUMIDA, *Dalman*, sp.

Atrypa tenuistriata, Sil. Syst., p. 623. *Meristella tumida*, Sil., 4th ed., pl. xxii., fig. 20.

Cheiracrinstic British Fossils. Plate 20.



a, *b*. *Original*. Two views of the same shell; *Wenlock limestone*, Wenlock Edge. Mus. G. S. I.

LLANDOVERY to LUDLOW.—Sil., 4th ed., p. 525. "*Meristella tumida* is a common shell in the *Wenlock limestone* of Dudley, Woolhope, Benthall Edge, near Walsall, May Hill, &c. In addition, various localities in *Wenlock limestone*, *Lower Ludlow*, and *Aymestry limestone* of the Malvern, Abberley, May Hill, Usk, and Llandeilo districts are given in Mem. Geol. Surv., vol ii., part i., p. 279. In Scotland it has been found in the *Wenlock shales* of the Pentland Hills." Brit. Sil. Brach., p. 111. In Ireland it has been collected by the Geol. Survey in *Wenlock shales* at Ferriter's Cove S. and Clogher, Co. Kerry; also at Kilbride, Cong, Co. Galway.

FIG. 4.—*a*, *b*. ATRYPA RETICULARIS, *Linnæus*, sp.

A. *affinis* and A. *aspera*, Sil. Syst., pp. 614 and 623. Sil., 4th ed., pl. xxi., figs. 12, 13.

a, *b*. Two views of the same shell. From Brit. Sil. Brach., pl. xiv., fig. 7 *a b*, Wenlock limestone, Dudley.

LOWER LLANDOVERY to UPPER DEVONIAN.—"This fossil has the greatest range known of any Palæozoic shell; it is particularly abundant in the Llandovery and Wenlock rocks. In England it is plentiful in the *Wenlock limestone* and *shales* at Dudley, Wenlock Edge, and Walsall; in various localities in the Malvern, Woolhope, May Hill, Usk, Llandeilo, and Marloes districts, as recorded in Mem. Geol. Surv., vol. ii., part i., p. 278. It is not uncommon in the *Upper* and *Lower Ludlow rocks*, and abounds of large size in the *Aymestry limestone*. It also occurs in the *Woolhope limestone* at Littlehope; in the *Upper Llandovery* sandstone of May Hill and Huntley Hill; at the Hollies Farm, Shropshire; and in all the *Lower Llandovery* grits and shales of South Wales. In Scotland it is common in the *Wenlock shales* of the Pentland Hills and in various localities in the Girvan district, Ayrshire, in *Upper* and *Lower Llandovery* rocks. In Ireland it occurs at Ferriter's Cove and several other localities in the Dingle district, Co. Kerry; in beds of *Wenlock* and *Ludlow* age." Brit. Sil. Brach., pp. 132, 3. It has also been collected by the Geological Survey from *Wenlock* rocks at Kilbride, Co. Galway.

FIG. 5.—*a*, *b*. PENTAMERUS GALEATUS, *Dalman*, sp.

Atrypa galeata, Sil. Syst., p. 623. *P. galeatus*, Sil., 4th ed., pl. xxi., figs. 8, 9.

a. View showing both valves. From unpublished plate Geol. Survey; Wenlock limestone, Dudley.

b. Longitudinal section; showing the position of the internal plates. From the same engraving.

WENLOCK AND LUDLOW.—Sil., 4th ed., p. 527. "The vertical range and geographical distribution of *Pentamerus galeatus* is very considerable; for it is common to the *Wenlock*, *Middle Ludlow*, and *Devonian* formations. It abounds in the *Wenlock limestone* and *Upper Wenlock shales* near Walsall and Dudley." Brit. Sil. Brach., p. 147. In the Mem. Geol. Surv., vol. ii., part i., pp. 291, 2. Many localities for this species are given in *Wenlock limestone* and *shale* of the Malvern, Abberley, Wool-

hope, May Hill, and Llandeilo districts. In the *Lower Ludlow* of the Malvern and Abberley districts; and in the *Aymestry limestone* of the Malvern and Usk districts. In Ireland it occurs with *P. Knightii* in the Croaghmarhin (? *Aymestry*) beds, Dunquin, Dingle district, Co. Kerry. G. S. I.

FIG. 6.—*a, b.* RHYNCHONELLA BOREALIS, *Schlotheim.*

Terebratula lacunosa and *bidentata*, Sil. Syst., pp. 624, 5. *R. borealis*, Sil., 4th ed., pl. xxii., figs. 4, 5.

a, b. Original. Front and back view of the same shell; Wenlock limestone, Wenlock Edge. Mus. G. S. I.

LLANDOVERY and WENLOCK.—Sil., 4th ed., p. 527. "In Britain, *Rh. borealis* and its varieties *diodonta* and *bidenta* range from the Lower Llandovery to the *Upper Ludlow*, but are most abundant in the *Wenlock limestone*. Brit. Sil. Brach., p. 177. *Lower Llandovery rocks*, east of Mechlin; *Upper Llandovery*, at Chirbury, Malverns: Bogmine, near Shelve, Shropshire. M. G. S., vol. iii., pp. 278, 361, 362. In *Wenlock* and *Ludlow* rocks. "*R. borealis* is by far the most common species of Brachiopod." Sil., 4th ed., p. 121. Many *Upper Silurian* localities are recorded for this abundant shell in the Malvern, Abberley, Woolhope, May Hill, Usk, Llandeilo, Freshwater, and Marloes districts. Mem. G. S., vol. ii., part i., pp. 279, 80. In Ireland, it has been collected from *Wenlock rocks* at Ferriter's Cove, and in ? *Wenlock limestone*, at Caherconree, Co. Kerry. Mus. G. S. I.

FIG. 7.—*a, b.* ORTHIS ELEGANTULA, *Dalman.*

O. orbicularis, and *O. canalis*, Sil. Syst., pp. 611, 640.

O. elegantula, Sil., 4th ed., pl. v., fig. 5; ix., fig. 19; xx., fig. 12. Brit. Sil. Brach., p. 211.

a, b. Original. Two views of the same shell in Wenlock limestone from Whitfield, Tortworth. Mus. G. S. I.

LLANDEILO to LUDLOW.—Sil., 4th ed., p. 526. The wide range of this very abundant and highly characteristic Silurian fossil is alluded to in the work cited "as being equally abundant in both divisions;" *ibid.*, p. 225. It is so universally distributed throughout the formation that it would be almost needless to specify the localities. In the Mem. of the Geol. Surv., vol. iii., pp. 258, 9, many localities are enumerated in *Upper Llandeilo* and *Caradoc rocks* in North Wales. In *Lower* and *Upper Llandovery* also, *ibid.*, p. 277; and in *Wenlock* rocks, N. Wales, *ibid.*, p. 277. In Mem. Geol. Surv., vol. ii., part i., pp. 287, 8, many localities for this species are recorded; in *Upper Llandovery*, *Wenlock*, and *Ludlow* rocks, both in North and South Wales, Herefordshire, Shropshire, Gloucestershire, &c; Horderly and Coniston in Westmoreland are mentioned as additional *Lower Silurian* localities, and Dudley in *Upper Silurian*. Cat. Brit. Foss. (1854), p. 140. In Cornwall it is said to occur at Gorran Haven; Sil., 4th ed., p. 145; and Scotland, in *Caradoc* and *Llandovery* beds on the banks of Girvan Water, Ayrshire; *ibid.*, p. 156; and the *Wenlock shales* of the Pentland Hills, near Edinburgh. Brit. Sil. Brach., p. 213. In Ireland it has been obtained from *Caradoc-Bala* beds at Portraine and Lambay, Co. Dublin; and from *Wenlock rocks* at Clogher, Co. Kerry; Kilbride, Cong, Co. Galway; and Holyford, Co. Tipperary. Mus. G. S. I.

FIG. 8. STROPHOMENA EUGLYPHA, *Dalman*, sp.

Leptæna, Sil. Syst., p. 622. *Strophomena euglypha*, Sil., 4th edition, pl. xx. fig. 16.

Original. Wenlock Limestone, Dudley and Dormington Wood. Mus. G. S. I.

LLANDOVERY TO LUDLOW.—Sil., 4th edition, p. 528. In Mem. Geol. Surv., vol. iii., p. 276, in the list of *Lower Llandovery* fossils, the Quaker's Burying Ground, near Welshpool, Montgomeryshire, is given as a locality for this very characteristic Upper Silurian species. *Upper Llandovery; ibid.*, p. 361, at Pen-y-lan, Llandovery; also in *Wenlock* rocks, near Llansannan (*ibid.*, p. 279), at Frid-y-fedwen. In Mem. Geol. Surv., vol. ii., part i., p. 284, many localities are mentioned in *Wenlock Limestone* and *Shale* in the Malvern, Abberley, Woolhope, and Usk districts; in *Lower Ludlow*, Malvern, and Usk districts; *Aymestry Limestone*—Malvern, Woolhope, and Usk districts; as well as W. of Rock Farm, May Hill district; Aberedw, Builth district; and Swansea-road, Golden Grove, &c., in the Llandeilo district. In Ireland, it has been collected by the Geol. Survey from *Upper Llandovery* rocks at Belvoir, Co. Clare; and from *Wenlock rocks*, Smerwick Harbour; and Gortadoo, Kerry.

FIG. 9.—*a*, *b*. STROPHOMENA DEPRESSA, *Dalman*, sp.

Leptæna, Sil. Syst., p. 623. *S. depressa*, Sil., 4th edition, pl. xx., fig. 20.

a. Original. Ventral valve; Wenlock Limestone, Dudley. Mus. G. S. I.

b. Original. Interior of same valve; Wenlock Limestone, Wenlock Edge. Mus. G. S. I.

CARADOC TO LUDLOW.—Sil., 4th edition, p. 528. "A shell frequently found on the surface of slabs of limestone at Wenlock and Dudley." This highly characteristic fossil occurs both in *Aymestry* and *Wenlock*, but most abundantly in the latter; it is sparingly distributed throughout the other strata of the Silurian series. Sil. Syst., p. 623. In Memoirs Geol. Surv., vol. iii., p. 269, list of *Caradoc fossils*; localities are given for this species in Caernarvonshire, Denbighshire, Montgomeryshire, and Merionethshire. *Lower Llandovery, ibid.*, p. 277. *Upper Llandovery, ibid.*, p. 361; and *Wenlock rocks*, in North Wales; *ibid.*, p. 279. In Mem. Geol. Surv., vol. ii., part i., p. 283, numerous localities are recorded in *Wenlock* and *Ludlow rocks* in North and South Wales, and various counties in England. In Cat. Brit. Foss. (1854), p. 147, Westmoreland is mentioned as an additional locality. In Ireland it occurs in *Caradoc-Bala* limestone, at the Chair of Kildare; also in the schists of Desertcreat, Tyrone; and from *Upper Llandovery rocks* at Ballycar, Co. Clare; and *Wenlock rocks* at Ferriter's Cove, and Coosathurrig, Dingle; and in Limestone W. side of Cahirconree, Co. Kerry.

PLATE XXI.

FOSSILS OF THE WENLOCK ROCKS.

MOLLUSCA.—*CONCHIFERA.*

FIG. 1.—PTERINEA ORBICULARIS, *M'Coy.*

Synopsis Sil. Foss. of Irel., p. 21., pl. ii., fig. 8.
Original. Radiated valve, Carhoo, Dingle. Mus. G. S. I.
WENLOCK.—Sil., 4th ed., p. 529, "one of the largest and most plentiful" of the Aviculoid group, which are abundant in the Dingle District, ibid., p. 228. Also in *Ludlow Rocks*, Derrymore Glen, Co. Kerry. Mus. G. S. I.

FIG. 2.—*a-b.* PTERINEA PLANULATA, *Conrad.*

Salter, Mem. Geol. Surv., vol. ii., pt. 1, p. 368, pl. xxiii., fig. 2-4.
a. From fig. 3 in the vol. cited.
b. Original. Enlarged portion of surface, showing concentric and partially radiating striæ. Wenlock Limestone, *Wenlock Edge.* Mus. G. S. I.
LLANDOVERY TO LUDLOW.—Sil., 4th edition, p. 529; "a common Wenlock species doubtfully referred to this genus;" ibid., p. 228, distributed pretty generally through the Lower Ludlow and Wenlock rocks, abounding at Dudley and the neighbourhood, in the Shales; M. G. S., op. cit., p. 369. In Ireland it has been found, at Ferriter's Cove, E., Clogher, and Cahirconree, Kerry, in Wenlock Rocks; Mus. G. S. I.

FIG. 3.—MODIOLOPSIS ANTIQUA, *Sowerby*, sp.

Modiola.—Sil. Syst., p. 628, pl. xiii., fig. 1. *Modiolopsis;* Sil., 4th edition, p. 229, pl. xxiii., fig. 14.
From Sil. Syst., pl. xiii., fig. 1. *Wenlock Shale*, Glass House Hill, East of May Hill, Gloucestershire.
WENLOCK.—Sil., 4th edition, p. 530; "a common species;" ibid., p. 229.

FIG. 4.—MODIOLOPSIS GRADATA, *Salter*, sp.

Mytilus gradatus, Mem. Geol. Surv., vol. ii., pt. 1, p. 363, pl. xx. fig. 3, 4, 5. *Modiolopsis gradata;* Sil., 4th edition, p. 530; *M. Nilssoni*, ibid., p. 229, Foss. 61, fig. 8.
From Mem. Geol. Surv., op. cit., pl. xx., fig. 4, "common in the Ludlow Rocks of Shropshire and South Wales;" ibid. p. 363.
WENLOCK AND LUDLOW.—Sil., 4th edition, p. 530.

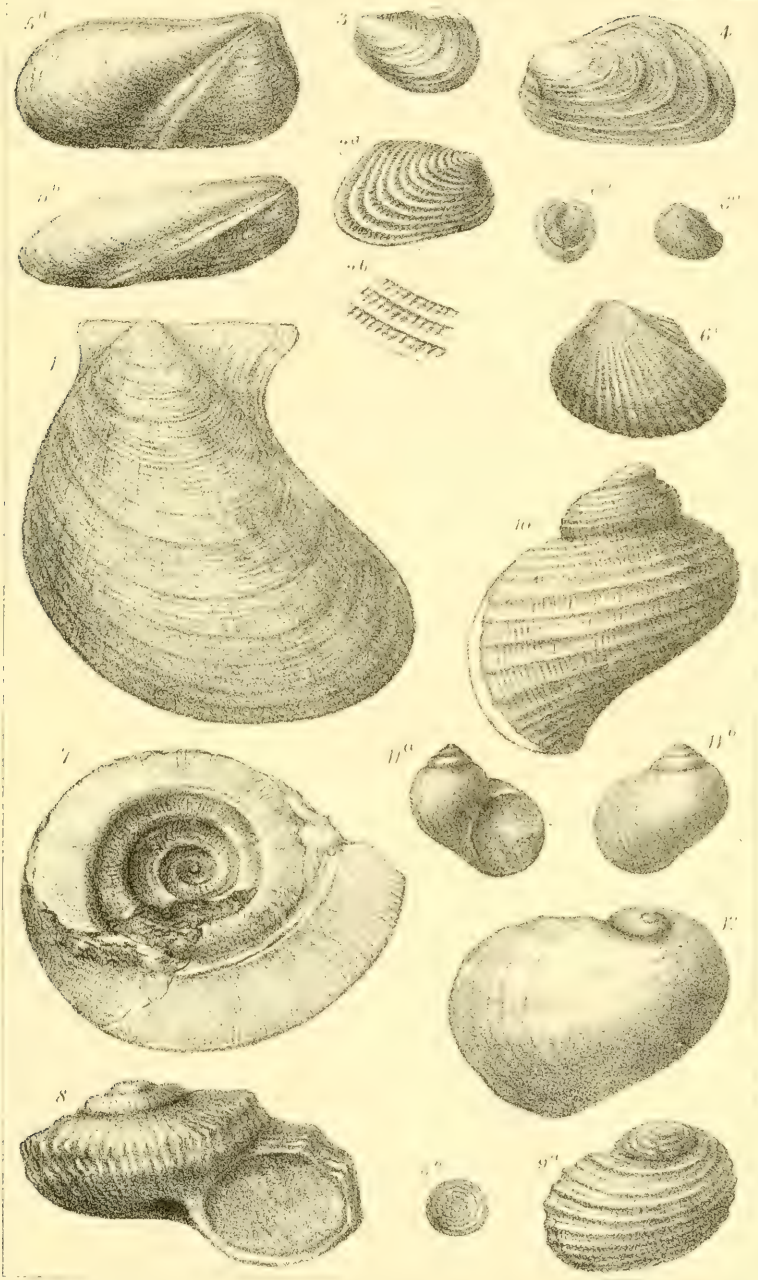


FIG. 5.—*a-b.* GRAMMYSIA CINGULATA, *Hisinger*, sp.

Nucula.—Leth. Suec. Suppl., pl. xxxix., fig. 1. *Orthonota*, Salter, Mem. Geol. Surv., vol. ii., pt. 1, p. 360, pl. xvii., fig. 1 (not 2).
Grammysia, Sil. 4th edition, p. 229, Fos. 61, fig. 1.
a. From Mem. Geol. Surv., op. cit., pl. xvii., fig. 1. Wenlock, Dudley, *b. Original.* Squeezed out of shape, from Wenlock Rocks, Ballincolla, and Ferriter's Cove, Dingle, Co. Kerry; Mus. G. S. I.
WENLOCK AND LUDLOW.—Sil. 4th edition, p. 530.
Ludlow Rocks, Kendal, Westmoreland; Mus. G. S. I.

FIG. 6.—*a, b, c.* PLEURORHYNCHUS ÆQUICOSTATUS, *Phillips.*

Mem. Geol. Surv., vol. ii., pt. 1, p. 359, pl. xvi., figs. 1, 2, *Conocardium* Brown.
From Mem. Geol. Surv., op. cit., pl. xvi., fig. 2, a, b; *a*, Right valve, *b.* posterior end, both natural size; *c*, enlarged view of 6 a. Wenlock Limestone, Dudley.
WENLOCK.—Sil. 4th edition, p. 531. Wenlock Limestone, Dormington Wood. M. G. S., vol. ii., pt. 1, p. 359.

GASTEROPODA.

FIG. 7.—EUOMPHALUS ALATUS, *Hisinger.*

Leth. Suec. pl. xi., fig. 7; Sil. Syst., p. 631, pl. xiii., fig. 28.
Original. Wenlock rocks, Ferriter's Cove, Kerry; Mus. G. S. I.
WENLOCK AND LUDLOW.—Sil., 4th edition, p. 531. Wenlock Shale, Delves Green; Tame Bridge. "It is chiefly a Wenlock Shale species, and occurs of the largest size in the Dingle promontory in Ireland; ibid., p. 231.

FIG. 8.—EUOMPHALUS RUGOSUS, *Sowerby.*

Min. Conch., pl. lii., fig. 2.
Original. From Wenlock Limestone, Wenlock Edge; Mus. G.S.I.
WENLOCK.—Sil. 4th edition, p. 532. "Four species of Euomphalus are especially abundant in the Wenlock rocks at certain localities, viz.: E. *discors*, *rugosus*, *funatus*, and *alatus*;" ibid., p. 231. Localities, Wenlock, Dudley, Cat. Brit. Foss., p. 248.

FIG. 9.—*a. b.* EUOMPHALUS FUNATUS, *Sowerby.*

Min. Conch, pl. ccccl., figs. 1, 2.
Original. *a.* Side view of shell, Wenlock Limestone, Wenlock Edge; *b*, operculum, Wenlock, Limestone, May Hill; Mus. G. S. I.
LLANDOVERY TO LUDLOW.—Sil., 4th edition, p. 531. Localities, *Wenlock rocks*, Dudley; Walsall; *Ludlow rocks*, Aymestry; Usk. Cat. Brit. Foss., p. 248. In Ireland it has been collected in abundance from the *Wenlock rocks* of the Dingle promontory, Kerry, as well as from *Ludlow rocks*, Derrymore Glen, Co. Kerry; Mus. G. S. I.

FIG. 10.—MURCHISONIA BALTEATA, *Phillips*, sp.

Pleurotomaria, Mem. Geol. Surv., vol. ii. pt. 1, p. 358, pl. xv., figs. 1, 2.
Murchisonia, Sil., 4th edition, p. 532.
From Mem. Geol. Surv., op. cit., pl. xv., fig. 1. Wenlock Limestone, Hobbes, Longhope, near Woolhope.
WENLOCK.—Sil., 4th edition, p. 532. Rock farm, May Hill, M. G. S., op. cit., p. 358.

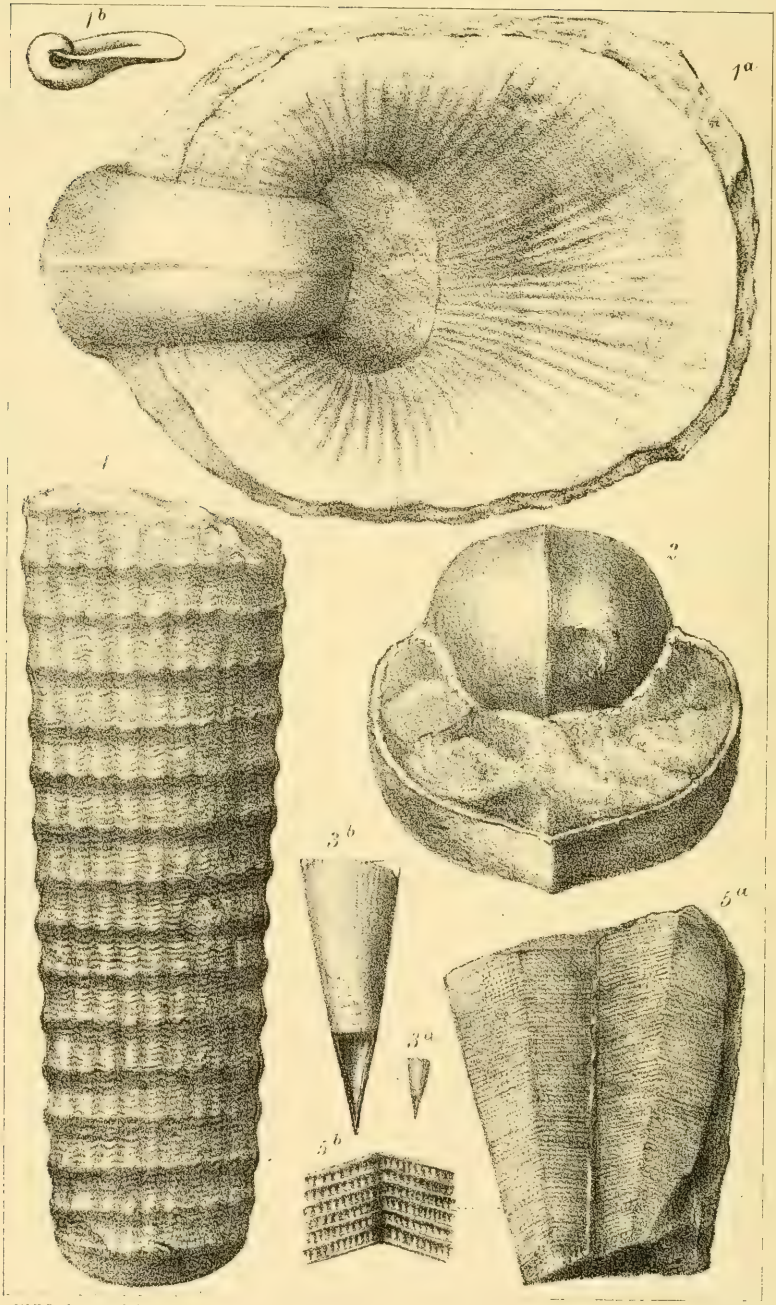
FIG. 11.—*a*, *b*. ACROCULIA PROTOTYPA, *Phillips*, sp.

Nerita, Mem. Geol. Surv., vol. ii., pt. 1, p. 358. *N. spirata*, Sil., Syst., p. 625, pl. xii., fig. 15. *Acroculia*, Sil., 4th edition, p. 531, pl. xxiv., fig. 8.
Original. *a*, Showing mouth; *b*, back of the same shell; Wenlock Limestone, Wenlock Edge. Mus. G. S. I.
WENLOCK.—Sil., 4th edition, p. 531. Localities, Woolhope Limestone, Presteign, Explanation of pl. xxiv.; ibid. "*Acroculia haliotis*, and *A. prototypa*, are exceedingly abundant, (the first especially), in the Wenlock Limestone;" ibid., p. 231.

FIG. 12.—ACROCULIA HALIOTIS, *Sowerby*, sp.

Nerita, Sil., Syst., p. 625, pl. xii., fig. 16. *Acroculia*, Sil., 4th edition, p. 531, pl. xxiv., fig. 9.
Original. From Wenlock Limestone, Ledbury, Herefordshire; Mus. G. S. I.
LLANDOVERY AND WENLOCK.—Sil., 4th edition, p. 531.
Llandovery Rocks, St. Ishmael's Church; Mus. G. S. I.
Wenlock Limestone, Ledbury, "exceedingly abundant in Wenlock Limestone;" ibid., p. 231. *Llandovery*, Ayrshire; *W. L.* Dudley; Cat. Brit. Foss., p. 239. It has been collected from the *Wenlock rocks* of the Dingle promontory, S. W. of Clogher Head, Kerry; and *Ludlow rocks*, Derrymore Glen, Kerry; Mus. G. S. I.

Characteristic British Fossils. Plate 22.



W. H. Baily, del. et lith. Printed by Forster & Co. Dublin

PLATE XXII.

FOSSILS OF THE WENLOCK ROCKS.

MOLLUSCA.—*HETEROPODA.*

FIG. 1.—*a*, *b*. BELLEROPHON DILATATUS, *Sowerby*.

Sil. Syst., p. 627, pl. xii., figs. 23, 24, Sil., 4th edition, Foss. 41, fig. 8, pl. xxv., figs. 5, 6.

a. From Sil. Syst., pl. xii., fig. 23. View of Aperture, natural size. Wenlock Shale, Burrington, near Ludlow.

b. From Sil., 4th edition, Foss. 41, fig. 8, p. 199. Side view, much reduced in size.

CARADOC TO WENLOCK.—Sil., 4th edition, p. 533; "one of the largest Heteropod or Nucleobranch shells in the Ludlow and Wenlock rocks;" ibid., p. 232. *Lower Llandovery*, Ayrshire; and *Upper Llandovery*, Shores of Lough Coolin, Co. Galway; and Lough Corrib, Co. Mayo; Mus. G. S. I. *Caradoc*, Desertcreat, Tyrone; Portl. Geol. Rep., p. 398, pl. xxix., fig. 1.

FIG. 2.—BELLEROPHON WENLOCKENSIS, *Sowerby*.

Sil. Syst., p. 705, pl. xiii., fig. 21, Sil., 4th edition, pl. xxv., fig. 7.

From the figure in Sil. Syst. op. cit. Wenlock shale, Croft, Malvern.

WENLOCK.—Sil., 4th edition, p. 534. This and the preceding species "are characteristic Wenlock fossils," Sil., 4th edition, p. 121. "*B. Wenlockensis* is very characteristic of the strata implied in its name;" ibid., p. 232.

PTEROPODA.

FIG. 3.—*a*, *b*. THECA ANCEPS, *Salter*.

Mem. Geol. Surv., vol. ii., pt. 1, p. 355, pl. xiv., fig. 1.

a, *b*. From Mem. Geol. Surv. op. cit.; *a*, Natural size; *b*, Enlarged; Wenlock Shale, Eastnor Castle, Malverns.

WENLOCK AND LUDLOW.—Sil., 4th edition, p. 534: "a Wenlock shale species;" ibid., p. 232.

FIG. 5.—*a, b.* CONULARIA SOWERBYI. *Defrance.*

Blainv. Malacol, p. 377, pl. xiv., fig. 2; *b*,—*e*, *C. quadrisulcata*, Miller, Sil. Syst., p. 626, pl. xii., fig. 22; *C. Sowerbyi*, Sil., 4th edition, p. 534, pl. xxv., fig. 10.

a, b. Original. a, Natural size; *b*, Enlarged portion; Wenlock Limestone, Malvern; Mus. G. S. I.

CARADOC TO LUDLOW.—Sil., 4th edition, p. 534. "This beautiful and variable species, which ranges upwards from the Caradoc strata to the Ludlow rocks, is often found in Wenlock limestone, and occurs with a rarer species, *C. subtilis*, in the Ludlow rocks of Westmoreland;" ibid. pp. 199, 232. Additional locality, Wenlock Limestone, Wenlock Edge, Sil., 4th edition, description of pl. xxv.

FIG. 4.—ORTHOCERAS ANNULATUM, *Sowerby.*

O. undulatum, Hisinger, var. *O. fimbriatum*, Sowerby.
O. annulatum, Sil. Syst., p. 632, pl. ix., fig. 5.
From Sil. Syst. *op. cit.* Wenlock limestone, near Malvern.
CARADOC TO WENLOCK.—Sil. 4th ed., p. 535. Found at numerous localities in Wales; Shropshire; also in Wenlock rocks at Doonquin, Co. Kerry. Coll. G. S. I.

Characteristic British Fossils. Plate 25

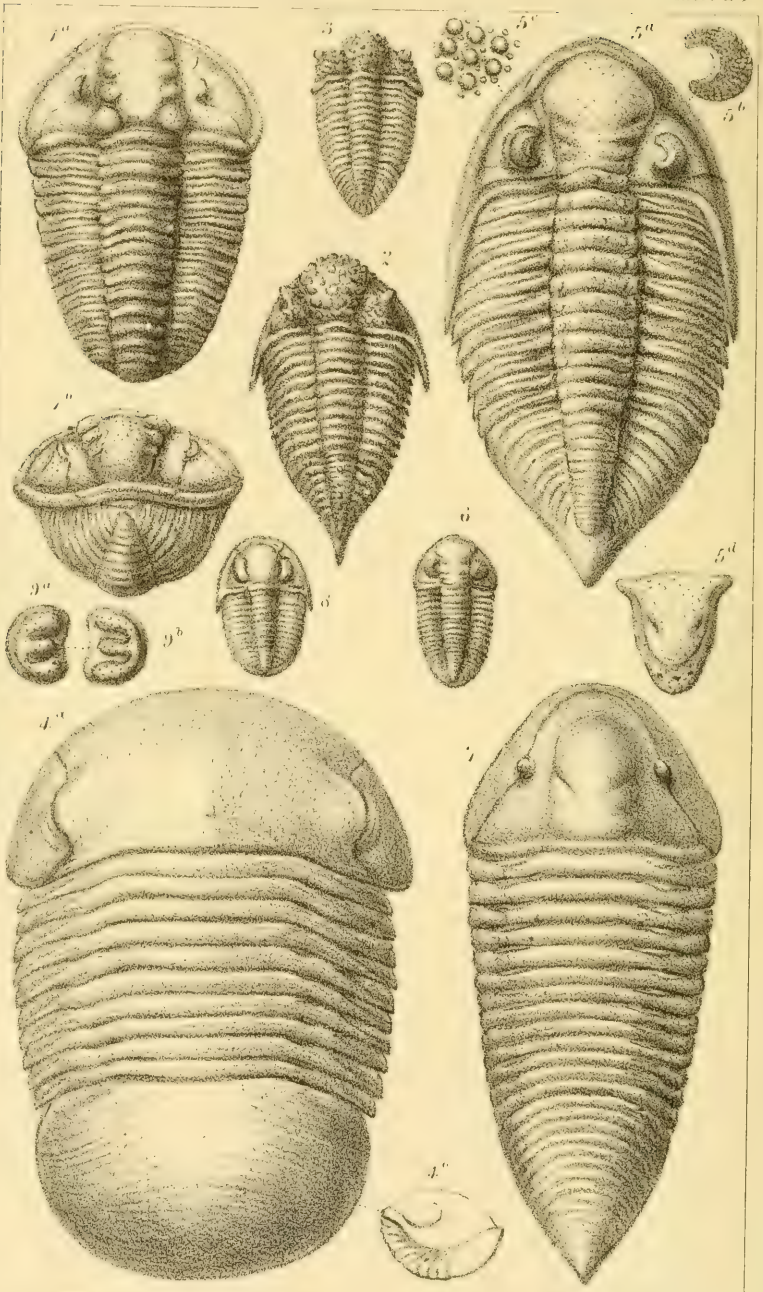


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PLATE XXIII.

FOSSILS OF THE WENLOCK ROCKS.

CRUSTACEA.—*TRILOBITA.*

FIG. 1.—*a*, *b*. CALYMENE BLUMENBACHII, *Brongniart.*

Crust. Foss., pl. i., fig. 1. Sil., 4th edition, p. 516, pl. xvii., fig. 1.
a. *Original.* Wenlock Limestone, Castle Hill, Dudley. Mus. G. S. I.
b. Coiled example. From Sil. Syst., pl. vii., fig. 7, Wenlock Limestone, Dudley.
CARADOC TO LUDLOW.—Sil. 4th edition, p. 516. "This common species was perhaps the most prolific of all the Silurian Trilobites. No other form had a greater vertical range, or is more widely diffused in geographical space than the long-known Dudley fossil. It has been found in abundance in the lower strata of the Caradoc formation near Snowdon; and from beds of Caradoc sandstone in Shropshire; a variety of this species also occurs in the Lower Silurian (Caradoc) rocks of Tyrone:" ibid., pp. 203, 4, 235. Additional localities: *Caradoc*, Bala; Berwyns.
Llandovery. Drummuck, Ayrshire.
Upper Silurian. Wenlock, Ledbury, Ludlow, Tortworth, Cat. Brit. Foss., p. 102. Dingle, Co. Kerry. Mus. G. S. I.

FIG. 2.—ENCRINURUS PUNCTATUS, *Brünnich*, sp.

?Calymene punctata, Sil. Syst., p. 661, pl. xxxiii., fig. 8.
E. punctatus, Mem. Geol. Surv., Dec. 7, p. 6. Description of pl. iv.
Original. Wenlock Shale, Malverns. Mus. G. S. I.
LLANDOVERY TO LUDLOW.—Sil., 4th edition, p. 517.
The tail of this species is figured (*ante*, p. 50, pl. xvi., fig. 12) as also characteristic of Llandovery rocks, especially in the Co. Galway, in rocks of the same age at Hope quarry, Shelve, Sil., 4th edition, description of pl. 10, figs. 4, 5. Additional localities: *Lower Silurian*; (*?Llandovery rocks.*) Pwllheli, Caernarvonshire; Mathyrafal, Montgomeryshire, N. Wales; S. Wales; Coniston, Westmoreland, *Upper Silurian*, Dudley, Usk, &c., Cat. Brit. Foss., p. 107. Ferriter's Cove, Co. Kerry. Mus. G. S. I.

FIG. 3.—ENCRINURUS VARIOLARIS, *Brongniart*, sp.

Calymene, Brong. Crust. Foss., pl. i., fig. 3 B. Sil. Syst., p. 655, pl. xiv., fig. 1; *Encrinurus*, Mem. Geol. Surv., Dec. 7, pl. iv., fig. 12, 13, p. 7. Sil., 4th edition, p. 517, pl. xviii., fig. 9.
Original. Wenlock Limestone, Dudley. Mus. G. S. I.

Wenlock.—Sil., 4th edition, p. 517. "*E. punctatus* and *E. variolaris* are known by the name 'Strawberry-headed' by collectors, and are found on every slab of Wenlock Limestone, but seldom perfect, except at Dudley;" ibid., p. 234. *Localities:* Wenlock Limestone and Shale, Dormington Wood, Woolhope; Dudley and Walsall (abundant). M. G. S., Dec. vii. Explanation of pl. iv., p. 7. Wenlock Edge, Sil. Syst., p. 655.

Fig. 4.—*a, b.* Illænus Barriensis, *Murchison*, sp.

Bumastus, Sil Syst., p. 656, pl. vii., bis., fig. 3, *a–d.*
Illænus, M. G. S., Dec. 2, pl. iii., and iv. Sil., 4th edition, pp. 111, 518. Foss. 17, fig. 2.
From M. G. S., Dec. 2, pl. iii.; *a*, reduced to two-thirds of natural size. Barr, Staffordshire; *b*, from the same plate, fig. 3, young coiled specimen.
Llandovery and Wenlock.—Sil., 4th edition, p. 518. "This fine fossil ranges from the lowest Wenlock beds to near the top of the Upper Silurian. It is one of the chief fossils, and is of the largest size in the Lower Wenlock or Woolhope Limestone, and is found in the pipe clay beds of that formation at Malvern; ibid., pp. 111, 121, and 235. *Localities:* Hay Head, near Barr, Staffordshire; Dudley; Ledbury. Woolhope, Nash Scar, Presteign, Herefordshire. M. G. S., Dec. 2. Description of pl. iii., and iv., p. 3.

Fig. 5.—*a, d.* Phacops caudatus, *Brünnich*, sp.

Asaphus, Brong. Crust. Foss., pl. ii., fig. 4 A–D. *A. caudatus et tuberculato-caudatus*, Sil. Syst., p. 654, pl. vii., fig. 8. *a, b, Phacops*, Mem. Geol. Surv., Dec. 2, pl. i. 4th edition, p. 520.
a. From M. G. S., Dec. 2, pl. i, fig. 1. *b.* Eye of a larger specimen from Sil., 4th edition, pl. xviii., fig. 1. *c.* Eye lenses enlarged. Wenlock Limestone, Dudley. *d.* Labrum or hypostome. From Dec. 2, pl. iii., fig. 3, Ledbury.
Landovery to Ludlow.—Sil., 4th edition, p. 520. "Distributed throughout the Silurian districts from *Llandovery* to *Upper Ludlow Rocks*." M. G. S., Dec. 2, p. 5. "Rare in Llandovery rocks," Sil., 4th edition, p. 213. With its variety, *P. longicaudatus*, very common in Wenlock and Ludlow Rocks;" ibid., p. 235. Westmoreland; Denbighshire. The Shales of Kircudbright, Scotland. M. G. S., Dec. 2, p. 5. The Dingle District, Co. Kerry. Mus. G. S. I.

Fig. 6.—Phacops Downinglæ, *Murchison*, sp.

Calymene? Sil. Syst., p. 655, pl. xiv., fig. 3. *Phacops*, Mem. Geol. Surv., vol. ii., pt. i., pl. v. figs. 2–4. Sil., 4th edition, p. 520, pl. xviii., fig. 2–5.
Original. Wenlock Limestone, Dudley. Mus. G. S. I.
Llandovery to Ludlow. Sil., 4th edition, p. 520. *Upper Llandovery.* Localities: Marloes Bay, Pembrokeshire; Norbury; and Bogmine, Shropshire. M. G. S., vol. ii., pt. i., p. 360. *Wenlock Limestone*, Dudley; *Ludlow Rock*, Pembrokeshire; Kendal, Westmoreland. "This Trilobite is one of the most characteristic, particularly in the environs of Dudley." Sil., 4th edition, p. 121.

FIG. 7.—HOMALONOTUS DELPHINOCEPHALUS, *Green*, sp.

alononotus. Sil. Syst., p. 651, pl. vii. bis, fig. 1. *a. b.* Sil., 4th edition, p. 111, Foss. 17, fig. 1.

Original. Reduced to half natural size, from a plaister of paris cast of Mr. Blackwell's specimen, Wenlock limestone, Dudley Castle, in Mus. G. S. I.

WENLOCK.—Sil., 4th edition, p. 518. "One of the chief fossils of the Lower Wenlock or Woolhope limestone, also occurring in the Wenlock limestone; ibid., pp. 111, 121. *Localities:* Woolhope and Dudley. Cat. Brit. Foss., p. 112.

FIG. 8.—PROETUS LATIFRONS, *M'Coy*, sp.

Forbesia. Sil. Foss. of Irel., p. 49, pl. iv., fig. 11. *Proetus.* Mem. Geol. Surv., vol. ii., pt. 1., p. 337, pl. iv., fig. 1. Sil., 4th edition, p. 520.

Original. Wenlock limestone, Dudley. Mus. G. S. I.

LLANDOVERY TO LUDLOW.—Sil., 4th edition, p. 520. "Far from rare in Wenlock Strata;" ibid., p. 235. *Llandovery,* Penwhapple Glen, Ayrshire. Mus. G. S. I. *Upper Llandovery,* common in the shale of Uggool, Ballaghaderreen, Co. Mayo. Sil. Foss. of Irel., p. 50. *Wenlock rocks,* Clogher, Kerry. Mus. G. S. I. Castle-craig-Gwyddon; Malverns. M. G. S., vol. iii., p. 360.

Upper Ludlow rock, Usk, Monmouthshire. M. G. S., vol. ii., pt. 1, p. 338. Kendal. Mus. G. S. I. Derrymore Glen, Kerry. Mus. G. S. I.

PHYLLOPODA.

FIG. 9.—*a, b.* BEYRICHIA KLŒDENI, *M'Coy.*

Ann. and Mag. Nat. Hist., second series, vol. xvi., pl. vi. Sil., 4th edition, p. 516.

a, b. From Sil., 4th edition, p. 234, Foss. 64, fig. 4. Enlarged figures of both valves (the natural size, about one-sixteenth of an inch, was inadvertently omitted to be shown.)

LLANDOVERY TO UPPER LUDLOW, Passage Beds, Sil., 4th, edition, p. 516. "The most abundant Upper Silurian species of these small bivalve crustaceans is very plentiful from the base of the Wenlock shale to the highest Ludlow stratum, varies greatly in shape, but is a good index of the Upper Silurian, though found sometimes in the Llandovery rocks:" ibid., p. 236. *Localities:* Shropshire; North and South Wales; in Ireland, at Curraculleuagh, Co. Kerry.

PLATE XXIV.

FOSSILS OF THE LUDLOW ROCKS.

ZOOPHYTA.—*ANTHOZOA.*

FIG. 1.—FAVOSITES FIBROSUS, *Goldfuss*, sp.

Calamopora, Petr. Germaniæ, p. 82, pl. xxviii., fig. 3, 4. *Alveolites*, Sil. Syst., p. 681, pl. xv., fig. 1. *Stenopora*, Brit. Pal. Foss., p. 24. *Favosites*, Brit. Foss. Corals, p. 261, pl. lxi., fig. 5. Sil., 4th edition, p. 510.

From Sil. Syst., pl. v., fig. 27, and the same figure in Sil., 4th edition, pl. xxiv., fig. 1, in which the coral is seen incrusting the small univalve shells Cyclonema corallii. Upper Ludlow, Trewerne Hills, Radnorshire.

LLANDEILO TO LUDLOW.—Branching and hemispherical varieties of this widely-distributed coral are figured with the fossils of the Caradoc Rocks. Plate x., fig. 1. *a-d.*, under the name of *Stenopora fibrosa;* the variety now figured "is found frequently incrusting particular species of shells. Cyclonema corallii and Murchisonia corallii of the Ludlow Rocks, as their names imply, being its favourite habitats." Sil., 4th edition, p. 132. *Locality:* near Ludlow.

ECHINODERMATA.—*ASTEROIDEA.*

FIG. 2.—*a, b.* PALASTERINA PRIMÆVA, *Forbes*, sp.

Uraster, Mem. Geol. Surv., vol. ii., pt. ii. p. 463; and Decade 1, pl. i. *Palasterina*, Ann. and Mag. Nat. Hist., vol. xx., p. 327.

a. Upper surface. *b.* Under surface. From the figures in the Decade cited, pl. i., fig. 2, *a, b;* and from a specimen in the Mus. G. S. I. *Loc.:* Ludlow Rocks, Underbarrow, near Kendal.

LUDLOW.—Sil., 4th edition, p. 513. "The most common species of Starfish in the Ludlow Rocks of Kendal;" ibid., p. 225. *Localities:* Underbarrow, Westmoreland; Leintwardine, Shropshire.

FIG. 3.—PALÆOCOMA MARSTONI, *Salter.*

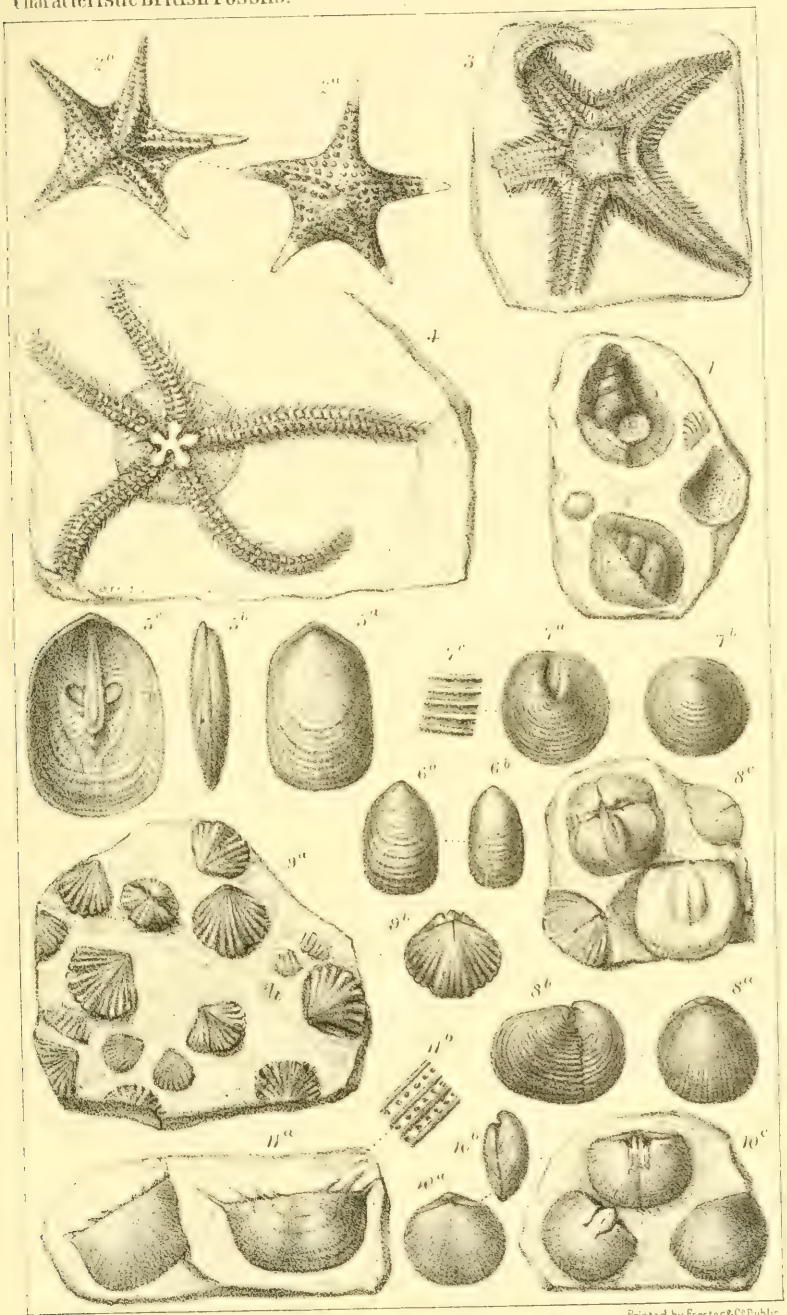
Ann. and Mag. Nat. Hist., ser. ii., vol. xx., p. 328.

Original. Under surface, Lower Ludlow, Church Hill, Leintwardine. Mus. G. S. I.

LUDLOW.—Sil., 4th edition, p. 513.

FIG. 4.—PROTASTER MILTONI, *Salter.*

Ann. and Mag. Nat. Hist., ser. ii., vol. xx., p. 330.



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Original. Under surface, Lower Ludlow, Leintwardine. Mus. G. S. I.
LUDLOW.—Sil., 4th edition, p. 513. "Abundant and of all sizes in the quarry at Leintwardine." Salter, op. cit., p. 331.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 5.—*a*, *b*, *c*. LINGULA LEWISII, *Sowerby.*

Sil. Syst., p. 615, pl. vi., fig. 9.
a. View of upper valve. *b*. Side view of both valves. *c*. Interior. All from Mr. Davidson's figures in Mon. Brit. Sil .Brach. Pal. Soc., pl. iii., figs. 3 and 5. Aymestry Limestone, Sedgley, and near Ludlow.
WENLOCK AND LUDLOW.—Sil., 4th edition, p. 525. "One of the commonest species of the Middle Ludlow, or Aymestry Rock;" ibid., pp. 227-8. "It is stated to have been found in the *Woolhope beds*, *Wenlock Shale*, and *Limestone*, *Lower Ludlow*, and *Aymestry Limestone;* but is most abundant in the last-named formation. It occurs also in the *Upper Ludlow* at Whitecliff, near Ludlow." Brit. Sil. Brach., pp 35, 36. Prof. Phillips, in his memoir on the Malvern Hills, &c., states its occurrence at various localities in the Malvern, Abberley, Woolhope, Usk, Llandeilo, and Freshwater Districts. Mem. Geol. Surv., vol. ii., pt. i., p. 275.

FIG. 6.—*a*, *b*. LINGULA CORNEA, *Sowerby.*

Sil. Syst., p. 603, pl. iii., fig. 3.
a, *b*. From Brit. Sil. Brach., pl. ii., fig. 30, 34. Passage beds, Railway near Ludlow.
LUDLOW AND PASSAGE BEDS.—Sil., 4th edition, p. 525. "Abounds in the Tilestone of the Upper Ludlow;" ibid., p. 228. *Localities:* Tin Mill, Downton, Railway cutting north end of Ludlow; Brockhill and Steventon Turnpike near Ludlow. Brit. Sil. Brach., p. 47.

FIG. 7.—*a*, *b*, *c*. DISCINA RUGATA, *Sowerby*, sp.

Orbicula. Sil. Syst., p. 610, pl. iv., fig. 47, 48, v., fig. 11.
Discina. Sil., 4th edition, p. 524, pl. xx., fig. 1, 2, xxxv., fig. 27.
a. *Original.* Lower or attached valve showing oval fissure.
b. *Original.* Upper or free valve.
c. *Original.* Portion of surface enlarged, showing concentric ridges, Upper Ludlow, Hole Farm, Abberley. Mus. G. S. I.

WENLOCK AND LUDLOW.—Sil., 4th edition, p. 524. "A common Ludlow species;" ibid., p. 226. *Localities*: Ludlow Promontory, very abundant; it occurs also in *Upper Ludlow* rock, at Ledbury; and is frequent in *Wenlock Shale*, near Dudley. Brit. Sil. Brach., pp. 64-65. Prof. Phillips in his Memoir op. cit., records its distribution in *Upper Ludlow* and *Aymestry Rocks* of the Malvern, Abberley, Woolhope, May Hill, Tortworth, Usk, and Builth Districts. Prof. M'Coy also states its occurrence in Upper Ludlow Rocks at Kendal, Westmoreland.

FIG. 8.—*a*, *b*, *c*. RHYNCHONELLA WILSONI, *Sowerby*, sp.

Terebratula, J. Sowerby, Min. Conch., pl. cxviii., fig. 3. Sil. Syst., p. 615, pl. vi., fig. 7*a*. *Rhynchonella*, Sil., 4th edition, p. 527.

a, Front view. *b*. Side view. From Brit. Sil. Brach., pl. xxiii., fig. 1, 1*a*. Upper Ludlow, S. W. of Hazle, Woolhope.

c. *Original*. Internal casts. Black Point, Dingle Promontory, Kerry. Mus. G. S. I.

LLANDOVERY TO LUDLOW.—Sil., 4th edition, p. 527. "This species has been met with in Llandovery Rocks of the S. of Scotland," and Tynewidd, Llandovery, "and is thenceforward persistent throughout all the deposits to the Upper Ludlow inclusive;" ibid., p. 210, "one of the species which chiefly distinguish the Ludlow Rocks; ibid., p. 226." In *Upper Ludlow* Rocks it occurs at Brockton, and Burton; Delbury, Salop; near Malvern, and at various places in the Woolhope District. In *Aymestry Limestone* at Sedgley; Aymestry; Abberley; Llanbaddock, &c., in the Usk District. In *Lower Ludlow* Rocks, of the Builth District. In *Wenlock Limestone* and *Shale*, near Dudley, Walsall; East of Ledbury; Malvern; &c., and in beds above the Denbighshire Grit, North Wales. In Scotland it has been found in the Wenlock Shale of the Pentland Hills, and in the same formation at Clogher Head, Kerry. Brit. Sil. Brach., pp. 171-2.

FIG. 9.—*a*, *b*, RHYNCHONELLA NUCULA, *Sowerby*, sp.

Terebratula. Sil. Syst., p. 611, pl. iii., fig. 1, v., fig. 20.

Rhynchonella. Sil., 4th edition, p. 527.

a. *Original*. A group of shells in various positions, Upper Ludlow, Lilleshall, Shropshire. Mus. G. S. I.

b. *Original*. Internal cast, Upper Ludlow, Malvern. Mus. G. S. I.

LLANDOVERY TO LUDLOW. Sil., 4th edition, p. 527. "A common fossil of the Upper Ludlow Rock;" ibid.; pp. 135, 226. *Localities: Lower Llandovery*, Cefn Rhyddan, &c., *Upper Llandovery*, Worcester Beacon; Marloe's Bay; May Hill; Damory Bridge. *Woolhope Limestone*, Woolhope, Bogmine Shelve. *Wenlock Limestone*, Eastnor Castle; Malvern; Woolhope District; Wenlock Edge, Dudley; Rock Farm, Longhope; Plas Madoc, &c., North Wales; *Lower Ludlow*, Woolhope District, Leintwardine, Shropshire, &c. *Aymestry Limestone*, Malvern, Woolhope, and Usk Districts, &c. *Upper Ludlow*, Malvern; May Hill, and Builth Districts; Collinfield and Benson Knot, Westmoreland. In Scotland it occurs in the *Wenlock Shales* of the Pentland Hills; and in Ireland in *Wenlock Rocks* of the Dingle Promontory, Co. Kerry. Brit. Sil. Brach., pp. 183-4.

FIG. 10.—*a*, *b*, *c*. ORTHIS LUNATA, *Sowerby*.

Sil. Syst., p. 611, pl. iii., fig. 12; v., fig. 15.

a. External Shell. *b*. Side view of do. From Brit. Sil. Brach., pl. xxviii., fig. 1. Upper Ludlow, Wonder, Woolhope. *c*. Internal and external casts;" ibid., fig. 2, Whitecliff, near Ludlow. *Ludlow*. "This species occurs abundantly in the Upper Ludlow at Whitecliff, and in several other localities near Ludlow in Shropshire. Prof. Phillips and Mr.

Salter record its presence in rocks of a similar age at various localities in the Malvern, Abberley, Woolhope, Usk, Builth, and Llandeilo Districts." Brit. Sil. Brach., p. 216.

FIG. 11.—*a*, *b*. CHONETES STRIATELLA, *Dalman*, sp.

Orthis, Dalman, *Leptæna lata*, Von. Buch. Sil. Syst., p. 610, pl. iii., fig. 10 *b*. v., fig. 13. *Chonetes lata*, and *striatella*, Sil., 4th edition, p. 524, pl. xx., fig. 8.

a. From Sil. Syst., pl. v., fig. 13, *Upper Ludlow*, Ludlow. *b*. *Original*. Magnified striæ, from a specimen in Mus. G. S. I. Upper Ludlow, Kendal, Westmoreland.

WENLOCK AND LUDLOW.—In the *Woolhope Beds* it occurs east of Merchlin Conway. In the *Wenlock Beds*, near Walsall and Wenlock. In *Lower Ludlow*, at Vinnal Hill, &c. In *Aymestry limestone*, Shucknall Hill, &c. In *Upper Ludlow* it is especially abundant at a great number of localities in the Malvern, Abberley, Usk, and Builth Districts; and at Kendal, Westmoreland. In Scotland it occurs in the Pentland Hills. In Ireland at Ferriter's Cove, and Doonquin, Dingle, Kerry. Brit. Sil. Brach., p. 333.

PLATE XXV.

FOSSILS OF THE LUDLOW ROCKS.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 1.—*a*, *b*. LINGULA LATA, *Sowerby.*

Sil. Syst., p. 618, pl. viii., fig. 11.

a, *b*. From Brit. Sil. Brach., pl. iii., fig. 40, 42. Lower Ludlow, Elton, near Ludlow.

Ludlow. Sil., 4th edition, p. 525. Mr. Davidson, in Brit. Sil. Brach., p. 50, states the occurrence of this small but characteristic shell, in the Aymestry Limestone of Mocktree, near Leintwardine, Shropshire; in the typical localities near the town of Ludlow it is found in the Lower Ludlow rocks, as well as at Ledbury and Aymestry. It also occurs at Kendal, and in Scotland, in the Ludlow beds of the Pentland Hills.

FIG. 2.—*a*, *b*, *c*. PENTAMERUS KNIGHTII, *Sowerby.*

Min. Conch., pl. xxviii. (*P. Aylesfordii*); ibid., pl. xxix., Sil. Syst., p. 615, pl. vi., fig. 8.

a. *Original.* Front view; reduced to two-thirds of natural size. *b*. Side view of the same shell, Aymestry limestone, Aymestry. Mus. G. S. I. *c*. From Brit. Sil. Brach., pl. xvi., fig. 3. Longitudinal section, showing internal plates, Aymestry limestone, Bodenham, Woolhope.

WENLOCK AND LUDLOW.—Sil., 4th edition, p. 527. "The most characteristic shell of the Aymestry Limestone;" ibid., p. 130. P. Knightii occurs rarely in the Wenlock and Ludlow formations; but it is exceedingly common in the *Aymestry Limestone*, at Mocktree, near Ludlow; at Aymestry, in Herefordshire; and at Leintwardine, Shropshire. It occurs near Wolverhampton, and in the Abberley and Woolhope Districts, all in the *Aymestry Limestone*, as well as in the *Wenlock Limestone* of Walsall and Wenlock Edge. Brit. Sil. Brach., p. 144. In Ireland it has been found at Doonquin and Great Blasket Island, Kerry.

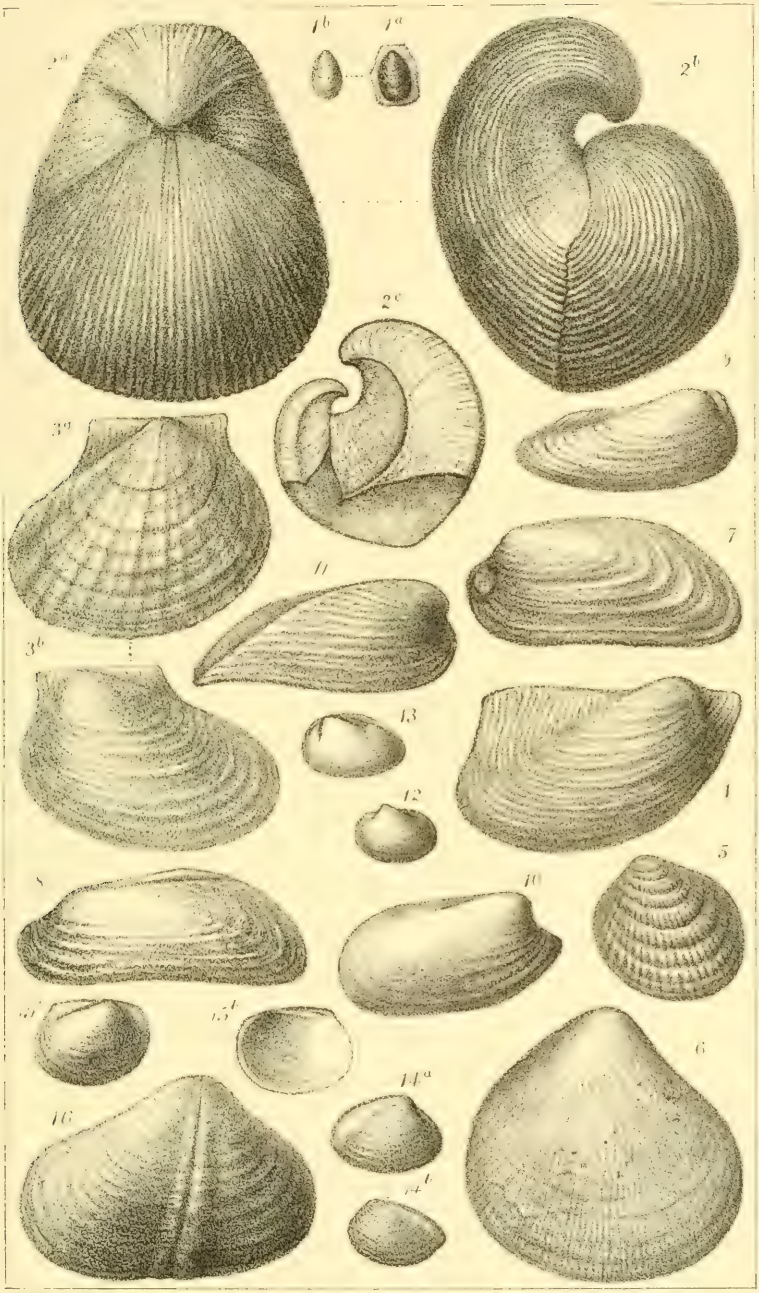
CONCHIFERA.

FIG. 3.—*a*, *b*. AVICULA DANBYI, *M'Coy.*

Brit. Pal. Foss. p. 258, pl. ii., fig. 11-15.

a. *Original.* Reduced to two-thirds of natural size. Left, or convex and radiated valve. Upper Ludlow, Kendal. Mus. G. S. I. *b*. From Brit. Pal. Foss., pl. ii., fig. 15. Reduced to half natural size. Right, or flat unradiated valve, from the same locality.

Characteristic British Fossils. Plate 25.



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Ludlow. Sil., 4th edition, p. 528. "Very abundant in the greenish Upper Ludlow quartzites of Benson Knot, Kendal, Westmoreland." Brit. Pal. Foss., p. 258.

FIG. 4.—PTERINEA RETROFLEXA, *Wahlenberg*, sp.

Avicula, Sil. Syst., p. 609, pl. v., fig. 9. *Pterinea*, Sil., 4th edition, p. 529.
Original.? Ludlow rocks, Clogher, Dingle, Co. Kerry.
Llandovery to Ludlow.—Sil., 4th edition, p. 529. "In the *Llandovery rocks* of Malvern, a variety of this species is plentiful, also in the Connemara tract of Galway;" ibid., p. 211. It is also an abundant species in the *Wenlock limestone;*" ibid., p. 121, and has been found in *Wenlock rocks*, North Wales. Mem. Geol. Surv., vol. iii., pp. 278-9; and in the *Upper Ludlow* of the Malverns, and Kendal, in Westmoreland. Prof. Phillips records its occurrence in the Malvern, Abberley, Woolhope, May Hill, Usk, Builth, Llandeilo, and Marloes Districts. Mem. Geol. Surv., vol. ii., pt. i., p. 271. In Ireland it is not unfrequent in Wenlock and Ludlow rocks of the Dingle Promontory, Co. Kerry.

FIG. 5.—CARDIOLA INTERRUPTA, *Sowerby*.

Sil. Syst., p. 617, pl. viii., fig. 5.
Original. Lower Ludlow, Vinnal Hill, Ludlow. Mus. G. S. I.
Caradoc, Wenlock, and Ludlow.—Sil., 4th edition, p. 529. "The most common of the Lamellibranchiate shells, in the Lower Ludlow; this species, formerly believed to be peculiar to this zone, has also been found in the Caradoc formation;" ibid., p. 127. It is recorded from Abberley, Malvern, Woolhope, Usk, and Builth Districts, in Wenlock limestone, Lower Ludlow, Aymestry limestone, and Upper Ludlow. Mem. Geol. Surv., vol ii., pt. i., p. 265. In *Wenlock rocks*, near Llansannan, &c., North Wales, at several localities. Mem. Geol. Surv., vol., iii., pp. 278-9. *Lower Ludlow*, Aymestry: Breidden Hills: Radnor Forest, &c. Sil. Syst., p. 617. In Ireland it has been collected by the Geol. Survey, from Derrymore Glen, Co. Kerry.

FIG. 6.—?CARDIOLA STRIATA, *Sowerby*, sp.

Cardium? Sil. Syst., p. 614, pl. vi., fig. 2. Cardiola? Sil., 4th edition, p. 529.
Original. Reduced to half natural size. Lower Ludlow, Leintwardine. Mus. G. S. I.
Wenlock and Ludlow.—Sil., 4th edition, p. 529. "Equally characteristic with the preceding species, and as yet known only in Upper Silurian rocks. It is found in all the fossil-bearing localities of Shropshire and the neighbouring regions;" ibid., p. 127. It occurs in *Aymestry limestone*, Aymestry, and in *Lower Ludlow*, near Shelderton. Sil. Syst., p. 614. It is recorded as occurring in *Aymestry limestone* and *Upper Ludlow rocks* in the Malvern, Woolhope, and Usk Districts. Mem. Geol. Surv., vol. ii., pt. i., p. 265.

FIG. 7.—MODIOLOPSIS COMPLANATA, *Sowerby*, sp.

Pullastra. Sil. Syst., p. 609. *Modiolopsis*. Sil., 4th edition, p. 530.
From the figure in Sil. Syst., pl. v., fig. 7. Upper Ludlow, near Bridgnorth.
Ludlow. Sil., 4th edition, p. 530. An Upper Ludlow fossil of the Mytiloid group of shells; ibid., p. 229. It is recorded under the name of *Mytilus complanatus*, as occurring in the Usk, Llandeilo, and Freshwater Districts. Mem. Geol. Surv., vol. ii., pt. i., p. 267. In Ireland it has been collected at Clogher, Kerry. Mus. G. S. I.

FIG. 8.—MODIOLOPSIS PLATYPHYLLA, *Salter*, sp.

Mytilus. Mem. Geol. Surv., vol. ii., pt. 1, p. 268, and Appendix, p. 364.
Modiolopsis. Sil., 4th edition, pp. 229, 530.
Reduced to two-thirds of natural size. From the figure in Mem. Geol. Surv., vol. ii., pt. 1, pl. xx., fig. 13. Uppermost Ludlow (Tilestone), Trichrug, Llandeilo.
LUDLOW.—Sil., 4th edition, p. 530. "Characteristic of the uppermost Ludlow beds;" ibid., p. 229.

FIG. 9.—ORTHONOTA AMYGDALINA, *Sowerby*, sp.

Cypricardia? Sil. Syst., p. 609. *Orthonota*, Sil., 4th edition, p. 530.
From the figure in Sil. Syst., pl. v., fig. 2. Upper Ludlow, Ludlow.
LLANDOVERY AND LUDLOW.—Sil., 4th edition, p. 530. "Abundant in the Ludlow Promontory, and very generally characteristic of the Upper Ludlow rocks." Sil. Syst., p. 609. It is recorded as occurring in the Malvern, Abberley, Woolhope, May Hill, Usk, Builth, and Llandeilo Districts. Mem. Geol. Surv., vol. ii., pt. 1, p. 265. It is also common in the Upper Ludlow quartzite of Kendal, Westmoreland.

FIG. 10.—ORTHONOTA PRORA, *Salter*.

O. semisulcata, M'Coy, Brit. Pal. Foss., p. 275. *O. prora*, Sil., 4th edition, pp. 229, 530.
From the figure in Brit. Pal. Foss., pl. 1 *K*., fig. 25. Upper Ludlow, near Kendal.
LUDLOW.—Sil., 4th edition, p. 530. "Not uncommon in the quartzite of Kirkby Moor, Kendal." Brit. Pal. Foss., p. 275.

FIG. 11.—GONIOPHORA CYMBŒFORMIS, *Sowerby*, sp.

Cypricardia, Sil. Syst., pp. 602, 609. *Goniophora*, Sil., 4th edition, p. 530.
From the figure in Sil. Syst., pl. v., fig. 6. Upper Ludlow, Ludlow.
LLANDOVERY AND LUDLOW.—Sil., 4th edition, p. 530. "One of the most abundant Upper Ludlow shells;" ibid., p. 229. It is recorded as occurring in the Malvern, Abberley, Woolhope, May Hill, Usk, Builth, Llandeilo, and Marloes Districts. Mem. Geol. Surv., vol. ii., pt. 1, p. 267.

FIG. 12.—CTENODONTA, ANGLICA, *D'Orbigny*, sp.

Nucula? ovalis, Sil. Syst., p. 609. *Ctenodonta Anglica*, Sil., 4th ed., p. 529.
From the figure in Sil. Syst., pl. v., fig. 8. *Upper Ludlow*, Trewerne Hills, Radnorshire.
LANDOVERY TO LUDLOW.—Sil., 4th ed., p. 529. This species is stated to occur in Upper Ludlow rocks at several localities in the Malvern District; also in the Woolhope, Usk, and Llandeilo Districts. Mem. Geol. Surv., vol. ii., pt. 1, p. 269; and in the Wenlock rocks at Fron Fawr, near Llansannan, North Wales. M. G. S., vol. iii., p. 280.

FIG. 13.—CUCULLELA ANTIQUA, *Sowerby*, sp.

Cucullela, Sil. Syst., p. 602. *Cucullela*, Sil., 4th ed., p. 530.
From the figure in Sil., 4th ed., pl. xxxiv., fig. 16. Upper Ludlow, Horeb Chapel, near Llandovery.
? CARADOC, LLANDOVERY, AND LUDLOW.—Sil., 4th ed., p. 530. "A common shell in the *Uppermost Ludlow*, 'Tilestones;'" ibid., p. 230. It is recorded as occurring in the Malvern, Abberley, Woolhope, Usk, Llandeilo, and Freshwater Districts. Mem. Geol. Surv., vol. ii., pt. 1, p. 268; also in Wenlock rocks at Mynydd, Tryfan, near Llansannan, North Wales. Mem. G. S., vol. iii., p. 280.

FIG. 14.—*a*, *b*. CUCULLELA COARCTATA, *Phillips*, sp.

Nucula, Mem. Geol. Surv., vol. ii., pt. 1, p. 366. *Cucullela*, Sil., 4th ed., p. 530.
From the figures in M. G. S., vol. ii., pt. 1, pl. xxii., figs. 1 and 2. Ludlow rocks, Freshwater East, Pembrokeshire.
UDLOW.—Sil., 4th ed., p. 530. "Found in great plenty in the *Ludlow rocks* of Pembrokeshire, and occurs also in the *Wenlock Shale*. It is also recorded as occurring in Westmoreland and Denbighshire. Cat. Brit. Foss., p. 194.

FIG. 15.—*a*, *b*. ANODONTOPSIS PEROVALIS, *Salter*, sp.

Mytilus. Mem. Geol. Surv., vol. ii., pt. 1, p. 363. *Anodontopsis*. Sil., 4th ed., p. 529.
From the figures in M. G. S., vol. ii., pt. 1, pl. xx., figs. 2, 2 *a*. Ludlow rocks, Llanbadoc, Usk.
Ludlow.—Sil., 4th ed., p. 529.

FIG. 16.—GRAMMYSIA TRIANGULATA, *Salter*, sp.

Orthonota, Mem. Geol. Surv., vol. ii., pt. 1, p. 361.
Grammysia, Sil., 4th ed., p. 530.
Original. Ludlow rocks, Kendal.
WENLOCK AND LUDLOW.—Sil., 4th ed., p. 530. "A typical Ludlow (Tilestone) fossil;" ibid., p. 230. Trichrug, Llangadoc, and Westmoreland.

PLATE XXVI.

FOSSILS OF THE LUDLOW ROCKS.

MOLLUSCA.—*GASTEROPODA.*

FIG. 1.—LOXONOMA SINUOSA, *Sowerby*, sp.

Terebra, Sil. Syst., p. 619. *Loxonema*, Sil., 4th ed., p. 532.
From Sil. Syst., pl. viii., fig. 15, Lower Ludlow, Aymestry.

LLANDOVERY AND LUDLOW. Sil., 4th ed, p. 532. "Chiefly a Ludlow rock species;" ibid., p. 231. It is recorded as occurring in the Malvern, Usk, Llandeilo, and Marloes Districts. Mem. G. S., vol. ii., pt. 1, p. 258; and in Wenlock rocks, near Llansannan, North Wales. Mem. Surv., vol. iii., p. 280. In Ireland it has been collected by the Geol. Surv. at Curracullenagh, Co. Kerry.

FIG. 2.—HOLOPELLA OBSOLETA, *Sowerby*, sp.

Turritella, Sil. Syst., p. 603. *Holopella*, Sil., 4th ed., p. 532.
From Sil. Syst., pl. iii., fig. 7*a*, Upper Ludlow, Horeb Chapel, Felindre.

LLANDOVERY AND LUDLOW. Sil., 4th ed., p. 532. "A frequent fossil of the uppermost Ludlow rocks in Westmoreland, Shropshire, and South Wales;" ibid., p. 231. Its occurrence is recorded in the Malvern, Usk, and Llandeilo Districts. Mem. G. S., vol. ii., pt. 1; also in Upper Llandovery at the Bogmine, near Shelve, Shropshire. M. G. S., vol. iii., p. 362; and at Tortworth, Gloucestershire. Sil., 4th edition, Explanation to pl. ix.

FIG. 3.—*a*, *b*, *c*. PLATYSCHISMA HELICITES, *Sowerby*, sp.

Trochus, Sil. Syst., p. 603. *Platyschisma*, Sil., 4th ed., p. 533.
From the figures in Sil. Syst., pl. iii., fig. 5; and Sil., 4th ed., pl. xxiv., fig. 12, 13. Upper Ludlow, Horeb Chapel.

LLANDEILO, LLANDOVERY, LUDLOW, AND PASSAGE BEDS. Sil., 4th ed., p. 533. "The Tilestone is crowded with this species," ibid., p. 231. It occurs in the Llandeilo and Marloes Districts. Mem. G. S., vol. ii., pt. 1, p. 260; also in Upper Ludlow Rocks, at Trichrug, Llangadoc, and Kendal, Westmoreland; Mus. G. S. I.

Characteristic British Fossils. Plate 26.

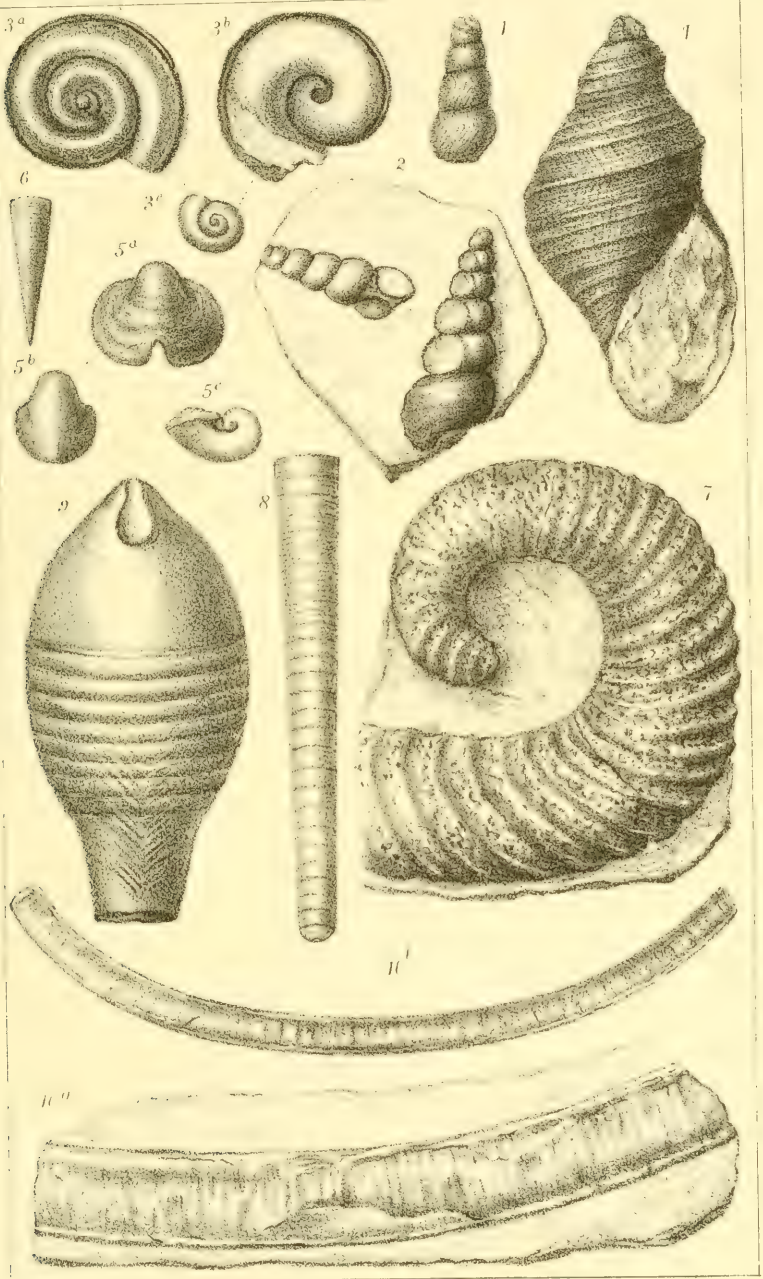

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FIG. 4.—MURCHISONIA LLOYDII, *Sowerby*, sp.

Pleurotomaria, Sil. Syst., p. 619.
From Sil. Syst., pl. viii., fig. 14. Lower Ludlow; Shelderton, Aymestry.
WENLOCK and LUDLOW.—Sil., 4th ed., p. 532. "Abounds in the *Middle* and *Lower Ludlow*, and is frequent in *Wenlock Limestone*;" ibid., p. 231. It is recorded as occurring in the Malvern, Woolhope, May Hill, Usk, Freshwater, and Marloes Districts. Mem. G. S., vol. ii., part i., p. 260, and in *Wenlock rocks*, at Craig-hir, and near Llansannan, North Wales. M. G. S., vol. iii., pp. 278, 280. In Ireland it has been found at Curracullenagh and Derrymore Glen, Co. Kerry. Mus. G. S. I.

HETEROPODA.

FIG. 5.—*a*, *b*, *c*. BELLEROPHON EXPANSUS, *Sowerby*.

B. globatus, Sil. Syst., p. 604. *B. expansus*, ibid., p. 613.
a. *Original*. Dorsal view; from Upper Ludlow rocks, Kendal. Mus. G. S. I. *b*, *c*. Young examples; from the Figures in Sil. Syst., pl. iii., fig. 15. Upper Ludlow, Felindre.
LLANDOVERY and LUDLOW.—Sil., 4th ed., p. 533. "Characteristic of the Upper Ludlow rock;" ibid., p. 232. It occurs in the Malvern, Abberley, Builth, Llandeilo, and Freshwater Districts. M. G. S., vol. ii., part i., and in Upper Llandovery Rocks at Norbury; and Bogmine, Shropshire. M. G. S., vol. iii., pp. 362, 363.

PTEROPODA.

FIG. 6.—THECA FORBESII, *Sharpe*.

Journ. Geol. Soc., vol. ii., p. 314.
Original. Upper Ludlow, Kendal. Mus. G. S. I.
WENLOCK and LUDLOW.—Sil., 4th ed., p. 534. It is recorded as occurring in the Abberley, Woolhope, Usk, Builth, and Llandeilo Districts. M. G. S., vol. ii., part i., p. 255, and in *Wenlock rocks*, near Llansannan. M. G. S., vol. iii., p. 280.

CEPHALOPODA.

FIG. 7.—LITUITES ? GIGANTEUS, *Sowerby*.

Sil. Syst., p. 622.
Reduced to half natural size. From Sil. Syst., pl. xi., fig. 4. Lower Ludlow, Mocktree Hays.
WENLOCK and LUDLOW.—Sil., 4th ed., p. 535. "One of the finest fossils from Leintwardine and Malvern;" ibid., p. 233. It occurs also in the Malvern, Abberley, Usk, and Llandeilo Districts. M. G. S., vol. iii., part i., p. 150.

FIG. 8.—ORTHOCERAS LUDENSE, *Sowerby*.

Sil. Syst., p. 619.
From the reduced figure in Sil., 4th ed., p. 232. Foss. 62, fig. 2 (reduced from a specimen two feet in length). Lower Ludlow, Ludlow.
LUDLOW.—Sil., 4th ed., p. 535. "A frequent Upper Ludlow form;" ibid., p. 232. It is recorded as occurring in the Malvern and Builth Districts. M. G. S., vol. iii., part i., p. 247.

FIG. 9.—PHRAGMOCERAS PYRIFORME, *Sowerby*, sp.

Orthoceras. Sil. Syst., p. 620. *Phragmoceras*. Sil., 4th ed., p. 536. Reduced to half the natural size. From Sil. Syst., pl. viii., fig. 19. Lower Ludlow, Leintwardine, Shropshire (abundant).
LUDLOW.—Sil., 4th ed., p. 536. It occurs in the Malvern, Abberley, Woolhope, and Llandeilo Districts. M. G. S., vol. iii., pp. 250, 251.

ANNELIDA.

FIG. 10.—*a*, *b*. SERPULITES LONGISSIMUS, *Murchison*.

Sil. Syst., p. 608.
a. *Original*. Fragment of a compressed tube (natural size). Upper Ludlow, Woodbury Hill, Abberley. Mus. G. S. I.
b. *Original*. Reduced to half natural size, from a specimen ten and a-half inches long. Upper Ludlow, Malverns. Mus. G. S. I.
WENLOCK and LUDLOW.—Sil., 4th ed., p. 514. "Very common in the *Ludlow rock;* some of the specimens measure twenty inches along its curve;" ibid., p. 234. "Very general throughout the *Upper Ludlow rock* of Salop, Hereford, Radnor, &c." Sil. Syst., p. 609. It occurs in the Malvern, Abberley, Woolhope, May Hill, Usk, and Builth Districts. M. G. S., vol. ii., part i., p. 228.

Characteristic British Fossils. Plate 27

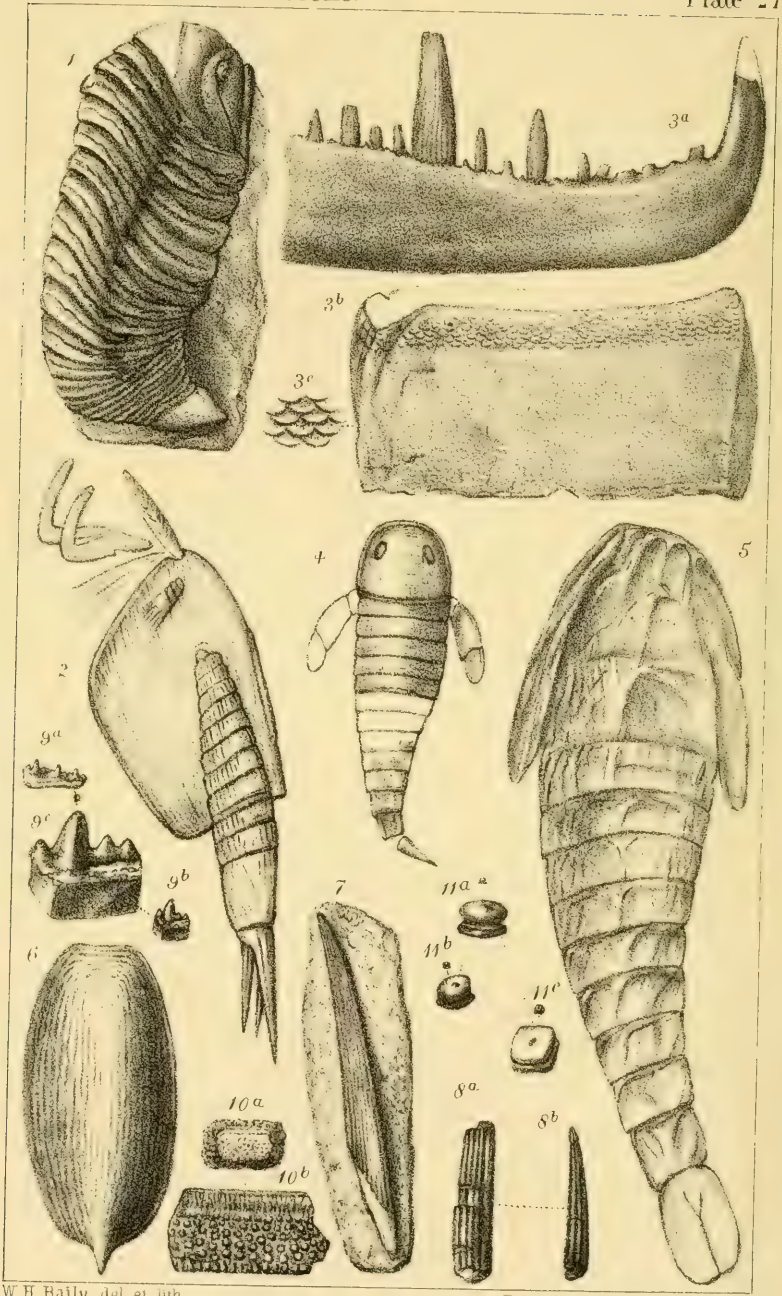

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PLATE XXVII.

FOSSILS OF THE LUDLOW ROCKS.

CRUSTACEA.—*TRILOBITA.*

FIG. 1.—HOMALONOTUS KNIGHTII, *König.*

Icon. Foss., fiig. 65. *H. Knightii* and *Ludensis*, Sil. Syst., pl. vii., figs. 1–4. *H. Knightii*, Siluria, 4th ed., pl xix., figs. 7–9.
From the figure in Sil. Syst., pl. xix., fig. 8; side view. Upper Ludlow, Ludlow.
LUDLOW.—Sil., 4th ed., p. 518. "Very characteristic of the Upper Ludlow rock;" ibid., p. 235. *Localities:* Shropshire, Herefordshire, Worcestershire, Radnorshire, Brecknockshire. Sil. Syst., p. 651. Kendal, Pembrokeshire, Freshwater, East, and Henllyn Hill, Builth. Mus. G. S. I.

PHYLLOPODA.

FIG 2.—CERATIOCARIS PAPILIO, *Salter.*

From Ann. and Mag. Nat. Hist., 1860, p. 154, fig. 3.
Ludlow.—Sil., 4th ed., p. 516. "Upper and Lower Ludlow (black flags), Lesmahago, Lanarkshire." Ann. Nat. Hist., p. 156.

EURYPTERIDA.

FIG. 3.—*a*, *b*. PTERYGOTUS PROBLEMATICUS, *Agassiz.*

Sil. Syst., p. 606. Poiss. Vieux Grès Rouge, pl. i.
a. Portion of the fixed ramus of the antennary chela, from the figure in Mem. Geol. Surv., Mon. i., pl. xii., fig. 9. Upper Ludlow rock, Hagley Park, Herefordshire. Mr. J. Harley's collection.
b. Anterior segment of the body; reduced one-third, from fig. 20 on the same plate (same collection). *Locality:* Ludlow.
c. Surface markings (slightly enlarged).
WENLOCK to LUDLOW and PASSAGE BEDS, or base of Old Red Sandstone.—Sil., 4th ed., p. 521. "Characteristic of the Upper Ludlow Rock;" ibid., p. 238. Mr. Salter describes it, in the monograph just quoted, p. 93, as "one of the most widely spread species." He mentions several localities in *Upper Ludlow rock* near Ludlow, Kendal, Westmoreland, Bone-bed, Ludlow, Downton Sandstone, Kington. *Base of Old Red Sandstone*, Railway Station, Ludlow, Cornstones of Hopton Gate; and as

probably occurring also in the *Upper Llandovery Rock*, of the Obelisk, Eastnor Park, Herefordshire. M. G. S., Mon. i., pp. 92, 3.

FIG. 4.—EURYPTERUS PYGMÆUS, *Salter*.

Quart. Journ. Geol. Soc., vol. xv., p. 232, pl. x., figs. 4–8.
Partly restored from figs. 4 and 6. Downton Sandstone, Kington. Mr. R. Banks' collection.
LUDLOW and PASSAGE BEDS.—Sil., 4th ed., p. 518. DEVONIAN. Forfar, Woodward and Salter's Chart, p. 24. "A small and abundant species in the Tilestones at Kington and Ludlow." Sil., 4th ed., p. 239.

FIG. 5.—PTERYGOTUS BILOBUS, *Salter*.

Himantopterus bilobus, Salter. Quart. Journ. Geol. Soc., vol. xii., p. 29, fig. 1.
P. bilobus, Salter. Mem. Geol. Surv., Mon. i., p. 39.
Original. A young example; reduced one-third, from Uppermost Ludlow Rocks, Lesmahago, Lanarkshire. Mus. Geol. Surv. Irel.
LUDLOW.—Sil., 4th ed., p. 521.

PISCES.

FIG. 6.—PTERASPIS TRUNCATUS, *Huxley* and *Salter*.

Quart. Journ. Geol. Soc., vol. xii., p. 100, pl. ii., fig. 1.
Original. Cephalic buckler or head. Uppermost Ludlow, "Passage Beds," Kington, Ludlow. Mus. G. S. I.
LUDLOW and PASSAGE BEDS.—Sil., 4th ed., p. 536.

FIG. 7.—ONCHUS TENUISTRIATUS, *Agassiz*.

Sil. Syst., pl. iv., figs. 57–59. Sil., 4th ed., pl. xxxv., figs. 15–17.
Fin-spine of a shark-like fish. From the figure in Sil. Syst., pl. iv., fig. 58. Upper Ludlow, Bone-bed, Ludford, near Ludlow.
LUDLOW.—Sil., 4th ed., p. 536.

FIG. 8.—*a*, *b*. ONCHUS MURCHISONI, *Agassiz*.

Sil. Syst., pl. iv., figs. 9-11. Sil., 4th ed., pl. xxxv., figs. 13, 14.
a, *b*. Fin-spines of a shark-like fish, "the most common species."
From the figures in Sil. Syst., pl. iv., figs. 9-11. Upper Ludlow, Bone-bed, Ludford, near Ludlow.
LUDLOW and ? PASSAGE BEDS.—Sil., 4th ed., p. 536.

FIG. 9.—*a*, *b*, *c*. PLECTRODUS MIRABILIS, *Agassiz*.

Sil. Syst., pl. iv., figs. 14-26. Sil., 4th ed., pl. xxxv., figs. 3-8.
a, *b*. Natural size. *c*, 9*b*. enlarged; probably portions of the jaws and teeth of a small ? ganoid fish. From the figures in Sil. Syst., pl. iv., figs. 20, 21, 26. Upper Ludlow, Bone-bed, Ludford, near Ludlow.
LUDLOW and PASSAGE BEDS.—Sil., 4th ed., p. 536.

FIG. 10.—*a*, *b*. PLECTRODUS PUSTILIFERUS, *Agassiz*, sp.

Sclerodus, Sil. Syst., pl. iv., figs. 27-32, 60-62. *Plectrodus*, Sil., 4th ed., pl. xxxv., figs. 9-12.

a. Natural size; *b*. enlarged. From the figures in Sil. Syst., pl. iv., figs. 28, 31. Upper Ludlow, Bone-bed, Ludford, near Ludlow.

LUDLOW.—Sil., 4th ed., p. 536.

FIG. 11.—*a*, *b*, *c*. THEÖLODUS PARVIDENS, *Agassiz*.

Sil. Syst., pl. iv., figs. 34-36. Sil., 4th ed., pl. xxxv., fig. 18.

a, *b*, *c*. Natural size and enlarged, granules of the skin or shragreen of Onchus? From the figures in Sil. Syst., pl. iv., figs. 34-36. "They occur by myriads." Sil., 4th ed., p. 241. Upper Ludlow, Bone-bed, Ludford, near Ludlow.

LUDLOW.—Sil., 4th ed., p. 536.

PLATE XXVIII.

FOSSILS OF THE OLD RED SANDSTONE OR DEVONIAN ROCKS.

PLANTÆ.

CRYPTOGAMIA.—*FILICES.*

FIG. 1.—*a*, *b*. PALÆOPTERIS HIBERNICUS, *Forbes*, sp.

Cyclopteris, E. Forbes. Brit. Assoc. Rep., 1852.
Adiantites, Ad. Brorgniart. Journ. Roy. Dub. Soc., 1857.
Palæopteris, W. P. Schimper. Traité Pal. Vég., 1869, vol. i., p. 475, pl. xxxvi.
a. *Original.* Reduced to one-sixth of natural size. Frond, showing fructification at its lower portion.
b. *Original.* Natural size. Portion of a pinnule with leaflets.
UPPER OLD RED SANDSTONE, Kiltorcan Hill, Co. Kilkenny. Mus. G. S. I. Additional localities: Gokane Point, W. of Toe Head; Tracarta, Castlehaven, Co. Cork; and Tivoli House, a little E. of Cork. Mus. G. S. I.

LYCOPODIACEÆ.

FIG. 2.—*a-d*. KNORRIA BAILYANA, *Schimper*.

Traité Pal. Vég., vol. ii., part i., 1870, p. 48.
a, *b*. *Original.* *a*. Lower portion of stem, showing axis; reduced to one-third of natural size. *b*. Natural size. From 2 *a*; showing longitudinal ribbing and alternate arrangement of cicatrices.
c, *d*. *Original.* *c*. Upper part of stem (*Cyclostigma minuta*, Haughton). *d*. Natural size. Portion of the surface of 2 *c*.
UPPER OLD RED SANDSTONE, Kiltorcan Hill, Co. Kilkenny. Mus. G. S. I. Additional locality: Tracarta, Co. Cork. Mus. G. S. I.

FIG. 3.—*a*, *b*. CYCLOSTIGMA KILTORKENSE, *Haughton*.

Journal, Royal Dublin Society, vol. ii., p. 407, pl. xvi., fig. 1. (Cyclostigma, pl. xiv., figs. 1, 2, 3; *C. minutum*, pl. xvi., fig. 2, and *C. Griffithii*, pl. xvii., are probably synonyms.)
a, *b*. *Original.* *a*. Reduced to half the natural size. *b*. Natural size. From 3 *a*, showing finely striated surface and widely distant cicatrices.
UPPER OLD RED SANDSTONE, Kiltorcan Hill, Co. Kilkenny. Mus. G. S. I. Additional locality: Tracarta, Co. Cork. Mus. G. S. I.

Characteristic British Fossils. Plate 28

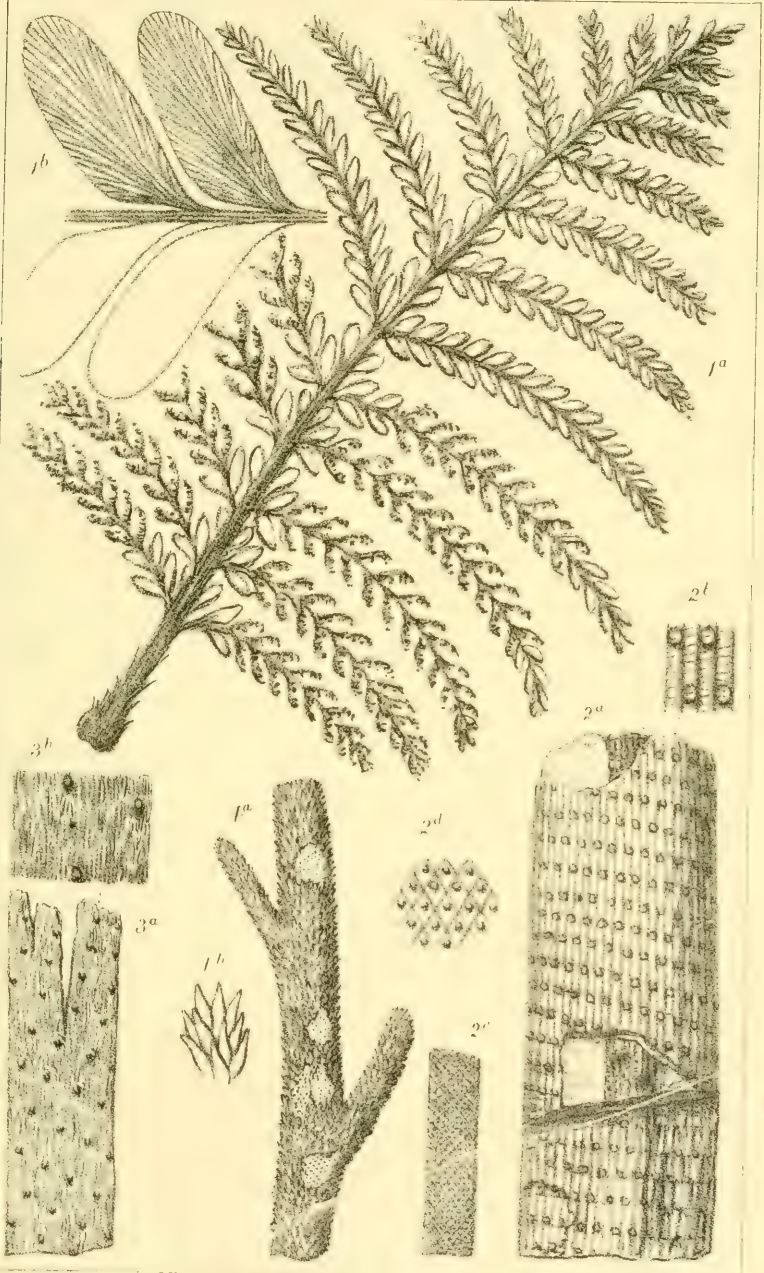

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FIG. 4.—*a*, *b*. (?) LEPIDODENDRON NOTHUM, *Unger*.

Salter, Quart. Jour. Geol. Soc., vol. xiv., p. 75, pl. v., fig. 9, *a*, *b*. Siluria, 4th ed., p. 269. Foss., 73, fig. 4, 4 *a*.

a, *b*. *Original*. *a*. Branching stem. *b*. Group of scales, or bracts, from surface of 4 *a*. Enlarged. Wick, Caithness.

MIDDLE OLD RED SANDSTONE.—Caithness flags. Siluria, 4th ed. Table of Upper Palæozoic rocks, p. 405.

PLATE XXIX.

FOSSILS OF THE OLD RED SANDSTONE OR DEVONIAN ROCKS.

AMORPHOZOA.

FIG. 1.—*a*, *b*. STROMATOPORA CONCENTRICA, *Goldfuss*.

Petref. Germaniæ, vol. i., p. 22. Phil. Pal. Foss., p. 18, pl. x., fig. 28.
a. *Original*. Transverse section. Middle Devonian, Torquay, South Devon. Mus. G. S. I. *b*. *Original*. Enlarged portion of the same, showing concentric laminæ, traversed by slender tubes.
MIDDLE DEVONIAN.—Chudleigh, Torquay, Dartington, and Asholt Common, Quantock Hills, Somersetshire. Collected by the late Mr. Jukes. Mus. G. S. I.

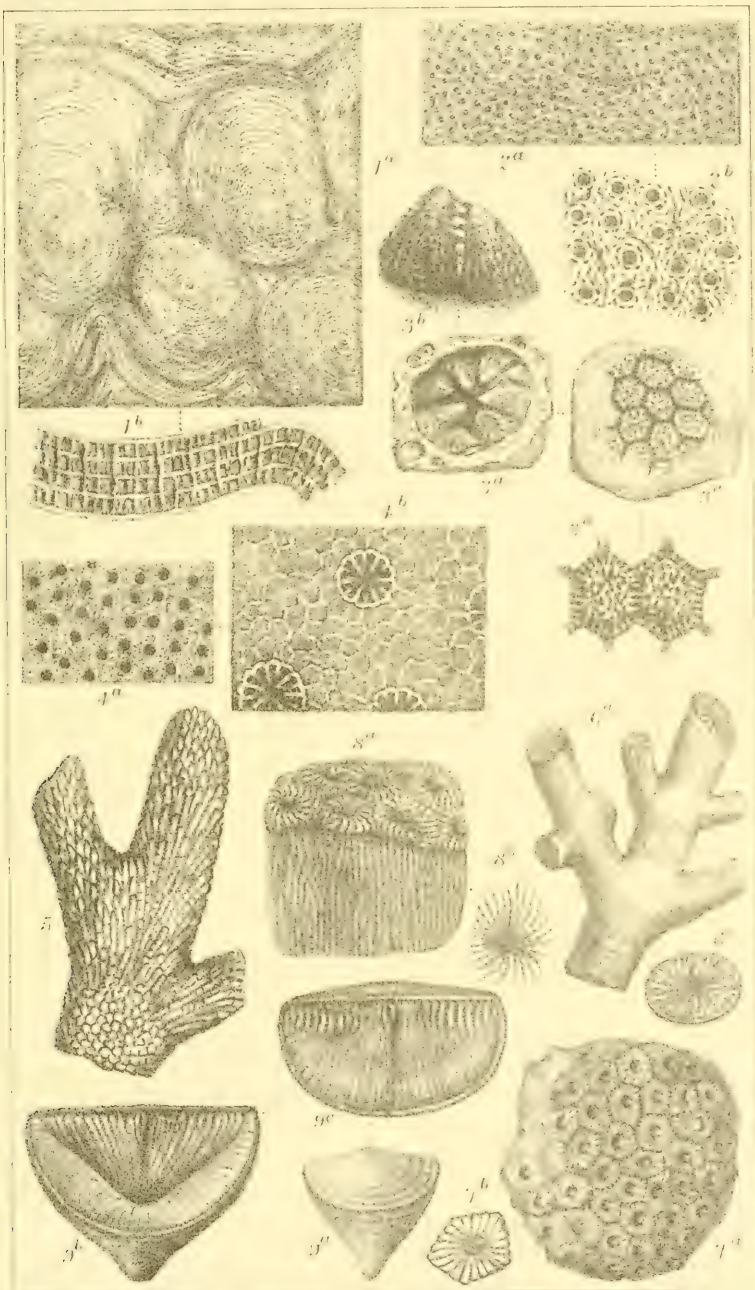
FIG. 2.—*a*, *b*. STROMATOPORA PLACENTA, *Lonsdale*, sp.

Coscinopora, Geol. Trans., 2nd ser., vol. v.
Cannopora, Phillips, Pal. Foss., p. 18, pl. x., fig, 29. *Stromatopora*, Morris, Catal. Brit. Foss., p. 65.
a. *Original*. Transverse section. Middle Devonian, Torquay. Mus. G. S. I.
b. *Original*. Enlarged portion of the same, showing large and smaller tubuli, or pores.
MIDDLE DEVONIAN.—Torquay, Plymouth, Ogwell, &c.

ZOOPHYTA.—*ANTHOZOA*.

FIG. 3.—*a-d*. PLEURODICTYUM PROBLEMATICUM, *Goldfuss*.

Petr. Ger., vol. i., p. 113. Phil. Pal. Foss., p. 19, pl. ix., fig. 24. M. G. S. I. Explan. of Sheets, 187, &c., pp. 24, 25, fig. 5, *a-g*.
a. *Original*. A group of Corallites. *b*. *Original*. Two of these corallites enlarged three diameters, united by intercellular structure. *c*. *Original*. Natural horizontal section of a group of corallites, showing their hexagonal form, and union, by intercellular structure. *d*. *Original*. Portion of the same, enlarged. All from Upper Devonian, Pilton beds, Braunton, North Devon. Mus. G. S. I.
DEVONIAN and LOWER CARBONIFEROUS.—*Upper Devonian* (Pilton beds), Braunton. *Middle Devonian* (Ilfracombe group), West Ogwell; Torquay. *Lower Devonian*, Meadsfoot, near Torquay; Looe, Cornwall. "It is confined to slate rocks, and, according to Mr. Godwin-Austen, ranges through the whole middle slate district of North Wales." Davidson in



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Pal. Soc. Brit. Dev. Brach., pp. 126, 127. In Siluria, 4th ed. (Table, p. 405), it is included as a characteristic fossil of the Lower Devonian. In Ireland it has been found in Carboniferous slate and grit at several places near Bandon, Belgooly, &c., in the county of Cork. Mus. G. S. I.

FIG. 4.—*a*, *b*. HELIOLITES POROSA, *Goldfuss*, sp.

Astræa, Petr. Ger., vol. i., p. 64. *Heliolites*, Brit. Foss. Cor., p. 212, pl. xlvii., fig. 1, *a-f*.

a. *Original.* Transverse section of a portion of this coral.

b. *Original.* Part of the same, enlarged, showing arrangement of calices and septa, and intermediate cellular structure, or cænenchyma. Middle Devonian, Torquay. Mus. G. S. I.

MIDDLE DEVONIAN.—*Localities:* Torquay; Babbacombe: Newton; Plymouth. Cat. Brit. Foss., p. 56.

FIG. 5.—FAVOSITES POLYMORPHA, *Goldfuss*, sp.

Calamopora, Petr. Ger., vol. i., p. 79. Favosites, Phil. Pal. Foss., p. 15, pl. viii., fig. 20.

F. cervicornis, dubia. Brit. Foss. Cor., p. 216, pl. xlviii., fig. 2.

Original. Upper portion of branch. Middle Devonian, Newton Bushel. Mus. G. S. I.

MIDDLE DEVONIAN.—"One of the most frequent of all the Devonian corals." Pal. Foss., p. 15. *Localities:* Combe Martin; Plymouth; Torquay; Ogwell, S. Devon. Cat. Brit. Foss., p. 54. It has also been collected, by the late Mr. Jukes, from near Doddington, and at Asholt Common, Quantock Hills. Mus. G. S. I.

FIG. 6.—*a*, *b*. CYATHOPHYLLUM CÆSPITOSUM, *Goldfuss*.

Petr. Ger., vol. i., p. 60. Brit. Foss. Cor., p. 229, pl. li., fig. 2.

a. *Original.* Portion of branch. *b*. *Original.* Transverse section of a corallite. Middle Devonian, Plymouth. Mus. G. S. I.

MIDDLE DEVONIAN.—*Localities:* Combe Martin; Hagginton; and Hillsborough, near Ilfracombe, North Devon; Torquay; Newton; and Plymouth, South Devon. Pal. Foss., p. 9.

FIG. 7.—*a*, *b*. ACERVULARIA PENTAGONA, *Goldfuss*, sp.

Cyathophyllum, Petr. Germ., vol. i., p. 60. *Acervularia*, Brit. Foss. Cor., p. 238

a. From Brit. Foss. Cor., pl. liii., fig. 5 *a*. *b*. Transverse section of a single corallite. Middle Devonian, Ogwell, Devonshire.

MIDDLE DEVONIAN.—*Localities:* Torquay; Babbacombe: Plymouth; and Newton Bushel, South Devon. Pal. Foss., p. 12.

FIG. 8.—*a*, *b*. ARACHNOPHYLLUM HENNAHI, *Lonsdale*, sp.

Astræa, Geol. Trans., 2nd Ser., v., p. 697. *Smithia*, Brit. Foss. Corals, p. 240, pl. liv., fig. 4. *Arachnophyllum*, Brit. Pal. Foss., p. 72.

a, *b*. From Geol. Trans., 2nd Ser., v., pl. lviii., fig. 3. *b*. Transverse section of a single corallite, showing arrangement of septa. Middle Devonian.

MIDDLE DEVONIAN.—*Localities:* Barton; Teignmouth; Newton; Torquay. Catal. Brit. Foss., p. 47.

FIG. 9.—*a*, *b*, *c*. CALCEOLA SANDALINA, *Lamarck*.

Animaux sans vertèbres, vol. vi., p. 235. Phil. Pal. Foss., p. 137, pl. lx., fig. 102.*

a. Reduced to half natural size. Restored figure, from Woodward's "Manual of Mollusca," pl. xv., fig. 26.

b. Reduced to two-thirds of natural size. *c*. Opercular portion; ibid., p. 232, fig. 152.

MIDDLE DEVONIAN.—Ogwell, near Chircombe Bridge, South Devon.

This fossil was formerly considered to be a Brachiopod shell. Lindström has, however, shown it to be a coral, belonging to the division *Zoantharia rugosa*. Geol. Mag., vol. iii., p. 356, &c.

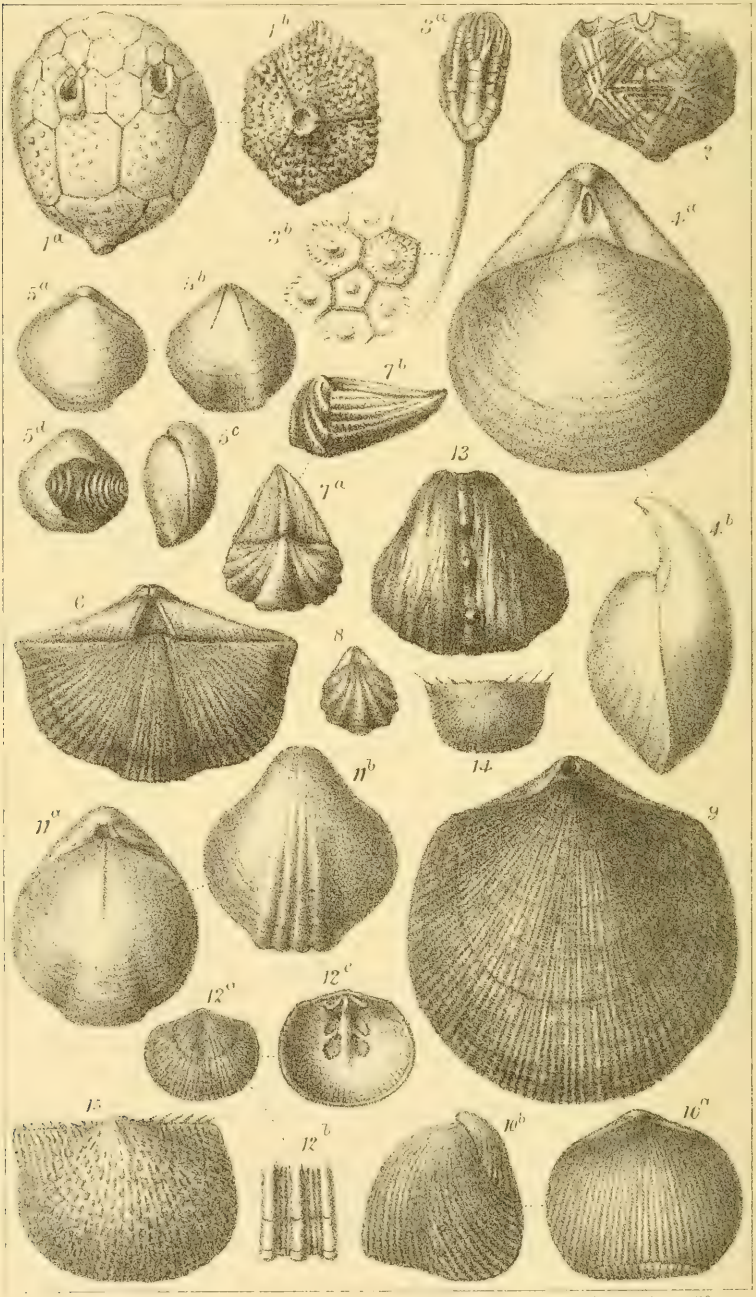

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PLATE XXX.

FOSSILS OF THE OLD RED SANDSTONE OR DEVONIAN ROCKS.

ECHINODERMATA.—*CRINOIDEA.*

FIG. 1.—*a*, *b*. HEXACRINUS INTERSCAPULARIS, *Phillips*, sp.

Platycrinus, Phil. Pal. Foss., p. 28. *Hexacrinus melo*, Austin's "Crinoidea," p. 49, pl. vi., fig. 1, *b*.
a. Reduced to two-thirds of natural size; side view. From Pal. Foss., pl. xiv., fig. 39, *c*. *b*. *Original*. Pelvic plate (natural size). Middle Devonian, Plymouth. Mus. G. S. I.
MIDDLE DEVONIAN.—Newton, Plymouth, South Devon.

FIG. 2.—CYATHOCRINUS GEOMETRICUS, *Goldfuss*.

Petref. Germ., p. 109, pl. lviii., fig. 5. Phil. Pal. Foss., p. 135.
From Pal. Foss., pl. lx., fig. 41.*
MIDDLE DEVONIAN.—Newton. In Prof. Morris' "Catal. of Brit. Foss.," it is also recorded as occurring in the *Carboniferous Limestone* of Wexford, Ireland; as, however, detached plates of Actinocrinus polydactylus may be easily mistaken for it, this may possibly be a wrong identification.

FIG. 3.—*a*, *b*. TAXOCRINUS MACRODACTYLUS, *Phillips*, sp.

Cyathocrinus? Pal. Foss., p. 29.
a. From Pal. Foss., pl. xv., fig. 41, *a*. Young example.
b. Ibid., fig. 41, *c*. Plates of the base (Pelvic).
UPPER DEVONIAN.—Brushford, North Devon.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 4.—*a*, *b*. STRINGOCEPHALUS BURTINI, *Defrance*.

Dict. des Sciences Nat., vol. li., p. 102. Brit. Dev. Brach., p. 11, pl. i., ii.
a, *b*. From Pal. Foss., pl. xxxii., fig. 141, *a* and *c*. Front and side view.
MIDDLE DEVONIAN.—*Localities:* Plymouth; Bradley, near Newton; Ogwell, South Devon; Combe Martin; and Hagginton, North Devon.

FIG. 5.—*a-d.* MERISTA PLEBEIA, *Sowerby*, sp.

Atrypa, Trans. Geol. Soc., 2nd ser., vol. v., pl. lvi., figs. 12, 13.
Merista, Brit. Dev. Brach., p. 20.
From Brit. Dev. Brach., pl. iii., figs. 2, 2 *a*, 2 *b*, and 3; the latter figure, reproduced on our Plate (fig. 5 *d*), has a portion of the shell removed, showing the spiral coil.
MIDDLE DEVONIAN.—*Localities:* "It occurs abundantly in the limestone near Plymouth, Torquay, Ogwell, Newton Abbot, and Ilfracombe." Brit. Dev. Brach., p. 20.

FIG. 6.—SPIRIFERA DISJUNCTA, *Sowerby.*

Trans. Geol. Soc., 2nd ser., vol. v., pl. lii., fig. 8; pl. liv., figs. 12, 13.
S. calcarata, extensa, gigantea, inornata: ibid., pls. liii., liv., and lv. *S. Verneuilii*, Murch. Bull. Soc. Géol. France, vol. xi., p. 252.
From Brit. Sil. Brach., pl. v., fig. iv. A small but typical example; Middle Devonian, Woodborough Quarry, near Newton Abbot.
MIDDLE and UPPER DEVONIAN.—"This very important species has been described and figured under many denominations. It occurs in the *Upper Devonian* grits and slates of Croyde Bay; near Barnstaple, Braunton, &c.; at South Petherton; Tintagel, &c.; in the *Middle Devonian* limestone, near Newton Abbot; at Ilfracombe; Barton, &c., near Torquay." Brit. Sil. Brach., pp. 25, 26. Its occurrence in the Carboniferous slate of Ireland, although recorded by so eminent an authority as Mr. Davidson, is not, I think, sufficiently established.

FIG. 7.—*a*, *b*. CYRTINA HETEROCLITA, *Defrance*, sp.

Calceola, Dic. Sc. Nat., vol. lxxx., fig. 3. *Spirifera*, Pal. Foss., p. 72. *Cyrtina*, Brit. Dev. Brach., p. 48.
From Brit. Dev. Brach., pl. ix., fig. 1, *a* and *b*.
MIDDLE DEVONIAN.—An important and characteristic fossil of the Middle Devonian limestone of England and the Continent. In Devonshire it occurs near Plymouth; Torquay; Newton Abbot; near Totnes; and at Haggington Hill, near Ilfracombe, North Devon. Brit. Dev. Brach., p. 49.

FIG. 8.—RETZIA FERITA, *Von Buch*, sp.

Terebratula, Mém. Soc. Géol. de France, vol. iii. *Retzia*, Sandberger Dic. Brach. des Rheinischen, &c., p. 34.
From Brit. Dev. Brach., pl. iv., fig. 8.
MIDDLE DEVONIAN.—"Characteristic of the Middle Devonian limestone of England as well as of the Continent. It occurs at Barton and Lummaton, near Torquay; near Newton Abbot, and Plymouth." Brit. Dev. Brach., p. 21.

FIG. 9.—ATRYPA DESQUAMATA, *Sowerby.*

Trans. Geol. Soc., 2nd ser., vol. v., pl. lvi., figs. 19, 20; and var. *compressa*, ibid., figs. 21, 22.
From Brit. Dev. Brach., pl. xi., fig. 1.

MIDDLE DEVONIAN.—Abundant at Woolborough Quarry, near Newton Abbot; Ogwell; Chircombe Bridge, &c.; at Barton, Lummaton, and Hope's Nose, near Torquay; in the Plymouth limestone at Datington, near Totnes; and in several other Devonshire localities. Brit. Dev. Brach., p. 59.

FIG. 10.—*a*, *b*. RHYNCHONELLA CUBOIDES, *Sowerby*, sp.

Atrypa, Trans. Geol. Soc., 2nd ser., vol. v., pl. lvi., fig. 24.
A. crenulata, *A. impleta*. Ibid., fig. 17, and pl. lvii., fig. 2.
Rhynchonella, Brit. Dev. Brach., p. 65.
From Brit. Dev. Brach., pl. xiii., fig. 16, 16 *b*. Lanes or Woolborough Quarry.
MIDDLE DEVONIAN.—Abundant in the limestone of Woolborough Quarry, Newton Abbot; near Ogwell; Bradley, North Down; Barton, &c., near Torquay; also common in the Plymouth limestone. Brit. Dev. Brach., p. 66.

FIG. 11.—*a*, *b*. PENTAMERUS BREVIROSTRIS, *Phillips*, sp.

Stringocephalus, Pal. Foss., p. 89. *Pentamerus*, Brit. Pal. Foss., p. 384.
From Brit. Dev. Brach., pl. xv., figs. 3, 5. Woolborough Quarry.
MIDDLE DEVONIAN.—Occurs plentifully in the limestone of Woolborough Quarry, near Newton Abbot; near Chircombe Bridge, West Ogwell, and Bradley, North Devon; Barton, Lummaton, and Hope's Nose, near Torquay; at Dertington, near Totnes; and Plymouth. Brit. Dev. Brach., p. 73.

FIG. 12.—*a*, *b*, *c*. ORTHIS INTERLINEATA, *Sowerby*.

Trans. Geol. Soc., 2nd ser., vol. v., pl. liii., fig. 11; pl. liv., fig. 14.
From Brit. Dev. Brach., pl. xvii., figs. 19, 23. 12 *a*. Petherwin, Cornwall; *b*. enlarged striæ from do.; *c*. interior of ventral valve, Petherwin.
MIDDLE and UPPER DEVONIAN.—It occurs abundantly in the Upper Devonian shales of Landlake, near South Petherwin, and Launceston, in Cornwall; and in the brown grits of North Devon, near Barnstaple, Croyde, Marwood, &c.; and, according to Mr. Valpy, in the Middle Devonian at Haggington Hill, near Ilfracombe. Brit. Dev. Brach., p. 92.

FIG. 13.—PRODUCTUS PRÆLONGUS, *Sowerby*, sp.

Leptæna, Trans. Geol. Soc., 2nd ser., vol. v., pl. liii., fig. 29. *Productus*, Brit. Pal. Foss., p. 390.
From Brit. Dev. Brach., pl. xix., fig. 24. Cast, from the Upper Devonian of Croyde Bay, North Devon.
UPPER DEVONIAN.—Croyde Bay, also in brown grits, Orchard Quarry, Pilton; Braunton; and in the Lower Marwood beds, near Marwood, North Devon.

FIG. 14.—CHONETES HARDRENSIS, *Phillips*, sp.

Orthis, Pal. Foss., p. 138. *Chonetes*, Davidson Mon. Brit. Carb. Brach., p. 186.

From Brit. Dev. Brach., pl. xix., fig. 7.

UPPER DEVONIAN and CARBONIFEROUS.—"Exceedingly common in the Upper Devonian grits and shales of North Devon. At Marwood and Braunton it is very abundant. It occurs also in several localities in the neighbourhood of Barnstaple; at Linton, and in other localities. Mr. Pengelly has found this shell in dark-grey slate at Black Hall, near Totnes. The identity of the Carboniferous species with that published under the denomination of *C. Hardrensis* cannot be doubted." Brit. Dev. Brach., p. 95.

FIG. 15.—STROPHALOSIA PRODUCTOIDES, *Murchison*, sp.

Orthis, Murch. Bull. Soc. Géol. de France, vol. xi., p. 254.

Leptæna caperata, Trans. Geol. Soc., 2nd ser., vol. v., p. 704.

Strophalosia, Davidson, Brit. Dev. Brach., p. 97.

Original. Cast. Upper Devonian, Braunton, North Devon. Mus. G. S. I.

UPPER DEVONIAN.—It is exceedingly abundant in the state of casts in the Upper Devonian grits and shales of North Devon; such as at Braunton, Pilton, &c. It is also very common at Petherwin, in Cornwall. Brit. Dev. Brach., p. 99.

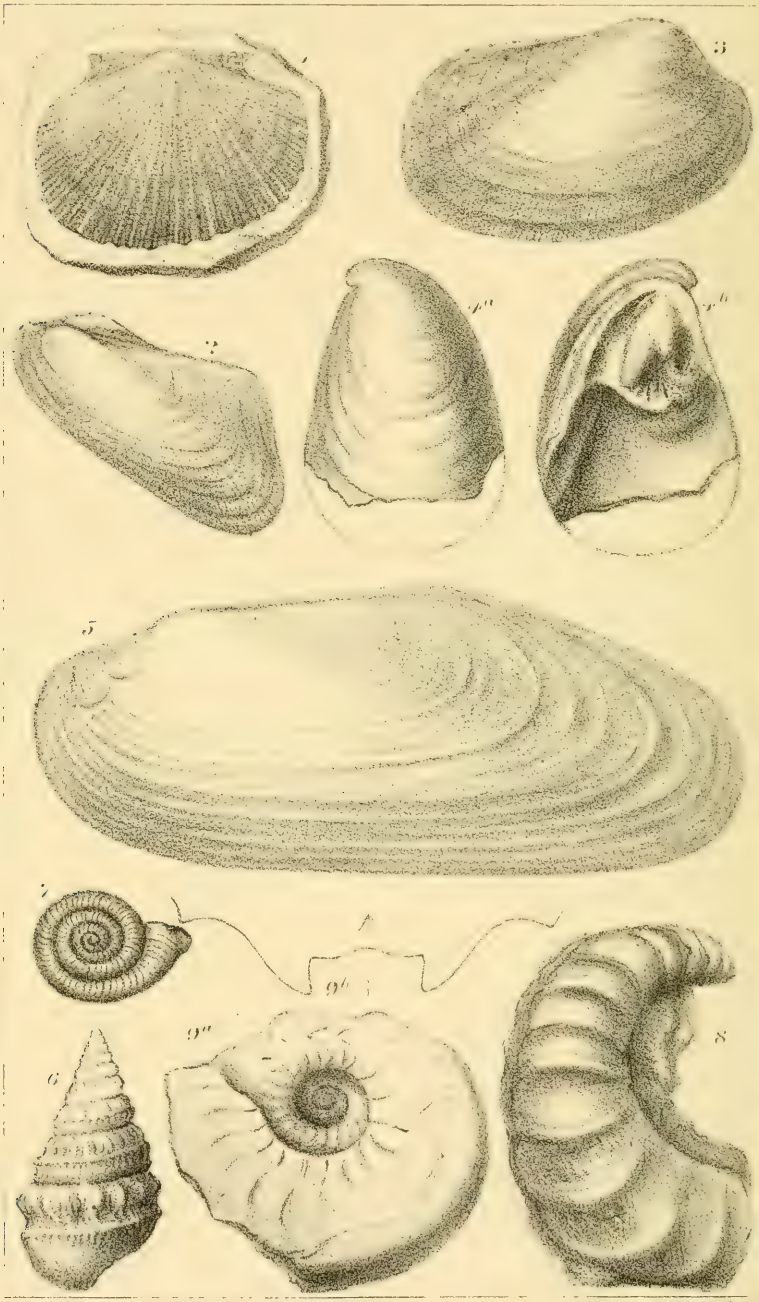

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PLATE XXXI.

FOSSILS OF THE OLD RED SANDSTONE OR DEVONIAN ROCKS.

MOLLUSCA.—*CONCHIFERA.*

FIG. 1.—AVICULOPECTEN TRANSVERSUS, *Sowerby*, sp.

Pecten. Trans. Geol. Soc. Lond., 2nd series, vol. v., pl. liii., fig. 3. Phillips, Pal. Foss. p. 46, pl. xxi., fig. 77.
From Trans. Geol. Soc., *op. cit.*
UPPER DEVONIAN.—South Petherwin, Cornwall; Baggy and Pilton groups, North Devon. *Passage beds*, Barnstaple, N. Devon. (Etheridge Journ. Geol. Soc., Lond., vol. xxiii., p. 625.)

FIG. 2.—AVICULA DAMNONIENSIS, *Sowerby.*

From Trans. Geol. Soc., *op. cit.*, fig. 22, Phil. Pal. Foss., p. 51, pl. xxiii., figs. 90, 91, 92.
UPPER DEVONIAN.—Pilton, Brushford and Braunton; Baggy and Pilton groups, North Devon. Journ. Geol. Soc., vol. xxiii., p. 624. "Abundant in the soft ferruginous sandstone of Marwood quarry." (Sowerby, Geol. Trans., *op. cit.*, Explan. of pl. 53.)
LOWER CARBONIFEROUS.—"Coomhola," Co. Cork, &c. (W. H. B.)

FIG. 3.—CUCULLÆA HARDINGII, *Sowerby.*

Trans. Geol. Soc., *op. cit.*, figs. 26, 27. Phil. Pal. Foss., p. 40, pl. xviii., xix., fig. 67.
Original. Marwood Beds, Braunton, N. Devon. Mus. G. S. I.
UPPER DEVONIAN.—Baggy and Pilton, N. Devon. (Etheridge.)
LOWER CARBONIFEROUS.—"Comhola," Co. Cork, &c. (W. H. B.)

FIG. 4.—*a*, *b*. MEGALODON CUCULLATUS, *Sowerby.*

Min. Conch., vol. vi., p. 132, pl. dlxviii.
Phil. Pal. Foss., p. 37, pl. xvii., fig. 60.
From Min. Conch., pl. dlxviii., *a*, exterior of left valve; *b*, interior of ditto. Middle Devonian, Limestone, Bradley, near Newton Bushel, Devonshire.
LOWER DEVONIAN.—Lynton group.
MIDDLE DEVONIAN.—Torquay, do.

FIG. 5.—ANODONTA JUKESII, *Forbes.*

British Asssociation Report, 1852. Trans. of Sections, p. 43. Geol. Surv. Irel.; Expl. Sheet, 147, &c., p. 16, fig. 3, *a*, *b*.

Original. View of left valve, showing anterior *adductor* muscular impression. Upper O. R. S, Kiltorcan. Mus. G. S. I.
Upper Old Red Sandstone.—Kiltorcan, Co. Kilkenny; Tivoli, and Gokane, Co. Cork.

GASTEROPODA.

Fig. 6.—Murchisonia bigranulosa, *D'Archiac.*

Geol. Trans., 2nd series, vol. vi., pl. xxxii., fig. 10.
M. bilineata, Phil. Pal. Foss., pl. xxxix., fig. 191.
Original. Middle Devonian, Plymouth. Mus. G. S. I.
Middle Devonian.—Torquay group.

Fig. 7.—Euomphalus annulatus, *Phillips.*

From Palæozoic Fossils, pl. lx., fig. 172.* Supplement, p. 138. Newton Bushel, South Devon.
Middle Devonian.—Torquay group.

CEPHALOPODA.

Fig. 8.—Cyrtoceras nodosum, *Phillips.*

From Pal. Foss., p. 116, pl. xlvi., fig. 221, reduced one-fifth. Newton Bushel, South Devon.
Middle Devonian.—Torquay group.

Fig. 9.—*a*, *b*, Clymenia striata, *Münster.*

Beitr. pl. iii., fig. 2. Phil. Pal. Foss., p. 125, pl. liii., fig. 240.
Original. *a.* Imperfect specimen showing the septa. *b.* Outline of septum, from Pal. Foss, *op. cit.*, fig. 240, *b.*
Upper Devonian.—Petherwin group.

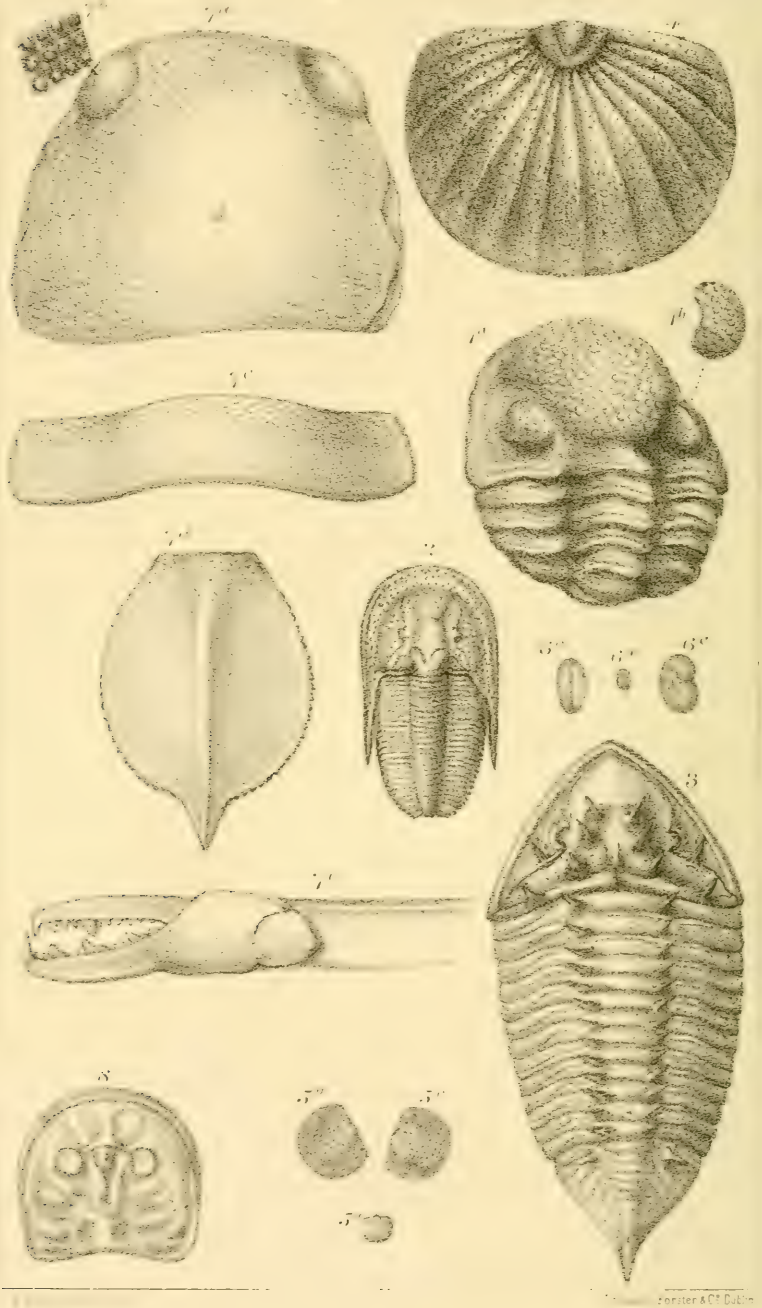

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PLATE XXXII.

CRUSTACEA.—*TRILOBITA.*

FIG. 1.—*a*, *b*. PHACOPS LATIFRONS, *Bronn*, sp.

Calymene, Leth. Geog., pl. ix., fig. 4. *C. Latreillii*, Steininger Mém. Soc. Geol. de France, vol. i., p. 351. Phil. Pal. Foss., p. 129, pl. lvi., fig. 249. *Phacops latifrons*, Morris Cat. Brit. Foss., 1854, p. 113.

Original. *a*. Cast of an entire, partially rolled, and slightly distorted specimen, from Upper Devonian Sandstone, Braunton, North Devon. Mus. G. S. I.; *b*, eye, enlarged one-third, showing arrangement of lenses.

MIDDLE AND UPPER DEVONIAN.—Baggy, Pilton, and Barnstaple (Passage), N. Devon; Torquay S. Devon. Padstow and Petherwin, Cornwall. (Etheridge), Journ. Geol. Soc., vol. xxiii., p. 620.

FIG. 2.—HARPES MACROCEPHALUS, *Goldfuss*.

Nova Acta Acad., vol. xix., pl. xxiii., fig. 2.

Phil. Pal. Foss., p. 127, pl. lv., fig. 246.

From Burmeister, Organiz. Trilobites, Ray Society, 1846, pl. i., fig. 11, reduced to half natural size.

MIDDLE DEVONIAN.—Barton, S. Devon; Torquay group.

FIG. 3.—HOMALONOTUS ARMATUS, *Burmeister*.

H. Greenii, Goldf. in Bronn N. Jahrb., 1843, pp. 560-5.

H. armatus, Burm. Org. Tril., p. 87, pl. iv., fig. 1.

From Burm., *op. cit.*, reduced to half natural size.

LOWER DEVONIAN.—Meadsfoot, S. Devon. (Etheridge), Journ. Geol. Soc., vol. xxiii., p. 620.

FIG. 4.—BRONTEUS FLABELLIFER, *Goldfuss*.

Act. Acad. Nat. Cur., vol. xix., pl. xxxiii., fig. 3. Phil. Pal. Foss., pl. lvii., fig. 254.

Original. Caudal portion (tail), Newton Bushel, S. Devon. Mus. G. S. I.

MIDDLE DEVONIAN.—Torquay group.

PHYLLOPODA.

FIG. 5.—*a*, *b*, *c*. ESTHERIA MEMBRANACEA, *Packt*, sp.

From Salter and Woodward's Chart of Fossil Crustacea, p. 17, fig. 18. *a*, natural size; *b* & *c*, enlarged.

LOWER AND MIDDLE OLD RED SANDSTONE.—*Caithness*.

OSTRACODA.

FIG. 6.—*a*, *b*, *c*. ENTOMIS SERRATO-STRIATA, *Sandberger*.

From Sandberger Verstein, Nassau, pl. i., fig. 2. *a*, natural size; *b* and *c*, enlarged.
UPPER DEVONIAN.—Petherwin, Cornwall.

EURYPTERIDA.

FIG. 7, *a–e*. PTERYGOTUS ANGLICUS, *Agassiz*.

Poiss. Foss. Vieux Grès Rouge, pl. i.
Mem. Geol. Surv. United Kingdom; plates iii. to vii.
From Mem. Geol Surv. *a*, *Carapace*, pl. iii., fig. 1. Reduced to one-fourth of natural size. *b*. Eye lenses, enlarged, from same plate, fig. 1, *b*. *c*. *Segment* (fifth) of a young specimen, reduced to half natural size; from pl. iv., fig. 4. *d*. *Telson* (twelfth segment) reduced to one-fourth of natural size; from pl. v., fig. 5. *e*. One of the antennæ, reduced to one-fourth of natural size; from pl. vi., fig. 4.
LOWER OLD RED SANDSTONE.—Balruddery, Perthshire.

FIG. 8.—STYLONURUS SYMONDSII, *Salter*, sp.

Eurypterus. Salter, Edin., New Phil. Journ. New series, 1857, vol. vi., p. 257. *Stylonurus*, H. Woodward. Journ. Geol. Soc. Lond., vol. xxi., p. 486, pl. xiii., fig. 4. Pal. Soc. (1872), p. 124, pl. xxi., fig. 4.
From Journ. Geol. Soc., Lond., vol. xv., pl. x., fig. 1. Head, reduced to one-third of natural size.
LOWER OLD RED SANDSTONE.—Rowlestone, Brecknockshire.

Characteristic British Fossils. Plate 33

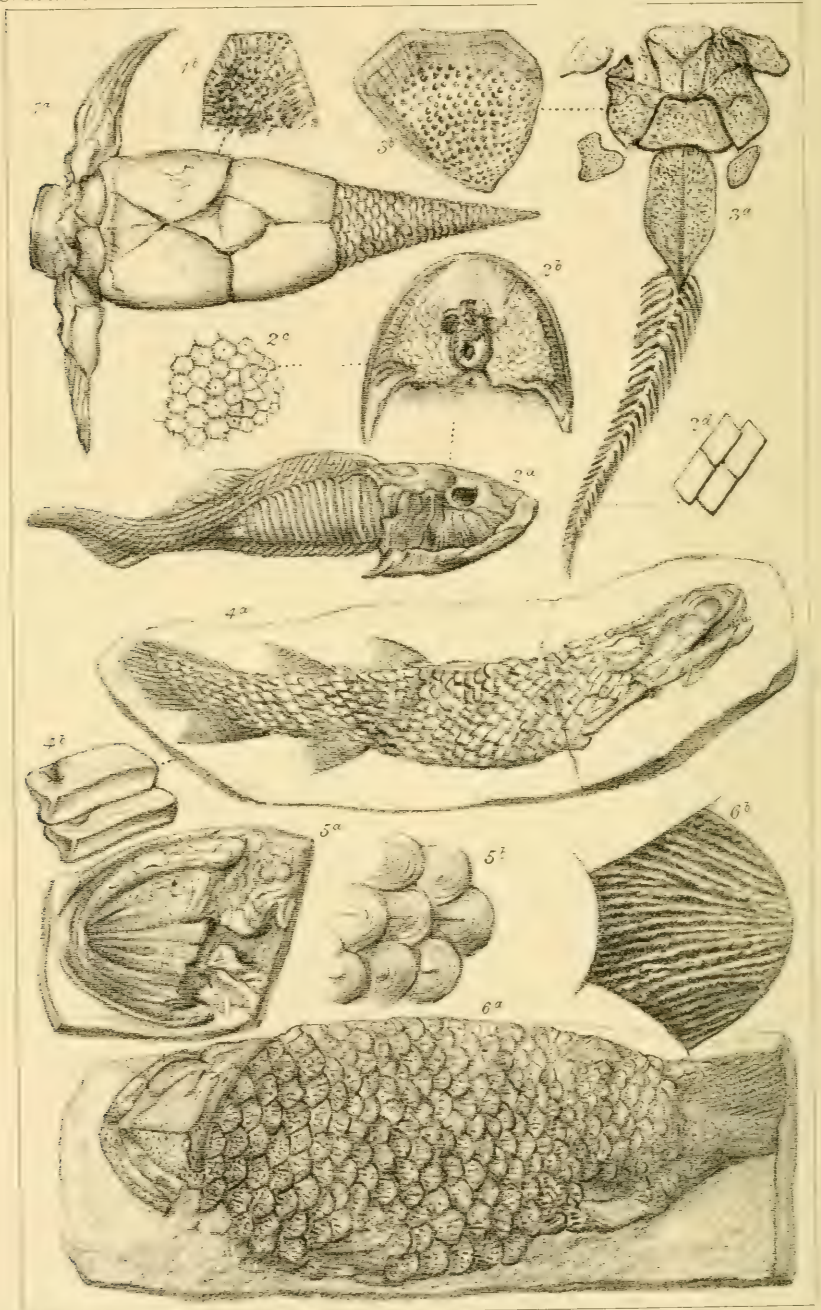

PLATE XXXIII.

FOSSILS OF THE OLD RED SANDSTONE.

PISCES.—*CEPHALASPIDÆ.*

FIG. 1.—*a*, *b*. PTERICHTHYS CORNUTUS, *Agassiz*.

Mon. des Poissons fossiles du vieux Grès Rouge, &c., p. 17, pl. ii., figs. 1—5.
Original. *a*. Upper portion of a nearly complete specimen in the unique collection of the Earl of Enniskillen, reduced to half the natural size. *b*. Portion of one of the plates of the body, showing granulated surface, from the same specimen.
MIDDLE OLD RED SANDSTONE.—Lethen-Bar, Nairnshire.

FIG. 2.—*a–d*. CEPHALASPIS LYELLI, *Agassiz*.

Sil. Syst., vol. ii., p. 589. Poiss. Foss. p. 142, pl. i., *a*, figs. 1–5.
From the figures in Sil. Syst., plates i. and ii. *a*. Side view of the entire fish, reduced to half natural size, *op. cit.*, pl. i., fig. 1. *b*. Upper view of head, reduced to one-third of natural size, *op. cit.*, pl. ii., fig. 1. *c*. Scales of the head, natural size, from the same figure. *d*. Scales of the back, enlarged three diameters. Glanmiss, Forfarshire. Museum, Sir. C. Lyell.
LOWER OLD RED SANDSTONE.—Herefordshire and Scotland.

FIG. 3.—*a*, *b*. COCCOSTEUS DECIPIENS, *Agassiz*.

Poiss. Foss. Grès Rouge, p. 26, pl. vii.–x.
a. *Original*. Showing bones of cranial shield, medio-dorsal plate, and impression of vertebral column, to extremity of tail, reduced to one-fourth of natural size. O. R. S. Lethen-Bar. Mus. Earl of Enniskillen.
b. *Original*. One of the plates of cranial shield, showing granulated and radiated surface. O. R. S. Edderton. Mus. G. S. I.
MIDDLE OLD RED SANDSTONE.—Cromarty; Caithness; Pomona, Orkney.

SAURO-DIPTERINI.

FIG. 4.—*a*, *b*. OSTEOLEPIS MAJOR, *Agassiz*.

Poiss. Foss. Grès. Rouge, p. 51, pl. xix., figs. 1-3.
a, *b*. From figs. 1 and 3 of the plate and work above cited. *a*. The entire fish, reduced to half size. *b*. Scales, (rhomboidal), of do., enlarged.
MIDDLE OLD RED SANDSTONE.—Lethen-Bar.

GLYPTO-DIPTERINI.

FIG. 5.—*a*, *b*. GLYPTOLEPIS LEPTOPTERUS, *Agassiz*.

Poiss. Foss. Grès. Rouge, p. 63, plates xx. et xxi.
a, *b*. From figs. 1 and 5, pl. xx. of the work cited.
a. Under surface of head, reduced to one-fourth of natural size, from fig. 4, pl. xx. *b*. Scales (cycloidal) of do. from fig. 5, same plate.
MIDDLE OLD RED SANDSTONE.—Lethen-Bar, Elgin.

FIG. 6.—*a*, *b*. HOLOPTYCHIUS NOBILISSIMUS, *Agassiz*.

Sil. Syst., vol. ii., p. 599, pl. ii., *bis*., figs. 1-4, 8 and (?) 9.
a, *b*. From Poiss. Foss. Grès Rouge, pl. xxiii.
a. The entire fish, under-side (from a specimen measuring 2 feet 4 inches, by 1 foot), reduced to one-eighth of natural size. *b*. Scale of do. (cycloidal) showing the large undulating furrows covering the surface of its exposed portion. Clashbennie, near Perth.
MIDDLE OLD RED SANDSTONE.—Perth; Caithness; Crickhowell. (Morris) Portishead, near Bristol (W. H. B.).

Characteristic British Fossils. Plate 34.

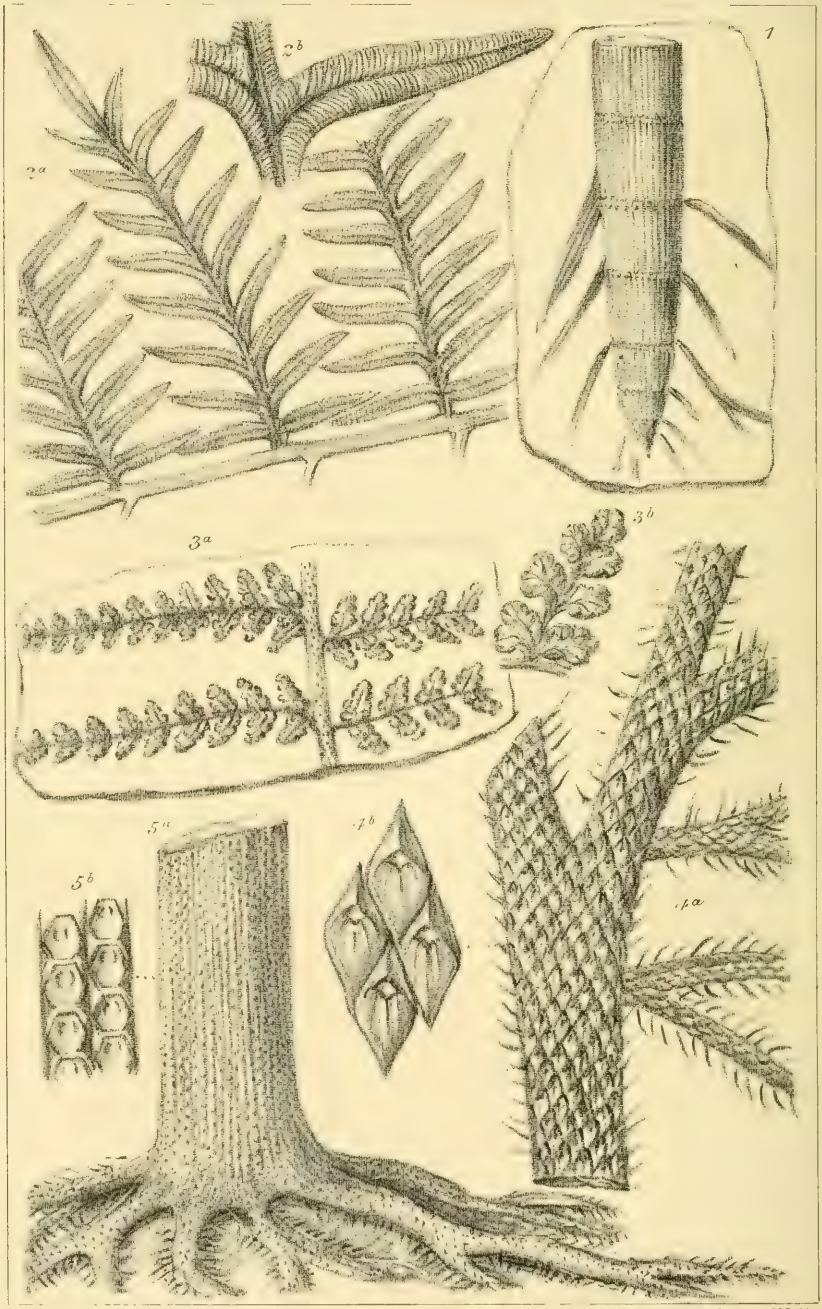

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PLATE XXXIV.

FOSSILS OF THE CARBONIFEROUS ROCKS.

PLANTÆ.

CRYPTOGAMIA—*EQUISETACEÆ.*

FIG. 1.—CALAMITES CANNÆFORMIS, *Schlotheim.*

Petr. pl. xx., fig. 1. Brong. Hist. Vég., pl. xxi. Schimper, Pal. Végét., vol. 1, p. 316.

Base of stem with attached rootlets From Lindley and Hutton, Fossil Flora, vol. 1, pl. lxxix., reversed figure, reduced to one-third of natural size.

COAL MEASURES; SHALE and SANDSTONE. Great Britain and Ireland. "One of the commonest species being found in almost every Coal-field in Europe." Lindl. and Hutt., vol. 1, p. 79.

FILICES.

FIG. 2.—*a*, *b*. ALETHOPTERIS LONCHITICA, *Brongniart*, sp.

Pecopteris Hist. Vég. Foss., p. 275., pl lxxxiv., *P. heterophylla*, Lindl. and Hutt. Foss. Fl., vol. 1, pl. xxxviii. *P. lonchitica, ib.* vol. ii., pl. cliii. *Alethopteris* (Sternberg), Schimper. Pal. Végét, vol. 1, p. 554.

Original. *a*. Portion of frond showing alternating arrangement of pinnæ. *b*. One of the pinnules enlarged. Dromagh Colliery, county Cork.

COAL SHALE.—Great Britain and Ireland. "One of the commonest of the plants of the old Coal formation occurring in great numbers in various Mines in France, Bohemia, Silesia, and England." Lindl. and Hutt., vol. ii., p. 153. It is also the most characteristic and abundant fossil fern in the Coal Measure shales of the South of Ireland.

FIG. 3.—*a*, *b*. SPHENOPTERIS HŒNINGHAUSII, *Brongniart.*

Hist. Vég. foss., p. 199, pl. lii. Lindl. and Hutt. Foss. Fl., vol. iii., pl. cciv. Schimper Pal. Vég., vol. i., p. 385.

Original. *a*. Portion of frond, showing alternating arrangement of pinnæ. *b*. One of the four lobed pinnules, enlarged three diameters. Glengoole Colliery, county Tipperary.

COAL SHALE.—Newcastle-upon-Tyne; south of Ireland, especially Tipperary Coal-field (frequent), Silesia, Saxony, Westphalia, &c.

LYCOPODIACEÆ.

LEPIDODENDREÆ.

FIG. 4.—*a*, *b*. LEPIDODENDRON STERNBERGII, *Brongniart.*

Brongt. Prod., p. 85. *L. elegans*, Brongt. Hist. Vég. Foss. ii., pl. xiv. *L. gracile*, *ib.*, pl. xv. *L. Sternbergii*, *L. acerosum* et *dilatatum*, Lindl. and Hutt., vol. i., pl. iv. and vii., figs. 1, 2. Schimper, Pal. Végét., vol. ii., part i., p. 19.

a. Reduced to half natural size. From Brong. Vég. Foss., Liv. 14, pl. xiv.; portion of fig. 2. *b*. Scales, from do., fig. 1, A.

Coal shale. "In the shales of almost all the coal basins of Europe and America." Sch. Pal. Vég., vol. ii., part 1, p. 20.

SIGILLARIEÆ.

FIG. 5.—*a*, *b*. SIGILLARIA TESELLATA, *Brongniart.*

Hist. Vég. Foss., p. 436, pl. clvi., fig. 1. *Favularia tessellata*, Lindl. and Hutt. Foss. Fl., vol. i., pl. lxxiii.–lxxv. Sch. Pal. Vég., vol. ii., part 1, p. 81.

Original. *a*. Base of Trunk with roots (Stigmaria), much reduced in size. *b*. Hexagonal leaf scars; from Vég. Foss., pl. clxii., fig. 6.

COAL MEASURES; SHALE and SANDSTONE.—Very abundant in British Coal-field, as well as in those of Germany and North America.

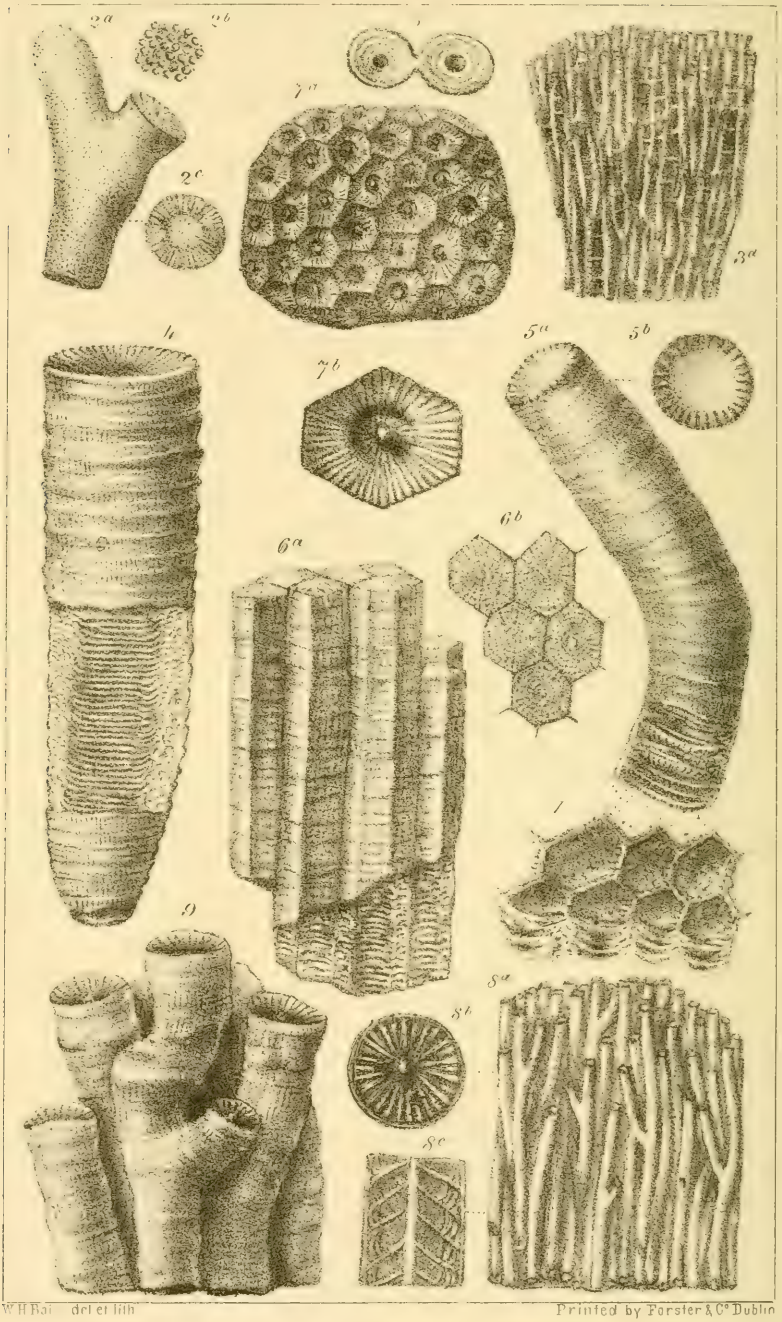

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PLATE XXXV.

FOSSILS OF THE CARBONIFEROUS ROCKS.

ZOOPHYTA.—*ANTHOZOA.*

FIG. 1.—MICHELINEA FAVOSA, *Goldfuss*, sp.

Manon favosum, Goldf. Petr. Germ., vol. i., p. 4, pl. i., fig. 11. *Michelinea favosa*, De Koninck, Anim. Foss., p. 30, pl. C., fig. 2.

Original. Fragment of the "Honey Comb" Coral of Parkinson, showing hexagonal surface of calices. *Carboniferous Limestone, lower shales*, Ballycannon Point, county Limerick. Mus. G. S. I.

CARBONIFEROUS LIMESTONE and SHALE.—A characteristic Lower Limestone fossil at numerous localities.

With this species, it is suggested, *M. megastoma* and *tenuisepta* Phil. sp. should be united, as well as *M. antiqua, glomerata*, and *grandis*, M'Coy, sp.

FIG. 2.—*a, b.* CHÆTETES TUMIDUS, *Phillips*, sp.

Calamopora tumida, Phil. Geol., Yorkshire. 2nd part, p. 200, pl. i., figs. 49-57, *Stenopora*, Morris' Cat. Brit. Foss. (1854), p. 64. *Chætetes*, Edwards and Haime, Brit. Foss. Corals, Pal. Soc. (1852), p. 159.

Original. a. Branching and showing tumid extremity. *b.* Portion of *calicular* surface, enlarged. *c.* Section showing radiations of *corallites* from centre of *corallum*. Carb. Limest. Shale., Clogher, Tyrone, Mus. G. S. I.

CARBONIFEROUS LIMESTONE and SHALE.—Abundant in shales of the Lower Limestone.

FIG. 3.—*a, b.* SYRINGOPORA RETICULATA, *Goldfuss.*

Pet. Germ., vol. i., p. 76, pl. xxv., fig. 8. Brit. Foss. Corals, p. 162, pl. xlvi. figs. 1, 1 *a*.

Original. a. Group of reticulated and branching Corallites. *b.* Transverse section of two of these Corallites showing their tubular connection, and concentric *infundibula*. Carb. Limst., Kesh, Fermanagh; Mus., G. S. I.

CARBONIFEROUS LIMESTONE.—Abundant at many localities in Great Britain and Ireland.

FIG. 4.—ZAPHRENTIS CYLINDRICA, *Scouler*, sp.

Siphonophyllia, M'Coy, Carb. Foss. Irel., p. 187, pl. xxxv., fig. 1. *Zaphrentis*, Brit. Foss. Corals, p. 171, pl. xxxv., fig. 1.

Original. Reduced to one-third of natural size.

a. Simple cylindrical corallum, showing circular accretion swellings, a portion being removed to exhibit the numerous *septæ* and *vesicular dissepiments*. Carb. Limest., Kilvarnet, Co. Sligo. Mus. G. S. I.

Carboniferous Limestone.—An abundant coral in the Lower Limestone and shales, especially in the North of Ireland, where they occur of very large size.

Fig. 5.—*a, b*. Amplexus coralloides, *Sowerby*.

Min. Conch., vol. i., p. 165, pl. lxxii. Brit. Foss. Corals, p. 173, pl. xxxvi., figs. 1 *a—c*.

Original. Reduced to half natural size. *a*. Portion of a simple cylindrical *corallum*, irregularly twisted and covered by circular accretion swellings and vertical lines, the outer edge of the *septa*. At its lower end are shown the closely set *tabulæ* and *septæ*.

b. Section showing one of the tabulæ with septal markings round its outer edge, corresponding to the *septal fossula*. Carb. Limest., Rathkeale, Co. Limerick. Mus. G. S. I.

Carboniferous Limestone.—This Coral is most abundant in the Carb. Limest. of Ireland, especially the Lower Limestone of the South. It is also met with in Derbyshire, Yorkshire, and the Isle of Man.

Fig. 6.—*a, b*. Lithostrotion striatum, *Fleming*.

British Animals, p. 508. *L. basaltiforme*, Brit. Foss. Corals, p. 190, pl. xxxviii., fig. 3.

Original. *a*. Group of compound hexagonal corallites, showing where fractured the closely arranged *septa*. *b*. Horizontal surface of astreiform corallites, showing their closely united and consequently hexagonal arrangement. Carb. Limest. Cookstown, Co. Tyrone. Mus. G. S. I.

Carboniferous Limestone.—This very common, and well marked species, is frequent in various parts of England, North and South Wales, and Ireland. It sometimes occurs in "stools" hemispherical in form, and several feet in diameter.

Fig. 7.—*a, b*. Lithostrotion Portlocki, *Milne Edwards*.

Astrea irregularis, Portlock, Geol. Rep., p. 333, pl. xxxiii., fig. 3. *Lithostrotion Portlocki*, Brit. Foss Corals, p. 194, pl. xlii., fig. 1.

Original. *a*. Upper surface of a small group of compound and irregular hexagonally arranged corallites. *b*. One of the *calices* enlarged showing *septa* and prominent *columella*. In red earthy Carb. Limest. Kildress, Co. Tyrone. Mus. G. S. I.

Carboniferous Limestone.—Derbyshire; North Wales, Bristol, Queen's Co., and county Tyrone, in massive bunches.

As there is some difficulty in defining the genera *Lithostrotion* and *Lithodendron*, we have included, under the first named genus, all those species in which the corallites closely adhere and are compressed together, as in the two here figured (figs. 6 and 7), whilst that of *Lithodendron* include those corals which are fasciculate, uncompressed, and only coalesce, or unite at intervals, as in the two following species (figs. 8 and 9.

FIG. 8.—*a, b, c.* LITHODENDRON JUNCEUM, *Fleming*, sp.

Caryophyllia, Brit. Anim., p. 509. *Lithodendron sexdecimale*, Phil. Geol. Yorks, vol. ii., pl. ii., figs. 11–13. *Lithostrotion junceum*, Brit. Foss. Corals, p. 196, pl. xl., fig. 1.

Original. a. Portion of a group, from Lower Limestone shale, Hook Head, Co. Wexford. Mus. G. S. I. *b.* Calice, enlarged. *c.* Vertical section of portion of a corallite enlarged; from Brit. Foss. Corals, pl. xl., fig. 1, *a, b.*

CARBONIFEROUS LIMESTONE.—One of the most frequent of the Carboniferous corals, especially in the Lower Limestone shale; occurring in tufts or bunches at numerous localities in Britain and Ireland.

FIG. 9.—LITHODENDRON AFFINE, *Fleming*, sp.

Caryophyllia, Brit. Anim., p. 509. *Lithodendron longiconum*, Phil. Geol, Yorks, vol. ii., pl. ii., fig. 18. *Lithostrotion affine*, Brit. Foss. Corals. p. 200, pl. xxxix., fig. 2.

Original. Portion of a group. Carb. Limestone, Cookstown, Co. Tyrone. Mus. G. S. I.

CARBONIFEROUS LIMESTONE.—A very frequent coral in Britain and Ireland, occurring in tufts or bunches of considerable diameter.

PLATE XXXVI.

FOSSILS OF THE CARBONIFEROUS ROCKS.

ECHINODERMATA.—*BLASTOIDEA.*

FIG. 1.—*a, b, c.* PENTREMITES DERBIENSIS, *Sowerby.*

Zool. Journ., vol. ii., p. 317, pl. xi., fig. 3. Geol., Yorksh., vol. ii., pl. iii., fig. 10.

Original. *a.* Side view. *b.* The same enlarged. *c.* Enlarged, showing arrangement of ambulacra, *oral*, *anal*, and *ovarian* apertures. Carb. Limest. Ben Naughlin, near Florence Court, Co. Fermanagh.

CARBONIFEROUS LIMESTONE.—Grassington, Derbyshire; Co. Fermanagh, Ireland.

FIG. 2.—PENTREMITES INFLATUS, *Sowerby.*

Zool. Journ., vol. iii., p. 89. Sup. pl. xxxiii., fig. 2. Geol. Yorksh., vol. ii., pl. iii., figs. 1—3.

Original. Side view, reduced to half natural size, Carb. Limest., lower. Raheny, Co. Dublin.

CARBONIFEROUS LIMESTONE.—Bolland, Yorkshire; Co. Dublin, Ireland.

CRINOIDEA.

FIG. 3.—PLATYCRINUS LÆVIS, *Miller.*

Crinoidea, p. 74, pl. i., (25). Austin, Crinoidea, p. 8, pl. i., fig. 1. De Koninck, Anim. Foss. Carb., pl. F., fig. 1.

Original. Side view of *Head*, *Arms*, and *Column.* Carb. Limest. shale (lower) Hook Head, Co. Wexford.

CARBONIFEROUS LIMESTONE.—Bolland, Bristol, Frome. *Lower Limestone shale.* Several localities in Ireland; "more abundant in the lower and middle beds of the Carb. Limest. than the upper." Austin, Crinoidea, p. 9.

FIG. 4.—PLATYCRINUS CORONATUS, *Goldfuss.*

Nov. Act. Acad., vol. xix., pl. xxxi., fig. 8. *P. mucronatus*, Aust. Crin., p. 22, pl. ii., fig. 1. *P. coronatus*, Goldf. Morris' Cat. Brit. Foss. (1854), p. 86.

Original. Side view of Head with *proboscis.* Carb. Limest., Knockacoller,, near Mountrath, Queen's Co.

CARBONIFEROUS LIMESTONE.—Bolland, Bristol, Mendip hills; Co. Limerick, and Queen's Co., Ireland.

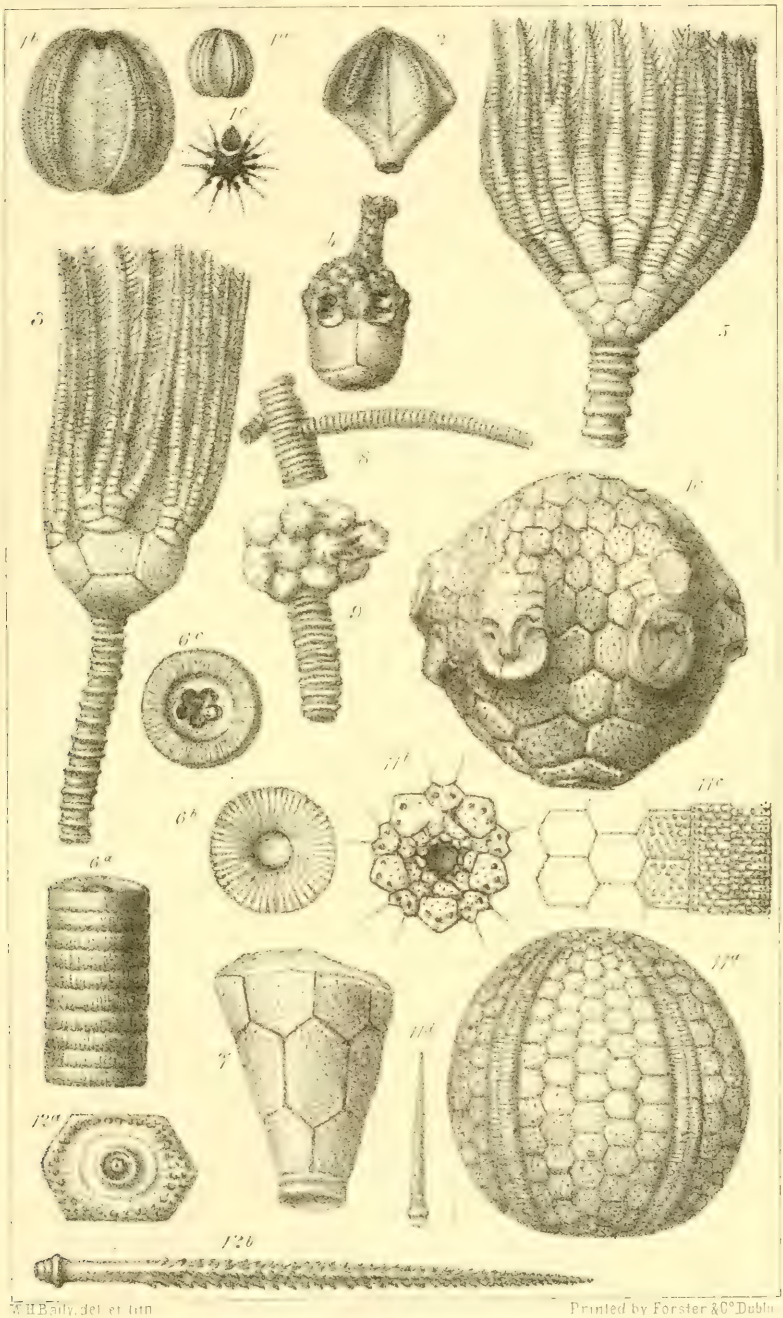

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FIG. 5.—WOODOCRINUS MACRODACTYLUS, *De Koninck.*

Brit. Assoc. (1857), Trans. of the Sections, p. 76. De Koninck and E. Wood, Geologist (1858), p. 12, pl. i.

Original. Reduced to half natural size; side view of head, arms, and portion of column; Carb. Limest., *Yoredale beds*, Swaledale, near Richmond, Yorkshire.

FIG. 6.—*a, b, c.* POTERIOCRINUS CRASSUS, *Miller.*

Crinoidea, p. 69, pl. xxii. Aust. Crin., p. 69, pl, viii., fig. 3, &c.

Original. *a.* Portion of column. *b.* Surface of a joint covered with radiating striæ, the central canal being circular; from lower part of column. *c.* Surface from upper part of column, in which the central canal is pentagonal, and the radiating striæ not continued to it. Carb. Limest., Cavan,

CARBONIFEROUS LIMESTONE.—Yorkshire, Bristol, Ireland. The columns of this species, sometimes three-fourths of an inch in diameter, are very frequent in the Lower Carb. Limest. of Ireland.

FIG. 7.—POTERIOCRINUS CONICUS, *Phillips.*

Geol. Yorks, vol. ii., p. 205, pl. iv., fig. 3. Portl. Geol. Rep. p. 350, pl. xvi., fig. 12.

Original. Lower portion of *Cup* or *Head.* Carb. Limest. Derryvullan, Co. Tyrone.

CARBONIFEROUS LIMESTONE.—Yorkshire, Bristol, Ireland.

FIG. 8.—ACTINOCRINUS, *sp.*

Cyathocrinus planus, Miller, Crin., p. 86, pl. xxx., fig. 27. *Poteriocrinus*, Austin, Crin., p. 61.

Original. Portion of *column*, with *ramules*, or *side arms. Carb. Limest.* (lower) shales. Hook Head, Co. Wexford. This figure is introduced merely to show the articulations of the ramules.

FIG. 9.—ACTINOCRINUS POLYDACTYLUS, *Miller.*

Crinoidea, p. 103, pl. xli., xlii. Geol. Yorks., vol. ii., p. 206, pl. iv., figs. 17, 18.

Original. Some of the lower radiated plates of the *cup*, or *body* of this Crinoid, attached to a portion of the stem. Carb. Limest. lower, Hook Head, Co. Wexford.

CARBONIFEROUS LIMESTONE.—Yorkshire, Mendips, Ireland.

It is probable that *A. triacontadactylus*, Miller, and some others will be found to be synonyms of this species.

FIG. 10.—ACTINOCRINUS AMPHORA, *Goldfuss*, sp.

Melocrinites, Goldf. Nova Acta Acad. Naturæ Curiosorum, vol. xix., p. 341, pl. xxxi., fig. 4. *Actinocrinus*, Portl. Geol. Rep., p. 347, pl. xv., figs. 4, 5, 6.

Original. *Cup* or *Head* composed of many hexagonal plates, and showing articulating surfaces of the arms. Carb. Limest. Derryvullan, Co. Tyrone. Mus. G. S. I.

Carboniferous Limestone.—Yorkshire, Bristol, Cos. Tipperary, Tyrone, and Fermanagh.

ECHINOIDEA.

Fig. 11.—*a–d.* Palæchinus elegans, *M'Coy.*

Synop. Carb. Foss. Irel., p. 172, pl. xxiv., fig. 2. Nobis, Journ. Royal Geol. Soc. Irel., vol. xi., p. 66, pl. iv.

Original. *a.* Side view of shell or *test.* *b.* Genital and ocular disk; enlarged to twice natural size. *c.* Portion of the ambulacra, with adjoining inter-ambulacral plates. *d.* Spine, enlarged twelve times; the line near it represents its natural size.

Carboniferous Limestone.—*Lower,* Hook Head, Co. Wexford. Mus. G. S. I.

Fig. 12.—*a, b.* Archæocidaris Urii, *Fleming,* sp.

Cidaris, Flem. Brit. Anim. *C. Benburbiensis,* Portl. Geol. Rep., p. 352, pl. xvi., fig. 10, 11. *Echinocrinus,* M'Coy, Synop. Carb. Foss. Irel., p. 174, pl. xxvii., fig. 1. *Archæocidaris,* Morris Cat. Brit. Foss. (1854), p. 72.

Original. *a.* One of the central rows of inter-ambulacral plates. *b.* Spine, Carb. Limestone (lower shales), Benburb, Armagh, and Tyrone.

Carboniferous Limestone.—Many localities in England, Scotland, and Ireland.

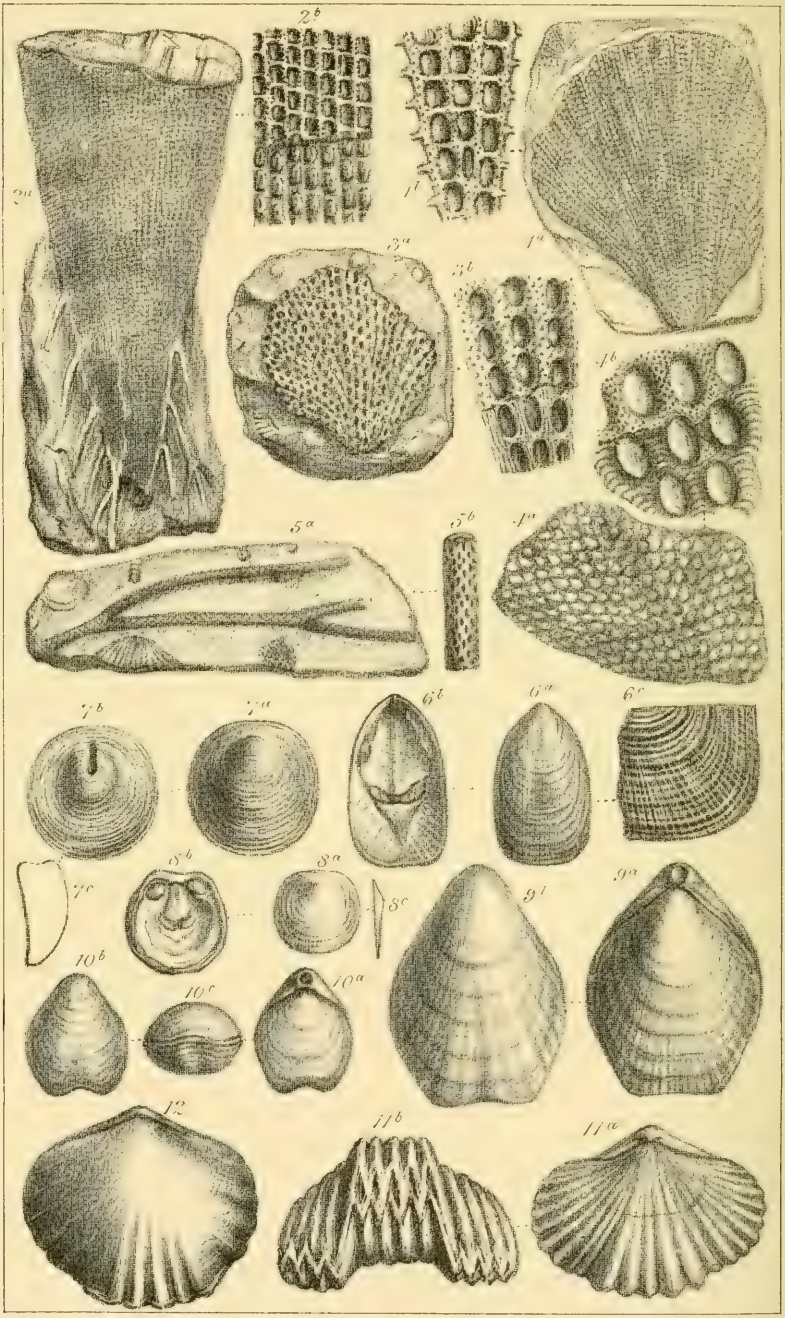

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PLATE XXXVII.

FOSSILS OF THE CARBONIFEROUS ROCKS.

MOLLUSCA.—*POLYZOA.*

FIG. 1.—*a, b.* FENESTELLA ANTIQUA, *Goldfuss.*

Pet. Germ., pl. xxxvi., fig. 3, Phil. Pal. Foss., pl. xii., fig. 35, *a.*
Original. *a.* Carboniferous Slate, Mallow, Co. Cork. Mus. G. S. I. *b.* Enlarged, Carb. Limest. Dungannon, Co. Tyrone. Mus. G. S. I.
DEVONIAN AND CARBONIFEROUS.—*Lower Devonian*, Lynton. *Middle Devonian*, Ilfracombe, N. Devon; Torquay, S Devon; Padstow, Cornwall. *Upper Devonian*, Petherwin, Baggy, and Pilton, N. Devon. *Lower Carboniferous*, Coomhola, Co. Cork, &c. *Lower Limestone shale*, and *Carb. Limestone*, at many localities in Ireland.
This species is probably identical with *F. flabellata*, *F. tenuifila*, Phil. Geol. Yorksh. and *F. plebeia* M'Coy, Carb. Foss. Irel. Expln. to sheets 187, &c., Geol. Surv. Irel., p. 15.

FIG. 2.—*a. b,* FENESTELLA MEMBRANACEA, *Phillips,* sp.

Retepora, Phil. Geol., Yorksh., vol. ii., pl. i., fig. 1—6.
Original. *a.* Reduced figure, showing root-like processes. Barrygaul, Co. Limerick. *b.* Portion of the upper or celluliferous surface, enlarged; this when removed exhibits impressions corresponding with the condition of the fossil named *Hemitrypa Hibernica*, M'Coy.
CARBONIFEROUS LIMESTONE.—Common at various localities in England and Ireland.
F. hemispherica, M'Coy, Carb Foss. Irel., is a synonym of this species.

FIG. 3.—*a, b.* POLYPORA FASTUOSA, *De Koninck,* sp.

Gorgonia, De Kon., Anim. Foss. Belg., pl. A, fig. 5.
Polypora, M'Coy, Ann. Natural Hist., 1848, p. 135.
Original. *a.* Celluliferous surface. *b.* Do. enlarged. Courtlough, Co. Dublin. Mus. G. S. I.
CARBONIFEROUS LIMESTONE.—Co. Wexford, Dublin, &c., Ireland.

FIG. 4.—*a, b.* RETEPORA UNDATA, *M'Coy.*

Griffiths's Synop. Carb. Foss. Irel., pl. xxix., fig. 11.
Original. *a.* Natural size. *b.* Enlarged, Mallow, Co. Cork. Mus. G. S. I.
CARBONIFEROUS LIMESTONE.—Ireland.

FIG. 5.—*a*, *b*. CERIOPORA RHOMBIFERA, *Phillips*, sp.

Millepora, Geol. Yorks., pl. i., figs. 34, 35.
Original. *a*. Natural size. *b*. Enlarged portion, Hook Head, Co. Wexford.
DEVONIAN AND CARBONIFEROUS LIMESTONE.—Upper Devonian, Baggy and Pilton, North Devon. *Carboniferous*, Yorkshire; Ireland.
C. gracilis is believed to be identical with this species.

BRACHIOPODA.

FIG. 6.—*a*, *b*, *c*. LINGULA SQUAMIFORMIS, *Phillips*.

Geol. Yorksh., vol. ii., pl. xi., fig. 14. Davidson, Brit. Carb. Brach. (Pal. Soc.), p. 205, pl. xlix.
a. External view of shell, from Brit. Carb. Brach., pl. xlix., fig. 4.
b. Interior of ventral valve; *op. cit.*, fig. 10. *c*. Portion of the shell enlarged, reduced from fig. 7.
UPPER DEVONIAN AND CARBONIFEROUS.—*Upper Devonian*, Baggy and Pilton, N. Devon. *Lower Carboniferous*, "Coomhola." *Lower Limest. shale*, and *Carb. Limest.* *Coal Measures*, *lower* and *middle*. "This is a common species in certain Scottish strata, and localities, and is found likewise in England, and in Ireland. Davidson, Brit. Carb. Brach., p. 205.

FIG. 7.—*a*, *b*, *c*. DISCINA NITIDA, *Phillips*, sp.

Orbicula, Geol. Yorksh., vol. ii., p. 221, pl. ix., figs. 10—13.
Discina cincta, Portl. Geol. Rep., p. 446, pl. xxxii., figs. 15, 16.
D. nitida, Dav. Scottish Carb. Brach., pl. v., figs. 22—29.
Original. *a*. Upper or conical valve in Ironstone, Coalbrook dale. *b*. Lower or flat valve; Carb. Limest. shale, Benburb, Co. Tyrone. *c*. Side view, in outline, to show elevation of upper valve.
UPPER DEVONIAN AND CARBONIFEROUS.—*Upper Devon.*, Baggy and Pilton, N. Devon. *Lower Carboniferous* to *Coal Measures* inclusive. It is a common shell at many localities in England, Scotland, and Ireland; especially in the Lower Coal Measures of the two latter countries.

FIG. 8.—*a*, *b*. *c*. CRANIA QUADRATA, *M'Coy*, sp.

Orbicula, M'Coy, Carb. Foss. Irel., p. 104, pl. xx., fig. 1.
Crania, Dav. Scot. Carb. Brach., pl. v., figs. 12—21.
a. From Carb. Foss. Irel., pl. xx. fig. 1. *b*. Interior of lower or attached valve, from Brit. Carb. Brach., pl. xlviii., fig. 9. *c*. Side view in outline, to show elevation of upper valve. Rahan's Bay, Co. Donegal.
CARBONIFEROUS LIMESTONE.—Holwell, near Frome; several localities in Scotland; and in Carboniferous shale. Co. Donegal.

FIG. 9.—*a*, *b*. TEREBRATULA HASTATA, *Sowerby*.

Min. Conch., pl. 446, figs. 1, 2, 3. Brit. Carb. Brach., pl. i., figs. 1—12.

a, *b*. Reduced to two-thirds of natural size, from pl. i., fig. 6. *a*, *b*. Front and back view of the same shell, showing radiating bands of colour. Longnor, Derbyshire.

Carboniferous Limestone.—This shell is abundant in many English and Irish localities, but is less frequent in Scotland.

Fig. 10.—*a*, *b*, *c*. Terebratula sacculus, *Martin*.

Anomites, Martin, Pet. Derb., pl. xlvi., figs. 1, 2.

Terebratula, Sow. Min. Conch., pl. 446. Carb. Brach , p. 14, pl. i., figs. 23, &c.

Original. *a*, *b*, *c*. Front, back, and end view of the same shell. Carb. Limest., Dovedale. Mus. G. S. I.

Devonian and Carboniferous.—*Middle Devonian*, Torquay group. S. Devon. *Upper Devon.*, Baggy and Pilton groups, N. Devon. *Carboniferous Limestone*, many localities, especially in the Derbyshire district. It also occurs in West Lothian, Scotland; and at several localities in Ireland.

Fig. 11.—*a*, *b*. Rhynchonella pleurodon, *Phillips*, sp.

Terebratula, Phil. Geol. Yorksh., vol. ii., p. 222, pl. xii., figs. 25, &c. *Rhynchonella*, Brit. Carb. Brach., p. 101, pl. xxiii., figs. 1, &c.

a, *b*. Front and end view of the same specimen, from Brit. Carb. Foss., pl. xxiii., figs. 1. 1 *a*. Carb. Limest. Bolland, Yorkshire.

Devonian and Carboniferous.—*Middle Devon.* Torquay, Ilfracombe. *Upper Devon.*, Petherwin, Cornwall, Baggy and Pilton, and Passage beds, Barnstaple. *Lower Carboniferous* to *Upper Carb. Limestone*.

In England this fossil shell is abundant in the Carb. Limest. and shales, especially in Yorkshire and Derbyshire localities. In Scotland it is found near Carluke, in Lanarkshire; Campsie also in West Lothian. In Ireland it occurs in the Red Sandstone of Kildress, Co. Tyrone, and in the Carb. Limest. and shales at several other localities. Brit. Carb. Brach., p. 105.

Fig. 12.—Rhynchonella pugnus, *Martin*, sp.

Anomites, Mart. Pet. Derb., pl. xxii., figs. 4, 5.

Rhynchonella, Dæv. Brit. Carb. Foss., p. 97, pl. xxii., figs. 1, &c.

From Brit. Carb. Foss., pl. xxii., fig. 2. Carb. Limest. Bolland.

Devonian and Carboniferous.—*Middle Devonian*, Ilfracombe, Torquay; *Upper Devon.*, Petherwin, Pilton. *Lower Carboniferous*, and *Carb. Limestone*. Etheridge, Journ. Geol. Soc., vol. xxiii., p. 622.

This species is common in the Carb. Limest. of Derbyshire, Yorkshire, &c., in England; also in the Isle of Man; Lanarkshire and Stirlingshire, Scotland; and in various counties in Ireland.

PLATE XXXVIII.

FOSSILS OF THE CARBONIFEROUS ROCKS.

MOLLUSCA.—*BRACHIOPODA.*

FIG. 1.—*a*, *b*. SPIRIFERA STRIATA, *Martin*, sp.

Anomites, striatus, Martin, Pet. Derb., pl. xxiii.
Spirifer Sow. Min. Conch., pl. cclxx. *Spirifera striata*, Dav. Brit. Carb. Foss., p. 19, pl. ii., fig. 12, and pl. iii., fig. 2, &c.
a. From Brit. Carb. Foss., pl. ii., fig. 20; dorsal view with portion of valve removed, showing spiral coil. Mus. Cambridge.
b. *Original.* Cast of interior, dorsal valve, Lower Carboniferous (slate), Farmers'-bridge, Co. Kerry. Mus. G. S. I.
CARBONIFEROUS.—*Coomhola grit* to *Lower Coal Measures.* Abundant at numerous localities in England and Ireland. In Scotland, according to Mr. Davidson, it is extremely rare. This species is the largest spirifer known, and is the type of the genus. It is one of the most characteristic fossils of the Lower Carboniferous Limestone. Brit. Carb., Foss., p. 21.

FIG. 2.—SPIRIFERA CUSPIDATA, *Martin*, sp.

Anomites cuspidatus, Martin, Trans. Linnæan Soc., vol. iv., p. 44, pl. iii., fig. 1, &c. *Spirifera*, Sowerby, Min. Conch., pl. cxx., figs. 1, 2, 3. Brit. Carb. Foss., p. 44, pl. viii., figs. 19—24, pl. ix., figs. 1 and 2.
Original. Dorsal view, showing the *beak* and large area, and angular *foramen* or fissure. Carb. Limest. Adare, Co. Limerick.
CARBONIFEROUS LIMESTONE.—"This species occurs plentifully at various localities of the Lower Carboniferous Limestone in England as well as in Ireland; no Scottish example is recorded." Davidson, Brit. Carb. Fossils.

FIG. 3.—*a*, *b*, *c*. ATHYRIS AMBIGUA, *Sowerby*, sp.

Spirifer Sowerby, Min. Conch., vol. iv., p. 105, pl. ccclxxvi. *Athyris*, M'Coy, Brit. Pal. Foss., p. 432.
a, *b*, *c*. From Brit. Carb. Foss., pl. xv., figs. 17, 17 *b*, and 23. *a*. Dorsal view. *b*. Side view. *c*. Dorsal view, with portion of shell removed, showing spiral coils, all from Carb. shales. Carluke, Lanarkshire.
CARBONIFEROUS.—*Coomhola grit*, *Carboniferous slate*, and *Limestone.*—This shell is not unfrequent in the Lower Carb. Limest. of England and Ireland; in Scotland Mr. Davidson states it to be rather common in the Carb. Limest. and shales of the Clydeside Basin, at Carluke, &c., Ayrshire, and Berwick-on-Tweed. Brit. Pal. Foss., p. 79.

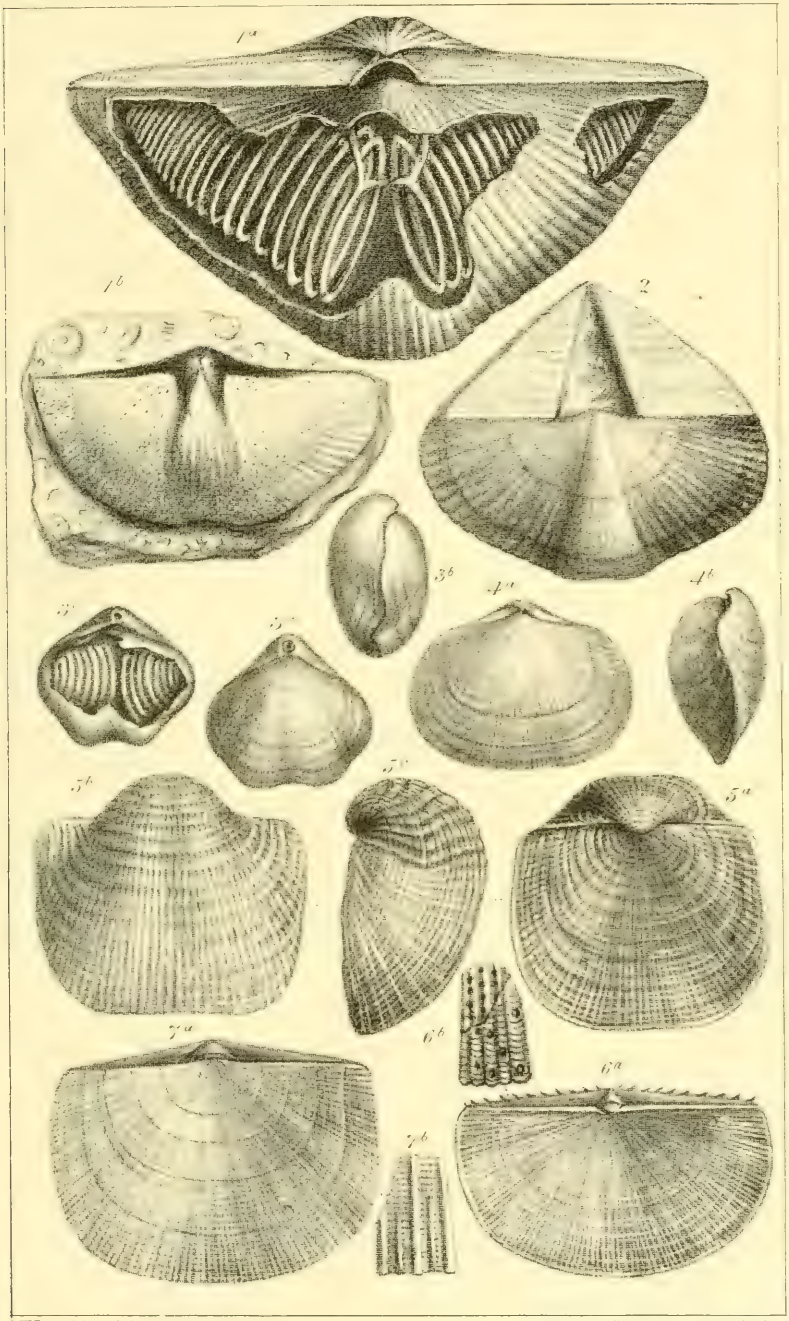

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FIG. 4.—*a*, *b*. ORTHIS RESUPINATA, *Martin*, sp.

Anomites, Martin, Pet. Derb., pl. xlix., figs. 13, 14. *Orthis*, De Kon. Anim. Foss. Belg., pl. xiii., fig. 9. Brit. Carb. Brach., p. 130, pl. xxix., figs. 1—6, pl. xxx., figs. 1—5.

Original. *a*. Dorsal view. *b*. Side view. Carb. Limest. Millecent, Co. Kildare.

CARBONIFEROUS LIMESTONE and SHALE. A common, well-known, and widely spread Carboniferous shell; in England it abounds in the Carb. Limest. and shales of many localities; it is also frequent in the Isle of Man, in Scotland and Ireland.

FIG. 5.—*a*, *b*, *c*. PRODUCTUS SEMIRETICULATUS, *Martin*. sp.

Anomites, Mart. Pet. Derb., pl. xxxii., figs. 1, 2, and pl. xxxiii., fig. 4. *Productus Martini*, De Kon. Carb. Foss. Belg., pl. vii., fig. 2. *P. semireticulatus*, De Kon. Mon. Prod., pl. viii., fig. 1, and pl. ix., fig. 1. Brit. Carb. Foss., p. 149, pl. xliii., figs. 1—11, pl. xliv., figs. 1—4.

a. Dorsal view, from Brit. Carb. Foss., pl. xliii., fig. 2 *a*.

b. *Original*. Ventral view; Carb. Limest., Kilmallock, Co. Limerick. Mus. G. S. I. *c*. Side view, from Brit. Carb. Foss., pl. xliii., fig. 2 *b*, (*a* and *c* are different views of the same shell from Carb. Limestone, Nellfield, Lanarkshire).

CARBONIFEROUS LIMESTONE and SHALE.—COAL MEASURES. "One of the most abundant and far spread species of the genus, found in almost every locality where Carboniferous Brachiopoda occur both in England, Scotland, and Ireland." Brit. Carb. Foss., p. 151. It occurs in the Coal Measure shales of Crateloe, Co. Limerick; and the Limestone of the Lower Coal Measures, Ballycastle, Co. Antrim.

FIG. 6.—*a*, *b*, CHONETES PAPILIONACEA, *Phillips*, sp.

Spirifera, Geol. of Yorksh. vol. ii., pl. ii., fig. 6. *Chonetes*, De Kon, Carb. Foss. Belg., pl. xiii., figs. 5, &c.

a. Dorsal view. *b*. Portion of shell enlarged; from Brit. Carb. Foss., pl. xlvi., figs. 5, and 5 *b*.

CARBONIFEROUS LIMESTONE.—At many localities in England and Ireland.

FIG. 7.—*a*, *b*. STREPTORHYNCHUS CRENISTRIA, *Phillips*, sp.

Spirifer, Phil. Geol. Yorksh., vol. ii., pl. ix., fig. 6.

Streptorhynchus, Dav. Mon. of Scottish Carb. Brach., p. 32, pl. i., figs. 16—22.

Original. *a*. Dorsal view. *b*. Portion of shell enlarged. Lower Limestone shale, Hook Head, Co. Waterford.

DEVONIAN AND CARBONIFEROUS.—"This shell appears to have had a very extended vertical range and is recurrent from the Devonian, if not Silurian, period." Davidson, Brit. Carb. Brach., p. 126. It is said to

occur in the *Upper Devonian*, Petherwin group, Cornwall. The *Middle Devonian*, Torquay group, S. Devon, and Ilfracombe group, N. Devon. *Upper Devonian*, Baggy and Pilton groups, and *Passage beds*, Barnstaple. Etheridge, Geol. Journ., vol. xxiii., p. 624. In the Carboniferous rocks it is found in all the stages from the lowest or "Coomhola grits" to the Upper Limestone. In England, Scotland, and Ireland, it abounds at many localities.

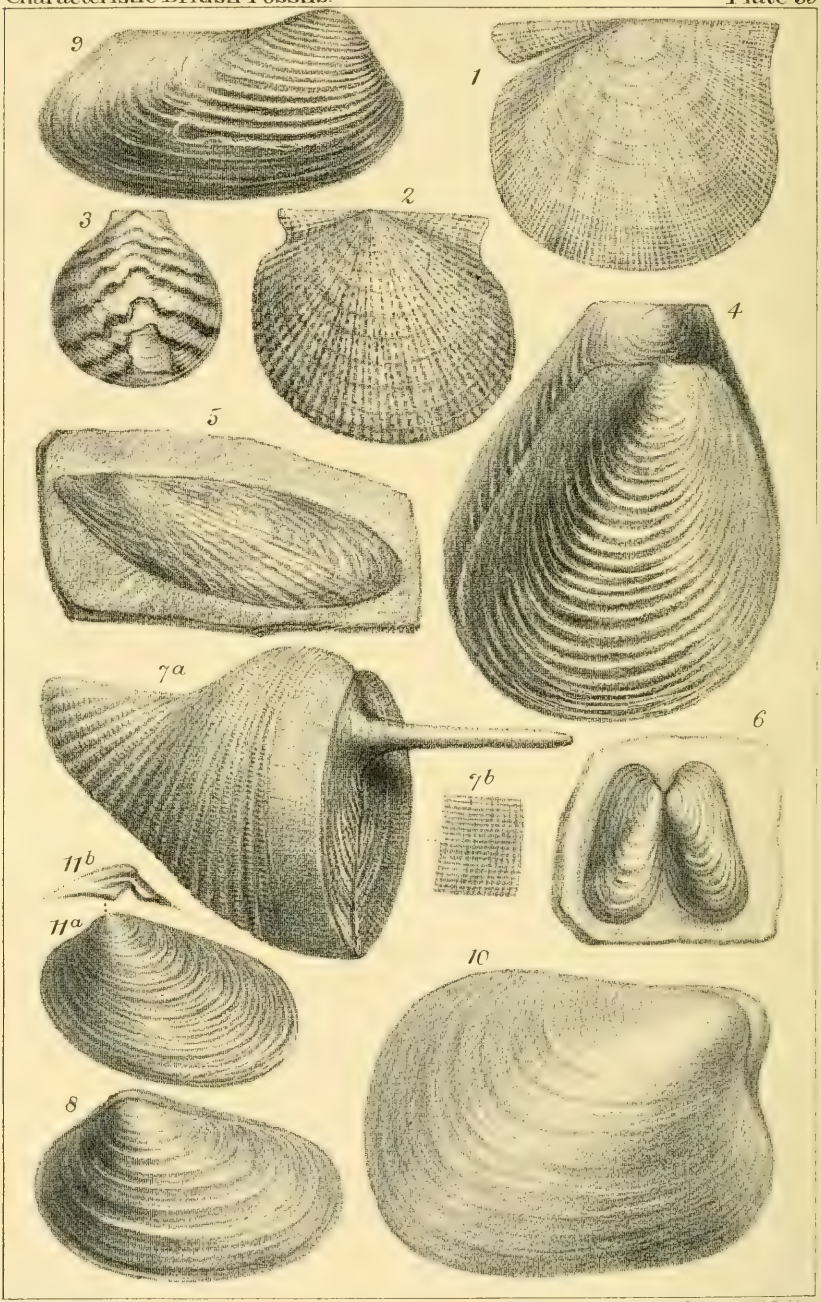

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PLATE XXXIX.

FOSSILS OF THE CARBONIFEROUS ROCKS.

MOLLUSCA.—*CONCHIFERA.*

FIG. 1.—AVICULOPECTEN PAPYRACEUS, *Goldfuss*, sp.

Avicula, Goldf. Petr. Germ., vol. ii., p. 126, pl. cxvi., fig. 5 *a*, *b*.
Pecten, Sow. Min. Conch., vol. iv., p. 75, pl. 354.
Aviculopecten, M'Coy, Morris, Cat. Brit. Foss. 1854, p. 164.
Original. View of right valve, reduced to two-thirds of natural size, from Lower Coal Measures, "Parks Pit," Boulea, Co. Tipperary.
LOWER CARBONIFEROUS, CARBONIFEROUS LIMESTONE, AND COAL MEASURE SHALES.—This very characteristic Coal Measure fossil has also been found as low down in the series as the Carboniferous slate, where it was obtained near Clonakilty, Co. Cork, by the fossil collector of the Geological Survey of Ireland, long ago, and identified by the author. Professor John Phillips also mentions its occurrence under the name of *Pecten papyraceus* in Carboniferous Limestone near Harrogate, and in Bolland.* It is also found in the Upper Carb. Limestone of the county of Dublin. Its great development is, however, in the Coal Measure shales, in which strata it occasionally forms matted masses, being accompanied, as at the locality from which the figured fossil was obtained, by other marine fossils such as Goniatites, and plant fragments. It is also found near Castlecomer, in Ireland, and in the counties of Limerick and Cork. It occurs at several Coal-fields in England. Bradford, Leeds, and Coalbrookdale are mentioned in the Cat. of Brit. Fossils.

FIG. 2.—AVICULOPECTEN GRANOSUS, *Sowerby*, sp.

Pecten, Sow. Min. Conch., pl. dlxxiv., *Aviculopecten*, M'Coy, Pal. Foss., p. 392. Morris' Cat. Brit. Foss., 1854, p. 164.
Original. View of right valve from Carb. Limestone (lower), near Rathkeale, Co. Limerick.
CARBONIFEROUS LIMESTONE, and SHALE.—Lower Carb. shale, near Banteer, Co. Cork. Carb. Limest., Bolland, counties Cork, Kildare, and Dublin.

FIG. 3.—AVICULOPECTEN SWWERBII, *M'Coy*, sp.

Pecten, M'Coy, Syn. Carb. Foss., p. 100, pl. xiv. f. 1. *Amusium* Megerle. See Brit. Pal. Foss., p. 478.
Original. From the very perfect example showing wavy bands of colour markings in addition to the concentric lines of growth; in a second specimen the lines are less wavy and much narrower. The markings are of a

* Geol. Yorksh., vol. ii., p. 213.

burnt umber colour. These beautiful fossils were collected by Captain R. B. Bennett, from the Carboniferous Limestone of Kildare, and are partly in his collection, and in that of the Rev. John Grainger, D. D., Broughshane, near Ballymena.

Carboniferous Limestone.—Many localities in Ireland, amongst them Kilgrogan, Co. Limerick; Ballyrichards, Co. Cork; St. Doolagh's and Cloghran, Co. Dublin. At the latter place it has also been found, showing zigzag bands of colour. Specimens from all these localities are in the Mus. Geol. Surv., Ireland.

Fig. 4.—Posidonomya Becheri, *Bronn.*

Leth. Geog., pl. ii., fig. 17, Sowerby, Geol. Tr., second series, vol. v., pl. lii., fig. 2—4. Phillips' Pal. Foss., pl. xliv., &c., pl. xxii. f. 72, 73, 74.

Original. View of the two valves in near proximity; the thinness of the shell is apparent from the impression of the underneath valve being shown through the upper one. From junction beds between the Upper Carboniferous and Lower Coal Measures, Loughshinny, Co. Dublin. Mus. G. S. I.

P. lateralis and *tuberculata* are synonyms of this species.

Carboniferous Limestone and Coal Measures.—Carb. Limestone, Budle, Northumberland, Morris' Cat., p. 181. A very characteristic shell at the junction of the Upper Carb. Limest. and Coal Measures in the counties of Dublin and Meath, and especially abundant in the dark grey contorted and cleaved shales, W. of Lispatrick, Old Head of Kinsale, Co. Cork; it occurs also in the Coal Measure shales of Foynes Island, Co. Limerick; near Ennis, Co. Clare; at Navan and near Trim, Co. Meath; and Loughshinny and Garristown, Co. Dublin. In some of these places it occurs in profusion in regular layers.

It is stated by Sir R. Murchison* that "it was through the discovery of this striking species in Carboniferous strata on the Coast of Northumberland (it also occurring in the 'Calp.' Coal Measures of Ireland), that the thin beds of black culm limestone in Devonshire, wherein it also occurs, are known to be of this age."

Fig. 5.—Posidonomya membranacea, *M'Coy.*

Posidonia Synopsis Carb. Foss. Irel., p. 78, pl. xiii., f. 14.

Original. In black shale Lower Coal Measures, Balla, Co. Mayo. Mus. G. S. I.

Coal Measures.—This transversely elongated shell is not unfrequent in the lower coal shales of Ireland. It must have been extremely thin, or perhaps membranous—and evidently belongs, like the preceding species, to the Aviculoid group of Bivalves.

Fig. 6.—Modiola Macadami, *Portlock.*

Geol. Rep. p. 432, pl. xxxiv., figs. 13—15, and *M. suparallela*, fig. 16.

Original. Showing both valves, Lower Carb. shale. Clogher, Co. Tyrone, Mus. G. S. I.

* Siluria (1869), p. 291.

LOWER CARBONIFEROUS SHALES.—This small species is very characteristic of the Lower Limestone shales in Ireland. General Portlock says: "It is of peculiar interest as occurring in great abundance in peculiar shales, and having been traced from Derry by Tyrone into Fermanagh." It has been collected by the Geological Survey in the Lower Carb. shales of the counties of Cork, Tipperary, Londonderry, and Armagh.

FIG. 7.—*a*, *b*. PLEURORHYNCHUS HIBERNICUS, *Sowerby*, sp.

Cardium, Sow. Min. Conch., pl. lxxxii., figs. 1, 2, and pl. dlii., fig. 3.
Pleurorhynchus, Phil. Geol. Yorks., vol. ii., pl. v., fig. 26.
Original. *a*. Partly restored figured, showing the long siphonal tube at the truncated or posterior end. *b*. Portion of posterior margin, *hood* enlarged to show croos striæ. Carboniferous Limestone, near Rathkeale, Co. Limerick. Mus. G. S. I.
Carboniferous Limestone.—Frequent in the limestone of the S. of Ireland. In England, it occurs at the Mendips, Bolland, &c. Geol. of Yorks., vol. ii., p. 210.

FIG. 8.—ANTHRACOSIA CENTRALIS, *Sowerby*, sp.

Unio, Sowerby, Geol. Trans., second series, vol. v., pl. xxxix., fig. 13.
Original. From Coal Measure shale, Wednesbury, Staffordshire, Dr. Frazer, coll.
Coal Measures.—Abundant in the coal shales at St. Helens, near Liverpool, and in clay Ironstone, Coalbrookdale, &c.

FIG. 9.—(?) MYACITES OMALIANA, *De Koninck*, sp.

Pholadomya, Kon. Anim. Foss., p. 65, pl. v., fig. 4. *Myacites* (?) Morris' Cat. Brit. Foss., p. 213.
Original. From Carb. Limest. Lisbane, Co. Limerick. Mus. G. S. I.
Carboniferous Limestone.—Derbyshire; counties Limerick, Dublin, and Armagh.

FIG. 10.—CARDIOMORPHA OBLONGA, *Sowerby*, sp.

Isocardia, Sow. Min. Conch., pl. ccccxci., fig. 2. *Cardiomorpha*, Morris' Cat. Brit. Foss., p. 191.
Original. From Carb. Limest. St. Doolagh's, Co. Dublin.
CARBONIFEROUS LIMESTONE.—Bolland, Yorkshire; counties Cork, Limerick, Dublin, &c.

FIG. 11.—*a*, *b*. CURTONOTUS ELEGANS, *Salter*.

Journ. Geol. Soc., vol. 19, p. 474. Expl. Sheet, 187, &c., Geol. Surv., Irel., pp. 27, &c., fig. 6 *a*, *b*.
Original. *a*. Exterior of shell. *b*. Hinge of left valve.
UPPER DEVONIAN and LOWER CARBONIFEROUS.—*Upper Devonian* Pilton group (Etheridge). *Coomhola grit*, Co. Cork.
This Bivalve with other species is frequent at several localities in the county Cork. Expl. 187, &c., G. S. I., p. 17.

PLATE XL.

FOSSILS OF THE CARBONIFEROUS ROCKS.

MOLLUSCA.—*GASTEROPODA.*

FIG. 1.—NATICA PLICISTRIA, *Phillips.*

Geol. Yorksh., vol. ii., pl. xiv., fig. 25.
Original. Back view of shell; from Carb. Limest. Morgan's, N., near Limerick. Mus. G. S. I.
CARBONIFEROUS LIMESTONE.—Bolland, Bristol; counties Limerick, Cork, Kildare, and Dublin (frequent).

FIG. 2.—LOXONEMA IMPENDENS, *M'Coy.*

Syn. Carb. Foss. Irel., p. 30.
Original. Front view, from Carb. Limest. Rathkeale, Co. Limerick. Mus. G. S. I.
CARBONIFEROUS LIMESTONE.—Counties of Cork and Limerick.

FIG. 3.—*a, b.* EUOMPHALUS PENTANGULATUS, *Sowerby.*

Min. Conch., pl. 45, figs. 1, 2. Geol. Yorks., vol. ii., pl. xiii., fig. 13.
Original. *a.* Upper view. *b.* Side view. Carb. Limest., Rathkeale, Co. Limerick. Mus. G. S. I.
CARBONIFEROUS LIMESTONE.—Bolland, Yorkshire; Northumberland. A common shell at many localities in Ireland.

FIG. 4.—PLEUROTOMARIA CARINATA, *Sowerby,* sp.

Helix. Min. Conch., pl. x. and dxl., fig. 3. *Pleurotomaria,* Phil. Geol. Yorks., vol. ii., pl. xv., fig. 1.
Original. Front view, from Carb. Limest., Cragmore, Co. Limerick. Mus. G. S. I.
CARBONIFEROUS LIMESTONE.—Yorkshire, Derbyshire; counties Limerick and Meath.

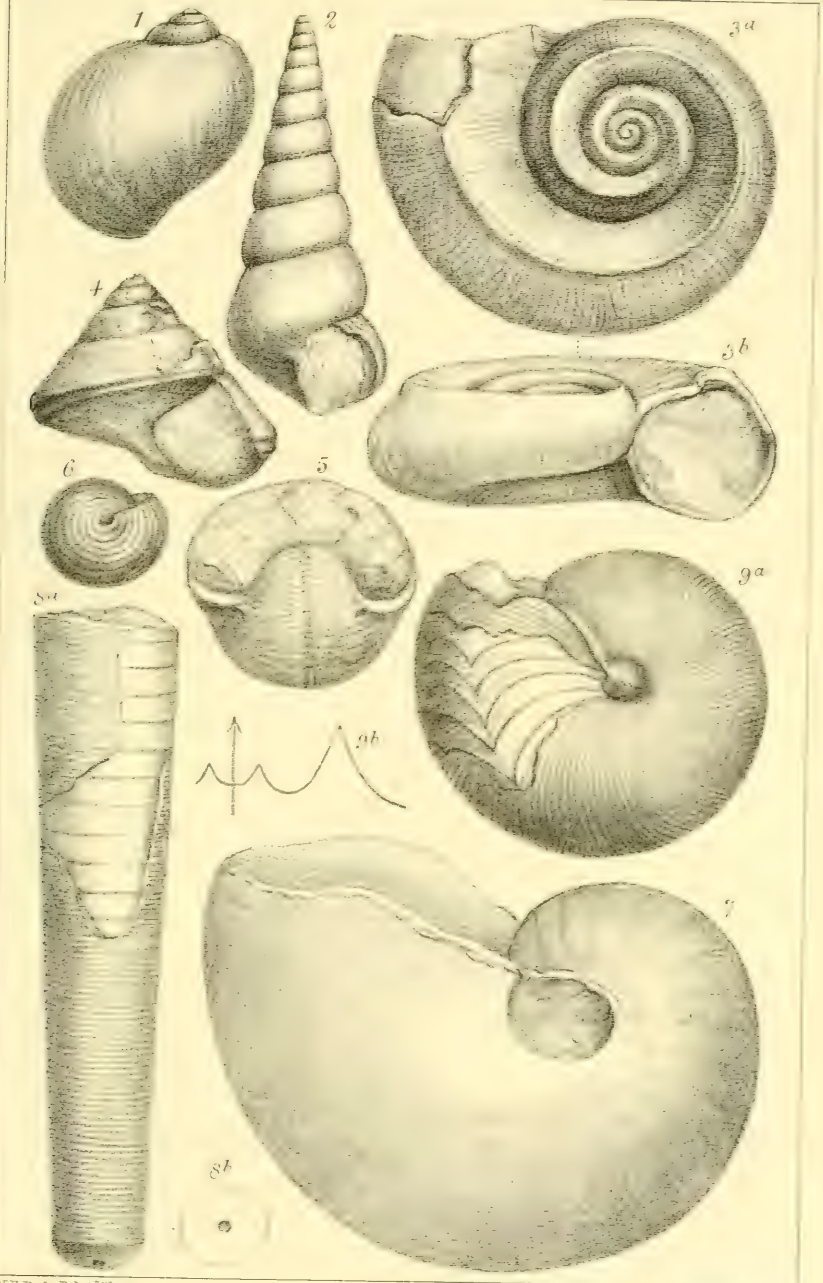
HETEROPODA OR NUCLEOBRANCHIATA.

FIG. 5.—BELLEROPHON HIULCUS, *Sowerby.*

Min. Conch., pl. 470. Geol. Yorks., vol. ii., pl. xvii., fig. 5.
Original. End view, reduced to one-third of natural size. Carb. Limest. Glenbane E.; Co. Limerick. Mus. G. S. I.

Characteristic British Fossils

Plate 40



W.H. Baily, Del et lith

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UPPER DEVONIAN AND CARBONIFEROUS LIMESTONE.—*Upper Devonian*, Petherwin group (Etheridge). *Carb. Limest.*, Bolland, Yorkshire, Derbyshire; counties Limerick and Meath.

FIG. 6.—BELLEROPHON URII, *Fleming*.

Brit. An., p. 338, Geol. Yorks., vol. ii., pl. xvii., figs. 11, 12. Portl. Geol. Rep., pp. 400, &c., pl. 29, fig. 9. (*B. interlineatus* and B. D'Orbignii), figs. 11 and 12.

Original. Side view. Lower Limestone shale, Draperstown, Londonderry. Mus. G. S. I.

UPPER DEVONIAN AND CARBONIFEROUS.—*Upper Devonian*, Baggy and Pilton groups, N. Devon; *Lower Limestone shale*, Co. Cork; *Carb. Limest.*, Rutherglens; Bolland, Tyrone, Fermanagh, and Londonderry; *Coal Measure shales*, near Abbeyfeale, Co. Limerick; Coal Island, Dungannon, Tyrone, Ballycastle, Co. Antrim.

CEPHALOPODA.

FIG. 7.—NAUTILUS DORSALIS, *Phillips*.

Geol. Yorks., vol. ii., p. 23, pl. xvii., fig. 17; pl. xviii., figs. 1, 2.

Original. Reduced to half natural size; side view, from Carb. Limest., Rathkeale, Co. Limerick. Mus. G. S. I.

CARBONIFEROUS LIMESTONE.—Bolland, &c. It occurs at many Limestone localities in the South of Ireland.

FIG. 8.—*a, b.* ORTHOCERAS CINCTUM, *Sowerby*.

Min. Conch., pl. clxxxviii., fig. 3.

Original. *a.* Part of the shell removed, showing septal divisions. *b.* Outline of septum and siphuncle. From Kilgrogan, Co. Limerick.

DEVONIAN AND CARBONIFEROUS.—*Middle Devonian* Torquay. *Upper Devonian*, Petherwin, *Carb. Limest.*, Preston; Bolland, Isle of Man, Co. Limerick, and Castleknock, Dublin.

FIG. 9.—*a, b.* GONIATITES SPHÆRICUS, *Martin*.

Petrif., pl. vii., figs. 3—5. Phil. Geol., Yorks., vol. ii., pl. xix., figs. 4—6. (*P. crenistria*), figs. 7—9.

Original. *a.* Side view, with portion of shell removed, showing septa. *b.* Outline of septal division; from Carboniferous Limestone, Glenbane, E., Co. Limerick. Mus. G. S. I.

CARBONIFEROUS LIMESTONE, AND COAL MEASURES.—Carb. Limest., Bolland, Derbyshire, Isle of Man; Cos. Kerry, Limerick (abundant); Co. Cork. *Coal Measures*, Cos. Clare, Limerick, Tipperary, Meath. With this species it is considered several others may be united, especially *G. crenistria*. See Expl. of Sheet 142, Geol. Surv. Irel., p. 12.

PLATE XLI.

FOSSILS OF THE CARBONIFEROUS ROCKS.

CRUSTACEA.—*TRILOBITA.*

FIG. 1.—*a–d.* BRACHYMETOPUS OURALICUS, *Vernueil,* sp.

Phillipsia, Vern. Geol. Russ., vol. ii., pl. xxvii., fig. 16.
Original. *a.* Head from Carb. Limestone; Ballysteen, Co. Limerick. *b.* Tail (*Pygidium*), from Carb. Limest; Dovedale, Derbyshire. Mus. G. S. I.
CARBONIFEROUS LIMESTONE.—Derbyshire; counties of Limerick, Kildare, Westmeath, and Dublin. The fossil named by Portlock *Phillipsia Maccoyi,* is identical with this species.

FIG. 2.—*a, b, c.* PHILLIPSIA PUSTULATA, *Schlotheim,* sp.

Asaphus pustulatus, Schlot. (1823), Nachtr. zur Petrefactenk. ii., p. 43. *Phillipsia,* De Koninck, Descr des Anim. Foss. Carb., p. 605, pl. liii., fig. 5.
Original. *a.* Head. *b.* Segment of body. *c.* Tail, from Lower Limestone shale; Hook Head, Co. Wexford. Mus. G. S. I.
LOWER CARBONIFEROUS TO COAL MEASURES.—*Carb.* slate, near Bantry, Co. Cork. Carb. Limest., many localities in England and in Ireland; COAL MEASURES, Ballycastle, Co. Antrim.

FIG. 3.—*a, b.* GRIFFITHIDES GLOBICEPS, *Phillips,* sp.

Asaphus, Geol. Yorksh., p. 240, pl. xxii., figs. 16—20. *Griffithides,* Geol. Rep., p. 311, pl. xi., fig. 9.
Original. *a.* Entire specimen, side view. *b.* Another example coiled up, Carb. Limest. Clane Quarries, Co. Kildare. Mus. G. S. I. These are the original specimens figured by Dr. Oldham, in the Journ. Geol. Soc. Dublin, vol. iii., p. 188. pl. ii.
CARBONIFEROUS LIMESTONE.—Many localities in England and Ireland.

OSTRACODA.

FIG. 4.—*a, b, c.* LEPERDITIA SUBRECTA, *Portlock,* sp.

Geol. Rep., p. 316, pl. xxiv., fig. 13, *a—e.* *L. Okeni,* Munster, sp. Jones and Kirby, Annals and Mag. of Nat. Hist., 1865.

Characteristic British Fossils

Plate 41

Printed by Forster & Cº Dublin

Original. *a.* A group of these small bivalved Entomostracan shells. *b.* Enlarged specimen, side view. Lower Limestone shale, Clabby, Co. Fermanagh. Mus. G. S. I. *c.* Do. end view from Ann. and Mag. Nat. Hist., vol. xv., pl. xx., fig. 2, *c.*

Carboniferous.—*Lower* and *Upper*. C. L. Weston, Somerset. Frequent in Ireland in Lower Limest. shale, counties Derry, Tyrone, and Fermanagh; in Scotland, at Burdie House.

Fig. 5.—*a, b.* Entomoconchus Scowleri, *M'Coy.*

Journ. Geol. Soc., Dublin, vol. ii., pl. v., Syn. Carb. Foss. Irel., p. 164, pl. xxiii., fig. 4.

Original. Carb. Limest., Castleknock, Co. Dublin. Collected by Francis J. Freeman, Esq. Mus. G. S. I.

Carboniferous Limestone.—Bolland, Yorkshire; Derbyshire; in Ireland, counties of Limerick, Kildare, Meath, and Dublin.

PŒCILOPODA.

Fig. 6.—Belinurus Reginæ, *Baily.*

Geol, Surv. Irel., Expln. 137, p. 13, fig. 3.

Ann. and Mag. Nat. Hist. 1863, vol. ii., pl. v., fig. 1, *a—d.*

Original. From Coal Measure shales; Bilboa, near Carlow, Queen's Co. Mus. G. S. I.

Coal Measures.—Queen's County, and Lahinch, Co. Clare.

Fig. 7.—Belinurus trilobitoides, *Buckland*, sp.

Bellinurus bellulus König, Icones fossilium sectiles (1820), p. 230, pl. 18.

Limulus, Bridgewater Treatise, vol. i., p. 396; and vol. ii., p. 77, pl. xlvi"., fig. 3. Geol. Tr. 2 ser. 5, pl. xli., fig. 8.

Original. From Gutta Percha cast. Coal Measures (Ironstone), Coalbrook Dale. Mus. G. S. I..

Coal Measures.—Coalbrook Dale; Dudley; Morris' Cat. Brit. Foss., p. 111. General Portlock in his Geol. Report on Londonderry, &c., p. 316, pl. xxiv., fig. 11, describes and figures a species from the Carb. Limest. shale of Maghera, Derry, which he hesitatingly refers to this fossil. Professor Morris includes this in his catalogue under the above specific name. On comparison it will, it is believed, be found distinct.

PISCES.—*CESTRACIONTIDÆ.*

Fig. 8.—(?) Tristychius minor, *Portlock.*

Geol. Rep., p. 464, pl. xiv., fig. 6. Cat. of Brit. Foss., p. 346. Fish spine (Ichthyodorulite) from Geol. Rep., *op. cit.* Carb. Limestone shale Kesh, Fermanagh.

FIG. 9.—*a*, *b*. PSAMMODUS POROSUS, *Agassiz.*

Poiss. Foss., vol. iii., p. 112, pl. xiii., figs. 1—18. Portl. Geol. Rep. pl. xiv., A, fig. 1.
Original. *a*. Tooth. *b*. Enlarged portion of poriferous surface. Carb. Limestone, Armagh. Mus. G. S. I.
CARBONIFEROUS LIMESTONE AND SHALE.—C. L. Bristol, Armagh. *Lower Limestone shale,* Hook Head, and Colloney River, near Sligo.

FIG. 10.—ORODUS RAMOSUS, *Agassiz.*

Poiss. Foss., vol. iii., p. 97, pl. xi., figs. 5—8.
Original. Tooth, from Lower Carbonif. Limest. Mountrath, Queen's Co.
CARBONIFEROUS LIMESTONE AND SHALE.—C. L. Bristol; Queen's Co., and Co. Cork. Lower Limest. shale, Hook Head.

FIG. 11.—HELODUS GIBBERULUS, *Agassiz.*

Poiss. Foss., vol. iii., p. 106, pl. xii., figs. 1, 2.
Original. Tooth; from Carb. Limest. Armagh.
CARBONIFEROUS LIMESTONE.—Bristol; Armagh.

FIG. 12.—PŒCILODUS JONESI, *Agassiz.*

Poiss. Foss., vol. iii., p. 174, and *transversus, ibid.*
Portl. Geol. Rep., p. 468, pl. xiv. A, figs. 6, 7.
Original. Tooth; from Carb. Limest. Armagh.

FIG. 13.—PETALODUS HASTINGSIÆ, *Agassiz.*

Poiss. Foss., vol. iii., p. 174. Portl. Geol. Rep., p. 468, pl. xiv., fig. 10.
Original. Tooth; from Carb. Limest. shale, Kesh, Fermanagh. Mus. G. S. I.
CARBONIFEROUS LIMESTONE AND SHALE.—Ticknall. Cat. Brit. Foss., p. 237. Carb. Limest. Armagh. *Shale,* Clogher, Tyrone; Kesh, Fermanagh.

LEPIDOGANOIDEI.—*HOLOPTYCHIDÆ.*

FIG. 14.—RHIZODUS HIBBERTI, *Agassiz,* sp.

Holoptychius, Agassiz Poiss. Foss., vol. ii., part ii., p. 180. Portl. Geol. Rep., p. 464, pl. xiii., figs. 1—13. *Rhizodus*, Owen, Odontography, pl. xxxv., fig. 2.
Portion of Jaw with large and smaller teeth: from Coal Measures, Burdie House. Owens Odontography, pl. xxxv., fig. 2.
COAL MEASURES,—Burdie House, Edinburgh.

PALÆONISCIDÆ.

FIG. 15.—*a*, *b*. PALÆONISCUS ROBISONI, *Hibbert.*

Trans. Roy. Soc., Edinb., vol. xiii., pl. vi., figs. 6, 7; pl. 7, fig. 3.
Agassiz. Poiss. Foss., vol. ii., p. 88, pl. x. *a*, figs. 1, 2.
a. The entire Fish, from Agassiz, Poiss. Foss., pl. x. *a*, fig. 1.
b. Scale of do. copied from same plate, fig. 2. Coal Measures, Burdie House.
COAL MEASURES, Burdie House, and Torbane Hill, Edinburgh. Mus. G. S. I.
General Portlock in his Report on Londonderry, &c., p. 462., pl. xiv. *a*, fig. 13—15, describes and figures some detached scales from Enniskillen, Fermanagh, which he doubtfully refers to this species. This supposed identification cannot, however, be relied upon from such insufficient material, and especially as is most probable they were obtained from Carb. Limest. shale, and not that of the Coal Measures.

REPTILIA (*AMPHIBIA*).—*LABYRINTHODONTIA.*

FIG. 16.—KERATERPETON GALVANI, *Huxley.*

Transactions of the Royal Irish Academy, vol. xxiv., p. 4, pl. xix.
Original. Reduced to half natural size, from a specimen impressed on coal in the collection of the Geological Survey of Ireland. Jarrow Colliery, Co. Kilkenny

This fossil exposes a dorsal view showing the posterior, and slight indications of an anterior pair of limbs, which are well exhibited in other specimens in the collection from the same colliery.

PLATE XLII.

FOSSILS OF THE PERMIAN ROCKS.

MULLUSCA.—*POLYZOA.*

FIG. 1.—*a, b, c.* SYNOCLADIA VIRGULACEA, *Phillips,* sp.

Retepora, Phillips, Trans. Geol. Soc. of London, 2nd ser., vol. iii., p. 120, pl. xii., fig. 6. *Fenestella*, Phillips, Bull. Soc. Géol., France, 2me. ser., vol. i., p. 25. *Synocladia*, King, Mon. Permian Fossils, Pal. Soc., 1850, p. 39, pl. iii., fig. 14; pl. iv., figs. 1—8.

Original. *a.* Side view of a small hemispherical example, Dalton le Dale. Mus. G. S. I. *b.* Celluliferous surface, enlarged. *c.* Non-celluliferous surface, do. Mus. G. S. I.

PERMIAN, MAGNESIAN LIMESTONE.—Humbleton, Dalton le Dale, Whitley and Durham.

BRACHIOPODA.

FIG. 2.—CAMARAPHORIA CRUMENA, *Martin,* sp.

Anomites, Martin, Pet. Derb., pl. xxxvi., fig. 4. *Terebratula*, Sow. Min. Conch., pl. lxxxiii., fig. 3. *Camaraphoria Schlotheimi*, King, Mon. Perm. Foss., p. 118, pl. vii., figs. 10—21; pl. viii., fig. 8.

Original. Dorsal view, Tunstall. Mus. G. S. I.

CARBONIFEROUS LIMESTONE AND PERMIAN.—Carb. Limest., Derbyshire Dove Dale; Settle, Yorkshire; West Lothian, Scotland. Permian, Humbleton, Tunstall, Tynemouth, and Durham.

FIG. 3.—*a, b.* CAMARAPHORIA HUMBLETONENSIS, *Howse,* sp.

Terebratula Humbletonensis, House, Cat. Perm. Foss., Trans. T. N. F. C., vol. i., part iii., p. 252. *Camaraphoria multiplicata*, King, Ann. and Mag. Nat. Hist., vol. xviii., 1st series, p. 28. *C. Humbletonensis*, Dav. Brit. Perm. Brach., Pal. Soc., 1857, p. 28.

Original. Internal casts. *a.* Dorsal valve. *b.* Ventral valve, Humbleton. Mus. G. S. I.

PERMIAN.—Humbleton quarry, and Dalton le Dale.

Characteristic British Fossils

Plate 42

Printed by Forster & Co. Dublin

FIG. 4.—STROPHALOSIA LAMELLOSA, *Geinitz*, sp.

Orthotrix lamellosus, Geinitz., Verstein, p. 14, pl. v., figs. 16—26, 1848.
Strophalosia Morrisiana, King, Cat. Perm. Foss., 1848, and Mon. of English Perm. Foss., Pal. Soc., 1850, p. 99, pl. xii., figs. 18—25, and 27—32.
S. lamellosa, Davidson, Brit. Perm. Foss., 1857, p. 44, pl. iii., figs. 24—41.
Original, View of ventral valve, Ryhope. Mus. G. S. I.
PERMIAN.—Tunstall, Tynemouth, Humbleton, and Ryhope.

FIG. 5.—*a*, *b*. PRODUCTUS HORRIDUS, *Sowerby*.

Min. Conch., vol. iv., p. 17, pl. cccxix., fig. 1. Brit. Perm. Foss., Pal. Soc., 1857, p. 33, pl. iv., figs. 13—26.
a. From Brit. Perm. Fossils, pl. iv., fig. 16. *b*. *Original*. Internal cast of the dorsal valve, showing the muscular impression. Tunstall Hill. Mus. G. S. I.
PERMIAN.—It abounds in the shell limestones of Humbleton and Tunstall Hills; in the compact Limestone of Midderidge, as well as in the Breccia of Tynemouth Cliff. It is also mentioned, from Derbyshire, Brit. Perm. Fossils, p. 36.

CONCHIFERA.

FIG. 6.—MONOTIS SPELUNCARIA, *Schlotheim*, sp.

Gryphites speluncarius, Schl. Akad, Münch., p. 30, pl. v., fig. 1, *a*, *b*, *c* 1816. *Avicula gryphæoides*, Sowerby, Trans. Geol. Soc. London. 2nd series, vol. iii., p. 119. *A. speluncaria*, Morris, Cat. Brit. Foss. (1854), p. 162. *Monotis*, King. Permian Fossils, p. 155.
From Permian Fossils, pl. xiii., fig. 7. Humbleton Hill.
PERMIAN.—Humbleton and Tunstall Hills, &c., "a common fossil both in England and Germany," King. Perm. Foss., p. 156.

FIG. 7.—BAKEWELLIA ANTIQUA, *Münster*, sp.

Avicula, Münster, Goldf. Pet., part ii., p. 126, pl. cxvi., fig. 7, *a*, *b*.
Bakewellia, King. Permian Fossils, p. 168.
Original. Tunstall. Mus. G. S. I.
PERMIAN.—Several localities in Durham, Yorkshire; Newtown, near Manchester; Kirkby Woodhouse, Nottinghamshire; near Dungannon, Co. Tyrone; a widely distributed species, appearing to be characteristic of every member of the Permian system.

FIG. 8.—AXINUS TRUNCATUS, *King*, sp.

Schizodus, King, Perm. Foss., p. 193, pl. xv., figs. 25—29.
Original. Tullyconnel, Co. Tyrone. Mus. G. S. I.
PERMIAN.—Humbleton, Tunstall, Silksworth, and Whitley, in shell limestone. Tullyconnel, Tyrone.

FIG. 9.—PLEUROPHORUS COSTATUS, *Brown*, sp.

Arca costata, Brown, Trans. Manch. Geol. Soc., vol. i., p. 32, pl. vi , figs. 34, 35.
Pleurophorus. King, Permian Foss., p. 181, pl. xv., figs. 13—20.
Original. Silksworth. Mus. G. S. I.
PERMIAN.—"This species appears to have had an extensive Geographical range. It is common at several localities in Durham, occurring also in the Permian Marls at Newtown, near Manchester," King. Perm. Foss., p. 182. It is found also in Irish Permians, near Dungannon, Tyrone.

GASTEROPODA.

FIG. 10.—*a*, *b*, *c*. TURBO MANCUNIENSIS, *Brown*.

Trans. Manch. Geol. Soc., vol. i., p. 63, pl. vi., figs. 1, 2, 3. Perm. Foss. p. 205., pl. xvi., figs. 19, 20.
a, *b*. *Original*. Back and front view; Tunstall Hill. Mus. G. S. I.
c. Enlarged front view, from Perm. Foss., pl. xvi., fig. 20.
PERMIAN.—*Shell Limestone*, Tunstall Hill, *Breccia*, Black Hall Rocks: *Marls*, Newtown, near Manchester.

FIG. 11—*a*, *b*. PLEUROTOMARIA ANTRINA, *Schlotheim*, sp.

Trochilites antrinus. Schl. Akad. Münch., vol. vi., p. 32, pl. vii., fig. 6.
Pleurotomaria antrina and *P. Tunstallensis*, King. Perm. Foss., pp. 215, 216, pl. xvii., figs. 1—6.
a. *b*. Front and back view. *b*. Showing fissure, from Perm. Foss., pl. xvii., figs. 1, 2. Tunstall Hill.
PERMIAN.—Plentiful in shell limestone, at Tunstall and Silksworth, somewhat rare at Humbleton, Castle Eden-Dene, and Dalton-le-Dale, in similar rock; very rare in the Breccia, Tynemouth-Castle, Cliff. King. Perm. Foss., p. 216.

PISCES.—*PLACOIDEI.*

Fam.—*PYCNODONTIDÆ.*

FIG. 12.—*a*, *b*, *c*. PLATYSOMUS STRIATUS, *Agassiz*.

Poiss. Foss., vol. ii., p. 168, pl. xvii., figs. 1—4. *P. parvus*, Ag. *op. cit.*, p. 170, pl. xviii., fig. 3. King. Perm. Foss., p. 231, pl. xxvii., fig. 1 pl. xxviii., fig. 1.
a. Reduced to two-thirds of natural size, from Perm. Foss., pl. xvii.
b, *c*. Scales from Poiss. Foss., pl. xvii., Marl-slate, Ferry Hill.
PERMIAN *Marl-slate*, Ferry hill and Whitley; *Magnesian limestone*, Low Pallion, Northumberland.

ERRATA AND ADDENDA.

DESCRIPTIVE REMARKS.

Page iii. Cancel Preface and substitute that dated July , 1875.

.. xix. Line 1, and "Explanation of the Plates," p. 14, Plate vi., fig. 2, *Nebulipora favosa*, is now *Monticulipora favulosa*.

.. ,, Line 4, erase *Stenopora* and the brackets to *Favosites*, on line 5, and read *Favosites fibrosus*.

.. xxi. Line 7, and "Explanation of the Plates," p. 19, fig. 2, for *L. plumbea* and *Obolella plumbea*, read *Obolus plumbeus*.

.. ,, Line 21, for *Ribieria* read *Ribeiria*. This fossil is now considered to be a Crustacean.

.. xxvii. Line 6 from bottom, for *Astreidæ* read *Astræidæ*.

.. xxix. Line 22 from bottom, for *Plæaster* read *Palæaster*.

.. ,, Line 18 from bottom, for *Ophuira* read *Ophiura*.

.. ,, Line 8 from bottom, for *Dyctyonema* read *Dictyonema*.

.. xxxii. Line 1, for *septæ* read *septa*.

.. xxxvii., xxxviii., and xxxix. The Woodcuts numbered figs. 1, 2, and 3, should read 11, 12, and 13.

.. xxxvii. Description of fig. 11 B, for *cPdicle* read *Pedicle*.

.. xlv. Last line and p. 61, Expln. of Pl. xx., fig. 9, for *depressa* read *rhomboidalis*.

.. xlvi. Line 23, for *has* read *have*.

.. xlvii. Line 13, for *lata* read *striatella*.

.. ,, Line 14, for *cymbæformis* read *cymbæformis*.

.. xlix. Line 12, and Explanation of Pl. xxvii., fig. 6, *Pteraspis truncatus* is now *Scaphaspis truncatus*.

.. ,, Line 21, *Plectrodus* "jaws and teeth," formerly considered as belonging to a ganoid fish, is now shown by Harley to be the prickly processes of the Cephalic shield of a Crustacea.

.. l. Line 3 of Table, for *Cœlenterata* read *Cœlenterata*.

.. liv. Line 24, for *Lepidodenriod* read *Lepidodendroid*.

.. lx. Last line of foot note, for *Palæontographical* read *Palæontographical*.

.. lvii. Description of fig. 15, *a* should be inserted before Pygopterus, and *b* before Clupea.

.. lx. Line 4, for *state* read *slate*.

.. lxiv. Line 9 from bottom, for *Cacmarthen* read *Caermarthen*.

.. lxix. Line 16 from bottom, for *fig.* 1 read *fig.* 11.

.. lxx. Line 10, for *Anthyris* read *Athyris*.

.. lxxi. Description of fig. 16, *a b* should be inserted before Atlanta, and *c* before Bellerophon.

.. lxxii. Description of fig. 17, *a* should be inserted before Creseis, *b* before Cleodora, and *c* before Conularia.

.. lxxvii. Line 21, for *Marcuniensis* read *Manccuniensis*.

EXPLANATION OF THE PLATES.

Page 5. Immediately over Dictyonema, HYDROZOA OR POLYZOA should be inserted.

„ 14. Line 10, for pl. 1, read Part 1.

„ 21, Immediately over Ribeiria CRUSTACEA should be inserted.

„ 22. Line 17, HETEROPODA OR should be inserted before PTEROPODA.

„ „ Line 10 from bottom, immediately above Theca should be inserted PTEROPODA.

„ 27. Line 6 from bottom, and p. xxvi. "Descriptive Remarks," before Petraia, which should be bracketed, *Cyathophyllum* may be inserted.

„ 30. Line 1, for *Asteriadæ* read *Asteroidea*.

„ „ Line 16, over Protaster insert *Ophiuroidea*.

„ 40. Line 15 from bottom, for *Palæontological* read *Palæozoic*.

„ 66. Insert at end of Description of fig. 5, as follows:—CEPHALOPODA.

Fig. 4.—ORTHOCERAS ANNULATUM, *Sowerby*.
O. undulatum, Hisinger, var *O. fimbriatum*, Sowerby.
O. annulatum, Sil. Syst., p. 632, Pl. ix., fig. 5.
From Sil. Syst. *op. cit.* Wenlock limestone, near Malvern.
CARADOC to WENLOCK.—Sil. 4th ed., p. 535.
Found at numerous localities in Wales; Shropshire; also in Wenlock rocks at Doonquin, Co. Kerry. Coll. G. S. I.

Page 76. Line 8 from bottom, for *cymbæformis* read *cymbæformis*.

„ 78. Line 4, for *Loxonoma* read *Loxonema*.

„ 82. Line 12 from bottom, for *Orchus* read *Onchus*.

„ „ Line 4, erase "*probably portions of the jaws and teeth of a small ganoid fish*," and insert "this and the following species are now determined to be processes of the carapace of a Crustacean."

„ 83. Line 1, for *pustiliferus* read *pustuliferus*.

„ „ Line 7. for *Theolodus* read *Thelodus*.

„ 84. Line 8, for *Brorgniart* read *Brongniart*.

„ „ Under line 16, insert: "This species is also said to occur in the South of Scotland with the fossil fish Holoptychius nobillisimus." Sil. 4th ed., p. 248. Berwickshire, Jedburgh. Brit. Assoc. Rep. (Aberdeen).

„ „ Line 18, bracket *Knorria*, and insert *Sagenaria* before it.

„ „ Line 12 from bottom, after Cyclostigma minuta, Haughton, insert* * Journ. Roy. Dub. Soc., pp. 419, 420, *Lepidodendron minutum*, Journ. Geol. Soc., Dub. Vol. vi., p. 235. Loc. Tallow Bridge, Co. Waterford.

„ 102. Line 1, erase *a*, commencement of paragraph.

„ „ Line 13, after septæ, insert *b*, transverse section.

„ 113. Line 6 from bottom, for *Swærbii* read *Sowerbii*.

„ 115. Line 12, for *croos* read *cross*.

„ 117. Line 12, for *Rutherglens* read *Rutherglen*.

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