STONES

OF THE VALLEY.

BY THE

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TO

MRS. HUGH E. STRICKLAND,

JARDINE HALL, DUMFRIESHIRE.

MY DEAR MRS. STRICKLAND,

There are few of the scenes portrayed in this little book with which you are not familiar, through the geological investigations and labours of your lamented husband. From him I received many of my first lessons in Natural History; and much *true friendship*.

This is my apology for dedicating to you, a brief description of the Geology of his home, for such I consider the Vale of Worcester. With much respect,

I remain,

Yours most faithfully,

W. S. SYMONDS.

Pendock Rectory, May 1, 1857.

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STONES OF THE VALLEY.

CHAPTER I.

DEVONIAN TRANSITION AND CARBONIFEROUS DEPOSITS IN THE MALVERN DISTRICT AND VALE OF GLOUCESTER, ETC.

I DO not think it possible for any one to enter upon the study of geology with ideas more adverse, or opinions more prejudiced, than when, nearly fifteen years ago, I first took up Sir Charles Lyell's "Principles."—I had left College, as too many others leave it, without a single idea concerning the common things of everyday life, or the slightest knowledge of any one of God's works; when I was thrown into the society of one,* whose memory I shall ever prize, who directed my attention to the wondrous history of the stones of the field, the birds of the air, and the "gnats above the summer stream." One day, after telling me a strange tale respecting a drifted pebble, which he said was carried by ice from Norway or Lapland, my friend invited me to examine his geological collection. I have sundry misgivings that I did not understand the term *geological;* it is true that, when attending divinity lectures at Cambridge, I had observed a diagram against the walls representing the range of the Malverns, and had been informed that those picturesque hills were a favourite theme of Professor Sedgewick when lecturing upon geology. Still I am not sure that I knew what geology meant! I shall not easily forget the first fossil I ever examined. The first fossil was the impression of the wing of an enormous dragon-fly that lived in the

* Mr. John Gibbs.

days of the Lias, and an engraving of which now holds an honoured place among the insects figured by the Rev. P. B. Brodie, in his work on Fossil Insects. (Brodie, pl. 10, f. 4.) Every nerve of this beautiful specimen was imprinted on the hard stone, and the fretted net-work of the wing was perfect as that of a newly-captured insect.—I looked and looked again! Next came the dragon head of a great fish lizard (*icthyosaurus*), the stony teeth grinning from jaws of adamant, the plates of the eye still preserved, and shaped somewhat like the cups of a closed opera-glass. There were fishes great and small, their bodies covered with shining enamel, one resembling a stony turbot, and another a fossil smelt. (*Pholidophorus Stricklandi*, &c.) Hundreds of fossil shells were ranged upon the shelves, and, among them, coiled and serpent-looking forms, which geologists call ammonites, though I then took them for *fossil snakes*. Nor were the VEGETABLE remains of the Lias absent, and I well remember specimens of petrified wood, also the leaves of fossil ferns (*Otopteris obtusa*), the veins of which were as distinct as the nerves of the aforesaid dragon-fly. I asked many questions, not I fear remarkable for their sagacity, and I often wonder now that my friend did not laugh out-right in my face; for in the first hour I had satisfactorily settled that those dead and stony forms were the relics of the Noachian deluge, and that it must be downright infidelity to suppose any other solution to the problem. There was only one absurdity that I believe I was *not* guilty of; I don't think I ever was fool enough to suppose that the stones *grew* into dragons' jaws, and "imitated" fish and shells and insects, through the aid of that inexplicable mystery called "plastic virtue." The thought haunted me as I walked homewards, that God must have created the stony relics I had just looked upon; and created them as *living, moving, breathing*, creatures. The insect must have once revelled in the air, the fish roamed in the sea, river, or lake, and the ferns have received nourishment, as ferns do now, from the constituents of the land. Would it not therefore be well to inquire into their history, and to know whether this geology was true or false? I borrowed Sir Charles Lyell's "Principles." Nearly fifteen years have passed since I perused the first edition of the "Principles," and much experience in personal investigation and practical field-work has convinced me, that the "Testimony graven upon the rocks" is bound to prove convincing where there is diligent and candid inquiry. A person cannot help believing where there is sufficient and tangible evidence, and ought not to believe where there is not. Belief in the facts of geology is no voluntary thing, dependent on man's will, for it is not possible for any one with common sense, common eyes; and common honesty, practically to investigate the evidence furnished by this science for ten years, nay for two, and to deny or question truths of which he has received such real and sensible demonstration.

From year to year the witnesses of geology keep pressing forward, and mere presumptions have become demonstrable truths or palpable fallacies. Many geologists supposed that the earliest condition of the earth's surface was that of a state of fusion, and believed that, for many epochs, the outbursts of igneous and volcanic matter from the interior, and the internal activity of the planet, were adverse to the conditions of life. Sir Charles Lyell, on the contrary, always inculcates caution on such generalizations, recommending his brethren of the hammer not to found positive data on merely negative grounds; a wise warning too often neglected by us all! In the geological section of the British Association for the Advancement of Science, held at Glasgow, September, 1855, an interesting statement was made by Sir R. I. Murchison, from a letter written by Mr. Salter, to the effect that he had discovered trilobites and annelids in the Longmynd or Lower Cambrians of Wales; which discovery, as these are the lowest sedimentary deposits known, militates against the former idea that thousands of feet of stratified rocks were destitute of organic remains, or that all the unnumbered ages that must have elapsed before the deposition of the Lower Silurian strata were azoic or destitute of life. Professor Rogers has also detected trilobites in the Cambrians of America.

The Silurian rocks, commencing with the Llandeilo formation, and ending with the Tilestones, have the enormous dimensions of 26,000 feet; and if we add to these the underlying masses of Cambrian deposits, "sedimentary masses of pretty similar mineral aspect, we have before us a pile of subaqueous deposits reaching to the stupendous thickness of 56,000 feet, or upwards of ten miles." (Siluria, p. 175.)

The Silurian deposits are in many instances crowded with animal remains, and the limestones are charnel-houses of shell-fish, corals, and crustaceans.

In the lower Llandeilo beds we find graptolites (animals allied to the virgularia and the sea-pen of the present seas), but which ceased to exist before the close of the Silurian epoch; myriads of mollusca (shell-fish), the brachiopoda being the most abundant, were the tenants of the sea, while crinoidea (stone-lilies), corals, trilobites, and cystidiæ (a genus of Silurian sea-urchin), give evidence that even in that remote period sentient existences were created, and the laws of Nature, and of life and death, established.

In the Upper Silurian rocks the geologist meets with marine mollusca, and the oldest remains of fishes yet known (placoid fishes, allied to the shark and ray), while land-plants also are first revealed.

The Old Red Sandstone or Devonian group

of deposits succeed the Upper Silurians, and we find a great change in the mineral character of the sediments, as well as the organic remains. Still we have the Paleozoic or old-life type of animals. The trilobite, though scarce, was still in existence, and the fossil shells affect Silurian shapes. Fossil fishes of the ganoid (shining scale) order are in some localities very abundant, and succeed the Silurian placoids. The fishes, crustaceans, shells, and corals of the Old Red Sandstone seas were different to those of the Silurian epoch, and we learn from Sir Charles Lyell that certain beds in America constitute a coral reef over an area of 500,000 square miles, and extend from the state of New York to the Mississippi.

The bones of a reptile, the only relics of that class of animals yet discovered in strata so old as the Old Red Sandstone, have been detected in Scotland, though a few years ago reptilian life was not supposed to have been created earlier than the New Red Sandstone epoch.

TRANSITION BEDS OF THE OLD RED SANDSTONE.

The Old Red Sandstone, upon the upper beds of which the coal-bearing or carboniferous system rests, furnishes, as we have already stated (Old Stones), unequivocal traces of a terrestrial vegetation, and we learn that the marine vegetable organisms of that remote period were in such abundance that they often communicate a fissile character to the stone in which they occur.

Two excellent sections in the Forest of Dean display the Upper Old Red and Carboniferous rocks graduating into one another, and it should be remarked that these passage-beds are perfectly conformable. It is probable that they are the equivalents of those beds in Ireland so rich in land-plants (*Knorria*, *Stigmaria*, &c.) and in fresh-water shells (*Anodon Tukesii*, &c.). At

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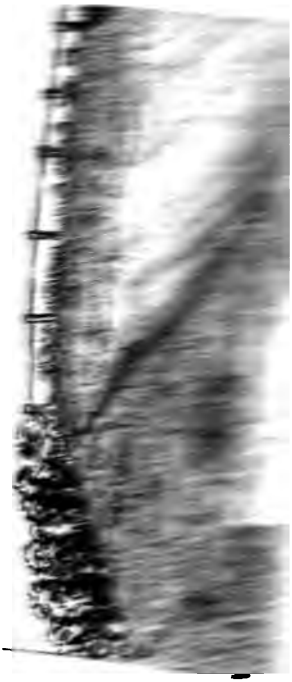

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the Drybrook section, we have traces of plants, though indifferently preserved. (See section.)

The transition-beds in Dean Forest would well repay the labour of thorough investigation, and reward the searcher with many a relic of an epoch that affords the earliest known records of a determinable terrestrial flora. They also teach that the Carboniferous era was not the first of luxuriant vegetation: the ancient flora of the Old Red epoch had perished before the sun shone upon the waving ferns of the Palæozoic coal! The land of the Old Red Sandstone possessed its tree-ferns (*Cyclopteris hibernica*) and calamites that "clustered in thickets beside its waters," and its river-floods swept them out to sea, or deposited them in lakes, estuaries, or bays.

A fine calamite from the upper beds, belonging to the Earl of Ducie, was exhibited at the meeting of the British Association at Cheltenham.

As far as we have evidence at present, these land-plants of the Old Red system were contemporary with the first known animal of reptilian form (*Telereton Elginense*) and the strange fishes of Dura Den in Fifeshire.

The history of the fishes of these upper strata is eloquently told in the ninth chapter of Hugh Miller's Old Red Sandstone. One (*Holoptychius*) was cased in armour which "might have served a crocodile or alligator five times the size," and its jaws "are composed of as solid bone as we usually find in the jaws of mammalia." Six species of this extraordinary fish are now enumerated. The scales are composed of enamel, and resemble small coins. At Dura Den in Scotland the remains of a species of pterichthys are abundant in these upper beds—that strange genus with enamelled plates and wing-like appendages. The Holoptychius is also found in the coal-measures—a significant fact which those who argue for hard lines and boundaries of creation would do well to consider.

These transition-strata in Scotland and Ireland are yellow and light-coloured sandstones, and they are much the same in Dean Forest, on the banks of the Wye, near Whitchurch, and below Symond's Yat. The latter section is much covered up by surface soil, but may yet be traced by the yellow sands which crop out at the surface on ascending the little path from the river Wye.

The following is the arrangement of the strata :—

1. Upper Sandstone (Pennant Grits), Clays, and Coal.

2. Millstone Grit.

3. Mountain Limestone.

4. Limestone Shale.

5. Transition Beds.

It was a bright spring morning on which I started with my first geological friend, to visit for the first time the coal-field of Dean Forest, where I was promised that I should behold impressions of the ancient ferns and other plants that flourished innumerable ages ago, and which *en masse* compose the precious mineral. Years have passed away, but there is scarcely an incident of that journey that I cannot recall. We arrived at Newnham, a well-known and picturesque village on the Severn, and the evening was passed in the study of Westbury Cliff. The geologist may imagine the delight with which a tyro revelled among the fossil-shells of the Lias, and the teeth, vertebræ, and other remains of extinct fishes and reptiles, that are so abundant in the "bone bed" of the "Garden Cliff." Our first inquiry on returning to Newnham was for the appearance of the tidal wave called "the Bore," the second for some intelligent person who knew the ways and doings of the forest.

The landlord stared with mingled wonder and contempt at our hammers and bags (geology was not so much the fashion as it is now), and directed us to a medical gentleman, who had many an idea above concocting a draught and rolling a pill.

There was not a person, or legend, or an in-and-out of the forest, with which he was not acquainted, and many a laugh rang through those old woods, as we wended our way on the morrow, at his description of sayings and doings within Her Majesty's royal chase.

I shall not forget either the mysterious unfolding of certain fossils, which I immediately concluded to be fossil leeches, from the Garden Cliff, and which my geological friend pronounced the palatal teeth of an extinct species of shark, much to the astonishment of myself and the doctor, while he informed us at the same time that *leeches* were not created in Liassic times. I have since, more than once, experienced the kindness and hospitality of our forest guide.

Newnham itself stands on the Keüper sandstone of the Triassic series; the beds crop out in the cliff at the "passage," and may readily be distinguished by the grey sandstones and red marls. On leaving Newnham for Dean Forest the explorer soon finds himself on the Cornstones or middle group of the Old Red Sandstone, to which succeed the pebbly beds known as Old Red Conglomerate, the yellow sandstones, the limestone shale, mountain limestone, and mill-stone grit, all of which form the encircling underlying edge of the great South Welsh coal basin, as well as of Dean Forest.

Immediately above the yellow sands of the Transition beds, but clearly separable from them by the abundance of their marine organic remains, both animal and vegetable, occur the lowest strata of the carboniferous system (No. 4). They may be seen, as already indicated, in Dean Forest at the railway cutting near Sudely; near Drybrook below Symond's Yat on the Wye; and Sir R. Murchison describes them as occurring between Chepstow and the Usk, in "the ravines between Well Head and Rug's Hole." (Sil. Syst. p. 159). They may be traced on the heights of the Blorenge, and the out-lier of Pen-Cerrig-Calch, and indeed along the rim of the great South Wales coal-field, from Caermarthen into Pembrokeshire.

Very considerable interest is attached to these beds, and we heartily wish that some local geologist would examine them closely. No doubt they were deposited under very different conditions from the yellow sandstones beneath, for no sooner do we pass the yellow sands than we find the strata teeming with seaweeds, shells, and corals, while at the *very base* in many localities we have a regular bone-bed, full of the remains of true oceanic fishes.

Lord Ducie discovered this remarkable mausoleum of extinct fish in the Tortworth district, and it occurs near Bristol, but I am not aware of its existence in Dean Forest.

The passage-beds from one geologic system to another have always proved of a most interesting character. Thus the "bone-bed" between the Upper Ludlow shales and the Downton sandstones was by many of us, for a long time, supposed to furnish certain evidence of the total destruction of Silurian life, while the Old Red Sandstone strata above were believed to represent a succeeding and entirely new creation. I am inclined to believe that bone-beds do *not* indicate the termination of distinct creations, but that they are entirely *local* phenomena, owing to the destruction of fish and other animals by submarine volcanic action, gaseous emanations, or the introduction of mineral ingredients into the ocean, which was fatal to those animals that came within the range of the deleterious agent.

A "bone-bed" is sometimes found to be persistent over a great distance in square miles, and the character of the remains varies considerably in *different localities.* Thus the Ludlow bone-bed at Ludlow contains the remains of numerous fishes; near Kington the relics of crustaceans predominate; at Hagley, Herefordshire, and Gamage-Ford, near Marcle, the remains of the Pterygotus are found associated with marine shells and the seeds of land-plants, the oldest terrestrial vegetable remains yet known; while at Malvern the equivalent bed is a thin stratum charged principally with a minute Lingula, casts of a Murchisonia, and a few traces of the Pterygotus.

This Upper Ludlow bone-bed, or rather shell-bed, was discovered in the Malvern district by the enterprise and exertion of the Vice-President of our Natural History Field Club (the Rev. F. Dyson) on the north side of Brockhill Copse, in a picturesque quarry where the Upper Ludlow shale is joined by the Downton sandstones, and on which unquarried junction beds Mr. Dyson employed a number of men for several days.

The association of the organic remains is entirely in harmony with the laws *now* known to govern the distribution of marine animals; fish affect one coast, crustaceans another, and shell-fish another. Off the south coast of the Isle of Wight crabs, lobsters, and prawns are extremely abundant, but fish are scarce, and shell-fish by no means abundant; again, on other parts of our British coasts crustaceans are rare and the mollusca very abundant. Marine animal life is influenced by circumstances of food, depth of water, calcareous or non-calcareous land-cliffs and sea-bottoms, proximity of shore-lines, and many other causes; and we should learn to extend our reasonings on *geographical* distribution to the histories of animal existences in former epochs. A sudden influx of lava, or turbid mineral and gaseous impregnated waters, in the neighbourhood of the Dogger Bank would cause the sudden death of myriads of marine animals and more especially fish; while the same destructive agent might also affect large areas where fish were scarce and crustaceans or shell-fish common.

Some time ago I was favoured by a friend and brother geologist (Mr. John Jones of Gloucester) with an authentic account of whole shoals of dead fishes floating on the surface of the waves between Mirimachi, New Brunswick, and the port of Gloucester. For this information Mr. Jones was indebted to Captain Parsons of the ship Harbinger, and it appears that for several hundreds of miles it was hardly possible to pull up a ship's bucket without catching four or five dead gar-fish. The fish were most numerous in that latitude through which the volcanic band of Iceland, the Azores, the Canaries, and Madeira passes. Believing that these immense shoals must have been destroyed by submarine volcanic action, and that we might thus learn a lesson of the manner in which some of our fish-beds have been formed, and even of the destruction of genera and species, I forwarded an account of Captain Parsons' description to that eminent naturalist Sir William Jardine, who immediately communicated a paper on the subject to the Edinburgh New Philosophical Journal. Sir William's remarks appear to me so excellent an explanation of the phenomena that I give them nearly in extenso.

"The specimen of the fish itself, as nearly as can be made out from the state in which it was dried, is the *Sygnathus anguineus*—a species inhabiting the British seas, but having a considerable extent of range southward. Mr. Yarrell informs me, he has seen specimens from the latitude of Madeira; and this fact is of some importance, as it renders it more probable that the destruction was caused by submarine disturbance taking place within the zone to which Mr. Symonds alludes.

"In the notice of the insular volcano, Hotham Island, which was raised in the Mediterranean, near the coast of Sicily, in 1831, 'a great quantity of dead fish was observed floating in the sea the day before the island itself was discovered;' and any similar convulsion which tears open the bottom of the deep, and goes through all the phases of an active volcano, only submerged from human sight, must be fatal to all animal life in the vicinity; but the extent acted upon need not necessarily be so great, and the deadly bounds of the convulsion may take place within the limits of a few, and more especially within the particular habitat of some one species. That these submarine volcanic actions have been the cause of death to the species which form many of our fossil fish-beds is most likely, but it does not follow that these always took place in the vicinity of the present locality of the bed. Wherever the primary destruction of the Sygnathus occurred, it is not at all probable that it extended over nearly the whole range where they were seen by the captain of the Harbinger;

it is much more likely that they were then being carried away by currents from the scene of the eruption, and we can easily conceive them so carried or drifted into some bay, or eddied into some hollow, and there deposited in mass; and the same causes would, ere long, cover them with a layer of sand or muddy silt, and place them in a modern fish-bed, far from the place of their destruction, and remote from the locality where the species was known to exist. Or if some shallow estuary happened to be the locality to which they were carried, and if they were left there during the ebb of one single tide, exposed to the sun and winds, the upper layer, at least, would be dried, bent, and crooked in every shape, their mouths open and their fins distended, and in such forms would they be sanded and silted over. We are not, therefore, in the case of fossil fishes to consider that they always inhabited the localities in which they are now discovered. The Sygnathus was drifting over a range of many miles; its comparatively hard covering would permit it to stand immersion without decomposition for some time, and the state of its preservation, wherever it happened to rest or be laid, would be perfect just according to the time of its exposure. It is remarkable that no other species was observed by Captain Parsons, either dead or dying, through the long track in which he observed the 'gar-fish;' which we would account for either from the peculiar floating properties that would be possessed by a hard-skinned Sygnathus, or by the limitation of the range of the destroying agent; but, although we cannot distinctly account for this circumstance, the fact is of interest as showing the occurrence of apparently similar causes in the destruction of the individuals forming the ancient fish-beds, which are sometimes filled almost with one species only.

"The accompanying figures, taken from Captain Parsons' log, point out the track of the Harbinger in which the fish were seen.

LAT. N.		LONG. W.		LAT. N.		LONG. W.	
		39°	0′	45°	56′	22°	0′
46°	49′	34	10	46	32	20	30
46	24	31	45	47	40	19	35
46	22	29	0	47	56	19	10
46	16	27	10	48	34	17	49
46	10	26	0	49	14	15	47
45	59	23	46	49	36	13	17"*

In some districts, the carboniferous strata between the yellow beds of the Upper Old Red Sandstone and the Mountain Limestone assume a vast thickness, and in Ireland partake of the character of slates.

In Scotland these *lower* coal measures attain a thickness of several thousand feet, and are interstratified with thin seams of coal. The

* Notice of Shoals of Dead Fish observed on the passage between Mirimachi, New Brunswick, and the port of Gloucester. Communicated by the Rev. W. S. Symonds. With some Remarks by Sir W. Jardine, Bart. (From the Edinburgh New Philosophical Journal, New Series, April, 1855.)

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LIAS INSECTS

Edinburgh building-stone belongs to this group of the carboniferous deposits, but it is to be observed that, whereas the organic remains of the lower coal measures of Scotland are of fresh-water or brackish-water origin, those of the limestone shale of the West of England are eminently marine. In Dean Forest we have Brachiopods of the genera Spirifer, Terebratula, and Rhynchonella, with numerous corals and the net-like Bryozoa, and I have detected the same shells and corals at the base of the South Wales coal-field, on the Blorenge and Pen-Cerrig-Calch; but in Scotland, Cyprides, with various species of fresh water shells (*unio*, &c.), are interstratified with characteristic coal-plants.

I doubt very much whether the lower limestone shale of this western district is in any way *the equivalent* of the Scotch lower coal measures and the Irish slates, or if those carboniferous strata were ever deposited in the West of England, while I imagine that our limestone shales are merely the commencement of that adaptation which terminated in the oceanic history of the Mountain Limestone.

CARBONIFEROUS OR MOUNTAIN LIMESTONE. (NO. 3.)

Viewing the character of the strata in ascending order, we pass on to the mountain limestone, so called from the fact of its so frequently occupying the escarpments of considerable hills.

The same group of rocks which we examine around Dean Forest, at the Clees, or afar across the Vale of Herefordshire on the Blorenge and the Welsh basin, has been traced over large areas in Europe, Canada, North America, the United States, and even to the borders of the Arctic seas.

In this country we find the carboniferous limestone in Derbyshire, Westmoreland, and Yorkshire; in Scotland, and many districts in Ireland, as well as our western coal-fields; yet in some places in this neighbourhood it is altogether absent, as at Dudley and Wolverhampton, where the coal measures rest upon *Upper Silurian* rocks without the intervention of the Old Red Sandstone.

Again, at Wyre Forest, near Bewdley, the upper clays and coal are deposited on Old Red rocks, the lower strata, shales, millstone grit, and mountain limestone being deficient.

That the carboniferous limestone was a marine deposit, an examination of the fossils at once convinces us. It is frequently charged with various species of Corals, Encrinites, and Shells. Brachiopodous shells of the genera Spirifer, Productus, and Rhynchonella are abundant, and I have obtained slabs covered with their impressions and imbedding their forms from Drybrook, above Withall near Ross, the Great Doward, and several other localities in Dean Forest. Many of these fossils have a *Silurian* aspect, but a stricter examination proves them distinct.

The net-like Bryozoa, retopora (net-pored), and polypora (many-pored), are very abundant. The relation of the Bryozoa is, Mr. Woodward informs us in his valuable manual, to the Terebratulæ, "as shewn in their oral apparatus and muscular system, but they have neither heart, arteries, or veins, and the nutrient fluid is contained in the common visceral cavity." The term is derived from two Greek words signifying a moss-like animal (*bryos*, moss, and *zoon*, an animal), and refers to their moss-like appearance. Nearly twenty species of the genus Bellrophon, a shell-fish allied to the Atlanta or glass-shells, are met with in the mountain limestone. The modern Atlanta possesses a delicate and exquisitely-formed shell, into which it can retire and close with an operculum. The Atlantidæ inhabit the warmer parts of the Atlantic ocean, and belong to the gasteropodous (belly-footed) molluscs. The highest class of the mollusca are also abundant; several species of the Orthoceratite, an abundant form of cephalopod in the Silurian seas, are found in the mountain limestone. These representatives of our present nautilus and cuttle-fishes were associated with nautili and goniatites. I have seen some magnificent specimens of goniatites in Sir William Jardine's collection from the carboniferous limestone of Killhead. It is worthy of remark that the presence of these chambered cephalopods indicates with a degree of certainty the depth of the mountain limestone sea, for it appears that they could not exist in very deep water, and were "probably limited to a depth of twenty or thirty fathoms at the utmost."*

The young geologist should never visit the beautiful scenery of the mountain limestone, whether among the crags and peaks of Derbyshire and Cumberland, the noble St. Vincent's rock at Clifton, or the glorious scenery of the Wye, without realizing the fact that in those

* Woodward.

bold and solid rocks he beholds the work of coral and encrinital animals that lived in a very remote period of the planet's existence. It is hardly possible to understand the history of the physical geology of the district under review without some considerations of analogous phenomena now going on in recent though distant seas. Enormous areas in the Pacific and Indian oceans consist entirely of coral formation, in one instance constituting a linear space more than four thousand miles in length. These coral accumulations are made up, as is the mountain limestone, of limestone consolidated by the accumulated labour of these insignificant polyps associated with shells and the remains of other marine creatures. In the gullies and hollows of the coral reefs beautiful green and other coloured fishes are associated with zoophytes of many tints;* and we learn from Mr. Woodward the interesting fact that the deep

* Darwin.

sea Collaline zone furnishes those living shell-fish most nearly allied to many of the mountain limestone species, "so interesting from their wide range and high antiquity."

Nothing but steady and practical field-work can enable the young geologist to realize the fact that the strata that encircle the coal-basin were once continuous and joined to their equivalent and corresponding beds around the South Wales coal-basin, and again with those of the now widely-separated Clees. A few square yards of coral-reef were not piled upon Pen-Cerrig-Calch, or Old Red Conglomerate on the Scyrrid, merely to puzzle geologists; and with the history presented by the Titterstone and Brown Clees, Pen-Cerrig-Calch, the Blorenge, High Bury, and Dean Forest, all now separated, but with identical stratified deposits of Old Red Sandstone, Mountain Limestone. Millstone Grit (and in the Clees the coal-measures), cropping out on and around their flanks, we cannot escape the astounding fact that these separated strata once formed a part of a regular series of conformable and continuous stratification.

I have stood upon the mountains of Wales, and looked upon the Vans of Brecon and the heights of Gadir,

> "Whose lonely columns stand sublime,
> Flinging their shadows from on high,
> Like dials which the wizard Time
> Has raised to count his ages by;"

and I have been enabled to realize the period when the salt wave rolled over the sites of hill and dale and brook and river, and the strange fish of the Old Red Sandstone swam in the waters; and again when, untold ages afterwards, those forms were buried below the coral-reefs of the mountain limestone sea: how land and luxuriant vegetation succeeded, and ages of denudation swept away every vestige of the accumulated masses, and enabled me to extract the Cornstone fish fragments from their stony bed, and read their bygone history. Simple but unequivocal were my silent and truthful witnesses—the Cornstone nodules, the old red Puddingstone, the coral-reef, and the sandstones and conglomerates of Millstone Grit.

Probably there is not a single square foot of land on this planet's surface that has not at some period been beneath the ocean; for how can we otherwise account for the enormous amount of wearing-down of stratified masses once piled one above another, or, in other words, the marvellous evidences of denudation, we have constantly to contemplate?

Any change, through volcanic movements, of the ocean bed, must always cause an alteration in the deflection of currents, the deposition of mineral ingredients over particular areas, as well as a change in the occupation of different animals. For instance, a very slight *downward* movement of the vast area over which the coral animals construct their habitations of stone, would entirely subvert the characters of *life*, as well as the physical proportions, of a large portion of the present marine adaptations of the Pacific. The coral animal would cease to exist, and the coralline limestone deposit would give place to drifted silt or sand or some other ingredient, borne often immense distances by gulf-streams or ocean-currents.

The great Gulf-stream traverses with a speed of *eighty miles a-day* the coast of North America; and the great Atlantic current, which divides near Cape St. Roque in Brazil, rushes with extraordinary violence through the Caribbean Sea, round the Gulf of Mexico.

It is not then difficult to comprehend the destructive influence which would be brought to bear even upon the most solid rocks, or the immense amount of material the waters would transport, as pebbles, sand, or mud, should some local depression or elevation affect a portion of the planet's crust, and place it within the range of grand movements of ocean-currents such as these.

THE MILLSTONE GRIT. (NO. 2.)

The geologist cannot fail being struck with the change manifested in the nature of the deposits in passing from the Mountain Limestone to the Millstone Grit, so called from being used for the purposes of millstones. There is such a remarkable difference in the mineral nature of the carboniferous deposits, that we are naturally led to inquire to what causes we may attribute this change, for although the Millstone Grit, like the Mountain Limestone, is occasionally absent, the researches of geologists prove that it occupies an immense area, not only in England but on the continent. We learn from Sir R. Murchison, that it not only covers up the limestone of the great South Wales coal-field, and ranges from Carmarthen into Pembrokeshire, but in Derbyshire, the West of Yorkshire, and Lancashire, "the shale, limestone, and grit," "swell out into a vastly thicker series." Professor Phillips, who has devoted much time and labour to the study of these deposits in Yorkshire, estimates the thickness of the Mountain Limestone at 1,000 feet, and this is surmounted by 800 feet of the Millstone Grit. The upper limestone of the midland and southern districts of Ireland is covered by this rock, and the indefatigable Murchison has traced the equivalent rock into Germany, and even into Spain (Siluria, 276, 376, 400). The Mountain Limestone of Dean Forest, the Welsh Coal-Field, and the Clees, must have been deposited under very different circumstances to those evidenced by the powerful currents which carried down the water-rolled pebbles which compose the lower millstone grit of that district, and present such unequivocal evidence of violent attrition. We can hardly convince ourselves, in some instances, that we have not fallen among the Old Red Conglomerate; in mineral character, nevertheless, they differ considerably, the one being more crystalline than the other. The raising of the bed of the ocean, the elevation of land above the waters, and a consequent change in the physical geography of the district, were without doubt the cause of this variation in mineral character; the check of the growth of coralline limestone and the contiguity of land is certain, as the remains of plants are not uncommon in the Millstone Grit. Mineral character is rarely to be depended upon: what different aspects as regards different sites would be presented, if the present surface of the Pacific or Atlantic were exposed as dry land! one area would be affected by the debris of a mighty river, another by the slow deposit of deep and tranquil waters; by such and numerous other circumstances, the character of *contemporaneous* deposits often acquires a *distinct mineral* character. The beginner, therefore, must not expect to find the coarse quartzose conglomerate *we* call Millstone Grit surmounting the Mountain Limestone everywhere, even in Great Britain; on the contrary, Sir C. Lyell tells us that in the Fifeshire coal-field in Scotland there is a wider departure from the type of the South of England, and a "complete intercalation of dense masses of marine limestones with sandstones and shales containing coal."*

The Millstone Grit is certainly not a favourite stratum of mine, although I have passed some pleasant days in its examination, and looked upon pleasant scenes by hill-sides and on mountain-tops when engaged in tracing its contact with the limestone. I fancy there are certain members of the Herefordshire (Woolhope) Field Club, who could recall a ramble on the Blorenge and a visit to the carboniferous rocks of the Welsh coal-field. We ascended the Blorenge

* Lyell's Manual of Geology, last edition, p. 262.

in a fog, and the strange fantastic shapes of the boulders that were scattered on the hill-side in every direction often excited exclamations of surprise, as we trudged along, like Southey, "growling at clouds and weather." We wondered too how the boulders *came there*, as many of them were evidently not parts and parcels of the Blorenge, but had been carried somehow from a distance. If I remember rightly, *I* argued for ice and the glacial theory as the transporting agent; others were for "waves of translation;" while one gentleman suggested that they might be relics of a game of "chuckie-stanes" played by Old Nick, or some demon of the hills. Our guide, who, fortunately for us, knew every inch of the ground, pointed out where rivers and mountains, and distant churches, and "the loveliest scenes," *ought to have been*, and no doubt were, if we could have seen them,—as it was, the mist and cloud drew largely on our imaginations. There is not much hospitality on the heights of the Blorenge; but an investigation of the cairn erected by the government surveyors on the summit might still furnish a bottle *without* the sherry, which was quaffed to the toast of "a brighter day, and better luck next time." It was no wonder, after this, that there was a burst of delight among the naturalists when the fog cleared, and the sun lighted up the bare rocks, and heath, and glen, and hills "smooth and green and high," arose before and around us, while some of us felt with the Ettrick Shepherd, "after a', what is any description by us puir creatures o' the works o' the great God?" It was on descending the hill that one of the party, separated from the rest, gave a loud view-halloo, and we quickly joined him to inquire into the "find." It was the impression of a large trunk of sigillaria upon a mass of Millstone Grit. What a *blessing* is a knowledge of Natural History! A casual observer would have passed this relic of another world, not so the geologist! The form and foliage of the original tree; the aspect of the land on which it grew; whether a river washed it out to sea; whence came the boulder of millstone grit itself; whence the particles that made up the grit imbedded with the ancient tree? These questions furnished us with discussion and pleasant chat for an hour after we had left the relic of that tree of a coal-forest, still lying on the portion of the old sea-bed which received it when first imbedded.

Ross, and Barrett's Hotel, are known to every tourist in Great Britain, and justly so, for there is not a lovelier situation or more comfortable hostel in her Majesty's dominions; while there are many fine points for geology, and other branches of natural history, within a walk or short ride.

I have often been asked for directions how to proceed on geological expeditions over this district, and how to see and do the most in a short time. I should commence with a walk at sunrise to the summit of the Penyard Hill, where the strata of the Old Red Sandstone well repay examination. Geological exploration should never be commenced by skipping the *basement* beds, and such we may consider the Old Red Sandstone rocks from this starting-point and in this instance. Proceeding by the "Camp," I recommend the lover of scenery to ascend towards the forest by Whittal, the residence of Mr. Collins; there is a pretty Herefordshire dingle, with a busy little streamlet running through it, well worth a visit, and above, you catch the Old Red Conglomerate cropping out on the side of the hill. Passing by Kiln Green and Dundle Hole, the Limestone Shale and Mountain Limestone may be studied. The spots bearing the *romantic* names of Howl Hill, Egypt, and Howl Green, are on Millstone Grit, on which rests a seam of coal. This district, though dreary enough, is important to the student, as it is a regular outlier of Coal and Millstone Grit, separated from the regular forest coal at Ruardean by a great mass of carboniferous strata. Following the left bank of the Wye, by Bishopwood house and Lydbrook, Symonds Yat, and the rocks below Coldwell Wood, should be well examined, while the magnificent points of view, the isolated and precipitously towering cliffs, and the jutting prominences of rock, tell an eloquent story of storm and desolation, of the earthquake's shock, and the denudation of sea-waves, in ages long since gone, when the heights of Symonds Yat and the Great Doward were coral-reefs, frequented by fishes and encrinital animals; when the silver Wye had as yet no existence, and the sites of Goodrich, Ross, Monmouth, and Hereford, were covered up by strata once continuous with the limestones on which the geologist stands, but of which, ocean currents and sea waves have long since borne away every vestige.

I may here mention that there are many varieties of wild flowers on these cliffs, many of them peculiar, while for the entomologist there is no better ground in this part of England.

Crossing the ferry over the Wye, I recommend the examination of the Mountain Limestone at that point, and the ascent of the Great Doward, the views from which are in the highest degree picturesque, or, as Coleridge would say, "beautiful exceedingly."

After the ascent of the Great Doward, the geologist will rejoice in his supper and a bed, and the evening may be finished in examining the survey-maps, and laying down the route for the day following. If a good walker, I recommend Monmouth and the Beaufort Arms; if not, there is a comfortable village inn at Whitchurch, where the bill of fare will, I answer for it, suffice for an appetite gained among the rifted rocks of Symonds Yat. The first time I ever had the pleasure of seeing Sir R. I. Murchison was at this village inn. We all remember our first meeting with eminent men, and, as I knew the "Silurian System" nearly by heart, it was not without emotion that I shook hands, for the first time, with the author, at the picturesque little village of Whitchurch.

Among the many notes I have dotted here and there, since I first became a follower of Nature, amidst the rocks and hills and waters, among stones and birds, fishes and insects, by day, and the bright stars at night, there are none more full of interest, at least to me, than the circumstances under which I first met men with whom, in former days of long plodding and wearisome research, I longed to converse, but scarcely ever even hoped to behold. Of one thing I am convinced, and that is, that the philosopher can never err in shewing little kindnesses to young naturalists who are following the same pursuits. The "noblest and the best" with whom it has been my lot to have been thrown in contact possess a goodness of heart which a love of God's works seems to infuse into their souls, and which is in a measure reflected upon those around them.

If the geologist wishes to work out the Millstone Grit and its superposition as regards the Mountain Limestone, he cannot do better than retrace his steps to the "Intrenchment" beyond Symonds Yat, and follow it by Braceland and Scowles Farm to Coleford. I recommend a boat—"a boat unto the ferry," and a steady pull down the Wye to Monmouth, and if it be that time of year when the water is bright, and the swallow skimming the surface—if the sunbeams light rocks and precipices, and the wild flowers blossom, I think the traveller will thank me for this advice. From Monmouth, the outlier of High Bury may be visited, and the phenomena of denudation learned before entering upon the vaster history of Pen-Cerrig-Calch and the Clees, for High Bury is an *island* of Carboniferous deposits, surrounded by Old Red Sandstone.

CHAPTER II.

THE COAL MEASURES. (NO. 1.)

COAL is so closely associated with our immediate comfort and enjoyment, and with our present and future destiny as a nation, that, of all the wonders of a bygone world revealed by geology, its history presents a study perhaps the most deeply interesting to man, and among the numerous adaptations around us for the benefit of the human race, we doubt if there are any which reveal higher evidence of the prescience and wonder-working powers of the Creator.

We shall consider the history of Coal under three several aspects. First, its Geological; secondly, its Chemical; and thirdly, its Botanical history.

GEOLOGY OF THE COAL STRATA.

The coal measures of the districts of which we shall principally treat (the Forest of Dean and the South Wales basin) occur immediately above the Millstone Grit, or Farewell Rock, so called by the miners, as when they meet with it they know that they bid good-bye to the coal.

Our first records of land vegetation date from the Upper Ludlow rocks, and through the enormous period of the Old Red Sandstone the history is dim and indistinct, and the remains broken and scattered; but, once place our foot upon the coal measures, and we meet with that marvellous profusion of vegetable remains, which distinguishes the Carboniferous from all other systems.

Sir Charles Lyell gives the following scale of the thickness of the whole Carboniferous group of rocks in Somersetshire and South Wales:—

1. Coal Measures, from 600 to 12,000 feet.

2. Millstone Grit, 600 feet.

3. Mountain Limestone, 900 feet.

The limestone shale is also of considerable thickness.

It must be remembered that the actual coal bears a very insignificant proportion of this vast thickness of sandstones, conglomerates, limestones, and shales. In South Wales the coal measures have been ascertained, by actual measurement, to attain the thickness of 12,000 feet, and in this mass of stratified deposits, one hundred coal-beds are intercalated at various levels; while in the North of England Professor Phillips calculates that the thickness of the coal-bearing group of rocks is not above 3,000 feet.

The geographical area occupied by the Carboniferous system, the thickness of the strata, and the vast amount of mineralized vegetation accumulated, must strike the geologist even with *awe*, when he really studies the subject of the formation of coal.

The whole of Great Britain and Ireland occupy an area of about 91,400 square miles. In the United States of America, the coal-fields cover more than 600,000 square miles, or a country nearly seven times the magnitude of our native isles. Coal-fields occur in the distant North, among the ice and snow of the Arctic regions, and again on the coasts of Chili and Peru. In Hindostan, Japan, Australia, New Zealand, and many countries on the continent of Europe, the geologist tracks the wreck of that profuse vegetable epoch, which appears to have reigned during the same period, over latitudes "as distant as Spitzbergen and Peru." It is important to remember these facts, for, whatever was the *cause,* the remains of this widely-spread and luxuriant vegetation exist over enormous areas, and at far-distant points. "This earliest luxuriant tree-vegetation is remarkable for its spread over many latitudes and longitudes."*

* Siluria, p. 463.

And it is altogether at variance with the present distribution of vegetable life, that an abundant terrestrial flora should have existed as far north as Melville Island in 75° north latitude.

Geologists have been much divided on the subject of the formation of coal, or rather on the manner in which such immense masses of vegetable matter were accumulated; whether drifted down by rivers and deposited in estuaries or lakes, or whether the plants grew as in recent peat-mosses, jungles, and cedar-swamps, and were gradually submerged, covered up by layers of mud and sand, and the new surface again clothed with luxuriant jungles of club-mosses and tree-ferns; this also submerged, and so on, until many subsidences had overlaid as many successive vegetable areas, as we have seams of coal in the various coal-fields.

The truth is, the vegetable matter of the coal was accumulated under very different circumstances in different localities, and the peat-moss and subsidence theory will answer in one case, while in another, we have to resort to transportation by rivers into the sea and into fresh-water lakes, just as now happens at the mouths of the Mississippi, and in the instance of the Great Slave River, which carries down enormous masses of drifted trees and plants into the Slave Lake, where the timber becomes water-logged, sinks, and is covered by sediment.

THE FOREST OF DEAN.

Last winter I accompanied a Swiss geologist, M. de la Harpe, on an investigation of this coal-field. We fell in with an intelligent miner, who expressed a wish to hear our account of the formation of coal. He listened quietly to my explanation of the "drift phenomena," and how thousands of tons of vegetable matter, are every year accumulated by such rivers as those of America and India, especially during periods of inundation. "That will never do for our coals, sir," he replied, "for here we have thick seams without a grain of sand or a pebble, all pure coal; then we have beds of sand, then pure coal again. Now, sir, the great waters you speak of would be very apt to mix up something in the shape of sand or mud with the vegetables, and would not bring them down clean and ready for burning."

The miner's objection was founded on observation; let us now try how far our own observation will solve the difficulty.

A section near Ruspitch, in Dean Forest, teaches, that, whatever were the agents which deposited the first coal-seams, they soon ceased acting, and for a long period no true coal was accumulated. On the Millstone Grit, which contains frequently the remains of drifted vegetables, rest a series of clays with two seams of coal, called, I believe, the "High Delph." From the purity of the coal, from the entire absence of earthy matter, such as sand, grit, and pebbles, and the number of the roots of plants that formed the coal (*Stigmaria*) found in the clay below, I see no way of solving the problem of the formation of the "High Delph," than by supposing that the plants grew on a surface area which was gradually submerged, and that, as in the instance of peat-mosses, new coal-plants grew and luxuriated above the decaying remains of those that preceded them.

A remarkable tract of land, called the "Sunk Country," near New Madrid, in the valley of the Mississippi, was submerged by the earthquake of 1811–12, and, when Sir Charles Lyell visited it, he observed "erect trees that had been standing ever since," and that "lacustrine and swamp plants" have been growing in the shallows, and an immense amount of vegetation accumulating. But the great fact to be chronicled by the geologist is, that this great morass is surrounded by so "dense a marginal belt of reeds and brushwood," that, "although several rivers have annually inundated the whole space, *no sediment* whatever has been carried by the waters into the vegetable morass within.

"The dense growth of reeds and herbage which encompasses the margins of forest-covered swamps, in the valley and delta of the Mississippi, is such that the fluviatile waters, in passing through them, are *filtered* and made to clear themselves entirely before they reach the areas in which vegetable matter may accumulate for centuries, forming coal, if the climate be favourable. There is no possibility of the least intermixture of earthy matter in such cases."*

Now let us apply this fact of existing nature to the far-distant epoch of the forest "High Delph," and the succeeding strata.

We find that the deposition or accumulation of the vegetable matter of the "High Delph"

* See Lyell's Manual, and Visit to the United States, vol. ii. p. 245.

suddenly ceased; probably from the submergence of the ancient swamp; and that above these first coal seams, eight hundred feet of green and grey coal-measure sandstones were deposited. So abundant, however, are the remains of drifted plants, ferns, reeds, and club-mosses, that we see at once the land was near, and that the same waters which deposited those green sandstones, carried down matted masses of drift vegetation.

We believe then, that the "Sunk Country" of the Mississippian valley, with its trunks of sunken trees, and the decay of aquatic and morass plants, preserved by lacustrine and swamp filtering reeds, from any admixture of sediment, is an excellent analogous example of the accumulation of pure coal; while, should this "Sunk Country" be submerged but a few feet below its present level, the marginal belts of filtering reeds would be submerged also, and river or estuary inundations would deposit sand, clay, or mud, and at the same time sweep into the accumulating strata such reeds and plants as the waters would have collected in their course.

We are aware that this hypothesis "can have little application to those other seams of coal which are interstratified with beds containing marine remains, the animals of which, such as Producti and Spirifers, must have lived in comparatively deep water;"* and the oscillation of land and sea level will alone account for vegetable accumulations interstratified with marine remains.

SOUTH WALES BASIN.

The Carboniferous rocks are wonderfully developed in the South Welsh basin of Monmouth, Glamorgan, and Caermarthen. The same succession from the upper beds of the Old Red Sandstone is seen as in Dean Forest, but

* Siluria, p. 279.

on a much grander scale, and there is a remarkable expansion of the strata associated with the coals on their westward strike; for instance, the total thickness of these upper strata at Merthyr, is nearly double that which is found to exist near Pontypool. The greatest thickness of the strata is believed to occur at Llanelly in Caermarthenshire. I am indebted to my friend and brother naturalist Captain W. V. Guise, (Elmore Court, Gloucestershire,) and Mr. Llewellin, of Glanwern, Pontypool, for some interesting particulars as regards the chemical character of the coal seams of the South Wales district. The coals of Pontypool and Abersychan yield about 30 per cent. of bitumen and volatile matter; which gradually decreases along the whole extent of the northern outcrop until at Merthyr and Aberdare it is reduced to 8 or 10 per cent. "This it is that imparts such peculiar value to the coals of that district (Aberdare,) and constitutes the celebrated smokeless engine coals of South Wales." At the Hirwain iron works, three miles beyond Aberdare, the same seams, so bituminous near Pontypool, "are changed into Anthracite."

At Llanelly, in Caermarthenshire, there is an enormous mass of "Pennant Grit," (Upper Coal-measure sandstone,) and associated within it are numerous seams of valuable coal, largely consumed at the copper-works of the Swansea district.

In the autumn of 1856 I accompanied the Members of the Woolhope Club upon an exploration of the Beaufort district near Merthyr, where we were introduced to a section of coal strata regularly quarried in the broad daylight, a rare sight in England. These beds were below the "Pennant rock," and displayed a regular succession of shales, ironstone, nodules, and below these a thick bed of the precious mineral. Many of the miners possessed a fair knowledge of geology, and for which they are indebted to Mr. G. Beavan, a medical gentleman residing at Beaufort. It is pleasant to find working-men pointing out the difference between Stigmaria and Sigillaria, the roots and the trunk, and even acquainted with the names of many of the fossil ferns. Mr. Beavan possesses a valuable collection of fossils illustrative of the district. The plants are for the most part well known and described species, and the fossil shells occur in the shales and ironstones between the coals, associated with the remains of fish and annelids. They are all *marine.* I recognised several Nuculæ, some minute Orthides, a Conularia, *Discina nitida,* (a mountain-limestone form,) and, if I remember correctly, some Spirifers; also a magnificent Nereites, beautifully preserved, and very like the Yorkshire specimens.

The *marine* character of the fossil remains is especially interesting, and an evidence of periodical eruptions of the sea over terrestrial and sunken vegetable surfaces. A low and *sinking* shore covered by luxuriant vegetation, gradual filling up of the depressed surface by sand and mud, and new plants luxuriating above the buried remains, is the history of this coal-field.

THE CLEE HILLS.

I have referred to the Carboniferous rocks of the Clees as outliers of the Welsh coal-field and Dean Forest.* The Carboniferous series of the Clee corresponds precisely, on a small scale, with the distant rocks across the vale of Herefordshire and Shropshire; and the geologist may study successively the upper beds of the Old Red Sandstone, the Mountain Limestone, Millstone Grit, and Coal measures. An ancient lava or basalt has also been erupted through the strata and overflowed on the summit of the Titterstone Clee. It is hardly necessary to say, that this "Jewstone" or ancient volcanic rock is

* Old Stones, ch. iv.

newer than the strata which it has burst through and *roasted.* The coal in contact with the trap is in the state of stone-coal or "culm," and it is very probable that the basalt of the Clee interposed a barrier to the denudation by ocean currents, which apparently set in from the north-east, and which has so completely removed the Upper Old Red rocks and the whole of the Carboniferous strata from extensive areas in Herefordshire and Shropshire, over which they must have been once persistent. Indeed the evidence of a much greater extension, both as regards the Trap (Jewstone), and Mountain Limestone, is plain enough to those who have eyes to read the history of the fragments of all the denuded rocks constantly turned up by the plough far from the base of the Clees; while, as we approach Tenbury, the gravel-beds are charged with rounded pebbles of coal-measure grits, mountain limestone, and Jewstone, the relics of submarine currents and ocean waves.

The Members of the Woolhope Club will long remember a ramble through this district, during the summer of 1855, with Sir Charles Lyell at their head! Who forgets the pleasant morning meal at our friend and brother naturalist's (Mr. H. Salwey), the scramble for the carriages at the old inn with timbered roof and paneled rooms at Ludlow, the drive, the sunshine, and the ramble up the hill? Who forgets the view from the basalt of the "Giant's Chair," the Black Mountain, Stiper stones, Malverns, and a hundred other interesting and distant spots; or the ringing of the geologist's hammer against the trap, the kindly explanation of Sir C. Lyell when appealed to for his opinion and information, the hospitable reception of Mr. Pardoe at the Nash, or a thousand other pleasurable reminiscences of that bright day? Let those who do, stay at home on the next occasion, and find objects better suited to their taste, with memorials better worth storing, than a summer's day, with the author of the "Principles of Geology," and the field-naturalists of Herefordshire and Shropshire.

NEWENT COAL FIELD.

A more uninteresting neighbourhood or town than that of *Newent* can hardly be conceived, and its coal-field is as profitless as the scenery is uninviting. The only redeeming point for the geologist as regards Newent, is its contiguity to the interesting Silurian dome of May Hill, celebrated for the May Hill sandstone, the debateable rock of Murchison and Sedgewick. The Newent coal-field is, I conceive, nothing more than a few upturned edges of the Carboniferous rocks, appearing at the surface along the great line of fault which runs from the mouth of the Severn to the Dee. A few years ago I carefully examined the pit opened by Mr. Onslow, at Oxenhall, which fully convinced me of the truth of the late Mr. Hugh Strickland's surmises respecting the *great fault* and the broken-up condition of the Paleozoic strata *east* of the Malverns, and especially in the *immediate* neighbourhood of such upcasts as are those hills and May Hill. The dip of the coal at Oxenhall, a short distance from the surface, was, as far as I now remember, at an angle of 70°, while at a short distance to the west, the New Red Sandstone (Newent sandstone) abuts unconformably against the Old Red Sandstone. The "reddish brown clunch" is the principal mineral of Newent coal-pits, interspersed however with sufficient *black specs* to mislead those who have been sufficiently unfortunate to invest their capital in coal-mines close to a *line of fault*. The advice of Sir R. Murchison is good, viz., that, "if coal-works are ever to be resumed near Newent, with any prospect of success, the trials should be made to the *east* of the town, by sinking through a thicker cover of the New Red Sandstone, than any hitherto penetrated."* At the same time, with all due deference to Sir Roderick, who probably never had the opportunity of examining a Newent pit, I should say *don't sink at all*, at least within five miles of Newent, unless you wish to sink your capital without hope of return! I was particularly struck with the coal at Oxenhall, some of it being a mere mass of leaves and fibres, very light and not much mineralized. At one time I fancied I had detected fossil grass or rushes, but I apprehend the long leaves were only detached leaves of Sigillaria. The strata are all inclined towards the south, and dip away from May Hill. In the pit at Oxenhall, the New Red Sandstone rested *unconformably* upon the coal, although elevatory movements have evidently considerably affected these strata since their deposition. It is an interesting piece of geology to trace out Sir R. Murchison's de-

* Silurian System, p. 154.

scription of these thin coal-beds from Gamage Hall! At Gorstley, to the *west*, we have a good section of Upper Ludlow, Downton, and Old Red Sandstone beds, near a marshy pool full of pike.

I once killed a fish there of 17lbs. weight, and hooked another which carried away my bait; he was afterwards found dead, and I was assured by the landlord of the little inn, on the banks of the pool, that he weighed nearly 30lbs. I have myself seen the fish here take the moorhens amongst the rushes, not, it appears, from want of food, for this is extremely abundant, but principally for change of diet or caprice! There is something very remarkable in that instinct, which enables certain birds to fly many miles for their favourite food. I have never seen so many snipes upon so small an area of ground as in the little marsh at the head of this pool. It is but two or three acres, perhaps not that, but, attracted by scent or some other mysterious impulse, these birds come for miles, and on some occasions have been seen in hundreds!

No other snipe-ground being in the neighbourhood, I have often wondered how the birds, in such numbers, found out so small a spot. I think scent must be their guide, for I have often observed the same phenomena in the Longdon Marshes. The wild fowl only visit our inland marshes when the vegetation has become fetid, a few days after the waters of a flood have abated, when widgeon and teal have been known to come in flocks at night, only to disappear with the return of daylight. How powerful must be that instinct, which guides them to a banquet, at an isolated spot so far from their own accustomed haunts!

FOREST OF WYRE.

The geology of the Forest of Wyre or

Bewdly is interesting in many respects. Sir R. Murchison describes this coal-tract as of slight value, owing to the thinness of the beds, and the inferior quality of the coal. These strata are deposited on the Old Red Sandstone, and are altogether deficient in the millstone grit, mountain limestone, and the limestone shales.

Here we have probably an instance of *drifted* vegetation carried by a river into an Old Red Sandstone bay or lake; and the thin seams of coal, separated by their accompanying thin strata of mud, grit, and ironstone, lead us to form such a conclusion. The physical history of the coal-field of Wyre Forest differs as much from that of the districts we have just described, as the accumulation of lignite in the Slave Lake, borne down by the Slave River, differs from the sinking cypress swamps and peats of the Sunk Country of America. The admixture of mineral matter, which renders the Wyre coal incombustible, is altogether wanting in the purer coals accumulated under different circumstances. No one can examine "the stuff" extracted, and still less *burn* it, without observing this difference. Nevertheless, the matted mass of vegetation deposited must have been considerable, and the land upon which the ancient plants flourished not far distant. Probably, the underlying Old Red Sandstone of Wyre was *dry land* during the deposition of the mountain limestone and the other marine strata encircling the Welsh basin and that of Dean Forest; but after their elevation, and when the coal flora flourished on the carboniferous shores, the Old Red Sandstone area of Wyre Forest was depressed, and received in its estuary or basin the vegetation that now constitutes its coal.

The *lowest* coal may have grown on its present site, and a coal-measure swamp have covered the Old Red area. On this surface being depressed, the drifted materials above may have been carried over the sunken vegetable surface. Such at least appears to have been the case near Pensax!

The trap of Kinlet may easily be reached from Cleobury Mortimer; and the dyke of Shatterford, near Kidderminster, alters the coal measures.

The Permian breccia of Church Hill in this district is well worthy of a visit, and the geologist may split theories over its angular fragments ad infinitum.

CHAPTER III.

CHEMISTRY OF COAL.

We now invite the reader to a few remarks on the chemistry of coal, a subject intimately connected with the formation of that mineral, and of great importance to the student, as relating to the changes produced in the ancient vegetation, by the re-arrangement of the chemical constituents.

It was once supposed that during the carboniferous epoch luxuriant vegetation was universal, at least over the *terrestrial* portion of the planet's surface; that the earth was surrounded by an all-pervading shroud of carbonic acid, incompatible with the existence of land animals; that the bright sun and starry host of heaven were as yet unrevealed to the denizens of earth, and that the plants which now constitute our coal, grew under conditions very different to any nature now presents to man's view and comprehension. In order to realize the carboniferous epoch, the young geologist was compelled to imagine an indescribable and universal dismal swamp, with a cellar-like atmosphere, where mighty tree-ferns, club-mosses and horse-tails, conifers and gigantic reeds, flourished and rotted, rotted and flourished, while accommodating earthquakes submerged the vegetation of the day, being equally ready to submerge the ultra-luxuriant and suddenly-developed vegetation of the morrow! Thus we had rapid precipitation of strata, rapid development of vegetable life, and summary operations of all kinds—"Plants and animals which in our day require a century for their development," shooting up "in rank luxuriance in a few days and months and years!"

All vegetables are organized bodies, endowed with certain functions connected with the great mystery of life, which are carried on by means of mechanical and chemical attractions exercised in their various organs. Plants are composed of carbon, hydrogen, and oxygen, with a little nitrogen, which they separate and combine in their sap and wood, fibre and leaves. As long as the plant lives, its constituents are balanced and connected together, but no sooner does death ensue, than a re-composition of the elements commences. If the plants decompose in the open air, the carbon unites with oxygen and flies off as carbonic acid, the hydrogen combines with oxygen and departs as watery vapour, and the small proportion of nitrogen is restored to the atmosphere. But when circumstances exclude the vegetable masses from all contact with the air, when buried in the earth, or covered up under great pressure beneath the sea, a new class of compounds, although consisting of the same elements, are formed, and these are *bituminous* compounds, such as coal, naptha, &c. The fermentation which all decaying vegetable matter undergoes is checked, and another species of fermentation ensues, with very different results. It is well known that animals entombed in peat, change into a kind of spermaceti, and vegetable matter under similar circumstances undergoes an analogous change.

Coal then is a bituminous mineral, the result of chemical transformation that occurred myriads of ages ago, and which has ever since been buried up in the bowels of the earth.

Plants derive their nourishment from the elements contained in the air, water, and soil, but the sunshine of heaven is equally necessary to them, and the effect of darkness upon their bright green leaves and resplendent blossoms is well known. It is in the sunshine that the leaf-pores of living plants open to its influence, and in the darkness that they exhale the deadly carbonic acid. Soil, water, and air were as necessary to the vegetation of by-gone ages as they now are to the oak of the forest, and analogous functions have no doubt been performed by these agents, ever since the first creation of vegetable life. Plants derive their carbon from the atmosphere, and water is the source of the gaseous elements oxygen and hydrogen; and every average sized oak, weighing about sixty tons, contains thirty tons of carbon, subtracted from the atmosphere.

It is impossible to remember without amazement the constituents of coal, and the enormous amount of carbon and gases locked up in every stratum of this mineral; for "of every pound weight of hydrogen gas that enters into its composition nine pounds weight of water has disappeared from the surface of the globe, and which has not yet been given to the globe by the process of combustion."* The same argu-

* Notes by C. Chalmers.

ment applies to the carbonic acid which has supplied the carbon. It is not however necessary to suppose any extraordinary amount of carbonic acid in the atmosphere during the elaboration of the palæozoic coal-plants, for chemistry has proved experimentally that the quantity of carbonic acid now present in the atmosphere is equal to the weight of "five trillion, two hundred and eighty-seven billion, three hundred and five million of tons!"* Coal then is a compound of carbon (an elementary substance which is most abundant in the vegetable creation, and obtained as charcoal from wood,) and the volatile elements or gases, hydrogen and oxygen, with a little nitrogen. All coal owes its combustible nature to the hydrogen and carbon, which are combined in a state of solidity, and it is to the hydrogen gas, that we owe the flame of our hearth-fires; when the hydrogen is consumed, the carbon continues to burn without flame.

* Griffith's Chemistry of the Four Seasons, p. 125.

The inflammability of coal, therefore, must necessarily vary with the relative proportions of carbon and gas.

One kind of coal, called Anthracite, has been so roasted and altered by heat, through its association and contact with ancient volcanic matter, that it approaches very nearly to pure charcoal, having had nearly all its gaseous ingredients driven off. It burns without flame or smoke, and contains above ninety per cent of carbon. The variety called Cannel coal, on the contrary, contains more than half its weight of gaseous volatile ingredients, and approaches in its composition nearly to bitumen or pitch. Mr. Bunbury informs us that the varieties of coal "may be arranged in a scale, at one end of which is charcoal, and at the other pure bitumen or asphalt." One is nearly carbon, the other nearly gas.

The common gas (carburetted hydrogen) that lights our streets in nearly every country town, is nothing more than coal distilled, and in its brilliant light we have an example of the triumph of science, for in the middle of the sixteenth century, the streets of Paris were lighted for the first time with fires made of pitch and rosin; while, in the discovery of paraffine by Mr. Young of Manchester, it is now probable that coal-gas will be condensed "into a white, dry, solid, odourless substance, portable, and capable of being placed on a candlestick or burned in a lamp."*

BOTANY OF THE COAL.

Botanists divide the vegetable kingdom into three great divisions, Exogens, Endogens, and Cryptogams. Exogens are the most highly organized plants, and are so called from their mode of growth, by the addition of external rings or layers. They also possess two cotyledons or seed-lobes, and are therefore dicotyledonous;

* Baron Liebig.

and their leaves are reticulated or netted: with few exceptions, Exogens embrace the principal forest trees, shrubs, and flowering plants with two seed-lobes.

Endogens increase from the inner part of the stem, their wood has a confused structure, they are monocotyledonous or possessing only one seed-lobe, and their leaves have parallel veins. Endogens comprise such flowering plants as have only one seed-lobe, such as lilies, daffodils, aloes, wheat, grasses, rushes, and canes.

Cryptogams or Acrogens consist of plants that have no flowers, properly so called, multiplying themselves by bodies called spores; their wood is arranged in a zigzag kind of structure, and a large proportion have no real leaves or stems. If they have leaves, they are fork-veined as in ferns. Cryptogams comprise such plants as ferns, lichens, mosses, equiseta, club-mosses, confervæ, and fungi.

Nowhere on the planet's surface do plants grow to such an enormous size as in the moist and sunny climate of the tropics, where a profusion of leaves and flowers encircles every tree of the forest, and the noblest forms of vegetation are produced. Tree-ferns rise to the height of forty feet, and plants allied to our British grasses are often larger than our English oaks. The palm-tree rears its lofty columns for nearly two hundred feet without a single leaf, and stems of rope-plants, thicker than a man's arm, twine around the columns of the noble ferns.

Our materials for judging of the nature of the vegetation from which the coal was formed are very abundant, but it may be profitable to make a few remarks upon existing vegetation, and its still greater abundance formerly.

"Where did all the coal-plants come from?" was a question I was one day asked; "all the trees in Great Britain would hardly suffice for one of the smaller coal basins!" The truth is, we Englishmen scarcely know what a forest is, and deem it absurd to be called on to imagine a rich vegetation in former days, in districts which now only boast a few stunted poplars or elms! but let us consider the phenomena as exhibited even in these days in other parts of the world, where the fire, the axe, the mattock, and the spade, have not as yet begun their work of destruction.

M. de Tegoborouski, speaking of the forests of Russia, in his Commentaries upon her productive forces, says, "Our forests exceed in extent more than twice the total superficies of the Austrian empire, nearly four times that of France, and nearly seven times that of Prussia."

Again, immense areas are covered by forests in Sweden, Norway, Hungary and Poland, and thousands of square miles are occupied by the wild woods of nature as yet unchecked by the hand of man; while who has not longed to behold the vegetation of the tropics, and the almost boundless forests of the New World?

Mr. Darwin mentions that even in the cold moist climate of Terra-del-Fuego the forests are so dense that "every landmark, though in a mountainous country, was completely shut out," and "that in the valleys it was scarcely possible to crawl along, they were so barricaded by great mouldering trunks which had fallen down in every direction." While at the island of Chiloe, it cost him three hours to go a mile and a half, and men, who knew the forests well, were frequently lost for days together, so impenetrable are the woods!

Here then arises a curious question on which the geologist would do well to reflect,—What is the vegetation of this earth, since man's influence has been extended over the globe, as compared with that which must have existed before man's creation?

Sir Charles Lyell has an admirable article on the "Influence of man on the physical geography of the earth, by the felling of trees," in the ninth edition of his "Principles of Geology."

In times by no means geologically remote, vast forests grew where now there is *not a tree*, and not a river could have flowed to the sea or lake without its burden of vegetable matter.

The coal-period was not limited to the Palæozoic epoch. A very important coal-field in Virginia is of the age of the Lias, and the Molasse (*Miocene*) coal of Switzerland and Germany is made up of the remains of trees allied to our oaks, elms, willows, and ash; while a seam of coal nine feet thick, worked at Wildsfluth in Austria, belongs to the upper division of the Tertiary formation, and the vegetation of which was probably extant with some of the existing races of animals.

The best localities for obtaining fossil plants in Dean Forest are the newly opened pits, as the clay and shales that rest upon the coal are generally to be met with near the mouth of the pit.

FERNS.

It appears that Ferns form one half of all the fossil plants in the coal formation. They were estimated by Brongniart in 1849 at 250 species, whereas the whole of Europe does not furnish more than sixty living species of that tribe of cryptogamic plants. However the forms of the other plants may puzzle the beginner, there can be no mistake about the ferns, so much do they resemble their recent analogues.

Recent ferns are arranged into groups, according to the disposition of their spores or seed-vessels, and I have seen beautiful examples of fossil seed-spores in Captain Fletcher's cabinet near Dudley. Fructification is so generally wanting, nevertheless, in the fossil ferns, that the same principle of classification is not applicable to them. Veins of leaves are, therefore, employed for the distinctive character of fossil species. Tree-ferns grow in moist and warm climates to the height of thirty and forty feet, and allied fossil tree-ferns have been found in the coal-mines of Europe and America. The great abundance and luxuriant growth of this tribe of plants, have induced the best authorities to fix upon New Zealand and certain islands in the South Pacific, as furnishing the type of recent vegetation approaching most nearly to that of the coal epoch.

The Pecopteris and Sphenopteris are well known and most abundant coal-ferns, and very frequently to be met with in the shales.

LEPIDODENDRON.

The Lepidodendron forms a very abundant and important family, and forty species of Palæozoic coal-plants have been referred to this genus. The term is derived from *lepis* a scale, and *dendron* a tree, and alludes to the scaly exterior of the bark. Their stems are always divided by repeated branching (*dichotomous*), and they are considered by Brongniart, Hooker, and Bunbury to belong to the club-moss family (*Lycopodiaceæ*), of which the largest living species do not attain a greater height than three feet. The gigantic club-mosses of the coal were no such diminutive plants, but raised their tall stems to the height of fifty feet. The stems of these plants are covered with lozenge-shaped marks, shewing the scars of fallen leaves: the leaves are something like those of the Norfolk pine.

The Lepidostrobus, or fruit of the Lepidodendron, occurs in the shales in Dean Forest. It is very like the cone of the fir, composed of scales overlapping one another, and borne on the ends of the branches.

SIGILLARIA AND STIGMARIA.

Among the most abundant fossils that arrest the attention of the geologist in the shales, are long fluted stems, marked with impressions, which are scars left by the fall of the leaves. A large number of the trees of the coal epoch belonged to this genus Sigillaria, so called from *sigillum* a seal.

Thirty-five species of these plants are known to have existed. They grew to a great height, and specimens have been discovered that indicate a length of seventy feet. They were formerly supposed to be tree-ferns, but are now believed to be allied to club-mosses (*Lycopods*), though their relation to *any existing* plants is very faint. The leaves are long and narrow, and have been mistaken for fossil grasses.

I obtained many specimens of this curious fossil plant from the works near Whitemead Park.

The fructification of Sigillaria is unknown, but there is a very remarkable history respecting the *roots* of this coal-plant, and which roots are called Stigmaria (*stigma* a puncture), from the dotted or punctured appearance they exhibit. They were for a long time believed to be a separate tribe of plants; but in Nova Scotia, Sir C. Lyell and Mr. Dawson saw several erect Sigillaria with their roots attached and preserved, and these were the long-questioned *Stigmaria.*

These roots abound principally in the bed of clay *underlying* each bed of coal, where they are not accompanied by any other fossil; while on the other hand, the *overlying* shales abound in the impressions of ferns, reeds, club-mosses, and other vegetable remains. Sir William Logan ascertained that, of the hundred distinct beds of coal in South Wales, every one had its under-clay containing the stigmaria or roots of the sigillaria; and at Beaufort a miner pointed out to the Members of the Woolhope Club, one of the stems of this fossil marsh-plant, with the roots (*stigmaria*) still attached.

The under-clays were no doubt the *actual soil* of that coal-marsh, in which the roots of the *sigillaria* grew, while the stems and leaves flourished above with ferns and *lepidodendra*, and which were all gradually submerged, and buried under new accumulations of mud, clays, silt, and plants.

CALAMITES.

The Calamite was formerly supposed to belong to the Equisetum, or "Horse-tail" tribe, but the affinity is slight, and it is very doubtful if these extinct plants can be referred to any family now in existence. They are supposed to have formed dense and tall jungles or brakes, and sometimes to have flourished, as an undergrowth, in Sigillaria woods. The stems are fluted, jointed, and hollow in the centre, with a central pith. From the structure of their leaves, they appear to lay claim to a higher rank in the scale of vegetable structure, than the Equisetum. These plants are common in Dean Forest, and the Welsh coal-field.

Many other plants are found in the coal, which our space will not permit us even to enumerate, and among them are Conifers allied to the fir and yew. These Conifers make the nearest approach to recent dicotyledonous structure, or the type of our forest-trees. When we reflect that, out of a thousand species of known old coal-plants, almost all belong to the class of Acrogens or flowerless plants, we cannot consider the carboniferous type as highly developed. A fossil nut of one of the conifers (*Trigonocarpum*) occurs in Dean Forest, though rarely; it resembles the fruit of a Chinese yew (*Salisburia*).

What a history is connected with the study of recent and fossil plants, of vegetable life as it now exists, and vegetation long since dead, mineralized and entombed in the recesses of the earth! How much of pleasure do those ignorant of its lessons lose! The simplest flower that grows, draws sustenance from mineral principles, elaborated probably at Creation's dawn;

and with these, assimilates others from the rottenness and decay of man. Who shall tell of the varied forms, that the minerals which compose the sustenance of our crops have passed through, or the plants and animals they have again and again nourished! In some instances they even now bear witness to the transitory glory of the human race, while they administer to the pleasures, and even to the existence, of others who need them. Four hundred species of wild plants are found growing on the site of the Colosseum, that silent ruin of ancient Rome, where the wild beast was goaded to madness, "and the ancient Briton, the persecuted Jew, the agile Moor, died cursing the Roman and his gods—and here, from the blood-sodden soil, spring up the anemone, the mallow, and the yellow stonecrop, and children gather on a May morning the 'white rose, the violet, and the pink.'"* Nor is it at the Colosseum only that

* Flora of the Colosseum, by Dr. Deakin.

vegetation grows rank above the butchery of man. The corn-crops grow tall and strong in the plains of Waterloo, and for ages to come, the violet shall bloom with renewed vigour, on the heights of Inkermann, and the wild crocus and hyacinth bear witness, in renewed strength and beauty, to the death-struggle of Tchernaya Valley and the Alma heights. Far otherwise is it with the plants of the *coal.* Man, with his intellect, his might and power—and, alas! we must also say his sin—was not summoned into being, for myriads of years, after those relics of a bygone world had been stored in Nature's emporium, for his use and comfort. The body of that coal-plant, whose effigy we gather from the hardened rock, may contribute its quota of warmth and blessing to the poor man's home, or aid that wondrous propulsion that threshes his corn, prepares his garments in the loom, moulds his weapons of defence, or hurls him onwards in his transit on the rail. The oak of the forest furnishes material for our ships, the coal-plant carries them against wind and tide over the waves. Hundreds of plants renew our vigour, check the deadly fever, and restore us to health and happiness and friends, but the heat for their distillation, is furnished by the remains of a vegetation that has long ceased to exist, and the vitality of one would often lie dormant without the aid of the other. It is a strange tale, the history of plants *living* and plants *dead*.

ANIMAL REMAINS OF THE COAL.

It was formerly believed that, during the coal epoch, no *vertebrated* animals had been created of higher organization than *fish*. The remains of several kinds of reptiles allied to the Salamander have, however, been discovered since 1844. In America, Sir Charles Lyell and Mr. Dawson made a most interesting discovery of the remains of a fossil coal reptile, associated with the *first known land shell*, probably a Pupa. They were detected in the interior of an erect Sigillaria, in the state of charcoal, and appear to have been washed into the hollow tree with mud, during a flood.

Numerous reptilian foot-prints have also been observed on the ripple-marked flags of the lower coal measures of Nova Scotia; and Mr. E. W. Binney, of Manchester, has lately found the footprints of a "heavy slow walking animal, like a Tortoise, with an irregular gait," "of immense size, even larger than the 'Chelichnus Titan' of Sir W. Jardine," on slabs of the Millstone Grit of Tintwhistle.*

The fishes of this period were many of them gigantic, of very peculiar *reptilian* structure, and remote from any now living. Agassiz describes more than 150 species of Sauroids and Ganoids, some of them more highly organized than any living fish.

* Quart. Jour, Geol. Soc., Nov. 1856.

Teeth and scales occur in the coal-shales of the South Wales basin, but the remains of fish are far more abundant in the mountain limestone of this district than in the higher beds.

In Staffordshire, scorpions have been discovered, associated with various kinds of insects allied to cockroaches, crickets, and dragon-flies; while from the coal of Saarbruck, near Treves, M. Goldenberg describes twelve species of fossil insects. These interesting relics of carboniferous "grasshoppers," "locusts," and "white ants or termites," were imbedded with the leaves and branches of fossil ferns.

"The flower-feeding tribes of insects appear to have been absent, or comparatively scarce, for insects seldom feed on ferns or club-mosses."*

Fossil shells are abundant in many localities. They are sometimes freshwater, sometimes indicative of brackish water, and in other

* Lecture by C. F. Bunbury, Esq.

instances truly marine. The intercalation of beds can only be explained by supposing that oscillation of level continually occurred.

IRON.

The segregation of iron, in nodules interstratified with coal, is a very important feature in the geology of the Carboniferous strata. The remarkable section, near Beaufort in the South Wales district, of coal with ironstone nodules resting above has already been alluded to. The iron in this instance was most probably derived from *the vegetables* and segregated by chemical attraction, especially as the interior of every nodule displays the form of some fossil leaf or stem.

Ochre (hydrated oxide of iron) was formerly worked near Cinderford, in the limestone shales, but the works are now abandoned.

The mountain limestone of Dean Forest is worked in the *lower* beds for iron very successfully. This limestone is also the principal resource for the valuable ores of lead, zinc, and antimony. Mr. Page, in his valuable "Advanced Text book," gives our consumption of coal annually (including exports), at "forty millions of tons" (p. 150); and he is probably within the mark.

Some pleasant hours may be spent in Dean Forest, among the wooded glens, and especially in the neighbourhood of the Speech House, where the botanist may fill his vasculum, and the entomologist his insect-case. Tired with a load of fossils, I was resting, on a hot summer's day, under the shadow of those noble old trees; when a man in the usual miner's garb came up and inquired what was "the use of all those stones."—He stared in wonder at my hat which was lying on the ground, the inside full of insects, and the outside surrounded by a coronet of forest plants.—We had a long chat, and I laid side by side the green fern of the forest with its black prototype from the Cinderford pits, while we had quite a little lecture upon the organs of plants, the functions of roots, leaves, &c., with a few hints respecting the wonders of pre-Adamic history, and pre-Adamic plants, now converted into coal. I took out my pocket lens, and showed him the glories of the "Green Forester" under the magnifying glass. That rough miner stuck to me for hours, carried my fossils, and insisted on accompanying me to the station at Newnham. What particularly struck me, was his *appreciation of the wonders of nature* when put before him in a simple form. Many of his deductions were extremely accurate and his observations well timed, although it was evidently the first time he had ever heard a geological observation, or looked through a microscope. I booked this instance, and I might produce a hundred others, to prove that the human mind is ready to adapt itself to any simple teaching of God's works, and I firmly believe, that the bias too often exhibited in another direction is entirely owing to early education and circumstances. It is a great mistake to suppose that it is necessary to be highly educated, to be a classic, or a mathematician, in order to be a naturalist. A large amount of the knowledge of God's works is within the reach of every one; and some of the most eloquent writers on such subjects have been *working-men*, who have carried on their pursuit of the study of nature into the hard struggle of a laborious life. The history of Mr. Hugh Miller is a brilliant example, and I would recommend to everyone the study of the first chapter of his well-known and justly celebrated work, "The Old Red Sandstone."—The first chapter opens with his personal experience that "there is no necessary connection between labour and unhappiness," and informs the reader how a Scotch lad went to "work in a quarry" with a heavy heart in the morning, but upon whom, before night came, the wondrous book of nature impressed the conviction, "that a very *exquisite* pleasure may be a very *cheap* one, and that the busiest employments may afford leisure enough to enjoy it;" and that pleasure was the observation of the sea-waves, the wide moor, the misty mountain, and the ocean-worn cliffs around him.

CHAPTER IV.

THE PERMIAN SYSTEM.

1. Lower Lias.		Secondary Triassic—New Red Sandstone.
2. Upper Red Marls.	Keüper.	
3. Keüper Sandstone.		
4. Lower Red Marls.		
5. White and Red Sandstones. (Waterstones.)		
6. Upper Red Sandstones. (Bromesberrow Beds.)	Bunter.	
7. Lower Red Sandstones. (Stourport Beds.)		
8. Breccias and Conglomerates. (Haffield, Rosebury, Warshill, &c.)	Permians.	Palæozoic.
9. Coal Measures	Carbonife-rous.	

THE above series explains the correlation of the Permian series of strata with the Coal Measures below and the New Red Sandstone and

Lias above. The Permians constitute the same series of deposits as those formerly classed as the *Lower New Red Sandstone;* but, as the fossils seem more closely allied to those of the coal measures than to those of the secondary rocks above, it was proposed to separate them into distinct systems—to rank the Permian group as a Palæozoic-life period and the Triassic as Mesozoic (containing the middle forms of life). The term Permian was given by Sir R. Murchison, and is derived from the Russian government of Perm, an extensive region twice the size of France, and which composed the ancient kingdom of Permia.

It appears from physical evidence, that the close of the Coal period was distinguished by earthquake convulsions and volcanic outbursts throughout extensive areas, which must have affected the crust of the earth, over distant regions of Europe and America. This disturbance, however, was far from universal, for in

England there are large tracts where the Permian strata are perfectly conformable to the underlying coal measures, as also in Russia and America.

We cannot doubt, from the evidence afforded by the Caradoc Conglomerate of Miss Phillips, that in times as early as the Upper Caradoc epoch, the Malvern syenite had been upheaved to a *certain extent;* that the waves of a Caradoc sea washed the stony base of the hard crystalline Plutonic rock and mingled Caradoc trilobites, shells, and corals with fragments of the syenite, forming either an ancient sea-beach or a submerged line of marine rocks, which received in hollows and interstices the materials which compose the Caradoc conglomerate, and thus preserved the animal remains from the action of the waves. We have then, even at this early epoch, evidence of earthquake agency manifested as a *gradually* elevating *force*, acting on that great axial line of Fault which extends from the mouth of the Severn to the Dee; and it is probably *to* that *elevating* force, continued throughout unnumbered ages on the same line of upheaval, that we owe the configuration and extent of the Silurian districts of this part of England. Igneous or volcanic agency is known to manifest itself in very different ways, at different periods, and along the same lines; of this we have clear proof in the geologic history of the Malverns.

It is necessary for the student to make himself acquainted with the various *igneous* operations which have occurred along the Malvern Fault before he enters upon the examination of the Permian deposits. We therefore give a short condensation of the most remarkable and evident volcanic and earthquake phenomena.

In the first place we have good evidence that the Syenite of the Malvern ridge was cooled, crystalized, and consolidated long before its upheaval as a hill-range by subterranean forces; for the sedimentary and stratified deposits that are superincumbent upon the old Plutonic mass are altogether *unaltered* by their contact with the igneous rock. Those instances of metamorphism or roasting of strata along the line of upthrow, are due to *subsequent* volcanic action and the infiltration of trap, through fissures into the Syenite and sedimentary rocks. Secondly, It appears from the extension of *Cambrian strata,* such as the Black Shales and Hollybush sandstones, *eastward* of the Malverns (Gullet Pass and Valley of White-leaved Oak), and of the Upper Silurians, Devonians, and Carboniferous limestone, to Tortworth beyond the Severn, that the elevation of the Silurian district west of the Malverns, was not consummated until *after* the deposition of the Coal deposits; also that the Cambrian rocks, Silurians, and Devonians were not cut off, as now, with slight exceptions, along the line of fault, but extended eastward as well as westward, and ranged over sites now covered up by the Trias and Lias.

Thirdly; There is satisfactory proof that the elevatory forces which raised the Malvern hills as a line of Plutonic rocks, and the Silurian and Herefordshire area on the west and north-west into dry land, occurred *after* the deposition of the earlier Permian deposits and *before* the deposition of the *Upper* Permians. Again, when the western area along the whole range of fault was elevated, the eastern area, now occupied by New Red Sandstone, Lias, Oolite, &c. was *cast down*, and sunk far beneath the sea; denudation by ocean-currents, age after age and epoch after epoch, was at work along the sunken area; and the first deposits of sediment that covered up the edges of the depressed rocks were *Permian* conglomerates, cornstones, and sandstones, succeeded by Triassic and later deposits.

It is therefore probable from the study of the district in question that earthquake and volcanic agency commenced in a very remote geological epoch along the line of fault, and acquired peculiar force and violent convulsive efforts in the earlier ages of the Permian epoch. This period passed away, and was succeeded by one of quietude and repose, as is evidenced by the history of the later deposits; but that gradual elevatory forces continued long after the deposition even of the chalk, is also evident from the eastward dip of the Secondary deposits along the same axial line.

The Keüper marls and sandstones were seen in the Malvern tunnel, by my friends Messrs. Dyson, Edwin Lees, and Walter Burrow, and afterwards by the Field Club, in actual contact with the Syenite; it was crushed but unaltered, and with a dip of 50° to the east, yet at the distance of a mile from the range the dip is only from 10° to 11°.

PERMIAN DEPOSITS.

In the Malvern region these rocks are but poorly developed, and are *stratified*, unfossiliferous Conglomerates, *which extend up* the slopes of Devonian and Silurian upcasts, and dip under a thick mass of red sandstones (*Bromesberrow beds*), which lie below the Waterstones (No. 5) of the Geological surveyors. The best sections exhibited in this neighbourhood are at Haffield Camp, near Ledbury, the seat of W. C. Henry, Esq.; the southern base of Howlers Heath, near Toneys Farm; and the same breccias are seen in contact with the Malvern Syenite, in the grounds of Osman Ricardo, Esq., M.P. at the southern end of the Chase End Hill. Towards the north, they may be well studied at Rosebury rock, near Knightsford Bridge, on the Teme, the Berrow Hill near Martley, Stagbury, Warshill Top near Kidderminster, and the Clent Hills near Hagley. These Permian Conglomerates have of late excited considerable attention and speculation among geologists, as they are very remarkable for their only partially rounded, and in many instances, truly *angular* imbedded fragments.

In Professor Ramsay's paper, "On the occurrence of angular, subangular, polished, and striated fragments and boulders in the Permian breccias of Shropshire and Worcestershire," he inclines to the belief that these fragments are the relics of older rocks transported from a considerable distance. Had the fragmentalia been drifted by sea-waves and currents, they would have been rounded and water-worn, like the pebble beds of the overlying New Red Sandstone, but they are *not!* And yet these breccias extend throughout an area of 500 square miles, and often contain a number of Cambrian angular fragments, the parent rocks of which are supposed to be far distant. Thus arises the interesting question as to *how* these *apparent* erratics, were piled and stratified along certain bays and inlets of the ancient coast-line. Professor Ramsay believes that glaciers and floating icebergs existed during the earlier portion of the Permian epoch, and that ice agency transported those fragments and deposited them in their present position. One very strong argument against the theory of this distinguished geologist, is that urged by Mr. Hamilton, viz. "that the transported matter of glaciers is not to be found spread out with the regularity of a real subaqueous formation.* The same argument applies to the detritus borne by icebergs and ice-floes. On stranding and melting, such bearers of accumulations detached from distant rocks would deposit their burdens in a plum-pudding sort of arrangement, as in the boulder-clay or till. And it is not possible to escape the fact that the Permian breccias are *stratified* deposits, at least in the Malvern and adjacent districts.

In Scotland, where I had the pleasure of examining the equivalent breccias in company

* President's address; see Proc. of Geol. Soc. May 1856.

with Sir W. Jardine, Sir C. Lyell, and Professor Harkness, the conglomerates lie between Lower Silurian ranges of hills, and are entirely composed of *rocks in situ.* The great downthrow on the east, extending over a wide area of all the ancient rocks, should, we believe, be carefully remembered by the geologist in studying the history of the later deposits in our most difficult and peculiar district.* Having closely examined the Permian rocks at Warshill Camp, near Kidderminster, and the Clent Hills, I much suspect that they consist of a nucleus of Permian Cornstones bearing upon their flank Permian conglomerates and breccias.

I particularly recommend the geologist to examine a section in a ploughed field at Hoarstone Farm, on Warshill Camp, where the Permian sandstone is seen dipping from the Old Red Sandstone fault *into* the Camp, and *under* the conglomerates. Again, on the south

* See Strickland's paper, Phil. Mag., Nov. 1851.

Fig 1. Ichthyodorulite of Acrodus.
Fig 2. Portion of ditto.

KEUPER FOSSILS.

Fig 3. Estheria Minuta.
Fig 4. Teeth of Acrodus.

W. West Imp.

side a remarkable quarry at the brick-kilns shews breccias and conglomerates actually *interstratified* between solid grits and crystalline sandstones. Such sections do not favour the ice theory!

While in this neighbourhood, my attention was directed by Mr. G. Roberts, of Kidderminster, who kindly acted as my guide, to a remarkable quarry of *Old Red* Cornstone at Halls Farm; the beds here are identical with those of Leyster Sprowle near Leominster, and furnish plates of the Cephalaspis in considerable abundance. About a quarter of a mile north of this quarry, (Church quarry, Trimpley,) Mr. Roberts also discovered some lower beds, containing abundance of the remains of "Pteraspis ornatus," portions of carbonised vegetables, and the plates of Pterygotus found by Mr. Banks in the tilestones of Kington. Mr. Roberts is doing much in his own district, and adding continually to our knowledge of the "Stones of the Valley."

Kidderminster should be the head quarters for the exploration of this most interesting district.

The church is a noble building, and the carpet factories with their marvellous steam-power looms are well worthy of a visit.

The best locale for a sojourn of a couple of days at the Clent Hills, is either at Hagley or Bromsgrove.

I visited the Clent under the guidance of Captain Fletcher, of Lawnswood, from whom I received much unexpected kindness and hospitality. We saw no sections on the Clent so instructive as those of Warshill Camp. The best we could discover were near the curious old church of St. Kenelm's, on the eastern flank of the hills. There is a farm-house below the church, and a bridge over a small brook; by walking down the stream the Permian sands may be studied; again, *above* the church on the road to the hill, Permian Cornstones crop out and have been quarried for lime; higher up, the breccia beds are exposed, but they are much weather-worn and broken up. The slabs of stone at the summit of the Clents above Hagley Park, consist of Permian Cornstone; probably they were quarried near at hand.

The sandstones, cornstones, &c. of the Clent and Warshill, are lower in the series than any beds we have exposed in the Malvern district; but it is a question, if a railroad tunnel were driven either through Haffield Camp or Rosebury rock, if the grits and cornstones would not be found *in situ;* for both near Haffield and at the Berrow Hill, near Martley, I have observed fragments of these Permian grits in the breccia, while half of the Clent breccias are made up of them. We have no representative of the Magnesian limestone in the Malvern region, and we recommend our readers to study Sir R. Murchison's description of these strata in Russia, where they are so extensively developed. Our English Permians shrink into insignificance, and the Malvernia seem "incomparably small," when the Haffield conglomerate represents Perm and Permian.

PERMIAN FAUNA.

Geologists for a long time believed that the two greatest revolutions in the history of extinct creations were those which separated the Old-life or Palæozoic rocks from the Secondary group of strata, and the Secondary from the Tertiary and Modern deposits. The onward progress of the science continually requires that Philosophers should modify their statements on such subjects.

The Cassian beds in the Alps are the equivalents of the Keüper sandstones of England and Germany, a well-known series of rocks belonging to the Trias in the Secondary group of deposits. Here the sandstones and marls have few organic remains, but those few are more of

Oolite type than of Palæozoic. And yet these strata in the Alps are charged with "magnificent ammonites of the Triassic era," and have actually "eight hundred species of mollusca of the period of the Keüper." "These shells are not common to the Muschelkalk, and yet they include *some huge Orthocerata*," these said Orthocerata having been supposed to die out in the Carboniferous deposits. There is also a peculiar form of Productus, a *magnesian limestone* (Permian) form, in these St. Cassian or Hallstadt beds. If these statements prove correct we have Silurian forms and Permian shells meeting Liassic ammonites in Keüper strata, and where we should have suspected neither. Nevertheless, if hard lines in geology have no existence, boundary lines of nomenclature are useful; and, as most of the Permian animals appear more or less allied to the Carboniferous, the Permian is now classed as Palæozoic.

The British Permian organic remains are

described by Mr. King. The corals possess the old-type arrangement, as far as they are yet known, and the shell-fish are in some instances almost identical with Carboniferous forms. Different species of the Brachiopoda, Productus, and Spirifer, occur with conchifera named Bakevillia and Schizodus. There are five species of the Bakevillia determined, and, as this fossil occurs in Great Britain, Germany, and Russia, it is a good characteristic form for the geologist to obtain. The Bakevillia belong to the Aviculidæ or wing-shells; the Schizodus (Axinus of Sowerby) is a species of Arca, and is abundant near Durham.

Mr. Binney of Manchester discovered these shells, with several other genera, in red marls and shales, which is remarkable when we remember how rarely strata tinged with red oxides contain any fossils whatever.

I am not aware that any fossils have ever been found in this district; but I have seen fossil wood near Ashby-de-la-Zouch, where the Rev. W. Coleman has done much excellent work; he was good enough to explain the correlation of the strata, and furnished me with specimens. Mr. Coleman has since found "Sternbergia," a characteristic Permian plant, in that neighbourhood. In some localities, as on the coast of Durham and Yorkshire, between the Wear and the Tees, the Permian magnesian limestone contains abundance of fossil shells, and the rock as much as forty-four per cent. of magnesia. An interesting paper On the magnesian limestone having been produced by the metamorphism of an ordinary calcareous deposit, was read by Mr. H. C. Sorby at the meeting of the British Association at Cheltenham, and in which he satisfactorily proved, that in some cases ordinary calcareous limestone had been changed into the magnesian, through chemical changes in the constituents, owing probably to the formation of rock-salt and gypsum in the superinjacent strata and the evaporation of sea-water.

It is interesting to observe that the ancient type of the primeval fishes called "Heterocercal" by M. Agassiz is universal in the Permian strata. The Heterocercal fishes had the vertebral column prolonged into the upper lobe of the tail, as in the shark and sturgeon, the tail being unequally lobed; while the "Homocercal" fishes, which comprise almost all the known existing species, have the tail-fin equally divided, and the back-bone is not prolonged into either lobe.

The names are in some instances characteristic, as "Platysomus" (broad-bodied). We have also the Palæoniscus and Cælacanthus, Pygopterus and Acrolepis.

Reptiles of elaborate form and structure are not uncommon in the Permian system, and the eminent comparative anatomist Professor Owen informs us that the "Palæosaurus (ancient Saurian) and Protosaurus (first Saurian) occasionally walked on dry land," and were allied to the living Monitor.

The relics of these species, with that of the Thecodontosaurus (sheath-toothed Saurian), have been found in the Bristol conglomerates at Redland, and other Saurian remains have been detected in the breccias of the Bristol district.

Thus our evidence leads us to believe, that reptilian development was on the advance. The small reptile of the Upper Old Red Sandstone is the first registered in geologic history; the reptiles of the Coal period were air-breathers, allied to the Proteus and Salamander, and among them were giant forms. Reptiles of the highest order and class appear during the Permian age, and M. Herman Von Meyer has figured no less than eighty species from the Trias above; while the succeeding Oolitic epoch was known to swarm with every device of reptilian shape and form.

While on the subject of Permian reptiles, I must allude to the superb work of Sir William Jardine, Bart. of Applegarth, on the Ichnology of Annandale. The magnificent plates are faithful representations of the tracks of Chelonians, Lizards, and Batrachians on a sandy beach, while a description of the Physical Geology may be found in my friend Professor Harkness's paper "On the sandstones and breccias of the South of Scotland."*

In all my geological experience I cannot recall a greater treat than my visit to the celebrated Corncockle Muir quarry, near Jardine Hall, in the beautiful vale of the Annan, and to Sir William's "Footstep Room" at Jardine Hall.

Robinson Crusoe when he first beheld the impress of the human foot on the sea-beach could hardly have been more wonder-struck than myself, at the foot-tracks left by a gigantic

* Proceedings of the Geological Society, August 1856.

Tortoise of the size of a Hippopotamus, on the once sandy shore of a Permian sea. This reptile is well named "Chelichnys Titan" by Sir William Jardine.

Imagine, reader, a noble quarry of bright-red sandstone, backed by a large wood of Scotch and Spruce fir, tenanted by deer, not your *tame cattle* of home parks, but wild noble fellows; a moss stretching below, the old castle of Sped-lings in the distance, and the sun shining brightly on the quarried strata, which reveal the marchings of giant reptiles long since perished—is not this a sight for a geologist? In some instances may be seen where the animal has lifted its foot, and the mud and sand have clogged to the sole and been carried onwards to the next step, as Lias clay clings occasionally to the boots of the pedestrian.

It is remarkable that all the tracks tend one way, and have never yet been observed return-ing. A wag remarked that they were *Scotch* reptiles travelling *South*, and too good judges to think of coming back to their "ain cauld countrie."

The quarry is overlaid by a considerable thickness of glacial drift, and the plane of the sandstone is polished, striated, and furrowed to an extraordinary extent by icebergs and floes grinding along the surface, with their burden of stones and pebbles.

The "Footstep room" is fitted up with track slabs of the various animals, and the ripple-marks of the retiring waves. It is somewhat strange that no bones of these animals have yet been detected, or a single plate discovered. The Corncockle area is surrounded by Lower Silurian rocks charged with beautifully perfect Graptolites; and a minute shell, "*Siphonotreta micula*," found also in Bohemia and Russia, has been discovered by Professor Harkness, with the tracks of sea-worms. These sandstone strata were for a long time supposed to be *Triassic*, but some years since, Sir R. Murchison was disposed to rank them as Permian, in which opinion Sir C. Lyell, Mr. Binney, and Professor Harkness now concur.

The reptiles during the Permian epoch must have been exceedingly abundant, as it is probable that only one in very many left the records of its existence on the sandy beach or muddy patches of the Permian coast.

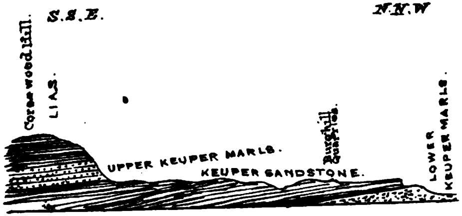
PERMIAN FLORA.

The Permian plants are mostly of carboniferous type, but certain forms, as Walchia and Noeggerathia, supposed by M. A. Brongniart to be alled to Cycas, are peculiar. Col. von Gutbier has discovered upwards of sixty species of fossil plants in the Permian rocks of Saxony. About one third of these belong to the coal measures also. The Psaronius is the silicified stem of a tree-fern, and is found abundantly both in Russia and Germany, while a different species of the same plant is found in the upper coal measures of Autun in France, and also in the upper coal of Ohio in America.

The Permian ferns are of old-type form, such as Neuropteris and Pecopteris; also coal-measure reeds, as calamites and equisetites, with the well-known Lepidodendra, associated with new forms that shadow forth the coming Triassic epoch. Sir R. Murchison gives Calamites arenarius as a *Permian* plant, "which has quite a palæozoic aspect, and differs from all known plants of the mesozoic or secondary series." I have however found stems of this reed in the Keüper quarries of Pendock, and the structure of the plant is tolerably well preserved.

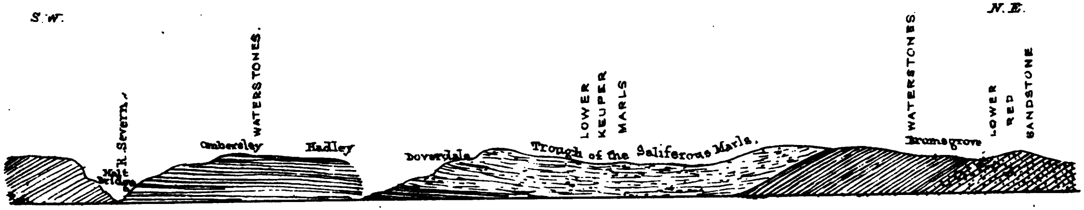
The geology of the Permian rocks in the British isles is not half worked out at present, though unfortunately in the neighbourhood of Malvern very little is possible: if we have no rocks we cannot expect to find fossils!

Since these pages were placed in the hands of the publisher, I am enabled to announce the discovery of reptilian footsteps, still more gigantic than those of Sir William Jardine's "Chelichnus Titan," in the Corncockle Muir quarry, a drawing of which, from a photograph, is given as a frontispiece to this work. Wonderful indeed are these "foot-prints on the sands of time,' for of all those giant reptiles only the impression of their tread remains, while the waters, that have left the roll of their waves rippled upon the sandy shore, have long ceased to flow. Yet now in the bright sunshine, we see a fair, frank face, leaning above those foot-marks of the extinct dead; and slender arms and gentle fingers, play for a few moments over the secrets of a sun-printing camera, and we are startled when, after a sleight of hand, the fair magician presents us with a faithful picture, of the footprints on the ancient beach and the ripple of former waves, and even the shadows of the tall firs that fall upon the red sands; footsteps, wave-marks, trees, and shadows, pictured by the same sun that shone upon the living reptiles and gleamed above the bygone waters.



Eldersfield Section.

Inkberrow Section.



Droitwich Section.

CHAPTER V.

NEW RED SANDSTONE OR TRIAS.

THE name of New Red Sandstone was originally given to this formation to distinguish it from the Old Red rocks, which lie beneath the Carboniferous strata. The term Trias, or Triple, is better adapted to the system as developed in Germany than in England, where one very characteristic group, the Muschelkalk, is altogether wanting. Our Triassic system therefore comprises only the Keüper and the Bunter, the following strata of which are well defined in the Severn Vale:—

Upper Red Marls. Keüper Sandstone.	Keüper—Grey Sandstones.
Lower Red Marls. Waterstones.	Yellowish Red beds with pebbles.
Upper Red Sandstone. (Bromesberrow) Lower Red Sandstone.	Brick red.

I cannot recommend a better lesson to the practical geologist than the examination of the members of the New Red Sandstone in the Malvern and adjacent districts; *without the sheets of the geological surveyors!* The maps are most truthful and excellent, but they ruin physical geology, as beginners trust entirely to the map, and thus never acquire the practised eye, simply from never feeling the necessity of personal investigation.

BROMESBERROW SANDSTONE.

In the Malvern district, the Permian breccias are covered up by a soft red sandstone, well displayed in the parish of Bromesberrow, at the southern extremity of the range. It is necessary to warn the geologist against confounding these beds with the sandstones of Newent; they *underlie* the Newent group, which are the Waterstones of the Survey and the Newent Sandstone of Professor Phillips. To understand the history of the Bromesberrow Sandstones, I recommend the geologist to commence his investigation from the Berrow Hill, two miles from the base of the Chase End, and which is easily reached from the "Duke of York" on the Tewkesbury and Ledbury high road. This hill is capped with an outlier of Lower Lias, below which and ascending nearly to the summit of the hill are the Upper Keüper marls.

The Keüper Sandstones and their underlying marls may be seen cropping out in several places in the parishes of Berrow and Pendock, at the base of the Berrow Hill. Having ascertained the correlation of the beds so far, the explorer may make the best of his way to the cross-roads at the Hawthorns at the base of the Chase End. Walking up the road towards the valley of the white-leaved oak, on the right hand (east), the high ridge of arable land, nearly opposite Mr. Ricardo's Berrow school, is Keüper Sandstone with Lower Keüper marls below. Nearer the hill, and just below a little lane, there is a section displaying the Lower Marls, rising against the Syenite, dipping into the lane and under the Keüper Sandstones on the east. Retracing his steps as far back as Mr. Ricardo's school, and crossing the fields to the Chase End Hill, the section hunter will come upon the carriage-drive to Bromesberrow Place. Let him turn neither to the right hand nor to the left, but follow a little footpath through the copse above, and in the wood yellowish red sandstones crop out, flanking the Syenite which rises through them a few paces higher, and dipping away at a high angle under the Keüper marls and sandstones of the vale. These are the yellow red sandstones of the Waterstones at the base of the Keüper system. To work out this section requires a little care, but it will save days of trouble, as the fault from Bromesberrow below Red Marley is extremely puzzling without this key in the narrow lane and the little wood.

Understanding the positions of the rocks down to the Waterstones, and returning to the carriage-drive, the geologist should journey south towards Bromesberrow. Immediately after passing through the first gate the Waterstones are again seen cropping out underneath some trees on the left (east). It is not difficult to perceive the difference between the Waterstones and the Bromsberrow sandstones, as the latter are of deeper brick red, and, turning to the right (west) after passing Bromesberrow Place, we come upon the Bromesberrow sandstones. These are the *lowest* Triassic beds at the southern extremity of the Malvern range, and the only representative in this neighbourhood of the great Bunter series. The relations of the Bromesberrow sandstones with the Waterstones may be best seen along the line of the Glynch brook, where they dip under them to the south.

During the excavations for the foundation of the Messrs. Burrows' house, near the Bellevue Hotel at Great Malvern, a dark red sandstone with black markings of protoxide of manganese was exposed, resting against the Syenite of the Hill, and covered up by a great thickness of debris.

This rock differs considerably in mineral character both from the Waterstones and the Bromesberrow beds, and I am, therefore, inclined to place it with the Lower Red Sandstones of the Survey. However this may be, the position of this red rock at Malvern proves either a very considerable elevation of those hills, or a depression of the vale since the deposition of the sandstones. Professor Harkness first observed that the Permian beds of Annandale exhibit signs of depression, and assimilates this downward movement to that which would occur on drawing off the water of a frozen pond, and the consequent sinking of the ice.

Bromesberrow, or the Barrow of Broom, probably derives its name from the rounded hills or mounds once covered with the bright blossoms of the Gorse (*Ulex Europæus*), rather than those of the Broom. It is a cheery hamlet, and affords many pleasant reminiscences to the naturalist, who has wandered in the shade of its lovely lanes and "ingle nooks." It is a favourite haunt of the great Stag-beetle, and the botanist registers the *Ornithogalum nutans* as one of its wild flowers; while old men still living remember the badger a tenant of the sandy banks, when Easter Sunday's wake settled alike the fate of rustic lovers and the baited brute. Times change, and with the times minds and opinions change also.

In former days, "the proudest moment" of the working-man's life, was, when the parson or squire rode up and told him he had fought manfully, and that the badger-baiting was about to begin. At the British Association at Glasgow, we beheld a different scene: one who had been a working-man rose to address a crowded assembly amidst the acclamation of hundreds; surely that must have been "a proud moment" in his chequered life, as he felt that the cultivation of intellect was more honoured than the mere presence of rank.

Bromesberrow is not deficient in its memory of days long past; I do not now allude to geological epochs, but to those old times when the cultivated fields were a forest chase, and when good Mistress Dorothy Stone bequeathed the "one pot and pann" to her lovely daughter, and "the sum of 4*d.* to the Cathedral Church of Herefort" (Hereford), and "a kerchief to the blessed Virgin of Bromesberrow;" gifts in those days of no mean consequence. The family of Stone possessed property in Bromesberrow when the second Edward was butchered at Berkeley Castle, and their descendants possess some relic still. There is food for thought in the dottings of these little circumstances. What of the progress, what of the development of man's history, or rather of man's intellect and power!

Could Mistress Dorothy Stone revisit this planet, and no doubt she was "a dame right well to do and apt to think," could she behold our railroads, steam-power, electric telegraphs, and all the evidences of accumulated and concentrated thought, what would be her sensations on first awaking from her long sleep, especially if she happened to meet a geologist, "cracking the hard stones," by the green hill-side, and interrogating the history of a creation that had become fossil before she lived and died?

KEÜPER SERIES.

Waterstones (Newent Sandstone).—I have already described an interesting *morsel* of these deposits at the back of the Hawthorns, and flanking the Chase End of the Malvern range, as just there the relation to the Syenite and Keüper marls is well portrayed; but to see trace, and shows in a bold escarpment, how the Waterstones have been uplifted through the overlying Keüper marls and sandstones.

I have searched the Waterstones in every hole and corner for fossils, and have never yet succeeded in detecting any specimens, but a few miserable fragments of triturated bone, in the upper grey beds of which the church at Red Marley D'Abitot is built; and all I can say of them is, that they were exceedingly like the broken fragments of Saurians that occur in the equivalent rocks near Shrewsbury (Grinshill). Apropos of fossils in these strata, I shall not forget a hunt at Grinshill last autumn! I was examining those magnificent quarries and the surrounding geology under the guidance of the well-known naturalist, T. C. Eyton, Esq. of Eyton Hall, when we heard from some quarrymen of certain curious remains of "something like a fossil bird," in the possession of a Mrs. — at a distant village. Away we went, up hill and down dale, first to one cottage, then another, and I doubt very much whether the keenest fox-hunter could be more excited than we geologists after the "fossil bird," which we ran into at the village of Clive. The fossil was a most valuable specimen of the Rhynchosaurus (a lizard with a *beak*). The animal was lying on its back in the slab of stone, the parrot-like beak, and a considerable portion of the skeleton, being in an excellent state of preservation; indeed, it was far superior to the specimen in the Shrewsbury Museum. Mr. Eyton offered a considerable sum for the Rhynchosaurus, which, as a valuable local fossil, should be in his excellent museum; but the owner declined parting with it, as her husband had found and valued the specimen, and she was a widow! We could not but respect the feelings which gave such a value to the stone, and only trust that care will be taken that this valuable relic of the Waterstones, may not be tossed aside when time shall have summoned its present possessor to join him whose memory she now holds so dear. The casts of rain-drops, presenting a blistered surface, are abundant on the Grinshill sandstones—asociated with the ripple-marks of ancient waves — from which we may infer the *litoral* character of the deposits. Red Marley is called D'Abitot from Geoffery D'Abitot, a descendant of the Norman Conqueror's steward.* Red Marley speaks for itself, as derived from the colour of the soil. It is very possible that any local collector might obtain fossils from the grey upper beds if a little attention was given to research. The indefatigable collector of the Geological Survey, Mr. Gibbs, detected an interesting fossil fish in the yellowish red beds of these stata near Bromsgrove. The tail of this remarkable fish, found in *unfossiliferous* sandstones! appears to indicate a link between the heterocercal and homocercal fishes ; the scales are those of a ganoid. Many

* Noakes's Rambles in Worcestershire.

remains of fossil plants occur in the Ombersley sandstones, but they are imperfectly preserved; there are a few specimens in the Worcester Museum. Some of the plants obtained by Mr. Strickland exhibited vegetable structure sufficiently perfect for Professor Lindley to determine the species; the "*Echinostachys oblongus*" was identical with the specimens published by M. A. Brongniart from the "Gres bigarré," and there were "many narrow Monocotyledonous leaves, resembling those of grasses, with a portion of a flabelliform leaf." Sir R. Murchison and Mr. Strickland considered that the sandstone of Warwick occupies the same geological position as that of Ombersley and Bromsgrove. These beds have afforded many organic remains of gigantic Batrachians (frogs), especially at Guy's Cliff, near Leamington. Red beds "of a deep red tint" occur at Blakedon Hill, also near Leamington; and I do not doubt, from Mr. Strickland's description, that these and the dark red sandstone below the Grinshill sandstones, are the equivalents of our Bromesberrow sandstones.

LOWER RED MARLS.

In Cheshire, Mr. Ormerod reckons the total thickness of the New Red Sandstones and Marls at 1,700 feet; the "Bunter Sandstein" (represented in the Malvern district by the Bromesberrow sandstone and the red rock of Malvern) is there estimated at 600 feet thick, the Waterstones 400 feet thick, and the Upper Keüpers, including the salt and gypsum, at about 700 feet. In this district we cannot assign more than 250 feet to the Waterstones, but the Upper Keüpers are of considerable thickness. The Lower Red Marls which rest above the Waterstones must in some localities possess a thickness of 500 feet.

Excepting to the physical geologist these Lower Marls have few charms. There are no fossils, or rather none have ever been obtained, with the exception of a few traces of plants mentioned by Professor Phillips in the vicinity of Malvern (Link Farm). The land is generally poor, consisting of a tenacious red clay, and so striking is the difference between the character of these deposits and the Waterstones, that a blind person could hardly fail to detect the difference. The best advice I can give to a brother geologist, is to *get off* these beds as quickly as possible, and take the strike of the Keüper sandstone ridges. There you are rewarded by beautiful views of the Malverns and surrounding country, but on the Lower Marls you generally find yourself in *a hole!* These strata may be seen to dip under the Keüper sandstones below the Chase End, Ragged stone, and Midsummer Hills. In the Newent district they may be seen between Huntly, Hartpury, and Newent, and in contact with the rocks of May Hill. Castle Morton (the Castle of the

Marsh) is an excellent locality in the Malvern district for studying the physical position of the Lower Marls, and obtaining information on subjects of historical lore! Some of the inhabitants believe that the Battle of Water-*loo* was fought near the castle mound, and that the remains of Bonaparte lie beneath that "hillock green;" while few persons in this part of Worcestershire are so really well versed in the archæological knowledge of his own neighbourhood, as Mr. John Lane of Curtlers. Castle Morton and Longdon marshes owe their origin, to denudation by an ancient backwater of the Seven Straits. The thickets and little copses in these vales always abound in nightingales, which prefer the valleys to the higher lands, and I have heard half a dozen in full chorus on a June evening.—In Sir R. Murchison's and Mr. Strickland's notice, "On the Upper Formations of the New Red Sandstone System,"* the geological

* Proceedings Geol. Soc., vol. i. p. 471, &c.

position of the Droitwich rock-salt is assigned to these Lower Keüper Marls, "the gypseous marls, with masses of rock-salt, having been penetrated to a depth of nearly 600 feet without an indication of any bed of sandstone." Sir C. Hastings has also an excellent paper "On the Salt Springs of Worcestershire."* As regards the formation of rock-salt, all kinds of theories and conjectures have been proposed. To us Sir C. Lyell's opinion seems most probable, which is, that gypsum, salt, and magnesia, in whatever strata they occur, have a similar origin, viz., precipitation from highly-charged saline waters, subjected to long-continued evaporation. Recent salt-lakes both in Siberia and Patagonia occupy shallow depressions in the plains, and in some instances the bed consists of snow-white salt three feet in thickness! Yet what is this to the Cheshire deposits, where beds of salt occur 90 and 100 feet thick? Then again arises the

* Analyst, vol. ii. p. 359.

question, how does it happen that no sediment is mixed with the Cheshire salt often for a great depth? It may be that the immense quantities of salt, segregated and crystalized in the mines of Cheshire and Worcestershire, may account for the paucity of fossil shells in our English New Red Sandstone strata. Mr. Darwin's account of the Salinas, or salt-springs, of South America, bears in a striking manner upon several phenomena of our Triassic strata: the crystals of sulphate of lime, the minute crustaceans adapted to lakes of brine, are to a certain degree analogous and worthy of observation, for it is not impossible that the abundance of salt in the waters east of the Malverns during the New Red Sandstone epoch, may have rendered the sea unfit for the development of an abundant molluscous fauna, for some considerable period both before and after the deposition of the salt-beds.

There are saline springs in many other parts of Worcestershire, besides those at Droitwich and Stoke Prior, as at Defford, Bourn Bank, and Churchhill near Spetchley.

Gypsum is also abundant in the Lower Marls; a thin vein occurs below the Red House, in the parish of Longdon, and in many other localities in this county.

If the land of the Lower Marls is often poor in an agricultural point of view, when we consider that the brine-springs and rock-salt of Cheshire and Worcester yield annually from 160,000 to 170,000 tons of salt, we have reason to be thankful for the industrial products of the Lower Keüper Marls.

KEÜPER SANDSTONE.

The best locality I know, for observing the relation of these light-coloured sandstones of the New Red era with the Lias and overlying rocks, is at Newnham, in Gloucestershire, where they may be seen in the cliff below the church, dipping under the Upper Marls and Lias of the Garden Cliff on the north-east. North of Newnham, these strata may be studied on the road between Flaxley and Westbury-on-Severn, where there is an interesting Fault bringing up the Old Red and Silurian strata against the Mesozoic Keüper. They are also exposed at Tibberton and Yew Tree Farm, near Hartpury.

The quarries of Burghhill, in the parish of Eldersfield, afford an excellent section in a line of old quarries, where the sandstones dip away from the rounded hill of Gadbury Camp, and rise again to the surface along the ridge of Dobshill opposite the Chartist settlement of Lowbands. The Anticlinals and Synclinals are most interesting in this district, and afford a most useful, though puzzling, walk to the physical geologist The ancient Camp of Gadbury is formed by the Keüper sandstones rising to an Anticlinal, and they dip rapidly to the south-east under the wooded mound of Berth Hill, and to the north under the Berrow Hill, where an outlier of Lias is still left. Thus such places as the Rue Green, Grafton's Farm, and Cleave House, in the parish of Pendock, are *above* the sandstones, not *below*, as the vale character of the country might lead the observer to suppose. The remains of the foundations of an ancient wall have lately been discovered by Mr. Hall, of Eldersfield Court, on the summit of Gadbury Camp; this wall was built quite round the table-land, which forms a level area on the top, and is capped by Northern Drift. Much of the stone consisted of Keüper Sandstone raised on the site, but I observed slabs of Hollybush Sandstone and Syenite from the Malverns. The fact of the Northern Drift being deposited on the top, lead us to the conclusion that the *rounding* of the numerous hills of New Red Sandstone in the vale of Worcestershire is owing to the waves and currents of the glacial sea. Several coins have been picked up amongst the rubbish, copper and silver, and all I believe of the reign of "good Queen Bess." The church of Eldersfield is built of Keüper Sandstone, and was within my recollection the most forlorn building, to call "God's House," that Christian men "e'er blushed to look upon." Thanks to the energy of the vicar (the Rev. R. Holmes), and the free good will of parishioners, not "passing rich," but alive to religious decency when once aroused, the village spire no longer stands forth, a monument of poverty and desecration, but an evidence of what men may do, "by a long pull, and a strong pull, and a pull altogether."

If Pendock holds forth no other inducement for the naturalist to pay a visit to its peaceful hamlet and quiet sunny green fields, it possesses one great recommendation to the geologist, for no where in all England is there a Keüper quarry so rich in New Red Sandstone fossils and no where are the organic remains better preserved. The quarry in question is near the Tewkesbury and Ledbury high road, situated on a branch lane between Moor Court and the Red House. The Keüper Sandstones are here seen in an excellent section dipping to the south-west, under the Upper Red Marls and Lower Lias of the Berrow Hill, that rounded and wooded *Barrow* a mile and a half distant. The quarry near Moor Court affords the following rough section.

	feet	in.	
Surface Soil	2	6	
Marl	2	4	Estheria rarely.
Sandstone	0	7	Fishes' teeth and bones.
Marls	0	5	Estheria in nodules.
Sandstone	0	6	Teeth and bones.
Marl	0	1	Estheria.
Sandstone	0	5	Remains of plants and coaly matter.
Osseous Conglomerate	0	1½	Fish-spines (icthyodorulites), teeth, and bones.
Thick Sandstone and Marls	(Unknown)		Plants. Estheria and a bivalve shell.

Professor Phillips describes our richest quarry

as Mr. Jones observes, the Estheria will probably serve "as a faithful index of a peculiar geological horizon." The recent Estheria is a *marine* crustacean.

A small bivalved shell, furrowed from the hinge to the margin of the shell, was detected by my young nephew (F. Symonds,) among the shales, when with me last summer hammering among the Keüpers of Pendock. This shell was supposed by some of the savans to whom I shewed it at the British Association at Cheltenham, to possess a Permian facies; it is certainly new to the English fauna. The fish-teeth and bones are exceedingly abundant in a thin osseous conglomerate, which at Pendock constitutes a regular bone-bed. These remains Sir Philip de Grey Egerton refers to a species of "Acrodus," (sharp-tooth). The teeth are evidently palatal. My friend, Mr. Brodie, states that the "Estheria minuta" occurs plentifully along the banks of the canal near Shrewley in Warwickshire, also numerous fish-spines of various sizes, with the same palatal teeth so abundant in the Pendock sandstones.

Mr. Brodie has also obtained from the same spot a cranial bone of that gigantic and frog-like lizard the Labyrinthodon.

A slab of Labyrinthodon footsteps may be seen in the Worcester Museum, and it is worthy of remark, that in India, footsteps of Batrachian reptiles are found in strata of this age which also yield the "Estheria." There is an interesting little quarry near the Hollybush turnpike, at the southern end of the Malverns, called the Fox-holes, which furnishes remains of fish and the little crustaceans; this is the nearest spot to the Malverns where I know of any fossiliferous Keüper. The plant-bed at the base of the Pendock Keüper quarry is very rich, but is rarely worked. "Calamites arenarius" and "Equisetites columnaris" are found here.

The equivalent beds in Warwickshire furnish

Voltzia, Calamites, and Fucoids. Coaly particles are abundant in some localities, and probably owe their origin to two sources, viz., denudation of the coal formation, and also from the carbonization of the Keüper plants, for I have often seen stems of reeds, &c. coated with coal.

Dr. Hooker and Mr. C. Fox Bunbury, both well known to the scientific world for their knowledge of fossil botany, did me the favour of examining several specimens of Keüper plants,* and determining the species. The range of "Calamites arenarius" is worthy of observation, being found in the Permian deposits of Germany: it is also abundant in the Oolites of Yorkshire and America.

At the time Chambers Court in the parish of Longdon was building, these sandstones were quarried, and abundant vegetable remains were occasionally exposed, with small fruit-like bodies, which Mr. Hugh Strickland also detected at

* Proc. Geol. Soc. April, 1855.

Ripple, on the east side of the Severn. At Harvington near Evesham, and Inkberrow, imperfect vegetable remains also occur. The Keüper sandstone is first-rate building-stone; for instance, Chambers Court, the residence of my friend E. G. Stone, Esq., and the farm-house (Hill End) in the parish of Berrow. One cannot but regret that in days gone by, our predecessors were so utterly ignorant of the utilitarian value of the rocks beneath their feet. The Castle of Eastnor is built of coal-measure sandstone brought from Dean Forest at an enormous cost of carriage, and within a mile and half there is a noble quarry of green Hollybush Sandstone. The church is built of Old Red Sandstone all the way from Dymock, while high on the Silurian flanks of the Malverns, an obelisk to the memory of the dead, is erected of inferior Oolite from the Cotteswoldes.

UPPER KEÜPER MARLS.

These strata are in this district from 200 to 300 feet thick, cover up the grey sandstones and shales, and graduate into the Lowest Lias in several sections in this neighbourhood.

The Garden Cliff near Newnham and Wainlode Cliff, near the Hawbridge, both on the Severn, are well-known and excellent sections. At Crowle also, near Worcester, my friend Mr. T. Baxter conducted me to a splendid section of the Red Marls and the Upper Grey Marls capped by the equivalent of the bone-bed, a sandy deposit, with a small bivalve on the upper surface.

In the Malvern district they constitute the bases of Berrow Hill, Corsewood, Sarnhill, and Queen Hill, and, although there is no exposure of the rocks, the geologist cannot mistake the change which occurs in the character of the soil and the agricultural value of the land, the moment he ascends from the Upper Marls to the stiff and sticky clays of the Lias. Limburgh Hill near Gloucester, and Berth Hill at Eldersfield, with many other rounded and barrow-looking hills nearer Worcester, are interesting examples of the action of ocean-currents, and the Lias only *just* denuded. It is necessary for the geologis to be made aware that, notwithstanding their colour and lithological appearance, the Upper Grey and Blue Marls are *not* Lias, and that the horizon is bounded by the bone-bed.

Mr. Baxter of Worcester has observed that limestone plants frequent the summit of those hills from which the Lias has been just denuded; this is the case at Trenchwood between Worcester and Crowle, and I have seen "Chlora perfoliata" and "Iris fetidissima" at Berthhill, Eldersfield, Apperley in Gloucestershire, and other localities, which appear to hint to the geologist, by means of their wild flowers, that perhaps beneath the sod some fragments of a vast formation which formerly stretched far and wide above the tops of the hills may still be left.

The geology of the Upper Red Marls leads us among many pleasant and delightful spots. There are many ancient and now restored churches which solicit a call as we pass, and many a legend which reminds us of a time when man was more primitive, although perhaps not less happy, than in these days of steam, galvanic batteries, and power-looms. If any geologist should take this book as his guide, and work out in detail the strata of the New Red Sandstone of the Severn vale, I recommend his commencing at Madresfield (supposing he starts from Malvern), and travelling south. At Madresfield, the church deserves examination; it is new and ecclesiastical. The Court is chiefly remarkable as being the residence of a noble soldier who fought at Waterloo, and has a heart in his bosom that never turns from the petition of poverty and distress! Dripshill, and the Old

Hills, both within a walk of Madresfield, are good examples of hills consisting of the Upper Keüper marls. Neither let the geologist pass by the ancient manor-house of Morton Court, and the resting-place of the last of the Bellomonts, in the picturesque church-yard hard by. The manor-house, with its complete moat and ancient walls and draw-bridge, is an unique specimen of the fortified residences of our English forefathers. They say that Wolsey once lived there, and officiated as chaplain to Giles Nanfan; the Nanfans were a family "of credit and renown," but, like other and older families, they have died out, and the last of the race met his fate, as soldiers love to die, in the attack upon the Redan. It is pleasant, when fishing in the old moat, to think of Wolsey, Arundell, Caldwell, Nanfan, Bellomont, all high and honoured names of men now gone to dust, but who, like us, once dreamed by the side of the old moat of Morton manor-house.

The adjoining parish of the Berrow has also its associations of "love and murder." The "Murder-house" is situated at the turn of the road from Ledbury and Tewkesbury towards the church. It is still shunned after dark by the superstitious, and no wonder, for during the latter part of the last century it was the scene of downright butchery. Every old wife tells the tale, which need not therefore be related here. The three victims of the unknown assassins lie in the same grave, and a large flat stone on the right hand on entering the picturesque old porch of the admirably restored church, covers their remains. The "Bloody Field" is also situated in the same parish and near the Hawthorns. This was the scene of a duel between a certain adventurous lover of a lovely Bridget Nanfan, and a brother of the "ladye fayre." The lover fell, and the damsel left a sum of money ere she died, to pay for an annual clerical harangue against love, duelling, and all such misdemeanours. Whether fair Bridget remained "to love and memory true," I never could ascertain, probably, like most of Eve's fair daughters, she came to the determination that a living lover is worth two dead ones, and acted upon that sagacious principle.

A number of valuable gold and silver coins were discovered last summer, not far from the base of the Berrow Hill in the parish of Pendock, on the farm of Mr. W. Fisher. The gold coins are Spanish, and of the time of Philip, husband of Bloody Queen Mary; the silver pieces range from the dates of Henry the Eighth down to Elizabeth, and are in a state of excellent preservation.

KEÜPER BONE-BED.

At the junction of the Upper Keüper Marls and the lowest beds of the Lias, there intervenes another of those phenomena of sudden death, a bone-bed. We have already stated our belief as to the cause of this wholesale destruction of marine animals over large areas,* and it is therefore sufficient to remark, that this platform of death at the termination of the Keüper series of strata, is an excellent illustration of the destruction that overwhelms the inhabitants of the sea whenever submarine volcanic action occurs, and an oscillation of the ocean-bed and contiguous land changes the flow of the currents, and alters the character of the sediment. This bone-bed was for a long time referred to the Liassic epoch, but Sir P. Egerton ascertained that the remains are those of Saurians and fish, which are either peculiar to the Keüper strata, or belong to species well known in the Muschelkalk of Germany. The fish belong to the genera Acrodus (pointed-tooth), Sauricthys (sauroid fish), and Hybodus (hump-tooth), &c. Some of the reptiles have already been noticed, as the Labyrinthodon and Rhynchosaurus,† but there are many others

* See Mountain Limestone Bone-Bed.

† Liassic reptiles also occur; see Mr. Hull's memoir of the Geological Survey.

known to Palæontologists. The most remarkable fact in connection with this Keüper bone-bed was the discovery, by Professor Plieninger of Stutgardt, of two fossil molar teeth and some other fragments of the earliest known warm-blooded quadruped, in an equivalent bone breccia in Wurtemberg. This little animal is named "Microlestes" or little beast of prey. Our English Keüper bone-bed ranges over a considerable area, and Mr. Strickland traced it from Axmouth in Dorsetshire to Watchett, Aust Cliff, Westbury-on-Severn, Wainlode near the Haw Bridge, and Coomb Hill near Cheltenham. At Crowle, near Worcester, I find it imperfectly represented by a thin sandstone, with a bone here and there, and abundance of the oval bivalve which has been named "Pullastra arenicola."

The New Red Sandstone or Triassic group of rocks, representing a vast epoch of past time, have been much misunderstood, through the barrenness of these strata in fossil remains in

Great Britain. It may, therefore, be useful to sum up the leading facts connected with the history of the Trias. There is no doubt that in *this district* considerable elevation of land and depression of the bed of the sea occurred *after* the deposition of the *lowest* Permian strata, and it is probable that a great destruction of Palæozoic animals and plants ensued, through the earthquake influences, of which we have such undoubted evidence as occurring at this period. That this Palæozoic destruction did not extend even to the Alps is evident from the fact that Palæozoic shells and animals are found in Triassic strata, and associated with Triassic fossils. It is also probable that during the Lower Permian epoch, the great fault on the line of the Malverns, and extending from the mouth of the Severn to the Dee, elevated the Silurian region into dry land, and depressed the eastern side, now occupied by the New Red Sandstone, Lias, Oolites, and Chalk, forming a wide and open sea, of which the Malverns formed a coast. The deposition of the Upper Permians and Triassic rocks took place after the great bouleversement, on the downcast area of older rocks. It is not improbable that the great abundance of salt and sulphuric acid in the Triassic sea may have prevented any great development of Triassic mollusca in this region, while on the continent certain strata of this epoch are extremely rich in fossil remains. Highly organised reptiles and birds of several species are known to have existed during the Triassic epoch in America, and the close of the period is known to have been extraordinarily rich in reptilian and icthyic life, from the occurrence of a bone-bed, containing in Germany the relics of a true mammal, and which was not likely to have been the only one of its kith and kind.

The *Permian* Flora is more allied to the *Carboniferous*, but the English and Germanic

Triassic Flora exhibits more of the *Oolitic* type. Voltzias, with Equisetites and Calamites, are abundant, but the total destruction or dying out of Palæozoic plants during the Permian epoch must be received, as that of the animals, "cum grano salis," for it appears that in the region of the Alps the Coal-Flora lived on to the age of Triassic Belemnites, and the Orthoceras, Euomphalus, and Goniatite flourished with the Monotis, Plicatula, and Trigonia.

CHAPTER VI.

LOWER LIAS.

To the study of the organisms of the Lias I owe my first geologic impulses, and many are the associations connected with the liassic rocks that must ever cause me to remember with gratitude those who assisted me in early explorations, and corrected wrong impressions, prejudices, and ideas. There was one especially, now, alas! no more, who, himself a most accomplished naturalist, was never weary of imparting information, even to the humblest, on those magnificent works of nature he knew and loved so well. I shall not forget his kind and simple manner as he expressed his conviction of the impossibility of God's Word ever really militating against His Works; and how the language of Holy Writ, which is often only in accordance with the *appearance* of natural phenomena, is in many instances misinterpreted.*

Inscrutable are the ways of providence. I never think of his fate, or of that of Hugh Miller, the victim of a maddening dream, without wondering why such men were called hence just when they seemed most fitted to inculcate on all around them deep lessons on the grandeur and beauty of creation. Is it that some minds touch the limits of allowed knowledge here below, and that "so far shalt thou go and no farther," may be a law of Deity even as regards the investigation of His works? Be this as it may, few can reflect upon the fate of Buckland, Forbes, Strickland, and Hugh Miller, without feeling the truth of those words of the latter: "It is in the dynasty of the future that man's

* The late Hugh Edwin Strickland.

moral and intellectual faculties will receive their full development. The expectation of any very great advance in the present scene of things, great, at least, when measured by man's large capacity of conceiving of the good and fair, seems to be, like all human hope, when restricted to time, an expectation doomed to disappointment."

1. Inferior Oolite.
2. Upper Lias, or Alum Shale.
3. Marlstone.
4. Middle Lias.
5. Lower Lias.
6. Keüper Bone-bed.

The above series comprehends the general correlation of the strata from the Keüper bone-bed to the inferior Oolite. The term Lias refers to the *layers* of limestones and shales, of which the formation is chiefly composed, and it is remarkably free from pebble-beds and drifted conglomerates.

It is probable that the Keüper bone-bed and the lowest deposits of the lias were laid down on a rapidly shallowing sea-bed, but that after the deposition of the Lowest Lias, depression of the eastern area re-commenced, and the strata of the *Middle Lias* must have been deposited in water many fathoms deep, as is evidenced both by the nature of the beds and the character of the organic remains. We have especial proof of the existence of a great breadth of tidal, shallow shore, during the deposition of the earliest liassic strata in that remarkable bed the " Insect Limestone."

THE INSECT LIMESTONE.

Twenty-seven feet eleven inches above the Keüper bone-bed, rests the " Insect Limestone" of Mr. Brodie, thus designated because insects are the most interesting and characteristic fossils.* When studying the history

* "Fossil Insects in Secondary Rocks." Rev. P. B. Brodie.

of this deposit, the geologist cannot fail to be impressed with the conviction that land was near, for, not only are the remains of insects abundant, but their *soft bodies* are frequently preserved, and in such instances it is necessary to suppose that they were imbedded in soft mud upon the spot. During the period the insects were deposited, there were, I believe, large mud-flats from which the tide receded, and over which waters charged with carbonic acid ebbed and flowed; and this will account for the occasional envelopment of a few litoral shells, with the remains of crustaceans and fishes, in the same strata. Again, the farther you proceed from the ancient coast-line, the rarer are the remains of insects, and, although we may obtain the limestone, there are no insects out at sea, that is to say, beyond the ancient tide-mark. An interesting account is given by Mr. Darwin of the countless myriads of insects which are occasionally blown out to sea. When the Beagle was off the shores of Northern Patagonia, "vast numbers of butterflies, in bands or flocks of countless myriads, extended as far as the eye could range." "Even by the aid of the telescope it was not possible to see a space free from butterflies." "Some moths and Hymenoptera accompanied the butterflies, and a fine beetle flew on board." The geologist has but to apply such phenomena to some of the immense mud-flats, as the Bay of Fundy, and he has at once the elements of an insect bed. The consolidation of the *mud* into limestone is probably due to the infiltration of waters charged with carbonic acid, or the discharge of that gas from underlying beds and decomposing animal remains.

These ancient mud-flats have rendered good service to the geologist, for without them we should have known nothing of the profusion of beautiful Lias-insects that were carried by the winds, and left their relics by thousands on the shore of the retiring wave. We know not the land from which they came; Old Malvern may have nurtured many; or Triassic islands, every vestige of which has long since passed away, may have been their habitat. They do not appear to differ much from forms now living, and, if we may judge from wings, legs, bodies, and other fragments, the insect kingdom has altered less in the history of the past, than aught else of the animal creation.

No geologist should work at the Insect Limestone without possessing Mr. Brodie's admirable work, in which most of the species that occur are fully described. Mr. Brodie has a magnificent collection, and among the specimens is a dragon-fly (*Libellula*) with the body nearly perfect, and the four wings attached. At one time I paid a good deal of attention to these beds, and my cabinet contained from 200 to 300 specimens; they are now dispersed, but those who wish to see Lias-insects, and have no time to search for themselves, may find some characteristic fossils at the museums of Worcester and Malvern. Fish, crustaceans, and marine shells are found with the insects, also ferns and fossil wood, and in the Malvern Museum there is among my fossils the tail of a species of prawn overlying one half of the wing of a large dragon-fly. Underneath the Insect Limestone, in some localities, I have met with a regular lignite bed, as at Sarnhill and Forthampton. This is interesting, and looks as if the mud-flats which received the remains of dragon-flies, grasshoppers, flies, and beetles, were a low shore, covered with trees, during the period that preceded that of the insect deposits. The best localities in this district for obtaining specimens are the Garden Cliff near Newnham, Wainlode near the Haw Bridge, Sarnhill two miles and a half from Tewkesbury, and Strensham beyond Upton-upon-Severn. Bidford in Warwickshire is rich in Lias-insects, and the Rev. A. Ingram, of Harvington, possesses a most remarkable specimen of an Orthopterous wing; I believe this specimen is unique either as regards size or the state of preservation. As the Cliff at Wainlode is an excellent escarpment of the Keüper and Lowest Lias, I give the following section, made by Messrs. Strickland and Brodie, who descended by ropes.

	feet	in.	
LOWER LIAS :—			
Black Clay	3	0	
Ostrea Bed with Modiola and other shells	0	4	Seen at the Berrow Hill, Sarnhill, &c.
Yellow Shale with Fucoids	0	10	
Insect Limestone	0	5	Sarnhill and Strensham, Cleeve Hill near Evesham, &c.
Marly Clay	5	3	
Yellow Limestone with Cyclas. Cypris and plants	0	6	At Sarnhill and Forthampton; fossil wood at the base.
Yellow Clay	9	0	
Black Shale	3	0	
TRANSITION BEDS :—			
Greystone with fish-scales and teeth	0	1	

1. Marlstone. 2. Upper Lias. 3. Cephalopoda Bed and Sands. 4. Pea Grit. 5. Lower Freestone. 6. Oolite Marl. 7. Upper Freestone. 8. Ragstone. 9. Upper Keuper Marl.

Section from Coomb Hill to Leckhampton.

Section across the Vale of Winchcomb.

TRANSITION BEDS *(continued)*.

	feet	in.	
Black Slaty Clay	1	6	
Bed full of small Pectens	0	4	
Black Shale	8	0	
UPPER KEÜPER MARLS:—			
Keüper Bone-bed	0	3	Also at Coomb Hill and Garden Cliff.
Black Shale	2	0	
Keüper Blue and Grey and Red Marls (about)	65	0	Grey marls of Crowle. The Upper Red Marls of the Berrow, Sarnhill, Apperley, Tunnel Hill Upton-on-Severn, Newnham, &c.

OSTREA AND SAURIAN BEDS.

It is my impression, that after the deposition of the insect-bed on a muddy shallow shore, from which the tide receded for a long distance, the whole of the eastern area occupied by the Secondary rocks in this district underwent gradual but uniform depression. That the mud-flats were depressed, and deeper water flowed over their site, is evident, for a few feet above we meet with a regular oyster-bed, and these shells require a considerable depth of water for their development. The Liassic fern (*Otopteris obtusa*) occurs in the Ostrea-bed, but I never saw the sign of an insect, indeed how could those fragile creatures have sunk through the depth of water necessary to the existence of the oysters, and have left their impression on that sea-bed? The Insect Limestone contains few shells, the Ostrea-bed is a mass of molluscous remains, the insect-beds contain litoral shells which lived near shore, and the fact of the Ostrea-bed covering up such deposits proves beyond a question the subsidence of the underlying beds. We endeavour to impress these points, as the geologist will have to deal with the phenomena of long-continued submergence over the whole of the Liassic area when he enters into the history of later deposits.

It is impossible for the geologist to visit the Berrow Hill at the southern extremity of the

Malvern range, and but two miles distant to the south-east, without being convinced that the Lias formerly extended to the Malvern coast when Wales and Siluria formed an island, or probably a portion of a great continent that stretched far away into the Atlantic, and of which Ireland and the Isle of Man are still relics. Standing upon the Barrow (Berrow), we have only to imagine long lines projected to the distant hills of Sarnhill, Queen Hill, and Corse, and, allowing a certain angle of dip, we have on those now separated and distant points, strata identical in their mineralogical deposits and their organic remains; they must have been once as continuous as the rind of a notched apple.

I have on the same day seen portions of the skeleton of the Ichthyosaurus, burning into lime at the Berrow, and the back-bone (possibly) of its mate, lying at full length upon a slab at Sarnhill, four miles distant. I have matched the well-known Ostrea-bed of the Berrow, and Sarnhill, with that of Crowle near Worcester, Queen Hill and Strensham, and been unable to say from which locality the slabs were brought, and yet they came from points now separated by valleys and ridges of red marls and sandstones, often several miles across, and from which observation tells us the Lias has been denuded. Abundant remains of those gigantic reptiles, the Ichthyosaurus and Plesiosaurus, are enveloped in the stone with the oysters and a minute species of Modiola, a shell belonging to the Mytilidæ or mussel tribe. In all the quarries, far and near, where the Ostrea-bed is exposed, I never yet failed to discover imbedded relics of one or other of these saurian monsters of the Liassic seas. The Ichthyosaurus was, as every one knows, a marine reptile of most singular organization, a kind of fish crocodile. The Plesiosaurus was equally anomalous, and possessed a swan-like neck, a short serpent-like head filled with sharp teeth, and long whale-like paddles; these animals must have actually swarmed off the Malvern coast in the days of the Lias.

Fine specimens have been obtained from Brockeridge Common near Upton-on-Severn, Sarnhill, Strensham, and many other localities. Even on the little outlier of the Berrow, there are many bones and vertebræ, and a lime-burner was once good enough to bring me a "fossil baby," in the shape of the body and ribs of a juvenile Ichthyosaurus. I have obtained the remains of the Plesiosaurus from Croome and Strensham, but have never seen any bones of the Pterodactyl in the Lower Lias, although Mr. Brodie possesses more than one humerus of this singular creature from the Gloucester district. This "marvellous beastie," like the elfin fish of Gawin Douglas, would have astonished any naturalist, could human eyes have looked upon its grisly form flitting through the groves and forests of that ancient land, now soaring in the air, now diving beneath the waters and bearing short the fish or cephalopod. The Pterodactyl was a winged lizard, and varied in size from that of a snipe to an albatross. The teeth, upwards of sixty in number, resemble those of a crocodile, the head and neck those of a bird, the wings were shaped like those of a bat, and with these were combined a lizard's trunk. Strange that we who live in times so remote from the period of the Lower Lias, should yet be enabled to determine with a degree of certainty the history even of the inhabitants of the *land*, and shadow forth, though dimly, a true yet dreamy vision of the past.

The succeeding strata of the Lias render evidence that in this district the eastern area still sunk gradually, and the influx of turbid and muddy waters destroyed suddenly thousands of marine animals, covered up their remains, and furnished habitats for other and often very distinct and dissimilar creatures. Beds charged with fossil Limas and Cardinias succeed to oyster deposits, as the sinking of the sea-bed rendered it a deeper water site than was adapted to the Ostrea, but suited the conditions of the Lima and Cardinia. Thus we have Lima-beds, Cardinia-beds, the Hippopodium-bed, Ammonite-beds, &c., all probably owing their existence and extinction to oscillation of the bed of the sea produced by earthquake agency.

The Lima-beds are not often quarried, but may be seen at the base of Churchdown Hill, and at Piffs Elm, near Cheltenham. The fossil Limas are large compared with their recent analogues, of which the largest species is found on the coast of Norway. "The Limas are free or spin a byssus; some make an artificial burrow when adult, by spinning together sand or coral fragments and shells."* The "Cardinia ovalis" is also a very characteristic fossil of these beds which terminate the Lower Lias division.

* Forbes.

MIDDLE LIAS AND MARLSTONE.

The Middle Lias (Lower Lias Shale of Strickland and Buckman) occupies the principal part of the vale of Gloucester, and extends below the Marlstone of Dumbleton and Bredon, stretching far to the north and south. The Middle Lias is the equivalent of the Dorsetshire shales and the lower shales of Yorkshire, and was evidently deposited under different marine conditions to the strata of the Insect Limestone and Ostrea and Saurian beds. Some good typical specimens of the fossils of the Middle and Lower Lias may be obtained on a pleasant trip by one of the little canal steamers which leave Gloucester every morning for Sharpness Point. About a quarter of a mile from the village inn, at the Passage, a portion of very fossiliferous Lias is exposed in a low cliff or rather bank occasionally washed by high tides. Nautili, Ammonites, Belemnites, Gryphites, with Pectens and Terebratulidæ, may all be found here with the assistance of a spade or pickaxe.

The student of nature soon begins to comprehend the language of fossils. The "wheels" and "snakes" he learns to call Ammonites, and a little instruction teaches that they belong to the same great class of Cephalopodous animals as the Nautilus; also that the Belemnite or "arrow-head" and "thunderbolt" of the quarrymen is neither more nor less than the internal bone of an extinct cuttle-fish. Only two or three species of living Nautilus are known, whereas above 100 species of fossil Nautili have been determined. The Nautilus and its congeners, rank at the head of the great Molluscous order of animals, and next to fishes in the classification of the animal kingdom. There is a wide difference between the Nautilus and the headless oyster. The Nautilus is furnished with bird-like mandibles, large fish-like eyes, an organ for hearing, a gizzard, a rudimentary spine, sucker-bearing arms on the head around a central mouth, and an exquisitely developed shell.

The animal of the Ammonite was probably nearly allied to the Nautilus, but if possible more complicated and of more delicate organization. Some important differences in the position of the siphuncle or air-tube require especial attention. In Nautili this air-tube is *central* or *internal*, while in Ammonites it is *external*, or near the outer margin of the shell. It is useful to remember this, as there are Nautiloid forms of Ammonites. Ammonites are very characteristic fossils of the Liassic and Oolitic (Jurassic) epochs, and die out with the chalk formation. Species similar to those of the inferior Oolite have been found on the Himalaya, 16,200 feet above the sea, proving the enormous elevation of those ancient ocean-beds. Triassic Ammonites are found in the

Alps, and I have seen Oolitic forms from Carpentaria in North Australia, in the cabinet of Sir William Jardine. The Nautilus, Orthoceras, and Ammonite, breathed by four gills, and therefore belong to the order Tetrabranchiata. I have seen many dead shells overgrown with corals and serpulæ, and Mr. Woodward mentions an instance of an Ammonite in the British Museum, the shell of which was evidently broken and repaired during the life of the animal, the shell being deposited from within.

Belemnites, from the exceeding abundance of their remains in many localities, constitute "Belemnite-beds," and must have been gregarious. Mr. Woodward says "that it is probable that they lived in a moderate depth of water, and preferred a muddy bottom. To understand the structure of the Belemnite, it is necessary to be acquainted with that of their recent analogues, the Calamaries or Squids. These are *naked* Cephalopods with *internal* shells. Naked Cephalopods (cuttle-fishes, &c.) "have powerful jaws, acting vertically, like the mandibles of birds; the tongue is large and fleshy;" "their eyes are large and placed on the side of the head, and their senses appear to be acute. All are marine and predatory, living on shellfish, crabs, and fishes." They breathe by *two* gills, whereas the Cephalopods with *external* shells breathed by four gills, with the exception of the Argonaut. They possess ink-bags, and discharge their ink into the water when frightened and to cover their retreat. "The cuttle-fishes are nocturnal or crepuscular animals," and MM. Quoy and Gaimard found a dead cuttle-fish in the Atlantic, under the equator, which must have weighed two hundredweight when perfect; it was floating on the surface, and was partly devoured by birds."* The common "Octopus" attacks and entwines its arms

* Woodward, "Recent and Fossil Shells."

around good-sized fishes and tears them with its sharp hawks-bill, while in some parts of the Southern seas the natives fear to bathe lest they should be pulled down by a giant Cephalopod.

Such is a short sketch of recent cuttle-fishes or naked Cephalopods, and to which the Belemnite bore much the same analogy as the Ammonite to the Nautilus. Nearly 100 species of Belemnites have been found in a fossil state, and my friend, Professor Buckman, of the Royal Agricultural College of Cirencester, possesses a Phragmacone from the Lias, containing the fossil ink-bag. The Phragmacone of the Belemnite represents the tail part of the Calamaries, and is divided into air-chambers with a tube or siphuncle, by which no doubt the animal regulated its ascent and descent in the water. Beautiful specimens of fossil Phragmacones occur in the marlstone of Dumbleton and Stanley Hill; they are changed into crystallized carbonate of lime.

When visiting the Lias near Pyrton Passage, the geologist should take a rowing-boat, and examine the Fretherne section, and then cross by Newnham to the Garden Cliff of Westbury: at these places a good series of fossils may be obtained, and, which is of more importance, the relations of the strata easily understood. The Fretherne beds dip under those of Pyrton, the Garden Cliff series under those of Fretherne, and the Newnham Keüper sandstones under those of the Garden Cliff. The Lias of Ardre, on the west bank of the Severn, is also interesting, as it proves the extension of the Liassic strata in times long antecedent to the period of the Severn river, up to the old coast-line of the Forest of Dean.

CARDINIA BED.

Higher in the middle Lias series we have the Cardinia Bed, with its characteristic fossil "Cardinia Listeri." This bed was exposed in the railway cutting between Eckington and Defford, on the Gloucester and Birmingham railroad. The Cardinia (or shell with a hinge) was not, as often supposed, a kind of oyster, but a siphonated Conchifer of higher organization than oysters, mussels, or unios: it is ranked by Mr. Woodward with the Cyprinidæ. A subgenus, Anthracosia, is abundant in the Mountain Limestone of Derbyshire, where it forms beautiful marble.

The Cardinias are very abundant in the Lias of Worcestershire, and I have seen them turned up in hundreds by the plough in some localities. They must have constituted regular shell-beds, like oyster-banks.

HIPPOPODIUM BED.

This fossil, though extremely abundant during the working of the railroad below the village of Bredon, is now difficult to obtain; it is a peculiar and characteristic Lias-shell, allied to Cyprina, and appears to have been a deep-sea shell. I have one rolled specimen of a dead shell from the litoral deposits of the Berrow Hill. Above the Hippopodium-bed we have the Ammonite and Belemnite-beds, with the Laminated Lias and Ochraceous Lias of Murchison, Strickland, and Buckman,* each group being more or less characterised by its peculiar fossils; type-specimens which it behoves the geologist to obtain. The Ochraceous Lias may be best seen at Charlton, and Battledown near Cheltenham.

THE MARLSTONE.

The Marlstone is glorious ground for the beginner, both for the beautiful scenery around its verdant slopes, the spring-time flowers that cover them, and the extraordinary abundance of the buried organic remains. On the flanks of the Cotteswoldes, this rock is generally covered

* Geology of Cheltenham, p. 42.

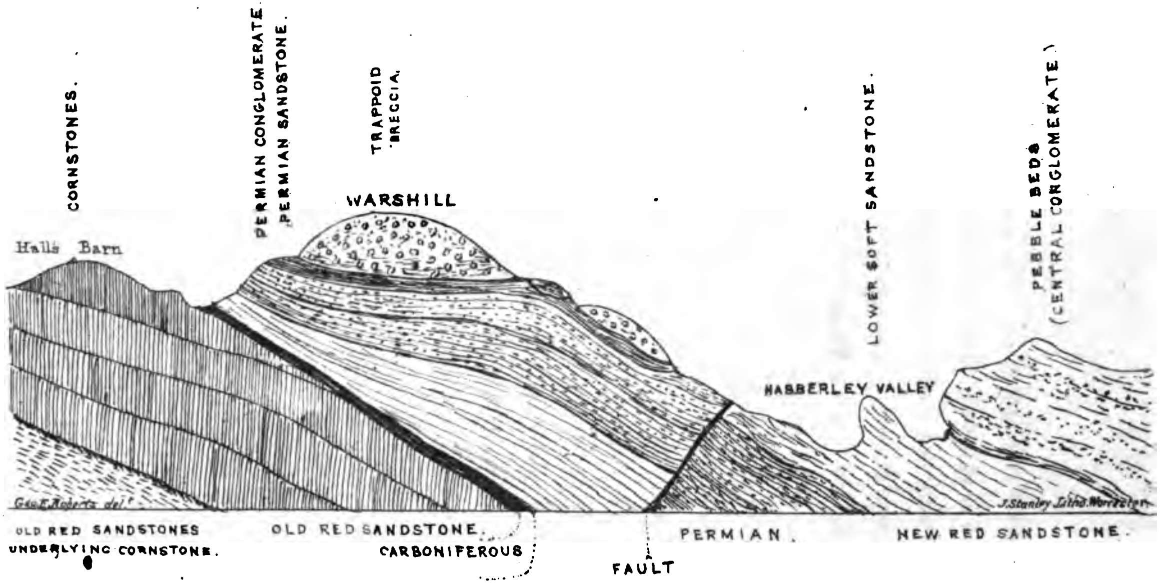
up by the Oolitic and Upper Lias debris, but on the summit of Battledown east of Cheltenham, at Churchdown, Dumbleton, Alderton, Stanley and Bredon Hills, and Edge Hill in Warwickshire, the Marlstone is a conspicuous feature. It is uncertain whether this rock extends southward as far as Bath.

For stirring up the zeal of a young geologist, commend me to the Marlstone. The quarries are literally full of fossil shells, like the inhabitants of the Arabian tale, converted into stone, yet still maintaining the places they occupied when alive. The perfect and splendid Pectens, Gryphites, Nautili, and more minute but equally well preserved Terebratulidæ, cannot fail to make a man think and wonder. One day on the Marlstone, and the inquiring mind is *bound* to question farther the marvels of geology. The impress of life is there, though the once living creatures are now *stone*—life, that barrier of the Creator's secret which we may never overpass;

stands forth in those quarries so clear, yet so stony a truth, that I have known men who affected to laugh at geology most effectually silenced by those rocky sepulchres.

It is not so much our object to call attention to the fossils of the district under review, as to afford information respecting localities where relations of the strata may be seen, and good typical fossils obtained. One of the most productive quarries I ever visited is at Stanley Hill, on the road from Tewkesbury to Winchcomb, and about a mile and a half from Winchcomb. "Cardinia crassissima," a very local fossil, is abundant here, and some magnificent Pernas. The Perna is a sub-genus of the Aviculidæ or wing-shells, a genus to which the existing pearl oysters belong; there are no living species in northern latitudes. Mr. Woodward mentions that "in some Tertiary Pernas the pearly layer is an inch thick."

The chemistry of shells must have been much the same in the days of the Lias, as when the



Section near Kidderminster.

oyster converted sea-chalk into a precious stone for an Egyptian Queen, who had sufficient knowledge of chemistry to dissolve the pearl in the pledge-draught of Love. The pearly nacre of the Marlstone Pernas often glistens in the sun, and quarrymen call them "glass stones." "Gryphæa gigantea" is also a good characteristic fossil, and belongs to the oyster tribe; there are thirty fossil species of Gryphites, commencing with the Lias, and dying out with the chalk. The Marlstone is quarried *on the hills* not *at the villages* of Alderton and Dumbleton. Alderton quarries are famous for their noble Pectens, which are so perfect that, were it not for their weight, we should be puzzled to tell in what they differ from the scallops of the present seas. A recent species, Pecten Jacobæus, is called St. James's shell, because it was worn by pilgrims to the Holy Land, and formerly all fossil-shells were supposed to have been dropped by pilgrims; there must have been an awful upset in the Alderton quarries!

Dumbleton quarries are not so much worked as formerly, but we have great hopes that the precious Upper Lias *fish* and other geological treasures occasionally found there by a young lady who lives hard by, and possesses more than a common share of intelligence and information, may constitute the nucleus of a good local collection. Beckford Inn on the Tewkesbury and Evesham road, is the nearest roadside Inn for either Dumbleton or Alderton.

THE UPPER LIAS CLAYS AND SANDS.

A fixed point to dwell on is of essential service to the memory when dealing with a multitude of details. I never could remember the Upper Lias in early geological lessons, until the great fact that the Upper Lias clays support the water which percolates through the strata of the inferior Oolite and the sands below, and give rise to the *Thames*, was made apparent. Having visited the springs and streamlets of the Thames in the Cotteswoldes, and realized the fact that *the* River of England, with its forests of masts floating on its bosom, and millions of hands in motion around and on its banks, and iron engines traversing its waters by night and day, took its rise from the retentive support of the Upper Lias, I did not afterwards forget those impervious clays or their importance! The sands above the clays were until recently referred to the Oolitic rocks, and described as the sands of the inferior Oolite; they are now believed to be the transition or passage beds between the Lias and the Oolites.

These relations are persistent often over considerable areas, but it is again necessary to warn the young geologist against laying too much stress on "sharply-defined formations." Such phenomena may extend throughout the British strata, and even a portion of the continental Oolites; but they have actually no existence over large tracts of the globe, where the Oolite is inseparable from the Lias, both as regards any physical change, or the sudden termination of particular forms of life. In most of the strata, from the Lowest Lias to the uppermost Oolites, some peculiar and characteristic fossils may be found; but the world-wide history of these, as of all other stratified deposits, is, that when certain species of animals were destroyed or died out, and the period of their existence closed for ever, others, often closely allied, although new and different, were introduced to supply their place; while the sudden and sometimes wholesale destructions among the inhabitants of former seas, should always be regarded as wrought by local and physical changes.

The most remarkable bed of the Upper Lias is a thin layer of white or rather yellow clay containing many remains of ganoid fishes and also of insects and crustaceans. Those persons who were present in the geological section at the British Association at Cheltenham will remember Mr. Moore's admirable paper and the breaking of the nodule containing a nearly perfect fish. Mr. Moore's exquisite fossils in the local museum at Cheltenham were from the Upper Lias of Ilminster. The geologist should split every portion of the yellow fish-bed that he meets with. My friend Mr. Brodie obtained some unique specimens both of fish and insects from thin slabs tossed aside by other visitants as unworthy of another crack. This bed in the Ilminster district occurs generally in nodules formed around some organism; and Mr. Moore has frequently been enabled to determine the species of fish enveloped from the shape of the nodule.

Just before the Cheltenham meeting (1856), I visited the Stanley Hill quarries in company with Mr. Moore and the Rev. A. Winnington Ingram; where the workmen had laid open an excellent section of Marlstone capped by this

Upper Lias fish-bed, and had stored away great numbers of the commoner Marlstone fossils, leaving the large yellow Lias nodules unheeded and unbroken, when Mr. Moore called their attention to the fact that a single specimen from these nodules would be of more value than a cartload of the Marlstone shells. The result of this advice was the capture of a splendid carp-looking ganoid (*Pachycormus*), which attracted much attention even among the many gems collected together, in the wonderful temporary museum at Cheltenham. In these beds we have again evidence of litoral deposits, although probably of limited period as compared with the Insect Limestone of the Lowest Lias shores.

UPPER LIAS SANDS.

These transition beds have been described at great length by Dr. Wright of Cheltenham.

* Quart. Tour of Geol. Soc., May, 1856.

That gentleman proves satisfactorily that the "Cephalopod-bed" at the top of the sands which succeed the yellow clays "contains a number of well-known Ammonites, Nautili, and Belemnites, and that the weight of palæontological evidence is in favour of the supposition that it belongs to the Lias rather than to the Oolite formation." The Rev. P. B. Brodie has also a valuable paper on these beds.* The sands may be traced by Crickley, Coopers, and Painswick hills, Frocester, and Wooton-under-Edge. Frocester is a celebrated section, much frequented by geologists of the district; Stonehouse is the nearest station. There is also a good section near the Horsepools, which may be reached from Haresfield station, near Gloucester. It appears that these sands attain a great thickness in Somersetshire and Dorsetshire, and Dr. Wright found the Ammonites from the Upper Lias of Whitby identical with

* Quart. Tour of Geol. Soc., vol. vi. p. 208.

those collected from the bed at Frocester. My own opinion on the Cephalopod-bed is that it is just a *bone-bed*, but that, instead of fish, marine reptiles, or crustaceans, Belemnites, Ammonites, and Nautili inhabited that part of the ocean when the destroying agent overwhelmed them. I also imagine that this destruction ranged over a considerable space of the ocean, even as far distant as France, Belgium, and Germany, and thus over *a certain area* marks the close of the Liassic epoch, as the Keüper bone-bed marks the close of the Triassic period in this part of Europe. At the same time I do not suppose that either bone-beds or Cephalopod-beds were *universal* phenomena, or that Liassic life was *universally* destroyed at the particular epoch of the particular Cephalopod-bed. What should we think of the naturalist who would argue, supposing that from some volcanic and other causes the Mediterranean and Caspian fauna were destroyed suddenly, that *therefore* the contemporaneous Atlantic and Pacific marine fauna perished also, or that if a volcanic outburst off New Zealand should render the waters of a large area of the Pacific noxious to life for a time, therefore the Atlantic, Mediterranean, and Northern fauna must perish also? The Cephalopod-bed was a deeper sea phenomenon than the Keüper bone-bed, and a *shore* deposit of the same period would probably furnish remains of fish and reptiles.

The succeeding beds of the Inferior Oolite are extremely fossiliferous, and I have been assured by my friends Professor Buckman and John Jones, Esq. of Gloucester, that several species of Brachiopoda range from the Marlstone and Upper Lias into the true Inferior Oolite. This is an important circumstance, as it appears from the observations of these gentlemen, that the destroying agent which was so fatal to thousands of Lias ammonites, nautili, and belemnites, spared several species of Conchifera and Brachiopoda, which lived on far into the period of the Inferior Oolite.

INFERIOR OOLITE.

It is not my intention to proceed farther with the Inferior Oolite than to call the attention of the geologist very briefly to those beds which overlie the Lias sands and Cephalopod-bed in the Cotteswoldian districts of Cheltenham and Gloucester.

PEA GRIT.

This lowest member of the Inferior Oolite is, according to the best authorities, a coarse, Oolitic rock passing upwards into Pisolite, and still higher into a rubbly Oolite made of flat concretions. Cleeve, Crickly, and Birdlip hills are good localities for examining the Pea Grit. Dr. Wright gives a long list of fossils discovered in these beds, of which the most remarkable are several species of beautiful and peculiar Echinodermata (sea-urchins).

As the Cephalopoda rank at the head of the Molluscous animals, so the Echinoderms stand at the head of the Radiata, animals which exhibit a disposition to form *rays*, both in their internal and external parts, such as Echini, Starfish, Jelly-fish, and Corals.

The spines and suckers of the sea-urchins of the Oolite are in some rare instances still found attached to the mamillated protuberances of the shell, and, as these spines fall off with the slightest touch when the animal is dead, we must conclude that such examples are evidences of sudden death and rapid entombment in the preserving medium. According to Bosc and Lamarck the food of the Echinus consists of young shell-fish and small crustaceous animals, which they masticate by means of the wonderful and complex machinery of five jaws, each containing a long tooth, and consisting of twenty-five pieces, moved by thirty-five muscles. The Lower Silurian Cystideans appear to be the representatives of the Echinoderms of the secondary, tertiary, and recent periods; Cystideans were sea-urchins with encrinital stalks or stems.

FREESTONE.

The next bed in ascending order is the building-stone of Cheltenham, well exposed in the great quarries of Leckhampton.* The Freestone is nearly 110 feet in thickness, and some of the beds are remarkable for their treacherous disposition after a frost. Last winter the shivering and splitting of window-sills constructed of this stone was universal in new buildings, and at Red Marley church Her Majesty lost her nose, and the Archbishop of Canterbury his wig and chin, entirely through the corbels being cut from the "wetstones" of these strata. The fossil remains are in a very fragmentary condition.

* See Mr. Hull's Memoir, Geol. Survey.

FIMBRIA BED.

This deposit, called also Oolitic Marl, owes its appellation to the "Terebratula fimbria," which is very abundant; it contains many other shells, allied to Lucina, Natica, Astarte, &c. The Fimbria-bed ranges throughout the Inferior Oolites of the Gloucester and Cheltenham districts.

When comparing the organic remains of different strata, the geologist should not fail to remark the probability of those strata having been formed at different depths, and therefore constituting distinct zoological provinces.

The Rhynchonella and Terebratula were deep-sea shells, not litoral, and such probably is the history of the Fimbria deposit.

OOLITE FLAGS.

These flag-stones consist of "brown shelly rubbly oolite, with many fossils;" they are twenty-six feet thick.

GRYPHITE GRIT.

The Gryphæa-bed is a wonderful mass of organic remains, and contains, in addition to Gryphæa Buckmani, Gervillia, Pectens, and many other shells. Some distance beyond the Horsepools above Haresfield, my friend Mr. John Jones, of Gloucester, conducted me to a small quarry where the Gryphæa Buckmani lay in the greatest profusion, not imbedded in hard rock as at Sudely and other places, but loose in sandy debris, and as perfect as when existing in the seas of the Oolite. The species is named in honour of Professor Buckman, who has done much for the geology of the Cotteswoldes. The Gervillia is an Avitula-like shell, which ranges from the carboniferous formation to the chalk.

THE TRIGONIA GRIT.

The characteristic fossils of this deposit, Trigonia costata, and T. decorata, are extremely abundant, and the stratum in which they lie is the uppermost of those beds of the Inferior Oolite, which constitute the escarpments of the Cotteswolde Hills. The "Fullers-earth" is a bed of clay which in the district under review separates the Inferior Oolite from the Great Oolite; it is however only a local deposit. The Great Oolite of Minchinhampton has furnished an extraordinary cabinet of fossils to the researches of Mr. Lycett.

I have heard geologists affirm that there is no evidence that the Inferior Oolite formerly reached to the Malvern shore. It may be very well for those who know nothing of a district, to make broad assertions, but I do not think it is possible to work out the Marlstone and Upper Lias outliers in the Severn Valley, and the Lower Lias from the Berrow, by Sarnhill and Strensham to Bredon Hill, without coming to the conclusion that the beds of the Inferior Oolite which cap that hill, and the Upper Lias and Marlstone below them, were once as certainly laid stratum upon stratum above the Lower Lias and New Red Sandstone, as the Lower Lias overlies the Red Marls of the vale. If it had not been for the *fault* which has uplifted the Bredon Hill on the northern, and depressed the southern side, and thus prevented the Oolite from being altogether denuded by the currents which swept from the northern, we should not have had the relic that is left to tell of its former extension even as far as Bredon. The same argument applies to the other outliers. It has also been said that the Marlstone and Upper Lias may be merely local, *islandic* phenomena, and that those deposits were probably never continuous over the whole vale. With the numerous strata, characterised as they are by their peculiar remains, fish-bed, ammonite-beds, belemnite-beds, oyster-beds, all occurring on identical planes around those separated and distant hills, wonderful must be the theory that can account for their deposition as local islandic phenomena. What accommodating waves, what simultaneous deaths, what persistent animals!

It was formerly believed that the temperature of the planet's surface was *universally* warmer during the Liassic epoch than at present.

A more advanced knowledge of the physical geography of our globe as at present constituted, tends to the subversion of such universal ideas. The remains of an Icthyosaurus were discovered by Sir E. Belcher, in Exmouth Island, among the Arctic ice; the remains may have been drifted. It is however probable, from the abundance of saurian and crocodilean animals, and the character of the plants and shells, that the climate of the secondary period was warmer in these latitudes than at present.

The Lias is a world-wide deposit, and is spread over extensive areas in France, Germany, and Switzerland, where I have been informed by my friend, M. de la Harpe, that it has been elevated to the height of 12,000 feet. It has been discovered, by means of its fossils, on the borders of the Apennines, in Cutch in India, and high up (16,000 feet) on the flanks of the mighty Himalaya. In America there is a splendid coal-field of the Lias period; the plants consist of species in many instances identical with the Oolitic plants of Whitby in Yorkshire; but the fish are mostly *Liassic*, and with them, in the shales below the coal, are associated the little crustacean (Estheria) of our English Keüper. It is interesting thus to realize the fact, that our Lias plants and animals were contemporaneous with the luxuriant vegetation that grew in Liassic times on the far distant shores of ancient Virginia.

The Lias of Yorkshire furnishes iron ore in great abundance, and Professor Phillips calculated that the band of ironstone, "often sixteen feet thick, may be worked under an area of some hundreds of square miles, with an average produce of 20,000 to 50,000 tons per acre."

CHAPTER VI.

THE NORTHERN DRIFT.

In the vales of Worcestershire and Gloucestershire, this deposit of boulders, fragments, and comminuted remains of older rocks, often occurs on the flanks of considerable hills, as regular shingle-beaches. To discuss the very different conclusions at which Geologists have arrived concerning the Northern drift, would require a voluminous work of itself. It is sufficient therefore for our present purpose to state that geological evidence, carefully weighed and sifted, proves satisfactorily, that those beds of sand and pebbles which every observant person must have remarked in this district, often at a very considerable elevation, are the representatives of that marvellous epoch of the planet's history known to Geologists as the *Glacial.* The long tertiary periods, with their many subdivisions of Eocene, Miocene, and Pliocene epochs, had passed away, and throughout the greater portion of the temperate and arctic regions of the northern hemisphere glacial phenomena, with all the concomitants of icebergs and icefloes, glaciers, moraines, arctic seas, shores, and straits, succeeded periods especially characterised by a profusion of gigantic and extinct quadrupeds, a warmer climate than at present, and a vegetation adapted thereto.

The Tertiary periods were for the most part distinct, that is to say, Eocene, Miocene, and Pliocene periods have all *peculiar* forms of life adapted to each epoch, though very many organisms pass both upwards and downwards, and link system to system in one grand cycle of geologic history. It was during the middle Eocene period that the mountain chains of the Alps, Pyrenees, and Carpathians in Europe were elevated, bearing upwards on their flanks the Ammonite of the Oolite and the Nummulite of the Eocene sea; the mighty Himalayas of Asia read us the same history, and indeed throughout Europe, Asia, Africa, and America, the *present* physical geography of the mountains and plains and vales *could not have commenced* until after the middle Eocene strata had been deposited at the bottom of the sea, these tertiary deposits being frequently elevated several thousand feet on the flanks of mountain ranges. During the Eocene epoch all, or very nearly all, the marine animals are of different *species*, but existing *genera;* and the climate in these latitudes must have been warmer than at present, as the Cone, Olive, and Volute were contemporaneous with crocodiles, sharks, and turtles that lived *in British seas*, while tapir-like animals, monkeys and opossums, inhabited the shore. This portion of the planet's surface underwent a gradual series of vicissitudes during the Miocene and Pliocene epochs, and as the existing physical conditions drew on. In every quarter of the globe thousands of enormous Mammalia were introduced: Europe had its Deinotheres and Mammoths, Asia, giant carnivora, Africa, wondrous forms, and amongst them Sivatheria, with the trunks of elephants and the horns of deer; while America possessed her enormous sloth-like Megatheria, giant Toxodons and Armadilloes, and Australia and New Zealand were tenanted—the one by gigantic kangaroos, the latter by birds, compared to which the ostrich is a pigmy.

Grand animals trod this globe, in hundreds of thousands, for thousands of years, and left their skeletons behind; and the geologist uncovers their strange forms from the ice gravel of Russia, the mud of the Pampas, and the gypsum of Montmartre, and learns to decipher their history, as Rawlinson interpreted the Cuneiform inscriptions of Babylon and Nineveh, not passage by passage and line by line, but letter by letter, bone by bone, tooth by tooth, and stratum by stratum, until the disinterred skeletons become living witnesses, and the bygone history of myriads of past ages stands forth revealed.

It is a strange history yet a true, that such conditions were gradually succeeded by an *Arctic* climate, and that, over a large part of the northern and temperate lands of the northern hemisphere, rolled the waves of a glacial sea.

During the epoch of the Northern drift, the whole of the vales of Worcestershire and Gloucestershire were under the sea, for its beds of gravel, containing worn fragments of boreal shells, cover the summits of considerable hills. Those who only know the glacial drift as developed in this district, can have little idea of the wonderful history presented by the rocks of the boulder epoch in travelling towards the North.

Masses of many tons weight have been transported for long distances, and must have been dropped by icebergs drifting towards the South, while among the hills of Scotland and Wales the action of glaciers has left polished surfaces and scratches, with the moraines of sand and gravel that glaciers leave on their sides and at their base. Iceberg action is seen frequently on the surfaces of soft sandstones, over which they have passed, and I have seen the Permian sandstones of Dumfries scored to the depth of an inch by one of these giants of winter, which has grounded, and then been propelled by strong and rapid currents over the grating surface.

The plane of the Corn-cockle Muir Quarry is not only *scored* but *polished*, when the till is removed and the sandstone surfaces are exposed. The till, or ice-borne detritus, is from twenty to thirty feet in thickness in that district.

What could have been the influence, what the agency, that converted the once balmy air of the Eocene epoch, into the biting, chilling blasts of the vigorous North? The glacial deposits extend more than 15° south of the northern limit of trees, and some writers endeavour to account for the change of climate by ascribing it to the obliquity of the Poles. Astronomers deny that such a change in the position of our planet has ever happened, for various reasons, of which astronomers and mathematicians are the best judges! It therefore appears probable that the agencies which produced the glacial phenomena are attributable to physical alterations of the *surfaces* of land and water. The vast ocean which surrounds our planet is affected in many ways, and by various causes, and whatever tends to affect or alter the flow of its powerful and extensive currents must also have an immense influence on the land in producing heat where there was formerly cold, and cold where an elevated temperature once existed. Water *moderates* temperature; and hence places situated near large seas are neither so cold in winter, nor so hot in summer, as are those situated in the interior of continents. Land radiates the heat it has absorbed very quickly, and in winter is rapidly reduced to a low temperature; large bodies of water on the contrary once heated, become great magazines of heat to the surrounding land and atmosphere. It is a curious question as to what would be the consequence, if, from the depression of so small a tract of land as the Isthmus of Panama, the great Gulf-stream should be turned into the Pacific Ocean. The waters of the great Gulf-stream soften and moderate the asperities of the climate of Great Britain and Ireland, for its waters retain a portion of the warmth contracted in the Mexican Gulf and temper the climatal condition of all the lands within their influence. The depression of the Isthmus of Panama would probably direct the great current into the Pacific, and an Eocene climate would shed its influences over its many islands, while the temperature of the Atlantic and its shores would be proportionally lowered. Such appears to have been the history of the glacial period; as the geological structure of Panama renders it extremely probable, that the great Gulf-stream rushed into the Pacific between North and South America at no very distant geological epoch.

It is also well to call to mind the history of the Antarctic circle at the present time, and under existing circumstances. There we have the high land of Victoria and Mount Erebus near the Pole, and elevated land in such positions must ever collect an enormous amount of snow and ice, of which large portions break off and drift as bergs far into other latitudes. The Antarctic regions are chiefly covered by the ocean, and the great waters prevail more exceedingly towards the tropics than in Arctic latitudes; but during the glacial epoch there must have been a larger area of sea in the northern regions by some thousands of square miles than at present, over which the icebergs and their burdens drifted, as the ice-floes of the Antarctic Sea drift now, where immense glaciers are found in the latitude of Paris, and perpetual snow would cover hills below the height of Snowdon or Ben Lomond. "I was astonished," says Mr. Darwin, "when I first saw a range only from 3,000 to 4,000 feet in height, in the latitude of Cumberland, with every valley filled with streams of ice descending to the coast." Again, it was formerly supposed that, during the glacial epoch, the land of northern latitudes must have been necessarily bereft, or nearly so, of life, either animal or vegetable. Such is the modifying effect of large bodies of water, that we learn from the experiences of recent travellers, that "humming-birds may be seen sucking the flowers, and parrots feeding on the winter's bark, in latitude 55° south," notwithstanding the icebergs; yet that latitude is nearly equivalent with that of Moscow and Kazan. Tree-ferns thrive luxuriantly in Van Diemen's Land in the latitude of Bordeaux, while Palm-trees grow in latitude 37°, and arborescent grasses, very like bamboos, in 40°. Were the sea-bed raised southward of the Antarctic regions, and the ocean to give place to land, should we not have our glacial phenomena represented, and the tree-ferns, parrots, and humming-birds cease to exist? would not the elevation of the sea-bed lower the temperature, and that uplifted land present to the eye of the geologist the evidence of having once lain beneath the waves of a glacial sea?

The land of the continent of Europe must have been limited, in comparison to what it now is, during the glacial epoch, and the deposition of the northern drift. Great Britain was probably represented by a few islands, which now constitute our highest hills; for on Moel Tryfan in Wales, this drift, with northern shells of existing species, occurs at the height of 1750 feet above the sea. After the glacial epoch and during its continuance, gradual *upward* movements were in constant and continual action, and not only in Great Britain, but over vast areas on the continents of Europe, Asia, and America, the upheaving force was slowly and silently but surely at work; and, although the great mountain ranges already alluded to, had been partly upraised during the Eocene epoch, it was the continual elevation through and after the glacial period that wrought the present contour and physical geography of the northern hemispheres. The drift covers large tracts in Scotland, Lancashire, Cheshire, Shropshire, Staffordshire, and Worcestershire, but becomes less marked as we travel south. Sea-shells, as Purpura lapillus, Turritella, Cardium edule, and

Ostrea edulis, are not uncommon in some localities; they have been found by Mr. Allies near Worcester, by Mr. Darwin and Mr. Eyton near Shrewsbury, and by Professor Buckman in the vale of Gloucester. I have seen them by hundreds in boulder clay in Scotland, at the base of ice-carried rocks of enormous size, as at Rothsay in the Isle of Bute. Strange that the ancient boreal mollusca should have continued to exist from times so immensely remote, while probably all the land animals have become extinct.

The Northern drift may be studied in the Malvern district at the southern end of the range, between the Dick House and Haffield Camp, in a little bay, and covering the waterstones and Bromesberrow sandstone; it also caps Wenlock shale, near Clincher's Mill, towards the south. Rolled lias gryphites are tolerably abundant here, and at the summit of Tunnel Hill, Upton-on-Severn, Bredon, Defford, and

Bromsgrove Licky. The Lias gryphites have been taken for fossil Ostrea edulis, and two scientific friends of mine can tell a tale of a journey to Hartlebury in the snow and frost in search of tertiary oysters, which proved to be the said gryphites denuded from the Lias, and washed into the gravel by glacial waves.

Professor Forbes has published a list of 124 species of shells from the Glacial beds, nearly all of which are now existing in British seas.

"At Chillesford, Suffolk, Yoldia arctica and Myalis occur of large size and in excellent preservation, with numerous specimens of Mya truncata, erect as they lived, in the muddy sea-bed."* These species are northern types, and occur with several arctic forms of Tellina and other boreal shells.

I once started, in a great state of excitement, in search of some fossil "Myas" on the other side of the Severn; they turned out to be

* Woodward.

Anodons, not Mya truncata! Geologists are not the only enthusiasts; a friend of mine was driving some years since on the banks of the Wye between Ross and Monmouth, with an old and valued servant who had imbibed somewhat of his master's taste for Natural History. My friend was musing and admiring the scenery, when, with a shout of "Master, hold the reins!" honest John bolted from the carriage, scrambled through the hedge, and disappeared like a shot down the hill-side. In about a quarter of an hour he returned puffing and smiling, and pinned inside the crown of his hat was a "Purple Emperor." The worn and faded specimen still remains in my friend's cabinet, a record of his servant's zeal, and the occasional, I may say the only, instance of the capture of "Apatura Iris" in Monmouthshire.

Mr. Strickland divided the final marine conditions of the Severn straits into separate periods,—the Northern drift of Sir R. Murchison, characterised by "marine erratic gravel without flints," and a later epoch of marine conditions "indicating a current from the chalk district lying to the eastward." There is good evidence that such a current set in, in all probability towards the *close* of the Glacial epoch, and was owing to the elevation of the sea-board of Chalk, Oolite, and Lias on the east. This gravel may be seen at a lower level than the true Northern drift, and is chiefly remarkable for the abundance of Oolitic fragments, Chalk, Flints, and rolled fossils. They are quarried for the roads at the village of Bredon and near Defford, and are from ten to fifteen feet thick. I have always considered this drift as a reminiscence of the *close* of the glacial and marine conditions of the ancient Severn straits.

ESTUARINE DRIFT.

After many long ages had passed away, the bed of the Glacial sea gradually rose and became dry land, but the Severn straits did not assume their present condition, or the lower lands emerge from the waters, until many a long period had elapsed.

For ages after the land assumed its present shape and contour, *estuarine* conditions affected the Severn vale, as is evident by the masses of shingle and drifted materials on the raised beaches at Kempsey, near Worcester, and at Bewdley still higher up the Severn. Such terraces afford proof of former water levels, before the river had worn down its channel to the present depth. These shingle banks are also beautifully marked on the banks of the Wye near Hereford, and present an elevated beach on either side often more than a mile apart.

In the neighbourhood of Powick, and the

valley of Langern Brook, near Worcester, the beautiful and picturesque Habberley Valley, near Kidderminster, also at Lincomb below Stourport, the tidal waters of the Severn estuary washed and scooped out the eminences by which they were bounded.* Thus, although ages elapsed before old Severn flowed in its present channel, or since its Estuarine waves rolled up the lateral gorges of Longdon Marsh and Habberley Valley, yet we recognise most of the phenomena now presented to our view. The Malverns rose high on the one side, the Cotteswoldes on the other, and the greater part of the New Red Sandstone and Liassic rocks of the vale were covered with forest-trees, and were tenanted by the elephant, urus priscus, and hippopotamus, all of which lived in Great Britain long after the Estuarine conditions had ceased, and the Fluviatile or River conditions had commenced. Professor Buckman discovered the

* Buckman's Straits of Malvern.

remains of a rhinoceros of large size in this Estuarine drift at the base of the Cotteswoldes, which may be seen in the Cirencester Museum. Mr. Dowdeswell, of Pull Court, also possesses the worn bones of "Elephas primigenius," from this drift near Bushley. The mammalian remains are not so well preserved as in the river gravel, and fresh-water shells are *altogether absent*. A good deal of care is necessary in this district to avoid confounding these gravels with those of a later period. *Marine* shells have been found at Upton by Mr. Sewell.

FLUVIATILE GRAVEL AND DRIFT.

The *Severn river*, with a chain of lakes, once extended down the vales of Worcester and Gloucester at a height of from twenty to fifteen feet above its present course, and the rivers Severn, Avon, and Wye were *considerably broader* than at present. This may be seen in many places in the ancient river terraces, beyond the present alluvial deposits. At Upton-on-Severn, Tewkesbury, Worcester, and Gloucester, on the Severn; at Broomy Hill, near Hereford, Sugwas, and many places on the Wye, and at Eckington and Cropthorne on the Avon, the ancient river drift is well exposed. During this *large river* epoch it is also very evident that many of our valleys were fresh-water lakes, which have gradually been silted and filled by the accumulations of unnumbered ages. Such must be the history of the flat marshy lands at Longdon, Eldersfield, and Apperley, which were first backwaters of the Severn Estuary, and afterwards for a long period *fresh-water lakes*. The alluvial deposits of Longdon Marsh were bored to the depth of from twenty to thirty feet, and numbers of recent fresh-water shells, such as Lymnea, Planorbis, and Bythinia, were brought up by the boring-rod. In excavations near Pull Court a peat deposit at the depth of ten or twelve feet was also observed. From the depth of these fresh-water deposits, it is very evident that the large river and lacustrine epoch must have been of long duration, and that many ages elapsed before the last modifications of the present rivers and valleys, and the Severn, Wye, and Avon, presented the aspect they now afford. At the mouth of the Severn, and indeed as high up as Newnham, considerable expanses of low alluvial land may be studied as affording good examples of the "Delta" history, a picture on a microscopic scale of the grand alluvial and Delta deposits of the Mississippi, the Ganges, and the Nile. Sir Charles Lyell remarks that the whole period during which the Mississippi has been transporting its earthy burden to the ocean, though perhaps far exceeding 100,000 years, must be insignificant in a geological point of view, since the bluffs or cliffs bounding the great valley, and therefore older in date, and which are from fifty to twenty feet in perpendicular height, consist in great part of loam, containing terrestial, fluviatile, and lacustrine shells *still inhabiting the same country.* The alluvial plain of the Mississippi extends over an area of 30,000 square miles, and the alluvial plain of the Severn shrinks into insignificance when compared with such river action; but the history is the *same,* and our old river terraces may afford as good instruction to the geologist as the bolder bluffs of the great American water-shed. In both we have recent land and fresh-water shells, and in both we have the remains of large Mammalia. I have seen the common Cyclas of our brook extracted from the inside of a hollow elephant's tusk, and Bythinia tentaculata enclosed in the same iron-bound mass with the head of a beaver. I have also seen in Mr. Strickland's collection the head of the great Musk-ox lying side by side with the bones of elephants, hippopotami, and hyenas, accompanied with fresh-water shells now living in the Avon, and these animals must have inhabited the Avon and Severn valleys, and been entombed with those existing species of shells. I need hardly say that these animals have long been extinct in the localities where their remains are now found, and that the old river terraces, with their bones and existing species of shells, are *modern* as compared even with the Glacial drift, and yet of vast antiquity! With regard to the history of the past, all that we can arrive at is at best a mere approximation. The telescope reveals a Jupiter with four moons, and a Saturn with three rings and eight satellites. The actual speed of light is ascertained and calculated by means of the eclipses of Jupiter's moons, and thus the distance of the planet is known and its diameter measured; but *time* is actually *immeasurable* in geologic epochs, and it is more easy to calculate the distance of Arcturus, than to reckon the number of years that have passed since even the large river period of the Severn straits. Geology may be likened to a large book with many leaves and closely-printed lines. The student turns page after page until the eye wearies and the brain wanders amidst the revelations of the past: he looks at last for man's track, man's first appearance, and *less than a single line* of those closely-printed records of the planet's history will suffice for all the human generations that have existed under the sun.

CHAPTER VII.

A year seldom passes without adding considerably to the records of our science. Having lately been engaged in reviewing the proceedings of our Malvern Natural History Field Club; some of the facts connected with them appear to me sufficiently interesting to lay, with other supplemental data, before the reader.

Most geologists are aware that the Plutonic range of the Malvern hills was slowly cooled in the interior of the planet, before its upheaval in a solid state. No doubt is entertained of the enormous antiquity of these crystallized mineral masses, as ancient sedimentary deposits of Cambrian age, the Holly Bush Sandstone and Black Shales, rest on the Syenite unchanged, and, where there are no interposed trap-dykes, without a sign of metamorphism—very good evidence of the cooling and condensation of the old Syenite before the deposition of the Cambrian deposits. The great tunnel on the Hereford and Worcester Railway is now being driven through the centre of the Syenitic axis of the Malverns, and, enveloped in the ancient mass of Hornblendic rock, there lies a segregated lump of impure Graphite, with large crystals of carbonate of lime. I have ascertained that there is no rent or fissure in the Syenite which would allow of the infiltration of water charged with carbonate of lime from the surface, and the Graphite does not run in veins, but is segregated *en masse*.

The diamond is carbon in a state of purity, and pure Graphite, commonly known as black lead, consists of a substance nearly identical with the diamond, but wanting its crystallization. Carbonate of lime consists of carbonic acid and calcium, or of what may be termed a primitive union of oxygen with the primitive bases carbon and calcium; and it is extremely interesting to find evidence, in these most ancient rocks, that in days anterior to the consolidation of old Cambrian deposits, the elements carbon, oxygen, and calcium exercised the same chemical endowments as at present, and that those powers that now sustain the life-blood of every animal, and the plant-life of every green leaf and blade of grass, have stamped the monumental impression of their existence among the oldest of all old witnesses to the age of the planet's existence.

On a bitterly cold night in the winter of 1855, a multitude of people assembled to witness the kindling of the monster bonfire on the summit of the Worcestershire Beacon, the highest hill of the Malvern range. It will be remembered that this beacon-fire caused much cry, but showed little flame. Hundreds mounted every hill-top, far and near, to no purpose, for they saw nothing of the signal, light until it appeared on the following Saturday in the Illustrated London News. "It is an ill wind that blows nobody good," and the bitter blast that prevented the beacon-flame from ascending to "light the sky and burnish out the clouds" produced some interesting mineralogical phenomena through the concentration of the heat upon Syenitic rock, on which the materials of the fire rested. I was requested by Sir William Jardine to examine the Syenitic pedestal, and observe whether it was in any measure vitrified or fused, as is the case in Scotland on the sites of the beacon-fires kindled in former days.

I proceeded to fulfil Sir William's request, in company with Mr. W. Burrow and M. Philip de la Harpe. We found the blocks of Syenite forming the pedestal much altered by roasting, though not vitrified, and bearing an exact resemblance to the Syenite traversed by trap-dykes at a quarry near Newswood, between the Camp Hill and Eastnor Obelisk. This quarry we also visited, and when the specimens were laid side by side, the effect of the old lava and the modern bonfire appeared precisely similar.

The molecular changes and structural alteration which occur on the melting and sudden cooling of the ancient basalt near Dudley, termed "Rowley Rag," is also curious. The principal difference between the Malvern Syenite and the Rowley Rag, consists in the crystallization and condensation of their mineral constituents. The Plutonic rock of the Malverns must have been cooled gradually, probably at great depths and under enormous pressure: the Rowley Rag was in a state of fluidity near the surface, and traversed and altered the coal measures. It takes the columnar structure of basalt, and that it was cooled slowly we learn from the experiments of Mr. Chance. When melted in a furnace and allowed to cool gradually, it returns to the dark, stony, trappoid Rowley Rag; but when run into moulds of wet sand and cooled rapidly, the relative arrangement of the mineral particles is changed, and the stony mass becomes a beautiful marble, with the high polish of tempered steel or glass.

When some fifteen years ago I first understood that geologists taught that this planet has existed for past ages, that there has been a series of creations or of successive periods of life, and that the Deluge was not universal, but was confined to that portion of the planet's surface inhabited by man; I thought of setting myself the task of confuting the anti-scriptural theory, by a theory of my own, charged, like the Irishman's gun, to the very muzzle, with the "horrid blasphemies of geologists," internal explosions, and external cataclysms. Fortunately I had time to reflect; and indeed to comprehend that the science of geology requires a certain amount of knowledge of all the branches of Natural Science, and of which I knew as much as of Chinese or Hindoostanee. It also flashed across me, that among the many great men I found to be geologists, some of them might be wiser, more learned, and more religious than myself, and that it would be only fair to acquaint myself with the subject, before I set it down as a positive fact that "all their demonstrations were fallacies, all their discoveries delusions, and all their theories presumption."

Years have passed away, and I have every reason to rejoice that I did *not* attempt crushing the principles of modern geology, for I have no doubt the production would have been at least as remarkable as many of the delightful little books penned against the tenets of the geologist, and which have succeeded in confirming every theory they attempted to overthrow. I lately had the privilege of attending a lecture by Professor Owen, on the Palæontology of some of the wondrous extinct animals of South America. The lecture-room in Jermyn Street was crowded with the "wisest and the best." The Prince Consort, and Scotland's most intellectual Duke, listened with eager interest to Owen as he spoke of the fractured skull and claw-armed toes of the vast Megatherium, and told how Providence had provided a double skull for the protection of the brain, and giant limbs and appurtenances for the tearing down of the trees upon which it fed. Again I turned and saw around me, not only the Masters of Science, Lyell, Murchison, Egerton, Lyon Playfair, and many others, but great philanthropists, as Livingstone; renowned politicians, as the Marquis of Lansdowne; and last, though not least, fair women, who preferred the realities of creation to the fictions of the brain. As I walked afterwards, with an old friend, round the Museum of Practical Geology, I almost fancied I heard again the words of Sir David Brewster—"How strange is it that individuals are found who rejoice in the subversion of scientific doctrines which they *never have examined*, and by the truth or incorrectness of which neither their feelings nor their characters are affected."

MALVERN CAMBRIAN FOSSILS.

The narrow pass at the South end of the Malvern range, well known to geologists as the Valley of the White-leaved Oak, lies between the Ragged Stone and Chase End hills, and contains much intricate and interesting geology, in a very small compass. In my little guide-book on the Malvern district,* I have followed the arrangement of Sir Roderick Muchison, and grouped the Malvern Black Shales, which are seen at the Valley of the White-leaved Oak, and on the western side of Midsummer Hill, to overlie the Cambrian Holly Bush Sandstone, with the Lower Silurian deposits at the base of the

* Old Stones.

Llandeilo flags. These shales have yielded to the researches of the geologist (Mr. H. E. Strickland) one of the oldest known fossils, a small crustacean, " Agnostus pisiformis," only found in the ancient alum slates of Sweden, and these alum schists M. Barrande has shown, in a recent treatise, to be contemporaneous in date with the *Cambrian* rocks of Great Britain.* We are therefore called upon to refer our Malvernian black schists to an epoch anterior even to the Lower Silurians, and to look with still greater reverence upon the ancient organisms they contain, and which must now take their place with the trilobites found by Mr. Salter in the old Cambrians of the Longmynds, and the Oldhamia of the Irish beds, though probably of somewhat later date.†

Many of our readers have read, in popular treatises of the ancient history of the earth, of

* See Lyell's Supplement to 5th edition of Manual of Geol.

† Miss Lowe has a Graptolite from these beds.

Cambrian "boiling oceans," and "impenetrable darkness in Azoic or Cambrian epochs," and it may then be well to remind them that, so far as geological investigation goes, there are no stratified rocks, but the Gneiss and Metamorphic slates, which can be termed Azoic or lifeless, and it is impossible to argue upon these, as, if they *had* contained organic remains, all evidences would have been obliterated.

In a small museum in the beautiful town of Malvern, the property of the Members of the Malvern Field Club, one case contains a number of these Trilobites from the Cambrian black schists of the Malverns, which under a magnifying glass of low power shew distinctly, in some of the specimens, the remains of the eyes, or rather eye-pedicels. Should the reader ever look upon these old-life forms, will he allow me to supply a passage for his memory from Dr. Whewell's Bridgewater treatise! "Light is an element of the most peculiar kind and properties, and such an element can hardly be conceived to have been placed in the Universe without a regard to its operations and functions. As the eye is made for light, so light must have been made, at least among other ends, for the eye."

A few hints may be useful to the geologist who searches among the Black Shales for the "Olenus" and "Agnostus." They lie in a very thin and narrow band, and I have known collectors split the shales for a whole day, without finding a single specimen. The specimens at Malvern were presented by a lady, whose ready thought hit upon an expedient for securing them, the rougher sex had forgotten or neglected. She filled a bag full of the shale, took it home with her in the carriage, and, having dried it in the sun, split it with a pen-knife at her leisure. This is the only plan to be sure of obtaining specimens. We must not close our remarks upon these most interesting Cambrian fossils without a quotation from Sir Charles Lyell's last supplement to his valuable manual, on the doctrine of the supposed universality of a primeval fauna:—" Enough has been done to show that *distinct natural history provinces* existed at those very remote times, in Scandinavia, Bohemia, England, and the United States. Of Trilobites, twenty-seven species have been found in Bohemia in these "primordial" beds, seventy-one in Scandinavia, twelve in America, and ten in England, all referable to the same genera, but not one in a hundred species being common to the different areas. *The doctrine of the universality of a primeval fauna, once so popular, is thus completely and for ever overthrown.*"

While on the subject of Cambrian black shales, I may call the attention of botanists to the predilection of many plants for particular mineralogical ingredients; my friend Mr. Edwin Lees has published a paper in the Transactions of the Malvern Naturalists' Field Club, "On the plants that more particularly flourish on the Silurian Limestone;" and there is much truth in his remarks, "that certain limestones nourish particular plants more than others, and in some cases a partiality is shown apparently for a distinct geological formation."

I have already observed that limestone plants frequent the Upper Keüper Marls where the Lower Lias beds have been only just denuded, as especially ascertained by Mr. Thomas Baxter of Worcester, between Worcester and Crowle; while Mr. Lees expressly states that the "Grammitis Ceterach," or Scaly Hart's-tongue Fern, abounds on rocks and walls of the *Carboniferous* limestone, but does not grow on the *Silurian* rocks; that the "Polypodium calcareum" flourishes on the rocks of Cheddar, and the clustered Bell-flower (*Campanula glomerata*) on the Oolite, but both are absent from the Silurian limestones. Again, *Corex humilis* abounds on the Carboniferous limestone of Somerset, but is absent from the Oolites of the Cotteswoldes.

I have been informed that the rare "Asplenium alternifolium" fixes its habitat almost entirely on Black schists which range from Conway by Bedd-Gelert.

It is well known that when bleak Scotch heaths have been burned and dressed with the ashes of sea-weeds mixed with shells and marl, abundant crops of white clover have sprung up in the place of the common ling; and that the yellow gorse has in like manner been succeeded by the wild raspberry. This is unaccountable, save on the principle that germs of the seeds of plants maintain quiescent vitality within the soil, until warmed into life by some peculiar and developing cause. An instance of this tenacious vitality of the spawn or thallus of the common edible mushroom (*Agaricus campestris*) was made evident only last autumn in this immediate neighbourhood; and the *developing power* was a well-known mineralogical ingredient, our common table-salt.

An intelligent farmer of the parish of Forthampton, in the county of Gloucester,* determined to give a heavy dressing of salt to a field of grass which had been frequently flooded by a small brook that flows into the Longdon marshes. His reason, he informed me, was, "to take the *sourness* out of the grass." The field was dressed in the spring-time, and the following autumn a most astonishing crop of mushrooms sprung up. One person alone sold 20*l.* worth of "small buttons" for pickling, and immense baskets-full were gathered by many of the poorer neighbours who were fortunate enough to hear of this fungal development. I took some trouble to examine into this history, and cannot account for the circumstance in any other way than by the theory of *a quiescent vitality of the*

* Mr. John Knight of Downing.

thallus, which was developed by the salt. The field is an alluvial deposit, surrounded by many others of precisely the same soil, and also subject to floods, but which undressed with salt yielded no mushrooms.

The south-east escarpment of the Malvern Ragged Stone actually glows, during the summer months of June and July, with the rich purple of the common Fox-glove (*Digitalis purpurea*), but a few years ago the same hill-side was green with the fronds of the brake-fern (*Pteris Aquilina*); nor was it until some mischievous lads set fire to the fern and destroyed some acres, that the fox-glove sprang up in such extraordinary profusion.

British Botany, as usually set forth to the student, is principally a Registrative science, save a crabbed description of the number of petals a flower possesses, with the position of the stamens and calyx, and consequently its climax may be found in the London Catalogue of British

Plants. Thus we country naturalists are content with the register of particular poppies in particular fields, and there the *science* ends. Yet what a marvellous history is attached to the organization of plants! What more interesting study to be brought before the young, than that of a mighty oak developed from a tiny seed, spreading forth its wide branches and green leaves, and every one of those myriad lungs resolving with its thousand pores the carbonic acid of the atmosphere into carbon and free oxygen; purifying the air we breathe by the emission of the oxygen, and retaining the carbon to build us roofs for homes, "ships for war, and planks for coffins."

I have already mentioned the discovery made by Mr. G. Roberts, of Kidderminster, of certain beds of the Old Red Sandstone formation in that district. Having visited the section exposed below the school at Trimpley, I believe that these beds exhibit an *undisturbed gradation* from the Cornstones of the Old Red Sandstones into the "Tilestones;" and are equivalent to those of Lesmahagow in Scotland, Kington in Herefordshire, Ludlow, and several other localities. The Kidderminster beds are however, I imagine, considerably higher in the series than the Lesmahagow and Kington group, which pass downwards into the Upper Silurians. I had the pleasure of exhibiting a suite of specimens obtained by Mr. Roberts and Mr. Chelingworth, of Park Attwood, before the Geological Society of London, and in the presence of our first British Icthyologist, Sir Philip de Grey Egerton. The evidence afforded by these Kidderminster fossils is interesting and somewhat peculiar. Several remarkable crustaceans which make their appearance in the Silurian and Lower Tilestone deposits, are found at Trimpley associated with fishes, that were supposed to be limited to the Cornstone or middle group of the Old Red Sandstone; and the Pterygotus and Pteraspis of the Silurian rocks and bone-bed, pass upwards into beds charged with Cephalaspis Lyellii and Lloydii. Numerous plants occur in the same strata, and with these are the egg-shaped "Parka decipiens," queer reticulated meshes, formerly supposed to be the spawn of frogs or crustaceans, but which are now believed to be the panicles of an extinct species of Sparganium. Mr. Edwin Lees found one slab, while we were examining the quarries, which was covered with vegetable impressions; some of the plants were apparently terrestrial, and exhibited a parallel veined structure with furrowed stems: among them lay a portion of the great lobster, the Pterygotus, and a nest of the "Parka decipiens."

I never look upon these organisms of the Old Red rocks without calling to remembrance the sad and untimely fate of one whom naturalists of every class and every clime, where the English language is read and spoken, must ever deeply regret. I first met with Hugh Miller's work on "The Old Red Sandstone" when engaged, several years ago, in tracing the steps of Sir Roderick Murchison in Siluria. Among the heights of the Welsh mountains and the vales of Monmouth, Hereford, and Shropshire, far and near, in every gulley, by mountain pass and brook side, have I followed the rocks of Siluria and the overlying Old Red Sandstone, with Murchison's sections from "The Silurian System," in my note-book, and Hugh Miller's book in my pocket. And sometimes in my day-dreams did I wonder whether the time would ever come, when I should have the privilege of interchanging ideas with, or listening to the explanations of, those whose works I knew so well.

A few weeks before the meeting of the British Association at Liverpool, I did certainly think myself especially fortunate when, one bright autumnal evening, I found myself rambling with one of our most accomplished British naturalists, examining those magnificent relics of Carboniferous Conifers in the quarries of Granton and Craigleith, with the promise on the morrow of passing some hours with Hugh Miller. I started early to walk to Porto Bello, with the sunlight resting upon the waves of the Firth, and gilding the rocks of Arthur's Seat, the noble old castle, and the city of the Scotch kings. I walked from Granton with some carpenters going to their work in Edinburgh; they attended, they informed me, the Mechanics' Institute or Reading-room, and knew Hugh Miller well, and they differed as much from the general stamp of *English working-men*, as it is possible to imagine.

Hugh Miller had not risen when I reached his residence at Porto Bello, and, when he entered the apartment, I was engaged in examining a recent ganoid fish, a still existing reminiscence of his Old Red organisms, which had been lately sent by Sir Charles Lyell from America, and which he especially valued. I imagine this fish was a Garpike, of which several living specimens were exhibited at the American Association for the Advancement of Science held at Albany last August, and of which Professor Agassiz said, "that the apparition was hardly less striking than if one of the old Egyptians were suddenly to present himself in the hall." "There were very few types of this kind to be found among *living* fishes, but many among fossils. In the Old Red Sandstone he had found fishes called Glypticus, with the same sort of tail. Here were also two features observed in genuine reptiles, the power of moving the head on the back-bone, and the quasi tail."* I set down the dead ganoid of the American rivers to take a long look at the *working-man!* My first impression was that of slight disappointment; I expected a more sunny face, with

* Edin. New Phil. Jour. Ap. 1857, p. 359.

more of joyousness in the expression, and it was not until we entered his museum and his countenance lighted up, as he described the scenes of his earlier geological rambles, and his typical fossils,* that I recognised the strength of his intellect and at the same time the humility of his mind. Again, I had frequent opportunities of conversing with him at the Glasgow meeting of the British Association, and observing his kind and gentle manner to all around; truly has it been said, "To peer and to peasant Hugh Miller was the same." It may be a source of melancholy interest to those naturalists who visit the Museum at Worcester to be informed that the Pleistocene shells from Rothsay, in the Isle of Bute, presented by me to that Institution, were examined and named by that arduous and assiduous naturalist, whose intellect gave way

* Many of these were covered with lines and figures, as in the plates of the "Footprints of the Creator."

under the burden he laid upon it, as he endeavoured to rescue the truths of creation from the mis-interpretation and prejudices of men.

It has long been supposed that flowering-plants did not exist in the period of the coal formation; and "it has been questioned whether hitherto the botanist has obtained from strata older than the Wealden, a single well-determined specimen of any flowering plants, except Gymnosperms, such as Conifers and Cycads."*

Unfortunately for these carboniferous *hobbies*, Mr. Charles Fox Bunbury *has* obtained the spike of a "very highly organized flowering-plant in full flower," from the coal-measures of Newcastle. Dr. Hooker considers the resemblance of this plant, "Antholithes Pitcairniæ," is nearest to "Bromeliaceæ, amongst which the genus Pitcairnia is ranked." And surely, when chemists tell us that the *green colouring matter* of terrestial plants *cannot be formed in the absence of light;*

* Supplement to last edition of Manual, p. 29.

when such botanists as Lindley and Hutton, in their Fossil Flora, insist that "light is an agent without which no growing plants can exist at the present day for a single week, even in a low temperature, without suffering serious injury," the discovery of this single flowering-plant of the carboniferous epoch should establish the fact of the presence of *sunshine* during that, I believe, much misconstrued period. He would be a bold geologist, who, after this discovery of Mr. Bunbury's, should affirm that the interior of a carboniferous continent may not have been studded with the most highly organised structures of the vegetable kingdom, because geologists do not happen to disinter their relics from among the swamp plants of the Palæozoic coal. We do not expect to detect dahlias in the peat-bogs of Ireland, or gather the rhododendrons of the Himalayas, and the roses of Cashmere, among the reed vegetation of the "Sunk Country."

Again, when Sir Charles Lyell published the fifth edition of his Manual in 1855, only six species of Mammalia were known to Palæontologists from rocks *older* than the *Tertiary* strata; yet he now records in his new Supplement the discovery of seven or eight new genera of Mammalia in the Upper Oolite of Dorsetshire, as if to warn the geologist that it is not possible to determine, with any thing like precision, the *terrestrial* fauna or flora of pre-existing ages from the examination of submarine or even fluviatile deposits. In the interior of continents there are many species of land-animals and land-plants, whose remains are never buried in a condition to *become fossilized;* and so many theories of restrictive creations have of late years been demolished, that I now believe the geologist should entertain no theory whatever, however plausible, but wait patiently for the investigation of facts.

ADDENDA AND ERRATA.

ADDENDA.

The "Ramble with the Woolhope," page 40, &c. and other portions of the description of the Millstone Grit, have already been printed in Chambers's Journal, April No. 1857; and much of the Coal chapter was delivered at the Natural History Soirée of Sir Charles Hastings, at Worcester, January, 1857.

Farewell Rock, page 50.—Mr. G. P. Beavan, in his paper "On the Geology of the Coal Fields in the neighbourhood of Beaufort, Monmouthshire," printed in the Transactions of the Woolhope Naturalists' Field Club, and published since this work was in the press, mentions that there are occasional seams, termed "Rosser veins," found in the Millstone Grit.

Page 62.—Mr. Beavan has described beds containing *freshwater shells* (?) intermingled with a species of *Rhynchonella;* if such be the case, the freshwater remains must have been washed into *Marine* deposits. Mr. Beavan has found "wings of insects," "Lingula, Producta, and Conularia," in the coal seams.

Page 160.—My remarks on the Church of Eastnor may appear to cast some reflection on the restorers, and such would be far from my intention or desire, for a more beautiful parish church, or a building more appropriate for the worship of God, I do not know in this part of England.

ERRATA.

Chapter VII. is printed Chapter VI., and Chapter VIII. Chapter VII.

Page 10, *for* "Tukesii," *read* "Jukesii."

Page 12, *for* "Telereton," *read* "Telerpeton."

Page 13, *for* "Symond's," *read* "Symonds."

Page 30, *for* "Bellrophon," *read* "Bellerophon.

At pages 97, 204, 205, *for* "Quart. Tour." *read* "Quarterly Journal."

NOTE.

They say that a lady's letter is contained in the Postscript; there may be something in a *last* note!

Dr. Grindrod, of Townshend House, Malvern, has just shown me a fine specimen of an Annelid "Trachyderma antiquissima," Salter, from the Malvern Cambrians. The Doctor also possesses another relic that is likely to require explanation from our higher authorities, on the appearance of ancient fish; to these gentlemen I commend it!