# PROCEEDINGS

OF THE

# COTTESWOLD NATURALISTS'

# FIELD CLUB

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VOLUME X

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PRINTED BY JOHN BELLOWS, GLOUCESTER
1892

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VOL. X PART I



# PROCEEDINGS

OF THE

# Cotteswold Naturalists' FIELD CLUB

**For 1889—1890**

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CHELTENHAM

## Contents



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*Annual Address to the Cotteswold Naturalists' Field Club, read at Gloucester, April the 29th, 1890, by the President,*
Mr W. C. Lucy, F.G.S.

The Annual Meeting was held as usual at the School of Science, Gloucester, on Tuesday, April 29th, 1889.

After the President's Address, Mr J. H. Jones, the Hon. Treasurer, laid before the Meeting the accounts, shewing a balance in favour of the Club of £47 11s. 7d., which were passed and ordered to be printed.

Mr Lucy was re-elected President; and Dr Paine, the Rev. Dr F. Smithe, Dr Day, Mr John Bellows, and Professor Harker, Vice-Presidents. Mr E. Wethered, Hon. Secretary, and Mr J. H. Jones, Hon. Treasurer, were also re-elected.

Great regret was expressed at the absence of Dr Paine and Dr Day—both from ill-health.

The Field Meetings for the year were fixed :—

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| Tytherington and Thornbury ... | May 28th |
| Bourton-on-the-Water ... ... | June 27th |
| Cirencester and Andoversford ... | July 25th |
| Westbury and Flaxley ... ... | August 20th |

Professor Harker read a paper on "Remarkable Occurrence at Sharpness of the Eggs of *Tetranychus lapidus*," an Acarine Arachnoid observed by Mr W. B. Clegram, and which is published in the last number of the Proceedings, p. 396.

There was a large gathering at the dinner at the "Bell Hotel," and after the President had proposed the usual toast of "The Queen," Professor Harker requested permission to make a departure from the Cotteswold rule, and he proposed, in a very kind manner, the health of the President, who feelingly replied.

On Saturday, July the 10th, one of our Vice-Presidents—Deputy Surgeon-General Day—after a long and painful illness, died at his residence in Cheltenham.

I gather from an excellent notice of his life, in the "Cheltenham Examiner," that he was the third son of Mr W. Day, of Hadlow House, Sussex, and was educated under Dr Kennedy at Shrewsbury School; and on leaving there he studied Medicine at St. George's Hospital, London, and went to India in 1852 as Assistant-Surgeon in the Madras Army. He saw active service in the Burmah campaign, for which he received a medal. His leisure was devoted to his favorite pursuit—Natural History; and he was made Inspector-General of Fisheries in India, and published several works on the fishes of the most important rivers of that country.

In 1877 he retired from the Madras Medical Staff and settled in Cheltenham, and commenced to investigate the history of the fishes and fisheries of Great Britain, and gave the result—in 1880—83—of his researches in a work of two volumes, entitled, "The Fishes of Great Britain and Ireland."

In 1881 Dr Day received a Silver Medal from the Norwich Fisheries Exhibition for works on Ichthyology, and a Gold and Silver Medal from the Edinburgh Fisheries Exhibition in 1882.

He was appointed, in 1883, Commissioner for the Indian Department at the Fisheries Exhibition, and for his own exhibits he received three Gold Medals, and the 1st prize of £100 for "Treatise on Commercial Sea-fish." The services he rendered to the Exhibition were fully recognized in the following letter to the Secretary of State for India:—

"I am requested by His Royal Highness the Prince of "Wales (the President) and by the members of the Executive "Committee of the International Fisheries Exhibition, to "convey cordial thanks for the aid rendered by the Govern-"ment of India in this undertaking; and I would here ask to "mention Dr Francis Day, who has so ably carried out the "duties entrusted to him by the Government.

"Besides the services rendered by Dr Day, as Commis-"sioner of the Indian Empire, it is a duty which devolves upon "us to bring to your Lordship's notice the great benefits which "have generally been derived throughout the operations of the "Exhibition by the experienced and learned advice which has "been so freely and generously afforded to us by so learned "and competent an authority on all matters relating to "fisheries; and we trust that your Lordship may deem it "expedient to convey to Dr Day the sense which we entertain "of his assistance."

The Indian Government shortly afterwards made him a Companion of the Indian Empire.

Dr Day enriched our Proceedings with the following papers:—

"On the Burbot and Air-Bladders of Fishes."

"The Breeding of Fishes."

"Salmonidæ."

"The Propagation of the Common Eel."

"Notes upon the Breeding of the Salmonidæ."

"Notes on Hybridization."

It was only in January, 1889, the last one was given, which, owing to his illness, was read by his friend, the Rev. E. Cornford.

In our neighbourhood there was no one who possessed the same general and accurate knowledge of fishes, and he was in the first rank of the Icythyologists of Great Britain and the Continent; and while we mourn his loss, first as a justly esteemed departed friend, we cannot forget there will be a blank for some time to come in our Proceedings in that special branch of Natural History which was peculiarly his own.

Dr Day was a Fellow of the Linnean and Zoological Societies of London; an Honorary Member of several foreign Scientific bodies; and a member of the Severn Fishery Board.

William Brown Clegram died June 3rd last at Saul Lodge. He was born at Shoreham, in Sussex.

When a young man he accompanied his father, Captain Clegram, to Gloucester, who had received an appointment as Engineer to the Gloucester and Berkeley Canal Company.

Mr Clegram was also by profession an engineer, and was in the service of the Canal Company for sixty years.

He had a charming manner, a good knowledge of astronomy, was a diligent student with his microscope, took much interest in Natural History generally. In him I have lost one of my oldest and most valued friends.

For many years he was a member of the Club, and frequently attended the Field Meetings, but he did not contribute to our Proceedings. Shortly before he died he brought before Professor Harker some minute white eggs he had observed on stones at Sharpness, and which the Professor has described in a paper in our last number—under the name *Tetranychus lapidus*—a genus of *Arachnida* belonging to the family *Trombinada.*

It was only last week we lost very suddenly an Honorary Member, Mr Handel Cossham. He contributed to our Proceedings a paper on the "Cannington Park Limestone," and another "On a Discovery in the Kingswood Coalfield," both of which are in Vol. VIII.

Mr Cossham took a warm interest in the Club: we were frequently his guests, and the meetings held under his auspices were so well arranged and accompanied with such hospitality, that they will always be remembered by us as "red letter days."

Owing to the interest felt in the able paper on Tytherington, read by the Rev. H. H. Winwood before the Club, which appears in Vol. IX., the first Field Meeting was held at Tytherington and Thornbury on May 28th.

The Section was thoroughly examined and explained by Mr Winwood and the Hon. Secretary. It was seen under more than ordinarily favourable circumstances in consequence of the care which our colleague, Mr Meredith, Engineer of the Midland Railway, had taken in having the obstructions in the cutting cleared away, well exposing the different beds, and also to the admirable map he had prepared of various parts of the line.

After lunch at the "Swan," Thornbury, the members proceeded to the Castle, where they were met by the owner, Mr Stafford-Howard, who courteously explained its leading features.

It was commenced in 1511 by Edward Stafford, Duke of Buckingham, and was left by him in an unfinished state at the time of his execution in 1522.

Rickman, in his work on Gothic Architecture, says:—"It "is a fine specimen of the baronial mansions of that age, built "for magnificent display rather than for defence."

An interesting account of this Castle is given in the Presidential Address of Sir Wm. Guise in Vol. VI. page 7, of the Proceedings, where he refers to the visit of the Club to Thornbury in 1871.

The second meeting was on June the 27th, the members assembling at Bourton-on-the-Water Station, where conveyances were in waiting to convey them to the Eyford Quarries in the Stonesfield Slate, and on the way there Mr George Witts pointed out the "Buggilde Street"—a British road—which runs from Ryknield Street, near Bidford, in Warwickshire, ascends the Cotteswolds near Saintbridge and Willersey Camps, and joins the Roman Foss Way close to Bourton-on-the-Water. He stated that the first mention of this road is in a Saxon Charter, printed in Kemble's Codex Diplomaticus, dated 709.

Mr Witts called attention to several mounds in the fields passed, which he considered to be Barrows—probably British burying places—and that flint implements were often found when the land was ploughed.

At Eyford the quarries were described by Professor Harker and Mr Wethered, who were both agreed that the bed of clay at the base may safely be regarded as the upper stratum of the Fuller's Earth, upon which rests the Stonesfield Slate.

I am indebted to our Vice-President, the Rev. Dr Smithe, for the following list of the fossils found:—

Amongst others are—

*Teleosaurus. T. cadomensis* (scutes and teeth)
*Megalosaurus* (vertebræ and teeth)
*Palatal teeth of fish, viz.:—*
*Gyrodus trigonus. Ag.*
*Pycnodus rugulosus. Ag.*

*Spine of Hybodus dorsalis.* *Ag.*
— *apicalis*
*Belemnites Bessinus.* *D'Orb.*
*Rhynchonella concinna*
— *obsoleta*
*Trigonia impressa.* *Sby.*
*Ostrea acuminata*
*Nerita and Eulima* etc. etc.

At Eyford Park, the residence of Mr and Mrs Cheetham, an acceptable lunch was partaken of *en route* to Lower Swell Vicarage, where the Rev. D. Royce cordially welcomed the party, and showed his beautiful collection of flint implements, which were exhibited on 23 large cards. Time, unfortunately, would only admit of a cursory examination of this valuable collection, and the carriages were again taken to the Rev. F. E. B. Witts, of Upper Slaughter, to inspect the fine collection of fossils from the Stonesfield Slate—made many years since by his father; and a unique Star-fish was greatly admired.

After a most welcome tea, with strawberries, the church was visited, and an earthwork adjoining, which Mr George Witts considered to be Post-Roman. In the centre of the mound a well was found a few years since, which he thought belonged to the Saxon period.

On leaving our hospitable host and hostess, I wrote in the Visitors' Book—

"A visit, long to be remembered by the Club:"

and the 5.45 train was taken at Bourton for Cheltenham.

July the 25th was the third Field Meeting to examine the sections on the new line of railway from Cirencester to Andoversford.

On arrival at Cirencester, Saunders' stone yard was visited to see a large Ammonite embedded in a block of Bath stone, which, in sawing, was most fortunately cut through horizontally, shewing perfectly all the chambers. Ammonites seldom occur in solid masses of the Bath Oolite, hence the additional interest in this specimen.

While in the yard Earl Bathurst joined the members, and kindly invited them to see the fine yew trees in front of his residence, which were much admired.

From there the members proceeded to the station of the Midland and South Western Junction Railway, where they were met by Mr Shopland, the engineer, who had provided comfortably-seated trucks to convey them over the line.

The length is nearly thirteen miles, in which there are 28 cuttings, 27 embankments, and a tunnel at Chedworth 420 yards long. At one of the cuttings the engine was stopped, and Professor Harker gave a short description of it, and the beds that would be seen during the day. He remarked that the cutting showed the transition beds between the Great Oolite and the Forest marble, which thus represented two divisions of the Great Oolite series—the former known as the Bath freestone. A considerable distance of the line was in the Great Oolite, but as they proceeded they would descend in the geological scale, passing through the Stonesfield slate and Fuller's Earth into the Inferior Oolite.

A halt was made to see the Roman Villa at Chedworth, which, in the unavoidable absence of Mr G. Witts, was explained by the Hon. Secretary, Mr Wethered.

A walk over the tunnel brought the party to the railway trucks again, and in proceeding along the line the Hon. Secretary gave a lucid description of the beds, and explained the general position of the Inferior Oolite series.

During the day I called attention to the numerous fissures in the rocks in the cuttings, filled in with a reddish-brown clay, which I believed belonged to the boulder clay which once covered the Cotteswolds. It must have been of great thickness, as not only the vertical fissures, to the depth of 8 to 10 feet, were jammed with it, but it was also forced some distance into horizontal ones many feet below the surface.

Quartz pebbles have been found in this description of clay, and samples taken from various parts shew an average of 68 per cent. of silica in the clay—(for full particulars see my paper, "Extension of Northern Drift and Boulder Clay over the Cotteswold Range," Vol. VII., page 55.)

The rain began to come down in torrents, and the train was driven rapidly, over very bad gradients, to the discomfort of some of our nervous members, to Andoversford, where the one for Cheltenham was taken.

The fourth Meeting was on August 20th, when a large number of members proceeded in a brake from Gloucester to Flaxley under the guidance of your President.

Sir Thomas Crawley shewed the fine church, which was erected in 1856 at the expense of his relative, Mr Gibbs. Sir Gilbert Scott was the architect; and the reredos, by Mr Phillips, of London, was much admired.

Within a short distance of the church, and close to the schools, occurs the remarkable upthrust of Silurian and Old Red Sandstone rocks, of which I gave the following description:

The last time the Club visited this section was in July, 1877, and in referring to the notice given of the meeting in our Proceedings, I was painfully reminded of the losses we have sustained in the death of some of our most distinguished workers who were then present. Our President, Sir William Guise, Mr Witchell, the Rev. W. S. Symonds, and Dr Day are now no more. To the Rev. W. S. Symonds we were indebted for an able and interesting address on the geology of the district of May Hill, the Forest of Dean, and Flaxley. He told us how years had passed away since he visited this area with Mr Strickland, conducting the old Silurian chief, Sir R. Murchison, to the rocks we are now looking upon, and he dwelt generally upon the history of the Palæozoic rocks and their fossils. Mr Symonds said the Silurians swarmed with invertebrate life: mollusca, crustacea, corals, and like forms of marine animals were abundant, and it was not until the time of the Lower Ludlow rocks that the scales and scutes of a ganoid fish gave proof of the existence of vertebrate life. The Old Red Sandstone proper of this country was probably laid down under fresh-water conditions; and the Devonian rocks were the marine equivalents of the fresh-water beds of the Old Red. Alluding to the carboniferous period, with its wonderful land vegetation, he remarked how, after that period had ceased, in Permian times, igneous upheavals took place, which made the South Wales and Dean Forest coalfields available for man, and concluded his address with an eloquent description of the days of the mammoth and pre-historic man during the time of the Severn Straits. Now I am not going to dwell upon the many changes which have taken place in the Malverns and May Hill, and which were felt upon the spot upon which we are standing, but I strongly advise those who wish to study the subject to refer to the able paper by Dr Holl on The Geological Structure of the Malvern Hills; in the Quarterly Journal of the Geological Society, Vols. XX. and XXI.; and also Professor Phillip's Malvern Hills (Mem. Geol. Survey of Gt. B., Vol. II. pt. 1.) The time of the upheaval of the beds before us was during the Permian age, when probably the igneous rocks at Damory Bridge, near Berkeley, Charfield Green, and also the ridge of Silurian rocks which cross the Severn at Purton Passage were brought to the surface. That it was before the deposit of the new Red Sandstone is beyond all doubt, as that formation rests upon the boss under our feet at the slight dip of about 2 degs. S.S.E., the same as we shall presently see in the New Red Sandstone at Garden Cliff. You will observe a marked resemblance in the contorted condition of these Silurian beds to those in the quarry at Huntley, which was so well explained to us by Dr Smithe in 1887. There is the same evidence of great lateral pressure, but the beds are not folded to the same extent, as Flaxley is further removed from the seat of the disturbance which brought May Hill to the surface. I do not know a more interesting place in our neighbourhood wherein to study physical geology. All to the west are the older Palæozoic rocks rising into hills and mountains, while to the east and south the oldest rocks which are visible are those belonging to the Secondary or New Red formation, and we are now standing on the edge of an enormous downthrow fault. You may naturally ask where are all the older series of rocks? What has become of the Silurians; the great thickness of the Old Red; the 3,500 feet of the Carboniferous series of the Forest of Dean; the Permians, of which the only trace we know of is at Haffield?

Were these older rocks ever deposited in the plain before us? Fortunately we are now able to give a complete answer. The various borings for water which have been made in different parts of the kingdom have disclosed Silurian rocks at Ware, Upper Devonian at Erith, Meux's Brewery, London, Turnford, near London, and Harwich, and coal measures to the east of us at Burford, and they are without doubt underneath the Severn area we are looking upon. In considering the cause of all this change we must dismiss from our minds that it was altogether a local disturbance. It forms part, as Professor Phillips has shown, of a great line of dislocation extending 120 miles from Flintshire to Somersetshire, and he places the major part as having occurred at the close of the Permian. Strickland says this great fault seems to have formed a marginal cliff against which the Upper portion of the Triass or New Red Sandstone was deposited at Bewdley, Abberley, May Hill, and Purton Passage. I should like to say a word upon the change of organic life in the period represented by this boss. In the opinion of Professor Geikie, no greater contrast is to be found between the organic contents of any two successive groups of rock than that which is presented by a comparison of the Upper Silurian and Old Red Sandstone systems of Western Europe. The abundant marine fauna of the Ludlow period entirely disappear from the region when the Old Red sets in. On the land that surrounded the lakes or inland seas of that period there grew the oldest terrestrial vegetation, of which no more than mere fragments are now known. It has been scantily preserved in the ancient estuarine beds in Europe and England, and more abundantly at Gaspé and New Brunswick. The American localities have yielded to the researches of Principal Dawson, of Montreal, no fewer than 118 species of land plants. I have often been to this section, and when considering the great physical changes which have taken place, the words of the Poet Laureate have come into my mind—

> "The hills are shadows, and they flow
> From form to form, and nothing stands;
> They melt like mist, the solid lands
> Like clouds, they shape themselves and go."

After lunch at the Red Lion, Westbury, and the election of Dr Davis, of Cheltenham, and Mr F. W. Waller, of Gloucester, as members, a short walk brought the party to the classic section of Garden Cliff, where the President said—I am old enough to remember when the lower part of the section before us was regarded as belonging to the New Red, and above, where the beds are of a different colour, to the Lower Lias. Sir Philip Egerton was the first to suggest—grounded on a careful examination of the Fish remains at Aust, which he found were more of a Triassic than Liassic type—that they probably belonged to the former, or occupied an intermediate position between the two formations. Our old Vice-President, Dr Wright, in a paper printed in the Geological Society's Journal in 1860, placed the upper part in the zone of the Avicula contorta, from the presence of that very characteristic shell, considering them the equivalent of the Upper St. Cassian beds of the Alps. Mr Charles Moore, also a member of our Club, in 1861 read a very able paper before the Geological Society, in which he showed most conclusively that this important series is the representative in this country of the Upper St. Cassian and Kössen beds of Escher, and he called them Rhætic, from their occurring in the Rhætian Alps. Subsequently the Geological Survey, through Mr Bristow and Mr Etheridge, examined the beds in this area, and as they found them very fully developed at Penarth Head, opposite to Cardiff, they gave them the name of "Penarth," a term which has since then been adopted in the Survey Maps. The first detailed notice of Westbury in our Proceedings will be found in Vol. II. p. 88, in the President's Address for 1860. He says—"The Cliff has lately been carefully examined by our Secretary and Mr Lucy, who have noted a section differing from those already published, and by permission I will proceed to incorporate it in this resumé of our Proceedings." In 1865 Professor Etheridge wrote a most exhaustive paper upon these beds for our Proceedings, entitled, "On the Rhætic or Avicula Contorta Beds at Garden Cliff." The upper part of Mr Etheridge's section was practically the same as the one by

Mr John Jones and myself, and in the 35 feet the difference in measurement was only three inches. Mr Etheridge, however, included the Ostrea bed at the top, in the Rhætic, while we were disposed to place it at the base of the Lower Lias, and he further included over 14 feet of the Tea-green marls as belonging to the Rhætic. With regard to the latter beds, Mr Etheridge had fuller information than we possessed from having examined the same series at Watchett, Penarth, and other places where they are much developed. There is still, however, a difference of opinion upon the subject, as most geologists consider they belong to the Keuper. I would, however, mention two interesting matters in relation to these beds. Many years since—over thirty—Mr R. F. Tomes visited the section with Mr John Jones and myself, and when we came to the cream-coloured band of limestone he said at once from observations he had made in Warwickshire, "This is the Estheria bed." We replied sceptically it might be, but that we had broken up a great deal of it without finding any organic remains. "Well," he replied, "I don't mean to leave until I have found some," and in about five minutes he knocked out a fine cluster. The moral to be drawn from this is, "Never rely too much upon negative evidence in geology," and I would advise all young workers in the science to answer under like circumstances that "at present the fossil has not been found." The second case occurred in 1875, when the students of the School of Science were induced to visit the section after hearing a lecture of mine upon these beds. They found several specimens of the Brittle Starfish (*Ophiolepis Damesii*), a fossil then new to this country. Only twelve months before Dr Wright had received a specimen from similar beds at Hildesheim, in Prussia. The finding of this little fossil, Dr Wright thought, was decisive of the marine character of the bed in which it occurred.

The President then called upon Professor Harker to explain the palæontology of the beds. Professor Harker said that the chief interest which attached to the fossils of the Rhætic Beds was centred in the vertebrate remains, which comprised 30 species of fishes, five reptiles, and one mammal (microlestes). Sir Philip Egerton had pointed out that the fishes showed Triassic affinities, while on the other hand the Reptilia were undoubtedly of close relationship to the Lias. We had here the first known remains of those genera *Ichthyosaurus* and *Plesiosaurus* which were to form a marked feature and culminate in the Liassic division of the Jurassic period, while all the reptiles (save *Labyrinthodon*) and amphibia of the Trias were absent. Large vertebræ of *Ichthyosauri* and *Plesiosauri* have been found in the bone beds of the spot they were standing on. The fish remains, consisting of scales, spines, and teeth, were of intense interest. Three or four genera were represented in the Trias, and others extended up into the Lias. The most remarkable fish was *Ceratodus*, of which genus nine or ten species have been obtained. Founded by Agassiz on a single tooth, it was one of the marvels of Zoology, that a living fish of the same genus had, long subsequent to the founding of the genus, been discovered to exist in certain Australian rivers; the Barramunda or mud fish of the Darling River. It belongs to the order *Dipnoi*, characterized by the possession of a true lung as well as of gills, enabling it to exist for a long time out of water, embedded in the half-dried mud of its native creeks. It furnishes us with another proof that in a certain sense some Australian animals represent an old world fauna dating so far back as Devonian and Jurassic times. The commonest fishes here at Garden Cliff are *Hybodus* and *Saurichthys;* every slab of the bone bed contains some of their scales and spines. The small star-fish *Ophiolepis Damesii*, first found at Westbury, is the sole Echinoderm yet recorded. Some fifty species of Lamellibranchiate mollusca occur, of which *Pullastra arenicola*, *Cardium Rhæticum*, and *Avicula contorta* are most abundant. The general conclusion to be drawn from a study of the fauna was that the Rhætics were transition beds between the lacustrine and estuarine conditions of the Keuper, and the deep seas of the Lias; the land surface of the epoch, which must have been a very long one, furnishing an occasional mammal and numerous reptiles to leave their bones and coprolites in the shallow estuarines and seas of the time, and thus affording a clue to the zoologist of the changing land and shore fauna which probably included the earliest of mammals.

The Professor's remarks were supplemented by some valuable observations by the Rev. W. Winwood, who thought Professor Etheridge had carried the line of separation between the Rhætics and New Red too low, and that the series should be regarded as one of transition. After returning from the Cliff the members availed themselves of the thoughtful and kind hospitality of Mr and Mrs Colchester-Wemyss, who, in their fine old garden, had provided refreshments, which were much appreciated, and made an agreeable termination of a very pleasant day's excursion. Mr Colchester-Wemyss showed a very beautifully-worked flint hatchet, of neolithic type, which was found on his property at the Wilderness, in the Forest. The party then took the brake and reached Gloucester in time for the 6.30 train to Cirencester and Cheltenham.

I am indebted to Mr Colchester-Wemyss for the following interesting information as to the change of name of Garden Cliff:—

In the year 1591—33rd year of the reign of Queen Elizabeth—Manor of Rodley, is an entry—

"The Presentment of the aforesaid Jurors of the
"customarie tenants within the said Manor concerninge certen
"things there required of as followeth, viz.:—

"That every Barke or Pichard of any Stranger that shall
"make staie, load or unloade or bee att anchor in any place of
"Seaverne betweene the Pill of Newnham on the west parte
"and *Garron Cliffe* on the east parte oughte to paie kiellage—
"for every such Barke or Picharde iiij$^{de}$ (= 4d.)

And on the 1st October, 1683, there is an entry—

"At a Court Baron &c. this day held, the Jury presented
"the names of several persons 'To make up their Walls and
"Banks from Garron Mill to Gay Shard.'"

This is the last time the name of Garron occurs; and on the 14th October, 1731, is an entry, without mentioning the Cliff, but the Mill close to it, which was then called Garden Mill.

"At a Court Baron held this day, the Homage presented "that the late Philip Hampton had taken in part of the Lord's "Waste into a ground of his from the Gravells to *Garden Mill* "which part was to be thrown up again."

Again, 5th October, 1739—

"At a Court Baron held this day—The Jury presented "Thomas Crawley, Esquire, to erect a Bridge over the Great "Brook in Westbury at Garden Mill, by 25 March next."

On 13th October, 1786—

"At a Court Baron held this day—held at The Flat "House—The Jury presented Thomas Crawley Boevey Esquire "for not keeping a Bridge across the Great Brook at Garden "Mills, near The Severn."

Being anxious to know the meaning of the word "Garron," and seeing the name occurred in Ireland, I wrote to Professor Hull on the subject, and from whom I received the following satisfactory explanation :—

"According to Dr Joyce, Garrân, Garrane, and Garraun "means, in Irish Celtic, 'A Shrubbery.' It is not an uncommon "name in Ireland, and is the nearest thing to 'Garron' I can "find. At Garron Point, co. Antrim, the Cliffs are clothed in "a natural growth of small trees or shrubs, which may very "fitly have given the origin to the name."

The Sessions of our Winter Meetings commenced on November 26th, when Major Fisher gave a paper on "Falconry"—a subject new to the present members of the Club, and which he treated in an able and interesting manner, giving the result of many years of original observations.

This paper will be found in the forthcoming number of our Proceedings.

Mr T. S. Ellis afterwards read a paper on "River Curves," which was the substance of a paper he read before the School of Science Philosophical Society in February, 1882, and which he now illustrated with diagrams and maps.

Some discussion followed, and as the subject evidently much interested those present, and it was getting late, the President suggested that further consideration should be postponed until the next meeting.

The Second Meeting was on January 25th, when the discussion on Mr Ellis's paper was resumed.

He stated he believed that the formation in the course of slowly-flowing rivers of great horse-shoe curves round alluvial plains, and of double channels, leaving islands, as illustrated in the Severn near Gloucester, resulted from the entry of a tributary stream, and where the latter entered the main stream the tendency was to wear away the immediately surrounding bank, and thus open out a curve. Then the stream of the river, becoming gradually diverted, assisted in the formation of the curve by wearing away the bank.

Mr Keeling agreed with Mr Ellis as to the Severn above Sharpness, but gave an instance at Lydney to the contrary.

Professor Harker believed that curves originated from various causes, and referred to how an obstruction in a stream would divert its course.

Mr Embrey had tested Mr Ellis's theory in a voyage from the Upper Severn to Gloucester, and found it correct.

Mr Taunton took exception to the view of Mr Ellis that the natural course of a river passing through alluvial plains was to run straight, as the stream was subject to the influence of gravitation, and its course influenced by the amount of friction to be overcome, and he could not accept Mr Ellis's postulates.

Mr Buckman shewed by a diagram that the effect of the meeting of two volumes of water would be felt on the opposite side to which the tributary entered, and gave some instances where the entry of a tributary did not produce a curve.

Speaking from experience of rivers in India, General Babbage confirmed Mr Buckman's observations.

Dr Bond, the Rev. H. Winwood, and Mr Meredith also took part, and their views were generally adverse to Mr Ellis, who shortly replied.

In referring to some authorities on the subject of rivers, I find Dr Evans quoting from Sir Charles Lyell—10th edition of Principles of Geology, Vol. I. page 354—

"When we are speculating on the excavating force which "a river may have exerted in any particular valley, the most "important question is, not the volume of the existing stream, "nor the present levels of its channel, nor even the nature of "the rocks; but the probability of a succession of floods at "some remote period since the time when the valley may have "been first elevated above the sea."

And he, Dr Evans, further mentions that Mr Fergusson on "Recent changes in the Delta of the Ganges," says—

"That all rivers oscillate in curves, the extent of which is "directly proportionate to the quantity of water flowing "through them."

It appears to me, while Mr Ellis's theory is a factor, which must in future be recognised in the formation of river curves, it is only one of several. I have often noticed a brook, which is a miniature stream, in passing through alluvial meadows, is almost sure to wind, and sometimes it forms acute angles. The volume of water in a river—the velocity at which it travels—the character of the ground it passes through (as when hard rocks are crossed they often deflect its course)—and that the tributary *of a stream* is the minor force, and therefore under the control of the major one—the main stream—all of these, and probably others, must necessarily be present to our minds when considering the subject.

The paper led to one of the longest discussions the Cotteswold Club has ever had, and Mr Ellis deserves our thanks for having given his own views, the result of many years' original observations, on a difficult question.

The Rev. Dr Smithe followed with a paper, "Report on the Celestine (Strontian sulphate) of Gloucester and its vicinity, with remarks on the same mineral in Sicily," which will be found in our Transactions.

I wish to commend to our members the great value of papers like Dr Smithe's, and to express a hope that when they visit interesting places abroad, where like formations occur to those in our own neighbourhood, they will follow his example, and give us the result of their observations.

The Third Meeting took place on February 25th, when a paper "On the Geology of the New Railway now in course of construction between Andoversford and Cirencester," was given in two parts—the first by Professor Harker, which included—"The Sections of Forest Marble and Great Oolite between Cirencester and Chedworth, with their bearings on the study of Homotaxial Strata on the Cotteswolds;" and the second part by Mr S. S. Buckman, "On the Sections between Chedworth and Andoversford compared with similar beds exposed on the Cheltenham and Banbury line."

I have already referred to the visit of the Club in July, 1889, to these fine sections. At the conclusion of the papers I suggested, and it was at once accepted, that the Club should in the summer again inspect them, as they are now so fresh and well exposed, and are of great interest in the study and elucidation of our Jurassic Geology.

The Fourth and last Winter Meeting took place on April 1st at the School of Science, Gloucester, when the Hon. Secretary gave a paper "On the discovery of Coal in Kent, and the possibility of its occurrence beneath the Trias Rocks in the Severn Valley."

He began by referring to the Royal Commission on Coal appointed in 1866, and took exception to the part of the Report of the Commissioners which estimated that our coal supply would last 276 years, and gave the following figures, which show how largely the output has of late increased :—

| | | |
|---|---|---|
| In 1860 ... ... ... | 84,042,698 | Tons |
| „ 1870 ... ... ... | 110,431,192 | „ |
| „ 1880 ... ... ... | 146,818,522 | „ |
| „ 1888 ... ... ... | 168,935,219 | „ |

He laid great stress on the fact that, owing to the competition, the best seams were the most worked, and when they were exhausted would consumers be able to pay a higher price for the inferior that was left? This he regarded as a matter of serious consideration, and increased the importance of ascertaining what supplies are hidden beneath the secondary rocks, more especially in the S.E. of England.

Coal had been recently found in Kent, and a Committee had been formed to raise funds to extend the investigations. He thought, however, that the matter was one which the Government might reasonably be asked to undertake, and to receive in return a small royalty of about 1d. per ton on all coal raised from coalfields discovered by the Government.

A history was then given of the position of the rocks, commencing with the Plutonic, which were succeeded by the Laurentian, Cambrian, Silurian, Old Red, including Devonian, upon which rested the great Carboniferous deposits, which before they were brought to a close, were subjected to great physical disturbance, which produced synclinal and anti-clinal curves, and led to the formation of coal basins.

Then followed the Permian, and whether these beds belonged to the Palæozoic or Secondary, he considered a debatable point which did not now concern them.

The Secondary rocks covered up the coal basins, and after a time the former were partly denuded, thus giving us what are called "visible coalfields." But underneath the Secondary rocks which remain may there not be coal, and at what depth? These rocks are computed to be 17,350 feet thick, but they are not persistent, and as Professor Hull has shown, they thin out rapidly in an eastward direction. The Middle Lias, which at Leckhampton is 115 feet;—at Burford is only 20 feet. As to whether the Coal Measures have also thinned out is a question which might properly be raised, but he wished to impress upon them that the physical conditions under which the two systems were deposited differed very greatly.

It was to the late Mr Godwin Austen the credit was due of predicting that coal would be found beneath the Secondary rocks of the S.E. of England, and he was afterwards supported in this view by Professor Prestwich; and coal has now been reached at Dover at a depth of 1160 feet. The boring passed through 500 feet of the Cretaceous Strata, and the remainder was in the Oolite series, ranging from the Portlandian to the Bath Oolite; the whole of the lower Secondary rocks were absent.

Mr Wethered suggested borings in the Thames Valley, also south of the Mendips, and it would not surprise him if some day the smoke of collieries were seen as far as the classic city of Oxford and east of the Cotteswolds.

Dealing next with the Severn Valley, by means of a geological map, he pointed out that, if we look from the outcrop of the Forest of Dean coalfield towards Worcester, we see a narrow strip of country covered by red rocks of Trias age, which latter disappear eastward beneath the Jurassic rocks. This narrow strip soon widens out, and then we have black patches of coal measures, among which were the coalfields of South Staffordshire, Leicestershire, Warwickshire, and those known as the Severn Valley coalfields. The question he wished to ask was, is there a coalfield between the outcrop of the Forest of Dean coalfield and that of South Staffordshire? There are, as is well known, signs of coal at Newent, and still further up the Severn Valley (just north of the Abberley Hills), the coalfield of the Forest of Wyre. The inference to be drawn from these facts seems to point to a barrier in the Severn Valley, close to which, on either side, the coalfields thin out. Thus if we compared the thickness of the Carboniferous strata in the Bristol coalfield with the same rocks in the Forest of Dean we should discover a considerable decrease in the latter area. If we passed to the coalfield of South Staffordshire and to that of the Forest of Wyre, we should find the lower divisions of the Carboniferous rocks absent. The latter coalfield is the one nearest to the Forest of Dean, and it is significant that its seams of coal are of inferior quality. What he had stated was not conclusive proof that there may not be coal in the Severn Valley; still the facts he had mentioned were against the supposition that coal-getting there would be a sound commercial undertaking. There would be greater probability of finding coal in South Warwickshire, a little north of Stratford-on-Avon, but the question of depth was a speculative one on account of the great development of the Permian and Trias rocks northward. Doubtless the rocks thinned out southward, but what would be the thickness in South Warwickshire he could not say.

The Secretary was congratulated on his clear and lucid paper by the President, the Rev. H. H. Winwood, and Professor Harker; and owing to want of time the second paper by the Hon. Secretary, " On the occurrence of Characeæ in Purbeck Strata, near Weymouth," was taken as read, and it will be found in our Transactions.

During the year the following changes have taken place in our Members:—

The Rev. Christopher Smythe, Vicar of Bussage
Mr Charles Upton, Bownham, Stroud
Mr W. A. Bailey, Cirencester
Mr A. A. Hunter, Cheltenham
Mr E. Lloyd Harford, do.
Col. C. Frankland, do.

were elected. Dr Francis Day, Mr W. B. Clegram, the Rev. J. H. Lee Warner, and Mr G. F. Riddiford we have lost by death; and General Pearse, C.B., Mr G. Whitcombe, and the Rev. T. Keble have resigned.

I most heartily congratulate our indefatigable Hon. Secretary on having received from the Geological Society of London, at the Annual Meeting on February 21st, 1890, the Murchison Geological Fund, and I desire to place on record the words addressed to him on the occasion by the President, Dr Blandford:—

"Mr Wethered,—The remainder of the Murchison Donation " Fund has been awarded to you by the Council of this Society " on account of the researches you have undertaken into the " microscopic structure of sedimentary rocks, and to aid you in " prosecuting further inquiries. The results of your examina- " tion of the insoluble residues obtained from the Carboniferous " Limestone, and of the remarkable minute tubular forms " (apparently organic) from various limestones, that you have " ascribed to Girvanella, are of great interest, and have " furnished an important contribution to our knowledge of the " manner in which Palæozoic and Mesozoic limestones have " been formed."

Having concluded this rather long account of the work of the Club during the past year, in which I have been greatly aided by the admirable reports of the meetings in the newspapers from the pen of our Hon. Secretary, I trust you will not think I am presuming in making a departure from the rule observed by my predecessors. I now propose to take up a subject, and to give you

## A SLIGHT HISTORY OF FLINT IMPLEMENTS
### WITH ESPECIAL REFERENCE TO OUR OWN AND ADJACENT AREAS.

After seeing the Rev. D. Royce's fine collection—of which I have made mention in the early part of this address—and the beautifully-worked specimen shewn to the Club by Mr Colchester-Wemyss at the Westbury Meeting, I determined to obtain all the information in my power of their occurrence in the Severn area up to Worcester, of the numerous tributaries of that river, and of the high ground of the Cotteswolds and the hills west of the Severn.

The following are the brief references in our Proceedings to Flint Implements :—

When the Club met at Apperley Court in 1860, Mr John Jones mentioned the discovery of mammalian remains by Dr Falconer in a Cave near Palermo, and reference was made by the Rev. W. S. Symonds and Sir W. Guise to the occurrence of flint implements in the gravel of the Somme by M. Boucher de Perthes; a short paper by Mr John Jones in Vol. III. page 97, "On some Flint Instruments, and the geological age of the deposit in which they were found upon Stroud Hill;" a paper by the late Mr George Playne in Vol. V., "On the early occupation of the Cotteswold Hills by Man," in which there is a plate at page 209 of ten worked flints, most of them found in the fields adjoining Hazlewood Copse Camp, and he mentions that Flints are scattered over the whole surface, a district of five square miles, having the village of Nailsworth as its centre.

Also, in Vol. V., page 271, is a short paper by Mr W. T. Thiselton Dyer "On some Flint-flakes from the Valley of the

Churn at Cirencester." He mentions having shown the most presentable to Mr Franks, of the British Museum, who accepted a few of them as being of human manufacture, and selected examples for the Christy collection: and in Professor Buckman's account of the British Tumulus at Nymphsfield. At page 188, Vol. III. of our Proceedings there is a drawing of three Flint-flakes which were found in the Tumulus.

It is not my intention to go at length into the history of Implements, which are so fully described by Dr J. Evans in his exhaustive work on the "Ancient Stone Implements of Britain;" and "Flint Flakes," by Mr Stevens; numerous works by Professor Prestwich, Professor Boyd Dawkins, Sir John Lubbock, Sir C. Lyell, and other authorities.

A brief account, however, is necessary; and as the history by Dr Evans is so clear, rather than make an imperfect paraphrase, I prefer to use his own words:—

"It was in the year 1847 that M. Boucher de Perthes, of "Abbeville, called attention to the finding of flint implements, "fashioned by the hand of man, in the pits worked for sand and "gravel in the neighbourhood of that town. They occurred in "such positions, and at such a depth below the surface, as "to force upon him the conclusion that they were of the same "date as the containing beds, which he regarded as of diluvial "origin.

"In 1855 Dr Rigollot, of Amiens, also published an account "of the discovery of flint implements at St. Acheul, near Amiens, "in a drift enclosing the remains of extinct animals, and at a "depth of 10 feet or more from the surface. From causes, into "which it is not now necessary to enter, these discoveries were "regarded with distrust in France, and were very far from being "generally accepted by the Geologists and Antiquaries of that "country.

"In the autumn of 1858, however, the late distinguished "palæontologist, Dr Hugh Falconer, F.R.S., visited Abbeville in "order to see M. Boucher de Perthes' collection, and became "'satisfied that there was a great deal of fair presumptive "evidence in favour of many of his speculations regarding the

" remote antiquity of those industrial objects, and their associa-
" tion with animals now extinct."

"Acting on Dr Falconer's suggestion, Mr Prestwich, F.R.S., " whose researches have been so extensive and accurate as to " place him in the first rank of English geologists, in April, " 1859, visited Abbeville and Amiens, where I, on his invitation, " had the good fortune to join him. We examined the local " collections of flint implements, and the beds in which they " were said to have been found; and in addition to being " perfectly satisfied with the evidence adduced as to the nature " of the discoveries, we had the crowning satisfaction of seeing " one of the worked flints still *in situ*, in its undisturbed matrix " of gravel, at a depth of 17 feet from the original surface of " the ground.

" From the day when Mr Prestwich gave an account to the " Royal Society of the results of his visit to the Valley of the " Somme, the authenticity of the discoveries of M. Boucher de " Perthes and Dr Rigollot was established; and they were " almost immediately followed by numerous others of the same " character both in France and England. In this country, " indeed, it turned out, on examination, that more than one " such discovery had already been recorded, and that flint " implements of similar types to those of Abbeville and Amiens " had been found in the gravels of London at the close of the " 17th century, and in the brick earth of Hoxne, in Suffolk, at " the close of the 18th century, and were still preserved in the " British Museum and that of the Society of Antiquaries."

These implements are now met with in Middlesex, Berks, Bucks, Bedford, Herts, Northampton, Essex, Suffolk, Norfolk, Sussex, Surrey, Hants, the Isle of Wight, Dorset, Somerset, Wilts, Oxford, Cambridge, and Kent. In May, 1881, Mr J. E. Greenhill found at Stoke Newington, and almost close to Hackney Brook, two long pointed implements; and subsequently Mr Worthington G. Smith has met with, in the neighbourhood of London, and particularly at Stoke Newington, what he terms a Palæolithic floor [Memoirs of the Geological Survey of England and Wales, by W. Whitaker, Vol. I. Ed. ii. 1889, pp. 350, 351, Geology of London] and he remarks :—

"The implements have been found in such positions that "the idea is sometimes forced on one that all the makers of the "implements suddenly left the place in fear of some impending "danger."

He believes he is able to divide Palæolithic man into three divisions. The men of the floor were probably, though savage, a peaceful and intelligent community. The abundance of scrapers shews that they scraped skin for clothing. Few of the implements are suited for weapons; and nearly all are obviously tools.

Of the men of the next underlying gravel he said they were ruder, "yet, as one finds undoubted scrapers. . . . it "must be conceded the men knew how to dress skins. It is "not easy to form an idea of the men who made the oldest "tools (in the basement gravels); they were savages of low "degree, with instruments suitable only for hacking and "battering. As no scrapers or knife-forms are to be found (in "that gravel) the men probably knew nothing of dressing skins, "and so went unclothed."

Year by year the area widens, and the number found greatly increases. The most recent addition is from the neighbourhood of Ightham, in Kent, by Mr B. Harrison, and it has been fully described by Professor Prestwich in the Quarterly Journal of the Geological Society, May, 1889.

Last Autumn I had the pleasure of seeing Mr Harrison's collection, and he afterwards went over the ground to shew me where most of them were found, and the next day I visited Professor Prestwich, at Shoreham, who gave me additional information.

Within five miles of Ightham, upwards of 400 specimens were found, and at elevations varying from 110 to 600 feet above the sea level; but only 6 were found over 500 feet. The largest number—161—was at a range of 390 to 460 feet.

The most interesting feature in connection with these Palæolithic implements is the conclusion that so cautious an observer as Professor Prestwich has arrived at—"that the facts "described carry back these rude works of early man to a period "long anterior to the 'valley gravels,' formed under the present "river *régime*, and may, I think, prove even to belong to an "early stage of the glacial or pre-glacial period. The condition "of the implements themselves is certainly in accordance with "the assumption of extreme age, and they bear also the "impress of a very primeval art."

I will now consider the general difference between the Palæolithic and Neolithic implements. The former are mostly found in river gravel, or embedded in clay near the surface of the ground; they are fashioned in a rude manner, and appear to be separated from the Neolithic by a wide interval of time, in which probably the contour line of the country was somewhat different. The Palæolithic flints found, not only in our own country, but in France, shew a great resemblance to each other. Professor Prestwich remarks, in his Igtham paper—"the character of ordinary Neolithic surface specimens is very "distinct from that of these Palæolithic forms. The unpolished "Neolithic flint implements that are found on the surface are "at once recognised, not only by their form, but also by their "condition. The flint is weathered, and the black surfaces "have become irregularly whitened with a dull lustre, and with "the edges slightly blunted, but not water-worn. There is an "absence also of that uniform but varied colouring which "results from entombment in a matrix of a special character. "The specimens are free from incrustation, except in a few "cases, where they have lain in alluvial beds; while from "exposure on the surface they have commonly come in contact "with plough or spade, and the iron rubbed off by the sharp "edges of the stone has rusted and fringed them with strong "ferruginous stains, in contrast with the generally colourless "surface. The surface of these Palæolithic flints, on the "contrary, although they occasionally show contact with the "plough, are more usually free from these iron-marks, and "exhibit generally the deep uniform staining of brown, yellow, "or white, together with the bright patina resulting from long "embedment in drift-deposits of different characters; and "while some are perfectly sharp and uninjured, others are "more or less rolled and worn at the edges by drift action—"some very much so."

Dr Evans is of opinion that "in the case of the unpolished "implements of the Neolithic Period, which most nearly ap-"proach those of the Palæolithic in form, it will, as a rule, be "found that the former are intended for cutting at the broader "end, and the latter at the narrower or more pointed end. Even "in the nature of the chipping a practised observer will, in "most instances, discern a difference."

He further remarks—"If it be uncertain to how late a "period these Neolithic implements remained in use in this "country, it is still more uncertain to how early a period their "introduction may be referred. If we take the possible limits "in either direction, the date into which they fell into disuse "becomes approximately fixed as compared with that at which "they may have first come into use in Britain, for we may "safely say that the use of bronze must have been known in "this country 500 or 600 years B.C., and therefore that at that "time cutting tools of stone began to be superseded; while by "A.D. 1100 it will be agreed on all hands they were no longer "in use.

"We can, therefore, fix the date of their desuetude "within, at the outside, two thousand years; but who can tell "within any such limits the time when a people acquainted "with the use of polished stone implements first settled in this "island, or when the process of grinding them may have been "first developed among native tribes? The long period which "intervened between the deposit of the River Gravels (con-"taining so far as at present known, implements chipped only "and not polished) and the first appearance of polished hatchets, "is not in this country so well illustrated as in France; but "even there all that can be said as to the introduction of "polished stone hatchets is, that it took place subsequently to "the accumulation, in the caves of the South of France, of the "deposits belonging to an age when reindeer constituted one "of the principal articles of food of the cave-dwellers.

"As to the date at which these cave deposits were formed, "history and tradition are alike silent, and at present even "Geology affords but little aid in determining the question."

Palæolithic implements have also been found in caves; but Professor Boyd Dawkins believes there is distinct evidence that the River-drift men are older than the Cave men, and the latter possessed a singular talent for representing the animals they hunted as shewn by several sketches, found in the caves, on bone and stone.

Neolithic implements are found in all parts of Great Britain and Ireland, in Europe, parts of Africa and Asia, and in Oceania.

Dr Evans divides them as follows :—

1. Those merely chipped out in a more or less careful manner, and not ground or polished.

2. Those which, after being fashioned by chipping, have been ground or polished at the edge only; and

3. Those which are more or less ground or polished, not only at the edge, but over the whole surface (Ancient Stone Implements of Great Britain, pp. 59 and 88).

He afterwards divides the latter under the head of Polished celts :—

1. Those sharp, or but slightly rounded at the sides, and presenting a pointed oval, or *vesica pixis*, in section.

2. Those with flat sides.

3. Those with an oval section.

4. Those presenting abnormal peculiarities.

Dr Evans mentions the following ten places where flint implements had been found in Gloucestershire at the date of the publication of his book in 1872 :—

A hatchet of greenstone near Cirencester.

Flint flakes in graves from Oakley Park.

Three flint flakes from a barrow at Rodmarton; also some lozenge-shaped arrow-heads, apparently purposely injured at the point, from a long-chambered barrow.

Two from base of the cairn in the chambered tumulus at Uley.

Numerous specimens of cores of flint.

British hatchet of flint, Roman Villa, Great Witcombe.

An oval knife, about two inches long, ground at the edge, and over a great part of the convex face, found at Mitcheldean, is in the Museum at Truro.

A barbed arrow-head, Turkdean.

An almost spherical stone, but flattened above and below, where the surface is slightly polished, was found at Whittington Wood in 1866.

He also gives a polished celt from Cherbourg Camp, Pusey, Farringdon; but that is in Berkshire.

Although I was aware that The Earl of Ducie, the Rev. D. Royce, Mr G. Witts, the late Mr E. Witchell, and the late Mr G. J. Playne had made collections of flint implements, I did not know they had done so much, and was surprised to find the extent of the work of other gatherers in the field, and I now proceed to give you the result of my enquiries, by which you will see how largely our knowledge has increased since Dr Evans wrote.

No. 1 is a drawing of a hatchet found at the Wilderness Works, Mitcheldean, near the bottom of a valley, covered over with rubble washed down from the hill side, and about 5 inches below the surface, July, 1888. Natural size.

No. 2, Neolithic flint, from the late Rev. Winnington Ingram's collection in the Worcester Museum, labelled, "Found by George Stewart between Pitchill and Rouse Lench, Bevington Waste, when it was first cultivated in 1874," and seen by me at his cottage; bought 3rd November, 1878.

There is also in the same Museum a card with some flint flakes, found at Bredon Hill by the Rev. F. Holland.

From the Gloucester Museum I have two specimens, which were given by the late Mr J. H. Cooke, of Berkeley.

One was found in 1884, near some pit dwellings, now destroyed, as the land is converted into arable, at Westridge, near Wotton-under-Edge; and the other from the slope on the Stancombe side of Stinchcombe Hill. Mr Cooke pointed out the spot to Mr Bellows and myself shortly before he died.

I learn from The Earl of Ducie that he has flints in his collection from the district between Charlbury, Chipping Norton, Chipping Norton Junction, and Shipton-under-Wychwood.

Scrapers are the most numerous, numbering 10 to 1 of Arrow-heads: the barbed ones of the latter are about 400, and of the leaf-shaped form 150.

All the flints found were small in size, varying from ½ to 2½ inches in length, and were most abundant in sheltered situations near to springs. The shapeless fragments The Earl of Ducie has thrown away would fill a wheelbarrow.

At Tortworth only a few flint scrapers and two arrow-heads were met with.

The late Mr Edwin Witchell collected a considerable number of Implements from the high ground above Stroud extending to Lypiatt, Bisley, Brown's Hill, and Rodborough Common. In Vol. III. of our Transactions, page 103, in the plate given by Mr John Jones, are some flints of Mr Witchell's, found in excavating a reservoir on the brow of Stroud Hill. I have examined the collection: some are of very rude form, and I am indebted to Mr Charles Witchell for the cards on the table with specimens. He finds that the following correspond with plates in Dr Evans' book:—No. 1 to fig. 3; No. 4, fig. 5; No. 8, fig. 205; No. 12, fig. 36. The arrow-heads resemble those figured from the Yorkshire Wolds, 321-22-23, page 344, and the peculiar form on card from the Yorkshire Wolds, 221.

There are 50 flakes, 9 saws—the latter are of same character to figs. 199, 200—Evans; and 54 scrapers of various forms.

Mr Moore, of Bourton-on-the-Water, has about 30 fine arrow-heads, and numerous sling stones from Hasleton—a high plateau between Andoversford and Northleach; and he has kindly made for me the beautiful drawing I hold in my hand of some of them.

The Rev. D. Royce, of Lower Swell, has the finest collection I have seen, and they were found in an area embracing Luckley, Condicote, Swell Wold, Swell Hill, Lower Swell, Donnington, and Upper Slaughter. A few were picked up at Benborough and Scarborough. He has something like 1000 specimens, beautifully mounted and classified on cards. Scrapers are most abundant. The arrow-heads shew a marked difference in work and shape, and many of them have one side only partly made, or perhaps they have been broken, like figures 321, 322, and 323 in Mr Evans' book; and they are more numerous than the leaf-shaped form.

There are several, which apparently have been set in wood, with sharp chisel ends, and it has been suggested they may have been for sacrificial uses; some were probably needles; others have serrated edges.

There is a fine javelin, or spear-head; two celt hatchets, which have been broken, and are now about half the natural size; and there is a remarkable flint core 2½ inches long, with a naturally pointed end, with nearly one-half of the other end grooved out for the thumb, and a smaller groove underneath for the finger to rest in.

The rarest form is that of the lozenge or shuttle, which is beautifully worked, like figures 298, 299, Yorkshire Wolds, page 338—Evans.

The large specimen on the card greatly interested me when I saw it in Mr Royce's collection, and I am glad to find the opinion I then expressed that it was an igneous rock has been confirmed. It is a dolerite. From the rude character of the manner in which it was chipped I thought it might be Palæolithic. However, experts in London have, from the partly rubbed smooth face, pronounced it to be Neolithic. It certainly to my mind seems to partake of a transitional character. I would call especial notice to the beautiful specimens on the three cards he has sent me, and in one there are several sacrificial knives.

Mrs Dent, of Sudeley Castle, has kindly allowed me to inspect her beautiful and well-arranged collection of Implements, which were found on the high ground on one side of Sudeley, at Belas Knap, and the neighbourhood, and on the other side of the valley from Sudeley Lodge round to Farmcote Wood.

It comprises at least 450 arrow-heads with barbs—some of the latter are broken: others are very well executed, and correspond with figures in Dr Evans' book from 315 to 333.

Some of the leaf and lozenge-shaped javelins or arrow-heads are beautifully-formed, and are the counterparts of figures 278 to 279 of Dr Evans' book.

There are saws, borers, awls or drills, trimmed flaked knives, and sling stones similar to examples given by Dr Evans.

There is at least one sacrificial knife.

Round the Castle, and also at Stanway, only a few arrow-heads.

Mrs Dent has many hundreds of chippings, flakes, etc., still to classify.

She has some studs of like character to Figures 374 that were found in the field in which Belas Knap tumulus is, or on the hills by Farmcot.

Mr Ernest Sibree, of the Indian Institute at Oxford, has collected about 70 Implements from the high ground in the neighbourhood of Bussage, and most of them from a field at the north end of the Frith Wood.

He has one specimen of a long barbed arrow-head which was picked up in a field close to Rodmarton.

I am much indebted to him for having compared his specimens with the illustrations in Dr Evans' book, and he finds they correspond more or less to Figures 205, 206, 207, 210, 211, 212, 213, 215, 216; and 205 is the actual size. The knives like Figures 233, 241; and arrow-heads 279, 281, 311, 326; but some of the latter are only fragments. The remainder consist of chips of other worked flints which are difficult to identify—one possibly being the top of an awl, Figure 228.

With the flints, Pyrites were found, and they were doubtless used for the purpose of producing sparks, as they are as effective as iron—Evans, page 281.

Mr G. B. Witts has permitted me to retain for some time his specimens. They are as follows:—

ELKSTONE

No. 1.—Scraper. Dense flint.

„ 3.—Scraper. Flint.

„ 7.—Scraper. Cherty flint.

„ 8.—A partly formed large Javelin or Arrow-head. Cherty flint.

No. 10.—Cherty Flint, partly formed, with serrated edge.

ANDOVERSFORD

No. 2.—Celt. Igneous Rock. Probably an aphanite.

No. 4.—Celt. Unusually dense quartzite.

No. 5.—Celt. Fine grained quartzite.

No. 6.—Celt. Basalt—Diorite.

LECKHAMPTON

No. 9.—Scraper. Opaque flint.

No. 11.—Javelin or spear-head. Slate.

BIRDLIP

No. 12.—Flint arrow-head—beautifully formed.

No. 6.—Large Celt of the Irish type.

The igneous specimens were shewn to Mr Rudler, who submitted them to Mr Teale—a great authority on igneous rocks; but he refused to express an opinion unless he had sections taken, which could not be done without injury to the implements.

Petrologists now, by the aid of the microscope, make so many divisions of the igneous rocks, that the old general term of greenstone is in a great measure abandoned; but these specimens may safely come under the general head of very dense igneous Dolerite and Diorite rocks, which were transported from areas far removed from the Cotteswolds.

I have met with rocks of like character in the drift, and also many other rocks derived from distant areas, which will be found enumerated in Vol. VIII., page 34, of our Proceedings.

It was only within the last few days I became aware that the Rev. J. H. Cardew, who formerly resided at Cheltenham, had made, when he was there, a large collection of implements from the high ground of the Cotteswolds, extending as far as

Northleach. His son, Dr Cardew, has shewn me some of the specimens, and they correspond with those I have exhibited, and he told me that he believes his father must have had 200,000 flints, of all kinds, of which 10,000 exhibited evidence of human manufacture.

I was glad to hear that the result of the Rev. J. H. Cardew's observations is embodied in a paper which will shortly be read to the Gloucester and Bristol Archæological Society.

In commencing my investigations I thought I might be able to arrive at some general conclusion as to the number of kinds into which implements might be divided, the proportion of each, and variation in certain localities; but I have failed to arrive at any general law. Of the most highly worked implements, the lozenge-shaped and pear-like forms are the least numerous; and the arrow-heads perhaps are the most abundant; whilst the number of all kinds found, and the evidence of progress from rude to higher forms, certainly point to a long occupation of our hills by man. Indeed, some of them are so beautifully worked as to shew much artistic skill in the design and manufacture. They are not implements of mere utility, and the old inhabitants probably possessed a higher degree of intelligence than is generally thought.

I have been struck with the general resemblance of the implements found on our Cotteswolds to those of the Yorkshire Wolds, which seems to indicate a connection between the then inhabitants of both hill grounds. They may have been the Highlanders of the period.

Although we have evidence of how flint implements are made and used by uncivilised nations, reasoning by analogy it is fair to assume that they were similarly employed by the Neolithic people; yet, in looking over the various collections, I have observed some of the forms are so peculiar as to leave room for the imagination to run somewhat wild when suggesting the purpose for which many were intended, and more careful observation is necessary before their use is rightly understood.

The subject of Neolithic implements may be thought by some to belong more to Archæology than Geology, but the former study has always formed part of the investigations of the Club.

It is often difficult to define where one ends and the other begins, and indeed in this particular branch of the subject they appear to mutually assist each other.

The object for which these implements were made belongs more to the Archæologist, but he has to fall back upon that branch of Geology now much studied—Petrology—which determines the rocks they are composed of, where they are derived from, often hundreds of miles away—and which widens and deepens our knowledge, and gives additional interest to the subject.

And now to return to the Palæolithic implements, of which at present there is no reliable evidence of any having been found in our area, but I shall endeavour to give reasons for thinking there is hunting ground where they may be met with.

Dr Evans informs me the nearest spots to our district where they have been found are the Thames basin above Oxford, and the Valley of the Axe, near Axminster; but he has in his collection a black chert core from Fladbury, which may be natural, if not Neolithic.

In other areas where Palæolithic implements are found they are often associated with Mammalian remains, and as we are rich in specimens of them—as shewn in the Gloucester and Worcester Museums—it is in the localities and neighbourhood where they occur we should make diligent search.

I would suggest Lassington, Highnam, Limbury, east side of the Malvern range, Birth Hill, Bredon, and Cropthorne Gravel Pits, the hills on both sides of Evesham, Welford Hill, Broom, Stratford-on-Avon; and from there in the Northern Drift Gravel above the Stour to Shipston, and on to Mickleton and the Vale of Moreton.

When we know that Mr Royce was for many years at Swell before he was aware of the existence of implements in his parish or neighbourhood: and as they escaped the notice of so well trained an observer, we must be careful not to attach too much value to negative evidence: another instance

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of how ignorant we often are of the treasures which are within our reach.

In the remarks I have made I have simply placed before you the work done by competent observers, in the hope of stimulating you to pursue a new branch of enquiry, which, believe me, is full of interest. Should you take it up I feel sure you will attain the same eminence in it as you have done in those branches of Natural History of which your Proceedings give evidence.

## EXPLANATION OF PLATES.

*Royce Collection.**

### Plate I.

Fig. No. 1.—A large Celt of Dolerite, half natural size.

Figs. Nos. 2, 4.—Pear-shaped Spear or Javelin heads.

Fig. No. 3.—Leaf-shaped Spear or Javelin head.

Fig. No. 5.—An Arrow-head, with a long projecting wing at the base of one of the angles, of like character to Figure 338, Dr Evans, and said by him to be common in Yorkshire and Derbyshire Wolds.†

### Plate II.

Figs. Nos. 6, 7, 8.—Knives; probably sacrificial.

Figs. Nos. 9, 10, 11.—Arrow or Javelin-heads.

Figs. Nos. 12, 13, 14.—Lozenge-shaped Spear-heads.

*Witts Collection.*

### Plate III.

Fig. No. 15.—Celt. Fine-grained Quartzite. Locality: Andoversford.

Fig. No. 16.—Slate; probably a Javelin or Spear-head. Locality: Leckhampton.

Fig. No. 17.—Large Flint Arrow-head, beautifully formed. Locality: Birdlip.

Fig. No. 18.—Celt—Igneous: probably an aphanite. Locality: Andoversford.

Fig. No. 19.—Opaque Flint Scraper. Locality: Leckhampton.

* Kindly drawn by Miss Francis.

† One-barbed arrow-heads are frequently found on the Cotteswolds like fig. 321, Dr Evans, and he considers that "one of the barbs having been broken off, possibly in the course of manufacture, the design has been modified, and the stump, so to speak, of the barb, has been rounded off in a neat manner by surface flawing on both faces. The one-barbed arrow-head thus resulting presents some analogies with several of the triangular form, such as fig. 338."

## Plate IV.

Fig. No. 20.—Polished Celt, found at the Wilderness Works, Mitcheldean, about 5 ft. below the surface, July, 1888 (Colchester-Wemyss collection.)

Fig. No. 21.—Polished Celt, found at Westridge, Wotton-under-Edge, 1884. (Gloucester Museum.)

Fig. No. 22.—An Axe of extremely dense fine-grained quartzite (Witchell collection).

Fig. No. 23.—A Scraper: the butt-end has the appearance of a handle, and is like Fig, 221 from the Yorkshire Wolds, in Dr Evans' book, Fig. 277. (Witchell collection.)

ROYCE COLLECTION. Plate I.

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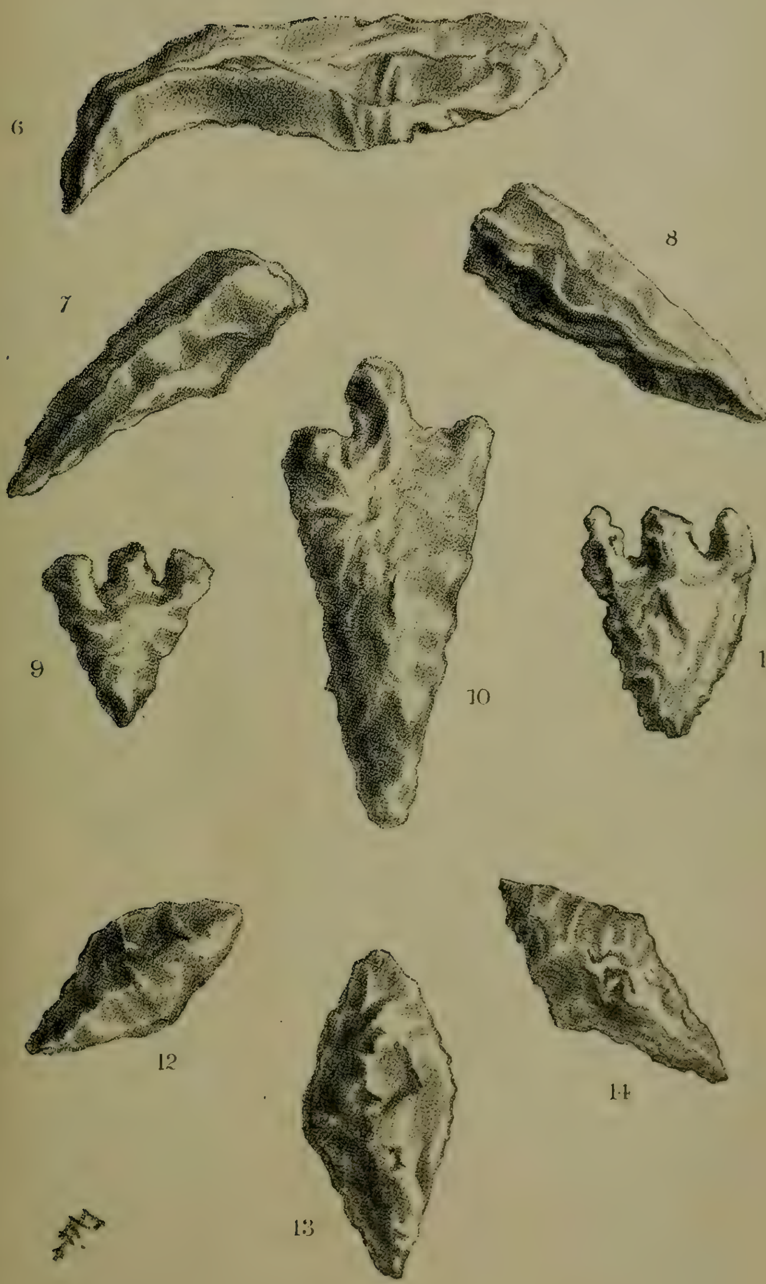
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Plate IV.

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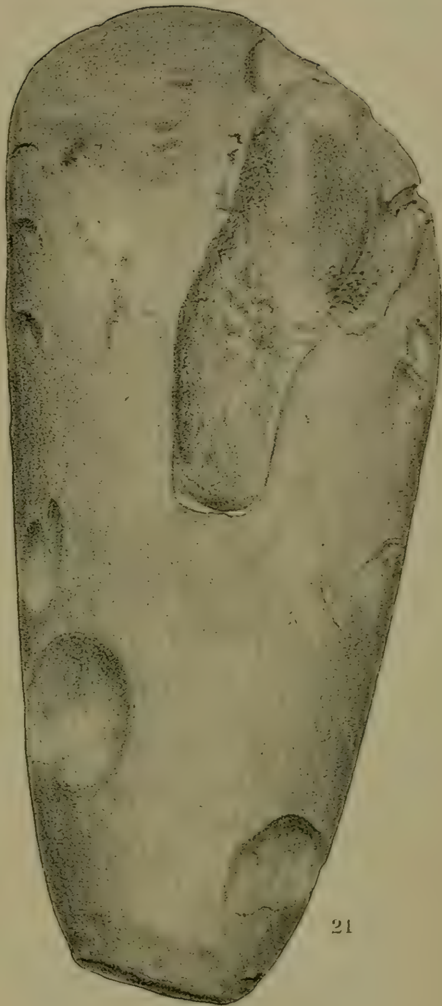

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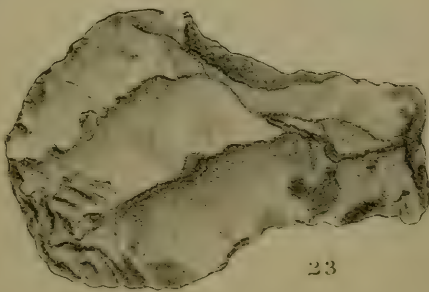

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DEATH OF THE MALLARD

## *Modern Falconry, by* Major Fisher
*Read November 26th,* 1889

[L'Envoi. Before submitting the following "paper" to the honor of finding a place amongst the publications of the Cotteswold Naturalists Field Club, its author desires to remind his fellow-members that on the 26th of November, 1889, when he undertook the task of essaying to read a paper on the subject, he soon felt obliged to discard all notes and previously arranged matter, and to deliver himself of what he had to say in an entirely impromptu and extempore manner. The reasons which compelled him to this course, were, 1stly, the very short space of time placed at his disposal—(there being a second, if not a third, paper to be read on the same occasion);—and, 2ndly, the fact that, whilst in the case of ordinary papers the exact sciences obtain the most, in the case of such an one as this, it is absolutely requisite that the Natural History treated of should be rendered interesting and amusing as well. For the dry details alone of the practice and knowledge of such an art as Falconry from its first inception as a mode of obtaining fresh meat for food, to its present state as a pleasing field sport, could not fail to be tedious, and, moreover, are to be found in most books on Falconry. The writer, therefore, ventured to trust entirely to practical acquaintance with his somewhat strange subject, and to rely very much on verbal description, of actual facts, and flights within his own experience. He is therefore entirely ignorant of what he did *say* in the whole course of the "paper" he is supposed to have *read!* and painfully conscious that he can speak more readily than he can write. In fact, it is only because it would be churlish to continue to refuse to comply with the flattering requests from

President, Secretary, and many of his fellow-members, that he has consented to try to reproduce by the pen the following "lame and impotent conclusion" of what he began "by word of mouth."]

As all modern Falconry is necessarily conducted very much in the same way—and with the same sort of hawks—as it was conducted by our ancestors, it is impossible to avoid some reference at least to ancient times, though it will be convenient on the present occasion to confine oneself as much as possible to what is not only possible, but of constant and almost daily practice by many amongst us, at the present day: and this the more from the fact that from the necessity of the case, and the greatly changed conditions under which Falconry, to be practised at all, must now be practised in this and most other countries, it has long been very little "en evidence" in public, and is pretty generally believed to have all but ceased to exist. This is not so. It has never yet ceased to be practised in Scotland from the earliest times. And the Scotch school of Falconers, represented by several distinguished Scotch families and their professional falconers, using and flying their native falcons at their native game, has long existed, and still exists. In England, from the more general practice of shooting, and the spread and increase of population, and enclosure of open land, it appears to have fallen into disuse about the time of the Commonwealth; whilst it lingered on the continent—and often on a great scale—till the period of Napoleon's wars. About the close of the 18th century, Lord Orford (uncle to Horace Walpole) and Colonel Thornton made a very considerable and successful effort to revive Hawking in this country, to which end they introduced "the Dutch School of Falconry" into England, with, of course, Dutch professional falconers from Valkenswaard, Eindhoven, Holland—the nursery place of Dutch hawking, and where its practice as a profession has never yet been extinct. This Dutch system of hawking had extended into Scotland, which has always had its own native falconers: the Scotch using eyesses, or nestling falcons, and the Dutch necessarily passage hawks, or wild caught birds, since no falcon breeds in the low lands of Holland, though nearly all varieties pass over it yearly when migrating. As a very sufficient knowledge of the importance and constant reference to falconry and its practice, its own peculiar vocabulary, rights, dignities, etc., etc., amongst our ancestors, doubtless obtains amongst us, a very short reference to Ancient Falconry must here suffice. I cannot, however, well help recollecting in the City of Gloucester, that King John, a great falconer, once sent his falconer, who bore the name of Hawkinus de Haw-ville (of which more anon) to Gloucester for the purpose, not then of using, but of moulting or mewing his falcons when the time for shedding their feathers had arrived. Moulting is a long and tedious and dangerous process in the case of most trained hawks, and specially in the case of that noble friend and companion of nobles in all ages—the Peregrine falcon—the most docile and useful by far of all hawks ever known to man. In short, the only real fault that *can* be alleged against this hawk is the fact that she is a slow and bad moulter, apparently even in a wild state. Mews, though now the designation of stables in London, were anciently the places of abode of falcons undergoing their annual process of moult, extending over 5 months, and the professional falconers, valets, and servants of their owners employed in caring for them. King John sent his servant to Gloucester, armed with a rescript to the Sheriff of Gloucester, to provide proper food, lodging, and maintenance for him, his men, and his hawks; and oddly enough some of them are mentioned by name! viz., the King's Gire (Jer) falcon, "Le Refus" (so called doubtless from her propensity to refuse to fly at the desired game: a propensity common to Jerfalcons of the present day); "Black-man," and "The foolish falcon." Oddly enough, too, the old family of Hawkins, of the Haw, near Tewkesbury, have long been famous sportsmen, though I have never heard of their being falconers of late years.

From the days of King John to the present time is a long interval indeed; but a remarkable succession of falconers from father to son, for many generations, occurs in the ancient Scottish family of the Flemings, of Barochan Tower, in

Renfrewshire. The present possessor kept hawks in India (as do the officers of the Guide Corps on the frontier, 3rd Sikhs, etc., and many of our own officers, and multitudes of the native princes and nobles). His father kept the Renfrewshire Subscription Hawks until his death in 1819; and his grandfather was a celebrated falconer. Peter Fleming, an ancestor, received a hawk's hood, set with jewels, from James IV. of Scotland, for beating the king's falcon with his tiercel. This interesting relic is carefully preserved in the family. The falconers employed by the Flemings have always been Scotchmen. No list of amateur falconers can be produced for England from the time of the last civil war to the close of the last century, from which period to the present day a very perfect list is well known. Notwithstanding this, the Dukes of St. Albans have for ages been Hereditary Grand Falconers of England. The last Under-Falconer of Scotland was Mr Marshall Gardener, who retired from his office in 1840. It is now in abeyance. As it is obviously impossible to do anything like justice to this subject within the ordinary limits of "a paper," I shall endeavour to avoid entering into details, and think it may be sufficient for our present purpose to consider shortly—

1st,—The various hawks usually employed in all modern as in ancient (European) falconry: those used more especially in Eastern and North African sport being merely glanced at.

2nd,—The way they are caught, or procured.

3rd,—The methods of taming, training, and using them, and the flights, *chasses*, or quarries for which each species is most adapted and most used.

4th,—The kind of country required for the satisfactory practice of these different flights.

5th,—Some general remarks on the modern practice of the old sport; the very great and increasing difficulties attending it; and, if possible, some of the writer's own experiences, and a short description of some of the flights he has seen and enjoyed; and he regrets his entire inability to do this in a better manner, or to his readers' satisfaction, by means of the pen alone: the subject requiring illustration by production of the hawk and her paraphernalia, etc., which to some extent he was able to do in the Lecture Room at Gloucester, but cannot here.

1st, then, the hawks employed.

These, as formerly, are of course divided, in falconers' fashion, into—" Hawks, long and short winged ;" and a very suitable division it is. In fact, Falconry proper means the employment of some species of falcon, long-winged : Hawking, that of some species of short-winged hawk. For all practical purposes, the long-winged hawks employed, consist of the three varieties of the great Northern falcons, called Jerfalcons, or Gyr falcon, viz., the Greenland, Iceland, and Norwegian Jerfalcons, the Hobby, and the tiny Merlin ; and last and best, the well-known Peregrine falcon. This sheet-anchor of the falconer in all ages and in every clime (for she truly deserves her name—Peregine Pelerin or Pilgrimsfalk)—is found at various periods of the year in most countries, where her peculiar and lovely stoop has in every age been a terror, not only to the swift but also to the strong. Yes, beloved bird, well may I praise thee! Adorned with every good gift—beauty, grace, strength, and unmatchable speed, courage, skill, and perseverance—to all these dost thou add the tameness and docility that so admirably adapts thee to be the companion, friend, and servant of man. Once held in the highest esteem by prince and noble, and never far off from thy owner, even when the day's sport was done, *thou* hast not changed. My friends and I have ever found thee exactly what our ancestors found thee, and as all who seek shall find thee, as long as thou art to be found. But what a change has occurred in thy old relations to man, in England ! No longer legislated for, and defended by custom from all harm, thou hast become a sort of common enemy, and the most ignorant of gamekeepers, deems and treats thee as "vermin," with the sanction, and by the desire, of him who should know and treat thee better, if for no other reason, then for the sake of thy faithful services to his predecessors, over the very lands, whereon I have had the pain of seeing thy poor skeleton depending from a vile rusty nail on the keeper's gibbet—thee who once sat caressed on the wrist of Beauty! The coast and inland precipices of the British Islands are some of the most favorite breeding places of this fine falcon, though the incessant persecution now bestowed on her everywhere, and the taking of her eggs and young so constantly as to render the procuring of young peregrine falcons to be trained for sport increasingly difficult, year by year, is rapidly reducing her numbers. Still the open downland country of the South, and the moorlands of the North of England are frequently graced by the peregrine's flight; and long may they so continue to be, for without her, falconry could hardly exist, though hawking would remain. The Goshawk and Sparrow-hawk are both hawks short-winged, and are easily to be distinguished from the aristocracy of their race—the falcons proper—by the yellow color of the iris of *their* eyes, those of all falcons whatsoever, being very dark brown, approaching to black (so black as to be little lighter in color than the black pupil of the eye itself). Foreign falcons, such as Sakers—and Lanners—and the lovely Indian variety of the peregrine falcon, called Shaheen, are all used in Persian, Moorish, Arabic, and Indian falconry. A variety of the golden eagle, called Bearcoot, is in use amongst the Kirghis of the steppes of Asia; and the Goshawk and Sparhawk in enclosed countries, anywhere, where speed is not so much required in the pursuer, as courage and determination.

2nd,—The way falcons and hawks are usually caught or procured alive and unharmed for the purpose of being trained.

They are usually divided into Haggard—passage or wild caught hawks; and eyesses, or nestlings taken by hand from the eyrie or nest, before they can fly. It is needless to say that the former are for all ends desired by the falconer but one (viz. tameness) immeasurably to be preferred. The one, in fact, may be roughly compared to a wild lioness or tigress, born and bred up, and well taught her business, by her parents, as in very truth *she* is. She is, therefore, of course, when caught by man and tamed sufficiently to be trained and used for sport, most competent to take, in the best of style, any fowl she may happen to meet, within her compass. The eyess, or nestling falcon or hawk, taken too young even to have once flown on the wing, and deprived for ever of the invaluable teaching of her parents, is entirely ignorant at first of any single thing she should know or do, except to eat meat at the hands of her keeper. She cannot even fly, without at least a month's flying loose, (called flying at hack, directly she is fully summed, or feathered.* Considerable powers of speed, and the desire, and in time the ability, to prey for herself *do* eventually come to the nestling's aid. I have *never* however seen or heard of any nestling falcon, however good and however prized and successful, whose style of flying and stooping came up to those of a wild caught hawk, whilst her powers of footing—(hawks *all* strike and catch with their feet alone, or by blows from their powerful and sharp back talons, in the case of falcons proper)—are for ever far inferior to those of her better trained, and better practised and once wild, congener. So that she, in turn, may be compared to a lioness, etc., born in a menagerie, Wild falcons, goshawks and sparhawks, are sometimes trapped unharmed, if great care is taken, on prey they have killed, and so come into our hands. If their valuable flight feathers and tail feathers are not much damaged, their captor deserves great praise. I have had three or four wild English peregrines thus procured, and have one such now. I have also most grateful memories of the services of one such—once an adult female peregrine falcon,—wild on the Wiltshire Downs, and who killed for me, in the grandest possible style, grouse after grouse daily, in September and October, in Northumberland, in a style, from a lofty pitch, and with the peculiar stoop, of the wild peregrine.

* This is usually effected by the young nestlings being provided with jesses and a large and heavy bell, large enough to hinder her greatly in attempting to take wild quarry. She is then set at liberty in any convenient place, where she may be tolerably safe from harm for twenty miles round, fed twice daily, and caught up as best she may be when she ceases to "come in pretty regularly to evening feed." I have even hacked hawks from Stroud, in the past—absurd as it seems, in the present, time!—and taken them up, after a month's good hack. I know of no place in England, where this can now be done. I have, however, at the present moment, three nestling peregrines from Dorset—now flying loose at hack in the neighbourhood of Thurley, Ireland—(from an old ruin).

that no one who saw is likely to forget. Poor dear old "Queen." She did not escape, scathless, from the cruel trap: her foot suffered thereby, and gout (unknown to her till her acquaintance with man) rendered her useless, after one season's brilliant performances. I used to know her stoop from all other a very long way off. As no dependence can be placed on such a source of supply, and as no one who can procure wild caught peregrines is likely to be contented long with nestlings, we modern users of peregrines, have resource yearly to a supply of this raw material for our sport, found, oddly enough, in the village of Valkenswaard, Eindhoven, Holland. No falcon, or no peregrine falcon, breeds in that flat land, but a yearly migration of birds of prey of most European varieties takes place there in November. This migration is, at that period of the year, entirely from west to east, and the usual track of the migration, appears to pass pretty centrally, over the barren heaths, on the confines of Holland, and Belgium. As the migration of birds is still very little understood by naturalists, or even where they go, or whence they come, in countless instances, conjecture is in vain. India is generally regarded as the hawk's goal, but it is but conjecture. What is certain, is, that for a month or so, usually in November, a multitude of birds of prey are then and there to be seen, at a vast height in the air, and the circumstance has been taken advantage of for ages past by the Dutch falconers. Dutch falconry had never been extinguished until the final disappearance of the Loo Hawking Club, formerly presided over by the Sovereign and princes of the Netherlands. Valkenswaard has from immemorial times been the home of hawk catchers, *and is so still.* Modern falconers yearly order of Adrian Mollen—formerly one of the Royal falconers—such peregrines as they desire, either adult—then called Haggard—or young, *i.e.*, birds of the year, from their color called red, or passage hawks—(adult peregrines are of a bluish color and totally different in hue from those in the brown dress of the first year's plumage). According to the number ordered, Mollen "puts out," or puts in order, so many "huts" on the heaths, and mans them with competent "catchers" for the brief migration or passage in question.

The method adopted is intricate and interesting, and must only be briefly described here. Moreover, our late lamented friend, Mr Barwick Baker, has pretty fully described the process, in a former number of our Society's Proceedings. The so-called "huts" are holes dug out, and walled with sods, and roofed with boughs and sods, so as to be very undistinguishable. The occupant, who is frequently by profession a cobbler, is provided with provisions, water, and Schnapps, and a sack of boots and shoes to mend. As his vision is but circumscribed, he depends greatly on a little living sentinel, who lives in full sight of his hut, in a little turf cabin or cage outside. This sentinel is the larger butcher bird or shrike, *Lanius Excubitor* —(I have hitherto avoided Latin names)—which bird is gifted with the most remarkable power of sight, and, as it would seem, with a tender conscience. Be this as it may, the moment he perceives any bird of prey, however far off—(I am told miles)— and however high—(I am told out of the power of any glass)— he begins to be agitated to a high degree, and calls and attracts the attention of the dullest hut tenant, exhibiting a terror so extreme and unusual, as really to suggest a sense of expectation of retributive justice, on himself, from the approaching hawk, for the countless cruel, and dastardly actions, of his whole life. Truly is this little beast named the Butcher bird, for like all shrikes, his method is, to rend his victims—mostly small birds—limb from limb, impaling them first carefully, on a long thorn, or fixing them in a fork near his larder, which he thus literally festoons with their remains. No one who has not seen the neat way in which the English shrike, *Lanius Collurio*, thus serves countless insects on a blackthorn bush, can have any idea of the pain inflicted. In addition to this sentinel, the hawk catcher is supplied with a pigeon, who lives in a little box on the top of a pole, and which is attached to a cord working into his hut. He has also another pigeon living in a box, or turf hut, *on the ground*. Some 20 yards from his hut door a carefully concealed bow net, working easily, and well, also from inside the hut, completes his devices. The butcher bird's actions denote the approach of the migrating hawk—(species, age, and sex unknown)—and the hawk catcher pretends to be able to determine the distance and quality of the approaching migrant by the different intensity of the terror of the sentinel. When deemed sufficiently near, the hawk catcher pulls the string of the pole pigeon, and causes him to flutter forth from his shelter, but so that he can instantly regain it at need. This lure is frequently sufficient to draw a passing hawk, (probably sharp set) from the clouds, and is often instantly followed by the rush of the lofty and violent stoop—most grateful of all sounds, to the patient ear of the concealed cobbler. In a moment the lure pigeon is gone—safe once more in his box. The disappointed hawk wheels round, whereupon the cobbler pulls the other poor devoted pigeon out of *his* shelter, and leaves him exposed. Down comes the hawk, very often, (seeing nothing wrong) and kills and soon begins to eat his prey. It may here be parenthetically stated that *nothing* will induce a wild falcon to eat a morsel of any live bird. She invariably kills it first with incredible ease and swiftness, by two or three powerful bites at the back of the neck, killing a pigeon, grouse, or partridge far faster than any human being can with their hands, and usually decapitating it as well. This finalè is arranged to take place very close to the sweep of a bow net, but the hawk is not disposed to relinquish her prey easily, and usually suffers herself to be drawn slowly along with it into the reach of the bow net. The line is fixed there, and the delighted cobbler takes a good hold of the cord or wire that throws the bow net (a most clever contrivance), and with one masterly pull, the hawk and pigeon are therein, from whence there is no escape. The taking of a wild falcon out of a net, without the slightest harm, and without even ruffling a feather, is a feat requiring much skill and practice; but it is soon done, and a curious arrangement of canvas and strings, reduces the proud and noble captive in a very few minutes, from a denizen of the air, to a motionless mummy, lying on its back entirely helpless on the heath, with its wings fast pinioned to its sides, an easy hood on its head, and its feet and legs manacled with soft list—a change as strange as rapid, and one that must be seen to be believed.

One, two, or even three, such hawks, are occasionally thus captured at a single "hut" in the day, though as often, whole days pass, without anything to excite the restless vigilance of the butcher bird sentinel. Buzzards, goshawks, sparrowhawks, merlins, and even, I think, an occasional eagle have thus also fallen a prey to the Valkenswaard falconers. In the evening the captures of the day (still in the mummy state) are taken from the hut to Valkenswaard, where a red, or young peregrine, is worth about £4.

As neither falconry nor hawking are longer practised in Holland, there is no need for the Valkenswaard hawks to be trained there. They are all ordered previously, by English and French falconers, and I think, at present, by no others, and when ready for removal, servants are sent for these falcons, or hawks, or occasionally a falconer or naturalist anxious to see with his own eyes the singular process of capture, and to enjoy the further sight of the long row of lovely peregrines (no longer mummies,) but sitting bolt upright on the pole-screen, with hood on head, jesses on leg, and attached by swivel and leash to the pole, whereon they stand. However, as a fortnight's care and gentle handling are usually bestowed on the captured hawks by Mollen and his sons (and I believe daughters) and his assistants, it may be well to mention the ordinary steps for taming so wild a creature, and eventually rendering her so docile and obedient as to "wait on" high in air, wholly her own mistress, and as free as when she first was observed by our butcher bird, and herself observed the cobbler's offered pigeon: but *this* time for the purpose, perchance, of striking to earth, with the self-same sort of stoop, a grouse or a partridge even now lying perdue in front of her owner's well-trained and motionless dogs, amongst the Northumberland heather. The newly caught hawk, when her furniture as above, has been supplied, and the sharp point of her beak, and the yet sharper points of her black talons have been slightly coped, or shortened, by the falconer's pincers (for the Dutchmen are very careful of their hands and fingers, and these necessaries of her wild life are not likely to be immediately wanted again) is probably replaced on the pole. Two such are also usually taken in hand by one person, and are sedulously attended to from morning to night, with very little intermission. The hood used at first is called a Rufter Hood. It is large and easy, and though preventing all sight, is one the hawk can eat through; and it is not removed night or day for a week, as she can easily sleep in it, though if they could themselves do without sleep (as truly they cannot) the Dutchmen would tame these falcons in half the time, could they but keep them awake for three nights consecutively as well as three days. For some reason, long-protracted deprivation of sleep, appears to deprive the wildest hawk (for a season) of her wildness, and seems to change her nature. If followed up by judicious treatment, the change is rendered permanent, but a very little inattention, and a very little sleep soon changes the scene. "*Elle se ravisera*," says old D'Arcussia, and all will have to be done over again. The best method of taming a wild caught hawk (no such easy task ordinarily I trow) is found to be, by *carrying* her about on the gloved wrist, and stroking her occasionally with a soft wing or feather. The unusual position and involuntary motion appear to disconcert the wildest, much to our advantage. She has to be broken to the hood also. Likewise none too easy. Some hawks dislike this appendage; others seem to care less for its inflictions. None like it, and all, unless skilfully handled therewith at their first making, are more or less hood-shy, and more or less disabled, for future usefulness. A wild caught hawk is not inclined to eat, and some will not eat for many days (always a bad sign of a wild, and shy, temper). However, hunger *is* a sharp sauce, and *F. Peregrinus*, having seldom known it as a wild, soon acknowledge its power as a tame (or captive) bird. She soon discovers that meat is offered, by the feel of it near her feet, and sooner or later will eat it through the hood. It is many days before she will eat it bareheaded (always on the falconer's wrist be it noted); and first of all by candlelight alone, afterwards in a room, and after that in the open air. Having fed, often and well, on and from the hand of man, she is placed on the pole, her hood is struck and removed, and she is tempted by something specially nice to step from the pole to the falconer's fist, to reach, and get it. Some are bold, others shy; some eager, others the reverse; but in time all (except the occasional schellums, or rogues, whom none can tame) come to, and finally jump, and then fly, quite long distances (in the room) to the fist for food. This exercise is long continued and maintained, by the food being good, but tough, and so the banquet of the hungry hawk is long protracted, to her own great improvement in tameness to her keeper and confidence in his good intentions. The pinion of a pigeon, or part of an oxtail, is excellent "pulling." Then the falcon is introduced to the "lure," the special engine of the falconer of all ages.

How long and how strong, was the feeling produced by the love and practice of falconry on our fathers, is proved by the presence to this day, of so many of the technical terms of falconry, in our language. "Lure:" to attract, speaks for itself. The substantive "lure" being the attraction offered by a falconer to his distant hawk, to bring her back to him. Most of us of the craft have had constant occasion to repeat poor Juliet's mournful cry—"Oh, for a falconer's Lure to call my Tassell (or, as it should have been spelled) Tiercel gentle, back again." Tiercel, from tiers three, is the falconry word for the male of all falcons and hawks, as they are invariably about one-third less in size and strength, than their mates. In incubating, the males of all falcons are observed to work ceaselessly to supply their mate, and ravenous—most ravenous—young, with food, whilst the stronger female spends her whole time close by their side, for their defence; and woe betide any prowling bird—raven, jackdaw, or herring-gull, that ventures to approach the rocky shelf on sea-cliff, or inland precipice, where *she* abideth: and I have myself known stout cliff-climbers, let down with rope for the purpose, have to give it up, frightened by the attack on their faces, of the infuriated old birds.

A "lure" is or may be, *any* portable object, on which a hawk has been fed—the dead body of the fowl it is more especially to be used to capture, is of course, a good "lure;" but as this cannot always be procured, and kept fresh, a dummy of iron, covered with tow and leather, a loop for a swivel, and wings of any sort (notably again those of the flight for which it is sought to use the hawk when trained) are attached, and strings by which pieces of meat, or bird, or even rabbit may be securely fastened. After being often and well fed on this, on the ground, the hawk in a creance or line is induced to come to it farther and farther, and when she *will* come to it, and *will* not leave it, but stick to it, and suffers herself to be taken up on it, rather than leave it, (of course being well rewarded thereon for her goodness) she is held up loose from all tether, and called to the "lure" from long distances. If a bird, dead or alive, of the sort aimed at, be then substituted for the "lure," and she acts equally well therewith, little remains but to introduce her to the serious business for which you desire her services, for which nature has so well inclined her, and for which, or some such work, her parents taught, and she practised, the lesson required, before you obtained possession of her, but which now (sweet docile bird) she is equally ready to practise for you! Many a time has my eight years' old falcon (and friend) "Lady Jane Grey," loudly uttered her note of chirping delight, by my side, when she has brought down the desire of her heart—a grouse: the very self-same cry as she whilom uttered thereon, in her wild state, when man was her most dreaded foe, to be avoided on sight, at a quarter of a mile off.

The "lure," in teaching a falcon to "wait on" for game is withdrawn, and concealed, just before her approach. This disappointment, causes her to circle round (exactly what you want), to see where it is. Instantly it is produced. When game is found in the field the same is done, and on the hawk attaining any height it is flushed under her, and she is not long in making her stoop: and let us hope that her first few efforts will be successful, and that if so her master will reward her most liberally thereon. (He had far best do so in fact.)

The noblest of all possible of flights, in which the powers of a trained hawk could be employed, were confessedly those of the wild kite, and the heron. Neither of these, of course, *ex necessitate rei*, could be effected in the waiting on style, neither kite, nor heron, allowing of that. In fact, nine times out of ten, in flying at the heron (the only one of these two grand chasses possible at the present day, from the simple reason of the disappearance of the kite as a common bird, entirely from the British Isles, and generally so throughout Europe) the hawk or hawks employed, have to be unhooded, and cast off, at the heron, high in air, and it is to be pulled down—if pulled down this well-armed, strong-winged, fowl, is to be—simply and solely by strength of wing and talon, of the far smaller falcon, aided by her courageous heart. It were too long a task for me here to essay to recount, how the princes and nobles of old, flew "*Falco milvus, regalis*" of yore, for they had first to procure hawks of sufficient strength and courage (Jerfalcons they, by preference); next, "to find their hare"—viz., the crafty aerial scavenger, with the forked tail, and powers of flight only a little inferior to their own, but coupled with a craven spirit; and thirdly, to bring him down from a speck in the blue, to a distance possible to be reached, by his intended assailants. All this, before the interesting struggle could even be begun—a struggle which neither I, nor any living falconer has seen in this degenerate age, nor ever will, I trow, unless some enthusiast to whom the expenditure of time and money are literally "no object" will spend not a little of both, in emulating the deeds of his fathers, having first discovered kites enough, in a country as open as the best part of Salisbury Plain was, 150 years ago.

The flight at the heron is universally esteemed, next: and has been practised in perfection, by the English and Dutch falconers of the Loo Club, at the Royal Palace of the Loo, in Holland, under the presidency of Prince Alexander of the Netherlands, until within some 40 years ago, when the Club was given up, and since then no heron hawking has taken place at the Loo. I find in "Fauconnerie par Schlegel et Wolverhorst," that in the year 1842, the falcons of the Loo Heron Hawking Club numbered 44, and the herons taken 148; in 1843, 40 and 200; in 1844, 36 and 100; about the same, until 1849, when it was 14 and 128; in 1850, 16 and 137 respectively. I have been unable to ascertain the annual expenses of this fine establishment, but from the number of falconers, and men and horses required (the latter having to gallop their best on the sound, holding, dunes, of heath land, surrounding the vast heronry at Loo for miles) it must have been very considerable. Mr Clough Newcome, one of the Club English members, long flew herons at his home at Hockwold, and at Didlington, in Norfolk; and in 1843 he had the best possible cast of passage hawks, for a heron flight, called "Sultan," and "De Ruyter." They were, of course, taken at Valkenswaard, and trained and used at the Loo, and during their third year they took at Hockwold and the Loo 54 herons, and in 1844 57 herons!

The herons thus taken were, with few exceptions, released very slightly harmed, but adorned with a ring attached to a leg, with date of capture added, and (if they possessed them) minus the black pendant feathers at the back of a mature heron's head—usually set with jewels and worn in the falconer's cap. I have never myself seen a heron flight, nor has there been one attempted by the Old Hawking Club, which yearly meets on Salisbury Plain. *Their* quarry is the rook, which, in early spring on those open downs, with no mean powers of wing (witness its evolutions in a wind sometimes) and aided by a most sagacious brain, with plenty of law, makes a substitute to-day, though a very poor one, for the noble heron of the past. The hawks of the Old Hawking Club accounted for no less than 258 rooks in the spring of 1890. They are taken about from place to place in a van, and the falconers are all well mounted and ride very hard. Rook-hawking is thus performed, to entire perfection:—

The nearest approach to a heron flight that I have ever seen, occurred in this wise. In October, 1889, my old grouse hawk, "Lady Jane," was waiting on at a height so great, that though she is upwards of three feet across from tip to tip of expanded wings, she appeared in the sky, like a pin's head, over the moor, the dogs being unable for some time to find her a grouse. Presently they stood, and on the men moving forward to put them up for her, I perceived her in the act of stooping. I called out, to prevent their purpose, and fixed my glasses on the hawk expecting to see her in pursuit of other grouse, raised accidentally. Presently she was down, and instantly engaged with some large bird, which I deemed, and the men asserted to be a carrion crow. As it looked large and light-coloured, I said, " then it is a hoody (Royston) crow ;" but in a moment, as the excited couple rose high in air—at it ding dong—I knew it was no crow. No; none of that ignoble brood, ever flew, or held the air, like this strange quarry, which, in a few seconds more, I made out to be " *Numenius arquata*," the common or long-billed curlew. I know no instance of this grand flier, having been taken by a trained hawk, and it is generally deemed beyond the power of any such. Of course it is occasionally slain by a wild falcon; but then, doubtless, the worst wild falcon is far before the best trained one, and if inclined and meaning it, can take most fowls that wing the air with more or less ease. My poor trained bird (I should add, the best I have ever had of her sex) was in very indifferent plumage then, but she stuck to her work for more than twenty minutes, during the whole of which time the curlew (in desperate earnest) was quite unable to get away from her. Stoop succeeded stoop, and, as I thought, too rapidly; and when it is considered that the sole effort of the curlew was to avoid the deadly blow, and mount higher than her adversary after its failure, and that every failure placed the stooping falcon 60 yards and more below the curlew, rapidly mounting on the best of wings, and that she had to regain her position, and get 100 yards above her hoped-for quarry, before she could again return to the attack, the courage, ability, and perseverance with which she kept at it, until both were out of sight of two of the best pair of eyes I have known, fairly astonished me. My excellent field glasses still shewed *me* two little black dots in the clear blue sky: the falcon even then repeating her unavailing efforts, by ringing widely against the wind, and so mounting laboriously over the curlew, whose upward progression was accomplished by the most extraordinary bounds (I can call her movements nothing else) I ever saw. Only two, of these many stoops, "told" all through this long contest. Twice I saw the curlew knocked round and up, and twice her feathers floated in the air like tiny dust; but the harm done was not enough, and the two dots finally separated, and the disappointed falcon was slowly recalled to us (though she needed no "lure," and seldom or never gets one shown, as she is perfectly willing to stay and work with *us*. It may be of interest to remark, that on looking round, we saw the pointer and setter (which on another occasion stood for half an hour by the watch) were still "on the point;" and when the hawk came over, still at a vast elevation, the long-suffering dogs were relieved. The grouse (three or four) were sprung, and "Lady Jane," tired as she was, stooped and killed one with her usual ease. Needless, I hope, to say she did not go hungry to bed that night, for want of a meal on grouse! We were all convinced, that, with a companion to help her, (two falcons are *always* flown together at a heron, as two greyhounds are usually slipped at a hare), the curlew would have been taken in five minutes, and with such a complete suit of new and good feathers as the old falcon *now* possesses, I should myself be very sorry indeed, to be a curlew in front of her. Shall I mention again a singular flight I once saw worked at a woodcock? This bird, when put to it, possesses remarkable powers of flight, as its extended migrations, and splendid shape and length, of wing, abundantly warrant. It occurred in this wise, in October, 1866. I found myself, with hawks (eyesses), dogs, gillies, a keeper, and my gun, on the moor near the western end of Loch-Eil, in Argyl, at a place called Fassiefern, not far from the place where Prince Charlie met his devoted Highland clansmen in arms for his crown, only to lose the day, and their lives, at fatal, and bloody, Culloden. I made a line to beat out a wide bank of bracken, then brown with early autumn, and saw a bird which I believed then to be a cock, and the keeper, a winged grouse, jump up in front. Had I but had the courage of my convictions, and put my favorite falcon, called "Taillie" from her broken tail—a Welsh hawk she, from the Glamorgan precipices, of the Worms Head, aloft, then she would have probably been saved much trouble, and we should have lost a glorious sight, and flight, for the day was stilly, bright, and lovely, and the sea loch and its waves sparkled in the sun. No; I took her on my fist, and struck her hood in readiness, half disposed to believe in McPhee the gamekeeper. Just where I saw the bird spring, suddenly up went a fine woodcock. No winged bird she, but in full possession of the excellent pair, that had not long before, brought her, (I suppose, for we do not know) from Finland, or elsewhere in the North, to Argyl. I unhooded and cast "Taillie" after her, and the flight began. This woodcock would have much astonished sportsmen only used to their actions in a thick cover. Up and up *she* went in long zig-zags, and precisely the style and action of her small relative, *Scolopax Gallinago*, the common snipe, but mute. The falcon mounted rapidly in her train, though at a considerable disadvantage at first. I saw it was going to be a long affair, got out my glasses, and lay down on the heather, and on one side, was my then falconer, Jamie Barr, one of the well-known family of Scotch falconers. There were once a father and three sons of that name (all falconers by profession), with most acute and trained vision, and on the other side the proud possessor of the best pair of eyes in all Argyl, if not in the West of Scotland—the so-called "foxhunter's" son, my gillie, Sandy Kennedy. This man got much employment in seeking sheep lost on the hills and mountains, and long practice had rendered his ancestral eyesight (his father's had been as good) equal to most glasses on the moor. The woodcock, with the falcon below and behind her, did not dare to come down or return—*vestigia nulla retrorsum* was her motto—and soon the pair of dots were high over the sea loch, there a mile wide, the cock's point being evidently Morven, on the other side of the strait. Soon I called out, "I can see but one." Presently from Barr came—"I canna see them;"

from Kennedy, "I ken 'em fine!" I hardly believed he could, for my own eyes were then far above the average, and aided by the best of Voightlœnder's field glasses, it was as much as I could do. Presently, methought, that the single dot in the sky, which I still discerned, became, instead of fainter, faintly more visible. "They are coming back," quoth Kennedy; and before long the spot had visibly increased, and the falconer Barr declared that he saw them once more. So did we, and so did all, before long, for the woodcock, finding herself over the water, and unable to shake off her pursuer, or gain the distant haven of Morven, had no alternative but to seek the shelter of the bracken on our side, from whence she sprang; so the poor fowl turned tail, and "went for it" in a long slanting descent from an incredible altitude. As they both neared us, they presented the appearance of two little balls falling out of the sky right towards us, and quite straight, with the difference (fatal to the poor woodcock) that "Taillie," that began below her, was now well above. The hawk was evidently unwilling or afraid to stoop over the water, but the moment the cock was over the land she shot herself forward, and straight in air, instead of slanting, half perpendicularly down, like her quarry (both moving with incredible speed) turned over, and stooped. No one knows the speed of a falcon's stoop, but it must be very great, as I have seen it bring a hawk up to old grouse flying hard down wind, just as though they had been sitting still, with absurd ease, if only she be but high enough. Anyhow, it was fatal this time to the woodcock, for, leaving a cloud of feathers behind, she tumbled head over heels before us, into the very patch of bracken she came from, and meeting there with an old ant hill, bounded off it, many a yard, and lay still. The hawk soon recovered herself, and dashed on to her well-earned quarry. Needless to say, I did not disturb her thereon, but served out the whiskey, and drank her health, all round. Then we, too, set to work at our lunch, and when this *very* tame pet hawk, had nearly done hers, I went to her and took her up, and having replaced the swivel in her jesses, and the leash in her swivel, and cleaned her feet, and wiped her beak, and kissed her, I fastened her to a stone in a lonely burn hard by, and witnessed her bathe and dry herself in the sun, preening her feathers to her own (and our) entire satisfaction, and I trust to the satisfaction of the readers of my tale.

As I presume that the account of flights will be found more amusing, if not more interesting, than the drier details of training a hawk, I am induced to try to describe a flight at our finest bird of game—*Tetrao lagopus*—the well-known red grouse of the British Islands. This fine bird, in the practical absence of flights (save very occasional ones) at the heron, the wild duck, and the woodcock, is certainly now (in my opinion, at least) the best flight remaining to "Modern Falconry." A most sporting bird, and, like Sir John Falstaff, the cause of sport to others, endowed with strength, wildness, great speed, and endurance, fairly plentiful, prized by all (especially as an article of diet by the Peregrine!) and above all, to be found and found only on the open moor—what better quarry can a falconer wish? His falcon wishes for no better. A grouse is entirely to her mind at all times, and she does her very best when flying it. As long as grouse will sit to the point of a dog—in some few parts of Scotland for a month in the season; in my own case, in Northumberland, about two days only—(though I *have* known them packed and inaccessible on the 12th August!) we use dogs to find them, setters being generally preferred, though my best hawk's dog has been a pointer for many years. Dogs used for this purpose, are trained to range out very far and wide, and to be very staunch on the point. I have known some, fully half an hour thus motionless, or perhaps lying down at last like a dropper. (In my young days dogs bred between pointer and setter frequently used to "drop" on the point; nowadays very few setters ever do so or "set," and a great improvement it is.) On coming to a firm point, I usually turn a fine glass on the dog, and as we know each dog's actions well on game, we can usually distinguish a point at game, from one where game has only been. Grouse leave a strong scent, except in the middle of the day. The report being favourable, off goes the hood, and the hawk (let us call her "Lady Jane Grey," my good old favourite passage falcon of eight years' service, the very highest mounter I have ever seen fly in thirty years of it) is off my own or my servant's fist, the rest of the hawks that day to be employed being carried by their attendant on the "cadge." This is depicted in Landseer's "Return from Hawking." It is a wooden frame, very light, with four legs (those of mine shut up on springs when required), the sides are padded, all four of them. The man steps inside, when the hawks have been secured to the sides, on which they stand. A pair of braces are crossed over his shoulders, and taking hold with each hand of one of the wooden sides, at a handle placed in the middle thereof, he and his charges accompany the hawking party all day long. In less time than I have employed, since mentioning "Lady Jane" last, we may confidently hope that she has made the best use of her time, and ascended to a great altitude, either against the wind and then returning to us, or in a calm day beating up, and up, with regular beatings of her wings, in wide circles. This fine flier, at her best, will often mount too high, if possible. At least, she has occasionally gone up clean out of sight of eyes, however good, and field glass also, in clear blue sky; but the game being found by the dog, we are able to exhibit it to her just when we please. "Now, sir, now!" says James Rutford, my falconer, always impatient, "she is high enough, plenty." "Do let her have it, Fisher," says some equally impatient friend. But I do like to see a hawk high, and keep them often waiting. It is *not* well to cause an impatient, or low flying, or young inexperienced hawk to wait long. They straggle off, and eventually get badly served, if at all. The hawk, to KILL game, is one that knows her business, knows the dog and what his point means, as well as he does, and will not leave him, on any account. Not "Lady Jane." No "lure" needed for her. The standing dog is her "lure," and before long, with a falconer's shout, James has at length gone up to the dog and put up what grouse are before him. Let no one think that grouse care much for a hawk over them, after a time or two. They certainly do lie the better for her presence on the moor, but later on, in the season, they wont have it, from the dog, at all. We then cast off a *steady* hawk on reaching any likely place, or even on coming into sight of a likely place, as the shaking of a plaid will cause wild grouse to rise many hundred yards ahead. Well, the grouse have risen, and one of them for the very last time, for here comes down "Lady Jane." Would that I could describe that singular stoop of hers better. It appears to begin, by her throwing herself forward, some,—probably many,—yards, then over she turns, and head foremost she flies down earthwards, moving her wings rapidly with the most singular swiftness. Let the grouse rise wild—let them even come unexpectedly over a hill and under the hawk, and she is round, and down, and into the flying pack, or covey, with ease, that seems portentous to men used to their approach down wind, towards their huts, in a drive. "Lady Jane's" stoop generally brings her down, a few yards behind her quarry: occasionally, but not often, on it. More commonly she becomes level, almost too quickly for eye to follow, and instantly is with the grouse she desires. 'Tis all over with the poor thing then. A cloud of feathers, the sound of a heavy blow—if you were near enough to hear—and the grouse (dead, I think, very often, then) is hurled many a yard through the air, and falls on the ground. If this ground should be hard, I have seen a grouse so struck, down wind, bound again (in one case 18 yards) as they do when shot dead from the butts in a breeze. The blow is given by the falcon's strong hind talon on each foot, usually as sharp as a needle, and driven at great speed by a bird weighing 2 lbs. This blow is not to be despised. No hawk that stoops from a very lofty pitch can clutch or grasp her prey: she rushes upwards like a ball from a trap, a couple of gunshots high, turns over, and is on the grouse at once. There she sits, and with two or three powerful bites the grouse is literally decapitated, his head constantly lying beside him. The head and the neck (though too much, I know) are usually "Lady Jane's" reward after every kill. She can kill four such grouse in a day—three are, however, enough; and she will be well fed on the last old grouse we may have taken, after her third successful, or in fact unsuccessful flight. I may mention here that I was once walking on the banks of the river Orrin, when I rented Glenorrin and Glengowrie, in Argyl, and put up three grey hens, old birds, and stouter and larger far than red grouse. Down came a wild falcon, at the bird in the middle. I saw and heard the blow. The grey hen staggered on, leaving the usual tribute of feathers, behind her; up rose the falcon in the grand and stately style so few trained hawks can ever adopt or regain—so much do they lose by captivity; over and down she came, and down fell the quarry as though she had had an ounce bullet through her. Down went my long rod, and off went I. My distant shout sent off *this* falcon, though I fully believe "Lady Jane" is ever well pleased, to see James or I come up, approves highly of shouting, and will at any moment leave a grouse and jump on the fist for the least bit of meat and sometimes for none at all. I took possession, somewhat meanly I trow, of the wild bird's prey. This is what I found she had done to it: the three first ribs on one side, were cut clean through, and separated from the back bone, as by a chop with a heavy knife, and strong hand, and one talon had gone on and split the base of the skull, from which the brains exuded!

Later on in the season, when grouse are wild, and full-grown, fine, birds, say in October, the sport is the best. We then make a wide line of five or six men abreast, and eighty yards or more apart, the man bearing the hawk being usually in the centre. He casts her off, and directly she is aloft a whistle or hand wave, and we move on. A dog ranges wide, but is not much attended to, as he seldom now gets much chance to point. Now is the time to see the grouse fly. Rising wild, and good at either cutting through a head wind, with driving wing, and close compact body, or careering down it, their pace is good. A Yorkshire keeper, seeing a hooded hawk for the first time with me, laughed the idea of her catching one to scorn. "She canna speed the buds," quoth he; though she soon undeceived him as to this. Grouse are sure to be found sooner or later, for though sadly packed I have always plenty. The stoop comes from a high altitude generally, and much more time having been afforded her the falcon, she either slays the grouse, or "puts it in." Every creature *I* know, and I believe every insect, has some peculiar way (peculiar to its tribe) of escaping from its enemies. Grouse, at all events, possess plenty of brains in their small heads, and shift in air, from the stoop, towards the end of the season, by a singular spring or shoot upwards, a few inches before the hawk's talon can touch them. Very much surprised she usually seems at this manœuvre. Their usual method is, however, to stop dead short, in their most rapid flight, and hurl themselves to the ground instantly. This should be seen to be at all believed. The very first time I ever saw it performed, close to me, was over the stony and rocky bed of a burn, into which an old cock grouse hotly pursued precipitated himself. Well, he has done it now, methought—a clear case of suicide. I'll pick up the little there can be left of him. I marked the very spot; no grouse, no blood; not a feather about. No; but to my astonishment up jumped a grouse, well and strong, from the stone at my foot. Down came the disappointed but now rejoicing hawk; and I have just wiped my pen, on a pen wiper, ornamented by R. Ward, with the stuffed head of a fine old Cheshire grouse killed by this falcon "Islay," belonging to my friend, the Rev. George Earle Freeman ("Peregrine" of the *Field* newspaper) in the first week of December. If I add that *my* grouse have developed a strange habit of flying into thick cover of young and old fir trees on the moor, like black game, but unlike *tetrao lagopus*, I have done with this fine sporting quarry. My eyess falcon, "Lundy," six years old, killed in 1885, 70 partridges, and in 1889 64 grouse and a teal. The partridge is a jolly little fowl, though not to be compared with the denizen of the heather. (I have usually three covies of partridges on my moor, where they appear to feed on the seeds of a rush, and are smaller and darker than the type.) I hawked them regularly for many years on the open downland arable expanse of South Wilts, using good dogs, and possessing two of the best partridge hawks—tiercels or males, and nestling peregrines—

possible. Of course it is indispensable to possess or rent a sufficient quantity of suitable ground, well stocked with partridges, and the right to preserve them upon it: 2,000 or 3,000 acres is quite necessary, if not more, for good sport and success. The fixed idea that "hawking drives birds off the land" is everywhere prevalent, and utterly unremoveable. This prejudice militates heavily, against even renting grouse, or partridge ground, for our present purpose. It happens to be a perfectly incorrect idea, from a common sense point of view, but it is useless to attempt to discuss it, nor will I write about it here. Suffice it to say that the constant presence of two or more wild peregrine falcons, living very much indeed on my own and neighbours' partridges, not only never drove our numerous partridges away, but was not thought to do so; whereas two or three miserably inferior tame hawks, not to be named in the same week, with the wild ones, with reference to their ability to take partridges, were believed to drive all our game away. Luckily it did not. On the contrary, when hard shot, it was our neighbour's lands that were bare, whilst ours, being kept quiet from the report of the gun, were a land of plenty (for partridges) to our great content, and I hope to our neighbour's disgust. But they stuck to their text just the same!

Every single flight, even at partridges, throughout the day differs considerably from its predecessor and its successor. The two best days I can remember were twelve partridges one day and fourteen on the next (both in October). I once remember killing a partridge with a nearly perfect game hawk called "Lundy," from his birthplace in the Bristol Channel, and who, before a bad neighbour killed him, to deliver a pigeon from his clutches, had taken more than 400 partridges in his four years of service, besides two kestrels, some falcons being desperately fond of going at any wild hawk. This little fellow had done enough one day, when a neighbour's keeper came up and asked to see a flight. Too late, said I, the other hawks being fed up. Just then the dog employed, a ceaseless worker and finder, came to a dead point in some high clover. Quite forgetting what I was about I struck the hawk's hood and cast him off, but to my horror with his swivel in his jesses, and the leash, a yard and a quarter long, and its button attached and dangling down. Few hawks, I hope, thus adorned or encumbered, have ever been asked to take partridges. But it seemed to make little difference to this old hand. Up he went in wide rings, and as fast, apparently, as ever, with his ridiculous appendages, and when high enough, the partridges were moved, and he stooped and killed one (for the keeper) with little ado.

On another occasion, I may be said to have "shot at a woodcock," viz., a partridge, "and killed a crow," viz., an old female sparrow-hawk. This very unusual occurrence happened on this wise. Late in the afternoon of an October day we tried our last flight, using a powerful and very keen Irish falcon called "Erin." She was very hungry, as usual, and after a long wait, birds being scarce, got a bad chance at distant partridges, and finally lost them in cover. The only bird of any kind I had seen for half an hour previously had been a female sparrow-hawk hunting for her supper, and apparently not likely to get it. I lured up the hawk; and "Here she comes," I heard my servant cry. And come she did; but in a moment, distant speck as she was, my glass showed me her wings in the rapid action of desperate speed, and not moving with the leisurely beat of a hawk coming to a "lure," which has no such attractions for her as the sight of live quarry moving before her. What could it mean? I felt convinced there were no partridges for half a mile, and I felt sure there was nothing else, save a wood pigeon, safe, in a distant belt of Scotch firs. However, on came the falcon, straight for us, (hence my man's very natural mistake), and unmistakeably flying *something*, for she passed very rapidly high over our heads, utterly ignoring the offered "lure." "Whatever can it be?" "Can't imagine, sir." Right in front of us, 300 yards off, and high in air, was the sparrowhawk, the only bird in sight, and I felt convinced that the falcon, absurd as it seemed, was bent on *her* capture! So I got on my horse (we always have one out, and near) and rode off. And well I did, for I saw one of the finest flights I ever have seen, wrought out entirely by strength of wing and good footing, high in air, between two birds of prey. No cover—not a twig—for an immense distance; her wings alone the only hope, the old tyrant of small birds, then possessed. Do what she would in the way of flying, within a short time the falcon was high above her, and round and down, in her first stoop. A clever shift, and the falcon was far below her, and the sparrow-hawk fifty yards nearer the distant firs. Another, and yet another stoop, all cleverly evaded; then passion seemed to seize the falcon, for she ringed up to twice the height she had hitherto deemed necessary, poised herself for the half-second required, and stooped. This time she did better, and a cloud of feathers followed in the wake of her stroke. This was a settler. She was soon again above her quarry, and the next stoop struck it dead 100 yards above my head. The sparrowhawk fell into high turnips, and there (by the sound of her bell) I found the Irish falcon coolly eating her hard won and revolting meal, in the shape of an old female sparrow-hawk, the destroyer of thousands of larks, and small birds in her many years of rapine, with her head lying by her side. I took up this "Erin" and gave her something better to eat, for the flight was worth that of a score of partridges, and went home with the only sparrowhawk I ever saw or heard of as taken by a trained falcon.

It may truly be said that the sparrowhawk at her best is no such great flier, but I suppose it will be admitted that the merlin *can* fly. Well, I have twice seen the before-mentioned tame "Lundy" tiercel (with all the disadvantages of a tame and captive hawk so largely deprived of the proper daily exercise of his wings enjoyed by his wild congeners, who have to catch their food, instead of having it given to them at the block) engage with a wild merlin in the open, and each time with conspicuous ability and success. In actual speed he was much the better of the two, whilst his stooping and footing (he being very fond of flying at any wild hawk he met) left little to be desired. The first merlin escaped into cover, after getting it hot for five minutes, by the skin of his teeth. On the second occasion, no cover being nigh, I really thought we should soon have had to boast of that all but impossible feat—the capture of a wild merlin by a tame falcon! Three times did the tiercel's stoop beat the merlin down, on his way to a distant hedge—his only hope. I was mounted, and saw it well. The last of the three stoops, sent the sweet little ladies' hawk rolling on the dusty clods, and had I but been up, he would never have got into the hedge a foot in front of our "Lundy" as he contrived to do.

Pulling out the leaden weight attached by a rope to the horse's bit from its pistol holster above my left knee, which all falconers use, and dropping it on the ground, I soon had the merlin out, to be again instantly dashed into the hedge by the tiercel. Time after time did I do this, till my men ran up, and if we could then have kept our heads cool, the merlin *must* have been ours (or "Lundy's"), for the hedge ended *on the open down*, and once driven out there, the who-hoop would soon have sounded for him, as it has for so many a magpie under the self-same conditions! Alas (for us) we drove the merlin the *wrong* way! towards a building and yard, ornamented—but not then in *our* eyes—by a fine walnut tree. The ill-used merlin just managed to get from the end of the hedge into the middle of the walnut tree, which we were all far too done, to climb. Needless to say, he was utterly indifferent to shouts, stones, and sticks, as well he might be. And there we left him, quit for the fright; for of course I turned a deaf ear to the vile proposition of the bailiff, to lend me his gun. This proposition seemed awful to me, and strangely enough, perhaps, for we had but just before, been moving heaven and earth, to catch the said merlin, by foot of another falcon! And there we will leave "Lundy," whose performances as a game hawk I have seldom seen surpassed. I saw him in Ireland once strike down no less than three grouse out of one covey, at one time, and found him with the third in his foot, and he wound up his day by joining a wild female peregrine, and going three or four miles away seaward with her. My man got him down to a pigeon eventually, and brought him home. If I say that I have many times seen this little hawk strike down two partridges out of the same covey in Gloucestershire, I think we may admit that he, at least, did his best for "Modern Falconry."

One more specimen of Gloucestershire partridge hawking, and I have done. Long ago, I was using a very steady old pointer, my man carrying "Tigress," and I "Blanche," two good eyess falcons. "Blanche" being specially fond of me, but of no man else, no one else could use her, for no one else could take her up, nor would she feed on my servant's hand, though she knew him well. In my absence her food had to be given to her on the ground at block, or on her perch. The dog had found birds in high turnips. I cast off "Blanche," who was soon very high, and we two leisurely went up to the dog, who was standing. The dog was her "lure," and she followed him regularly, high over his head. When within twenty yards of the dog up got a fine covey, and down came the falcon. She picked up a partridge in her foot (a partridge is nothing for a falcon, and is easily carried even by a tiercel) and took it under a distant hedge. "Blanche" was so fond of me that she never would eat until I came up to her, and very seldom would even kill her quarry, if she thought I was absent. I forgot this, and saying to my man, "That's the sort of hawk," I pointed her out with my gloved left hand. In a moment "Blanche" let the partridge go; the poor thing dashed off apparently quite unhurt; and in a moment the hawk was on my glove and looking up in my face. I confess I felt like a fool, though I could not help feeling also pleased with my pet, so I rewarded her well, and walked about feeding her (we did not intend to use her again that day, and "feed up" when that determination is made). I did this leisurely, the day being fine; finally put her to rights—swivel into jesses, leash into swivel—wiped her beak, and put on her hood. As it was now the turn of the other falcon, "Tigress," I thought of the dog for the first time, expecting to see old "Don" at the heels of my servant, as usual after a flight. Not a sign of him! "James, where is the dog all this time?" "Haven't an idea, sir." "Good gracious! look for her, and whistle." No result. The matter being serious—for Gloucestershire partridge hawking needs the best of dogs, and best of work, to *kill*—my trusty friend, my field glass, was put to work, also with no result for some time. At last it shewed me (fields are large at Coates, and near the College Farm) a white speck in the deep turnips, which a bright idea struck me resembled "Don's" nose! A nearer view thereof, confirmed the fact, and "Tigress" was rapidly divested of *her* swivel, leash, and hood, and set going. She, too, mounted well in the breeze, and we retraced our steps, after half an hour's absence, to the very place from which our first flight had started. There stood the pointer, just as before, and as he had all along been standing, though we had heeded him not, and at the self-same birds. Of course the birds that rose for "Blanche" had not been *his* birds, for directly this hawk came well up and over (she cared little for me or anyone, and all we got out of *her* had to be extorted) right in front of old "Don," we raised another fine covey, one of which speedily fell into "Tigress's" hands, and eventually into ours, for we did not again find a hawk willing to let it go, as I never had before, and never shall have again.

I will but add one more incident in the too short life of this charming hawk "Blanche," who killed my first wild grouse, before my delighted eyes, on the Bala mountains, and I will bring this long record of nothings to an end.

Suppose the same two of us, master and man, and near the same place, on the same errand, on a lovely serene late autumn day, just outside a huge cover near Sapperton and Pimbury Park. Kept too long on the wing for half a mile, in hope of the birds "Fan" could not, or would not find, and rendered desperate by a final false point, off set "Blanche" over the wooded valley in pursuit apparently of some wood pigeon or magpie unseen. The country, unlike the Wilts Downs, is hopeless in this case. No view to be had, nor any means of getting one. "We have done it now." "No use seeking her; I shall sit down and eat my lunch." And so I did, with my back to a gate, and a lovely field of white clover in front, full of its sweet perfume in the pleasant air. I enjoyed my repast, and said so. Not so my grumbling attendant, who declared he could not eat for thinking of his sufferings there on the morrow morning, when his duty would be to come up by the first train to seek the lost hawk, or to sleep at Tetbury Road Station, which he dreaded more. Lost hawks, of which I shall not here treat, are, as I think they were in old days and in all climes, the bane of modern falconry! I had finished my lunch; my man had finished his pipe; and "Fan" had finished the scraps. We were thinking of leaving for the railway station, whence we had come in the morning, for 'tis no use seeking a lost hawk in a series of deep wooded valleys—she must be sought when soaring high in air, looking out for herself, above or outside of such country—when I heard a hawk's bell sound, and instantly, with a swish of her wings, lo "Blanche" on the top of the gate-post over my head! I had not found her—she had found me, as in fact she always did, and as I was sure she would, unless she had killed, as I was afraid in this case she had, from her protracted absence: and to this day I do not know that she had not. It was certain she had not fed, however, by the look of her; so taking a partridge she had killed earlier in the day out of the bag, I flung it out to her close by, and she in her turn took her lunch, or, as our forefathers said, "her pleasure" thereon, the old dog crawling gently up to her and licking her feet.

Here my "paper" *must* needs come to an end. No one can this time, call it an untimely one; and in the length to which it has attained the writer admits he has taken full satisfaction, for the hurry of the Lecture Theatre. He regrets that this is not enough. Satisfaction should be given to readers and sportsmen alike; and he honestly believes that actually seeing, and taking part, in a well-managed, and successful flight, with a trained hawk is needed, to interest members of the Cotteswold Naturalists Field Club in so strange a pursuit as "Modern Falconry."

The frontispiece to this Paper, copied from one of Wolf's illustrations in "Knox's Game Birds and Wild Fowl," is used with the permission of Messrs Gurney & Jackson, successors to Mr Van Voorst, the publisher of the late Mr Knox's works, 1 Paternoster Row.

*The Minerals of Gloucestershire : Observations on Celestite, read at Gloucester, January 25th, 1890, by* FREDK. SMITHE.

In the Proceedings of the Cotteswold Naturalists Field Club for 1881—1882, at page 30, will be found a Paper written by the President, entitled, "On the Minerals of Gloucestershire, "with part of the adjacent counties of Somersetshire and Wor-"cestershire, compiled by Mr W. C. Lucy; also a list of Derived "Rocks found in the Northern Drift Gravel over the same area, "by Mr W. C. Lucy." This Paper includes a list of Minerals from the neighbourhood of Bristol, by E. Wethered, F.G.S., &c., of Cheltenham, in which is included the mineral Celestite, and its allied species, Baryto-celestite. This paper was followed, in the next number of the Proceedings (1883—1884) by a communication, at page 112, with the title, "On the occurrence of "the mineral Vivianite in the Cotteswolds, with remarks by "Fredk. Smithe, &c." So far it seems thus clear that Mr WETHERED is quite correct in citing the mineral Celestite as being in the neighbourhood of Bristol; but it is on the Somersetshire side of the Avon, and for this reason the author of this paper scrupled to include it in a list compiled by him of the Minerals of Gloucestershire, although he has had a specimen in his possession of the Celestite, from Pyle Hill, for over 30 years. This specimen came out of the Red Marls of Pyle Hill, just where the Avon separates it from the county of Gloucester; in other words, the mineral occurs on the Somersetshire side of the river at Bedminster, and at Pyle Hill. It is a pleasure now, not only to record Celestite in the list of Gloucestershire minerals, but also to claim its ally, Baryto-celestite, found lately at Clifton, and onward to the North of Bristol through the Midlands, as undoubtedly occurring in no small quantity in some places, which we will mention.

Details.—Celestine, 1815. W. Philips. Outlines of Mineralogy and Geology (1818).

In this mineral, strontian, combined with sulphuric acid, has obtained the name of celestine (*cœlestis*, celestial) from its delicate tint of light blue.

Celestite is a word altered by Dana, from Celestine, and is a native sulphate of strontian ($SrO.\ SO_3$.) The word Celestite appears to be superseding the older form, Celestine, and since it has been adopted in the mineralogical collection of the British Museum, Kensington, we employ it here; for Dana justly remarks that words terminating in *ine* are chemical, and should be restricted to the science of chemistry.

The tint of Celestite is generally of a cool blue, but this is not invariably the case: often it is colourless; frequently reddish; or again of a yellowish hue, which is sometimes varied by a charming iridescence, or glancing play of light. Touching the blue crystals, Wittstein finds that the colour is due to a trace of phosphate of iron; whilst Mr Stoddart, of Bristol, could not discover it in the pale blue crystals from Clifton. This may be explained by the fact that the Jena Celestite analysed by Wittstein is of a peculiarly dark blue fibrous kind. Neither strontium nor its oxide is met with in nature: the two minerals having that metal as its base are the carbonate of strontium (Strontianite) and the sulphate of strontium (Celestite). Strontianite occurs principally in Saxony and Westphalia in veins in cretaceous strata, now mined on the large scale as a source of caustic strontia, which is used for recovering sugar from molasses in refining. Celestite occurs normally in modified rhombic crystals, not infrequently flattened or tabular, also in long prismatic needles, more especially in specimens from Sicily—and in fibrous or massive varieties; but rarely in a granular form. Further on we shall refer to some erratic forms peculiar to the celestites of the sulphur deposits of Sicily.

Distribution.—In the South of England the mineral in question is but little known; say on the other side of Bristol, though it has been reported from Weston-super-Mare and

Watchet, in Somersetshire. The fine crystallized specimens for which Bristol was famous came from Pyle Hill, close by the station, but south of the line, where the Celestite was found by the workmen in considerable quantity, just below the datum line, when making the Bristol and Exeter Railway and goods sidings, and at a spot which will never be opened again. My old friend, Professor Etheridge, informs me that of all the best crystals, large pale blue tinted specimens, some are in the Museum of Natural History at Bristol, but probably the largest from that locality adorn the collection of the Museum of Practical Geology in Jermyn Street, London.

Leaving Pyle Hill, and crossing the Avon, we are in Gloucestershire, where, on Durdham Down, in 1874, some curious forms of blue crystals of Celestite were obtained from fissures in the Carboniferous Limestone.

At Clifton, which is near Durdham Down, large quantities of Celestite were, later on, thrown up whilst excavating for house foundations and drains between Alma and Oakfield Roads; and at Cotham. The mineral was also found in small quantities when making the Clifton Station Railway cuttings. The late Mr Tawney, M.A., F.G.S., published an account of this with full particulars; and since that time a valuable paper has been written by Mr Norman Collie, Student in the Chemical Laboratory of University College, Bristol, with the title, "On "the Celestine and Baryto-celestine of Clifton."* It is interesting to notice in this paper the information that Celestite has long been known as one of the most abundant minerals in the neighbourhood of Bristol. Also that, "in works written at the "beginning of the century, Bristol is mentioned as one of the "few localities where it might be found." (page 292.)

In an account sent me in 1875 by Mr E. B. Tawney, he refers to the celestite at Aust in these words :—"In the Aust "Cliff section the Red Marls, which come in below the Green "Marls, are given by Sir Henry de la Beche as 102 feet thick. "They here contain a great abundance of gypsum, both in

* Proceedings of the Bristol Naturalists' Society, New Series, Vol. II., Part III. (1878-79.)

"irregular strings, lying at all angles, and in lumps in layers. "In one of the faults in this cliff is a vein of a pale bluish "Celestite; this mineral is abundant in the marls, both at "Bitton and Wickwar." Passing from the Keuper Marls of Aust Cliff, we come to the mineral discovered in considerable quantities in the vicinity of Yate, whence it has been largely extracted; the finest crystals of the Celestite from this neighbourhood were yielded by the limestone, in cavities and fissures. Some are massive: others in large crystals of modified rhombs, tabular and often of ruddy hue. Specimens of fine crystals from this part have been kindly given to the Gloucester Museum by Mr Madan, M.A., &c., of Exeter College, Oxford; and to the British Museum by Lord Ducie, whose scientific knowledge enabled him to develop at Yate the industrial extraction of the mineral. At Wickwar the specimens show small reddish crystals, comparatively poor, and often of a saccharine character, owing to unfavourable thermic conditions. At Tortworth, Celestite is but sparsely produced; and passing northward from this district occurs in lesser or greater quantities, both in the limestones along the course of the red marls as far as Northampton, and Elton, near Nottingham; again appearing at Knaresborough in Yorkshire; also in North Britain at Carlton Hill, by Edinburgh, where it is to be met with in the marly shale and limestones that have been upheaved by the protrusion of igneous rock; and again at Tantallon in East Lothian, in the vicinity of trap rocks.

The distribution may be now further extended to other parts of Europe, that by the short notes given, and the foreign situations cited, the general range may be approached.

In France, this mineral is obtained at Condorcet on the Drôme. The specimens thence are mostly from marls and limestones, and are in hard compact masses, forming the *gangue* of the rocks, which is 5 mètres in thickness, consisting of gypsum and marl.

Other places are—St. Béat in the Department of the Garonne, where it is embedded in sulphur; and at Meudon it is found in chalk flints.

At Montmartre, near Paris, it is in compact nodules, with small needle-like crystals.

In the eastern part of France it is obtained in blue fibrous masses in the lower chalk, or "Neocomien."

In Germany, at Dornberg, near Jena, where there is a blue fibrous variety found in layers; and tabular crystals fill up the crevices of the rock. At Jena we have a blue variety of Celestite, which is pleochroic, occurring in marly limestone.

In Wurtemburg it pervades the Ammonite Beds.

At Weser, in the Oolitic formation, it fills the interior of fossil bivalves. Near Ratisbon, at Pschow, on the Danube, the crystals in the limestone are of rich tabular combinations. At Scharfenberg, near Meissen, it is yielded in the red marls.

In Hungary, near Herrengrund, in small blue crystals in limestone. Celestite occurs also in the Tyrolese Alps.

In Italy, at Montecchio Maggiore, in amygdaloid rock; and in Sicily in the sulphur marls in bands and courses, named "*Strontian Zones*." The crystals are beautifully white, when not pellucid, with sulphur and gypsum. The Girgenti Valley, at Caltanissetta, at Lercara, at Catollica. Also in the Valleys of Noto and Mazzaro. As a matter of caution we observe that no heed is to be given to the word *Girgenti,* for as in the case of shells, the dealers are ready, when asked, to proffer the word Singapore, when they do not know whence the shell came from, so the Sicilian gives the name *Girgenti* to every specimen of Celestite.

In Switzerland at Bex, and in Spain at Conil, fine crystals are produced. In the Seisser Alps it is in lamellar or in radiated nodules.

In North America and Canada: at Kington and at Strontian Island, Lake Erie, large well-formed but complicated crystals. Dana gives the names of several other places in the United States, and in the Dominion, where the mineral is obtained.

In Africa, among others, may be mentioned Mokattam, near Cairo: it occurs in the nummulitic limestones in large crystals, and in groups inclosing nummulites, and other remains of marine animals, which become exposed, owing to the gradual erosion of the crystals by water—thus showing that the mineral is soluble in water, and particularly so in brine. A crystal with bright faces was eroded in the same manner as those of Egypt, by immersion in a saturated solution of salt for 18 months. Many of our specimens from Yate, in Gloucestershire, in possession of the writer, are eroded in the same manner as those from Egypt. On the faces of some of these crystals the erosive action has left markings in the form of elliptical rings of about two millimètres in the axis major: these marks in most crystals containing water of crystallization are caused by weathering.

The erosion begins by a dull spot forming on a face. This gradually spreads in a circle, or an ellipse, until finally it occupies the whole face. Pape,* who has investigated the nature of these figures, finds that they are circles on crystals of the cubic system, but on the faces of rhombic crystals like Celestite, they are ellipses.

Baryto-Celestine.—Baryto-celestine of Walterhausen, is an amorphous combination of both sulphates of these minerals. From Greiner, in the Tyrolese Alps, the proportions of the bases of the mineral are—Celestite 4, Barytes 3. Another locality for it is Imfeld in Binnenthal, in Switzerland, Jocketa in Saxony, where it is near Dolomite in talc schists. Also (see page 1) at Clifton, in Gloucestershire.

The number of places mentioned as having credit for the productions of the Strontian mineral will be considered fairly sufficient thus far, without multiplying instances; but one spot in particular, namely, Sicily, seems to throw more light upon the subject than any other named. Celestite is nearly always accompanied by one or more associates, namely, gypsum, sulphur, and salt; and in that island, owing to the workings in the grey marls of Tertiary age, ample opportunities are offered to the geologist or mineralogist such as are not found anywhere else. From the first the island has been the scene of volcanic

* Juke's Geology (Geikie's edition), Weathering, page 45; also Pogg. Annalen., Vol. CXXIV., p. 329; and Vol. CXXV., p. 513.

activity, leaving features diversified by ancient igneous rocks and modern lava flows, mud volcanoes still in action, tripoli beds, deposits of salt, lime, sulphur, and bitumen.

The mud volcano, emitting nauseous gases, is in this connection worthy of a passing note. Near Aragona Caldare, the junction railway station for the Girgenti and Catania main line in a quarter of a mile walk westward—is an interesting example of the marshy condition, acted on by chemical and volcanic forces. The hill on which this volcano is situated consists of marly soil; its dimensions are about 120 feet by 140 feet with a cone on the summit of 2 to 3 feet, filled with liquid mud, which gives off a stench more or less strong of hydrogen sulphide, or carbon dioxide gas. The face of the country all around is desolation—not a blade of grass to be seen. A writer sends from Japan the following graphic description of a similar volcano:—"This volcanic mountain is bald, bleak, treeless, "whitening beneath the masses of cinders with which it is "covered. The mountain is burning, and there are pits of "flaming sulphur on its side. Also in one place called Usen, "are deep pools of boiling water; and one deeper, and indeed "unfathomable, instead of being filled with water, is full of "sulphurous mud, that seethes and bubbles, and rises and "splutters, in a dark abyss, emitting all the while a horrible "stench. The Japanese call it 'The Mouth of Hell,' and it is "said that drops from it blister the skin." Sicily has many of these *Maccalubi*, as they are called: one of them near Caltanissetta, is considered to be of Pliocene age. These indications will be seen to have a bearing upon subsequent remarks tending to ascertain the age of the sulphur-bearing beds of marl, which contain Celestite, and are known as the Strontian bands or Celestite deposits. The age of the sulphur and of the Celestite is the same; and we cannot help remarking that it is not an uncommon error to suppose that all sulphur comes from volcanoes. The Strontian-bearing strata are known by their peculiar yellowish colour, which probably represents banks of old sulphur deposits, either very poor or destitute of sulphur. "In such rare cases," says Signor L. Baldacci, Engineer of the Royal School of Mines at Rome, "the position of the Strontian "beds is between the gypsum and the limestone proper. These "beds are generally in proximity to the sea." *

We now adduce observations upon examples of Celestite from the rich mines of Lercara Friddi, lying to the N. West of the Girgenti Valley, with shafts of about 300 or 400 feet in depth driven through strata of Eocene age, and into light grey marls. The Professor of Geology at the Royal University of Palermo, Signor Gemmellaro, kindly assisted the writer, not only in his examination of the valuable collections of fossils and minerals of that institution, but directed him to visit the works at Lercara, which he found valuable in respect of gaining insight into the exploration of the formation. From specimens thus procured, the first example will be from the Calcedone (a miner's name), which forms the spoil banks of the workings. In one mine here about 800 men and boys are at work.

1.—Calcedone: very pale grey, in colour verging on white, lamellated; the layers are of gypsum and pale sulphur alternately, in contact. The marl about from 6 millimètres in thickness to double that thickness, or more, the light sulphur not more than from 1 to 2 millimètres in thickness, deposited regularly in films. The Celestite forms a capping of a dull white, and semi-crystallization, exactly like our ordinary loaf sugar. This specimen is exceedingly instructive, showing plainly the bubbling of the hydrogen sulphide gas depositing the sulphur in films, and leaving the incipient crystals of Celestite as the top layer, separating out from the sulphur, which forms amorphous blebs or clots, and has not begun to crystallize. The whole piece is traversed by vertical fissures, ending in holes, through which the gas issued, and has traces as of bubbles of sulphur bursting and leaving concave films of that substance. It is clear that this marl was mud.

2.—Calcedone. This specimen discloses an action of a slower character. It may be gathered from the bright canary yellow of the sulphur, and the sharpness of its crystallization; also from the thickness of the gypsum and its indurated condition, traversed by cracks, that in this piece the hydrogen

* "Memorie Descrittive, e Descrizione Geologica Dell'Isola di Sicilia di L. Baldacci, &c., &c., Roma." Tipografia Nazionale, 1886, page 286.

sulphide forced its way through the harder material by passing through cracks lateral and oblique in direction until it reached a flat surface, where sulphur crystals formed of two kinds—one of very pale colour, the other of a rich yellow. The Celestite separates on the top from the matrix, leaving the sulphur, and encrusts in fine incipient crystallization, or deposited in dots of various sizes on the faces of the sulphur crystals.

3.—Celestite. A specimen typical of most of the Sicilian mineral. Like the preceding examples, it came from the Jacomini mines at Lercara Friddi, and from the workings in the Eocene marls. It consists of Celestite and sulphur, with some lime sulphate. This is stalactitic in growth. The sulphur is bright canary yellow, in secondary crystals, moulding themselves upon and in the recesses and drusy cavities left by the stalactites, which are calcareous, and covered with finely semi-crystallized Celestite, whilst here and there, at irregular distances, shoot forth radiate groups of stout pellucid rhombic prisms of Celestite; others are more needle-like, studding the surfaces unoccupied by the sulphur. Some of these stalactitic forms are of surprising beauty, both in form and purity of colour, and the prisms cross and recross in delightful confusion, throwing out here and there obliquely-crossed prisms of the mineral as braces to strengthen and gird the compound group of Strontian, gypsum and sulphur.

4.—Is a specimen in the Royal University Museum at Palermo, that throws no light upon the origin, but is unique and distinctive, on account of its form and purity of colour. We can only compare the shape of this fine example to that of a hedgehog, through its resemblance to the oval form of that creature, also the fact of a distinct and remarkable symmetry, each lanciform-shaped crystal of equal length, and as truthful in position as the spines of the hedgehog: the colour, of pearly white and purity. This example was either from sulphur marls at the Caltanissetta workings (of Pliocene age), or from those at Lercara Friddi (of the Eocene).

Summary.—A close scrutiny of these specimens, taken in connection with the physical character of the island in the Tertiary epoch, say in the Pliocene era, also including the climatic conditions, would lead us confidently to pronounce the age of the sulphur marls to be that of the Congeria beds*—before the appearance of Etna as a volcano—for the sedimentary deposits in the environs of Etna are always covered up by lava flows and volcanic products, and the oldest lavas and tuffs yet recognised as from the massif of Etna are superior to the conglomerates of quaternary age. This was a period of immense upheaval of the coast, even to 3000 ft.: what is now hill and vale, the scene of sulphur mining, was then on a level, or accessible to the sea—a sea rich beyond conception in organic life—animal and vegetable in profusion—seething under the torrid zone, and yielding from its decomposition of organic matter the hydrogen sulphide, which in the case of briny marshes or shallow lagoons, oozed through the calcareous bottoms, depositing its sulphur film by film, between each layer of brackish mud. The chlorine decomposing the hydrogen sulphide, and the gases bubbling through, both nascent hydrogen and the sulphides becoming free, and their bases deposited in fine layers of sulphur, the Celestite separating, and the hydrogen sulphide rising and escaping by percolation, and, as an Italian geologist remarked, each film of deposited sulphur may have taken a year in the course of its precipitation. Organic matter has such an affinity for oxygen that it decomposes peroxides, and reduces them to protoxides, and so the presence of organic matter is the reduction of sulphates to the state of sulphides. Celestite is thus decomposed into strontian sulphide, which in water readily gives strontian carbonate and hydrogen sulphide, and the latter by oxydisation leaves a deposit of sulphur. The same process applies to calcium as a base. Layers of Calcite, Celestite, and sulphur have thus been formed in Sicily and elsewhere, as seen in the deposits of Tertiary age, and throughout all geological time where the same chemical conditions exist.

* These Congeria Beds are very peculiar brackish water deposits, like those of the Aralo-Caspian seas. On these beds the City of Vienna is built. For interesting particulars and explanations of this sub-division of the foreign Tertiaries, consult Phillip's Geology, the edition with the valuable editing of Prof. R. Etheridge, 1885, Part II., p. 664; also Von Hauer, Die Geologie, &c., Vienna, 1878, p. 619 (*et passim*).

ARTIFICIAL PRODUCTION OF CELESTITE.—Strontium sulphate, or the mineral Celestite, may be produced artificially, as in the case of Barytes. The procedure of Manross and Macé is especially to be preferred. M. Behrens has shown that by placing under the microscope a drop of liquid sulphuric acid, containing a little strontian sulphate, delicate slender crystals, crossing each other, can be seen, like those of barytes, only of larger size, and less transparent. M. Frémy has obtained crystals of Celestite by a slow double decomposition, by operating upon solutions of different densities, separated merely by a porous diaphragm, or a sheet of bibulous paper.

The method followed by Manross (Ann. Ch. Pharm. t. LXXXII., p. 348) to obtain strontium sulphate is by melting in a crucible, a mixture of potassic sulphate and strontium chloride. After washing the product, a crystalline powder is obtained, composed of small crystals of Celestite, identical both in form and composition with the natural mineral Celestite.

Macé's process is by bringing together two attenuated solutions, one of strontian nitrate, the other of ferric sulphate, by means of a wire plunged into each solution. Under such conditions the contact of the two salts causes them to act upon each other with extreme slowness, the result being that the Celestite crystallizes as it is forming.*

Both Celestite and Barytes are classed as concretionary and vein minerals: all the chemical synthetic methods prove the fact, and coincide in explaining the way in which these minerals are formed in nature.

Professor J. D. Dana mentions in his "System of Mineralogy, 6th edition, New York," that Celestite has been obtained by Dr Sullivan in lamellar crystals from solution in water at a temperature of 300° Cent. by fusing a mixture of gypsum and common salt, and treating the residuum with water.

The salts of Baryta are poisonous; those of Strontia are innocuous. Strontian sulphate (Celestite) has now quite superseded the former as an efficient means of clearing sugar when boiling, in the process of sugar refining.

* Macé, J. pour Chém. t. XXXXI. p. 825.

*On the Sections in the Forest Marble, and Great Oolite formations, exposed by the new railway from Cirencester to Chedworth, by* Allen Harker, Professor of Natural History, *Royal Agricultural College, Cirencester. Read* 25*th February*, 1890.

The construction of the new line of railway from Cirencester to Andoversford has necessitated a number of cuttings, which on account of their great length and depth, have exposed some highly important sections of the rocks forming the eastern and south-eastern slopes of the Cotteswolds.

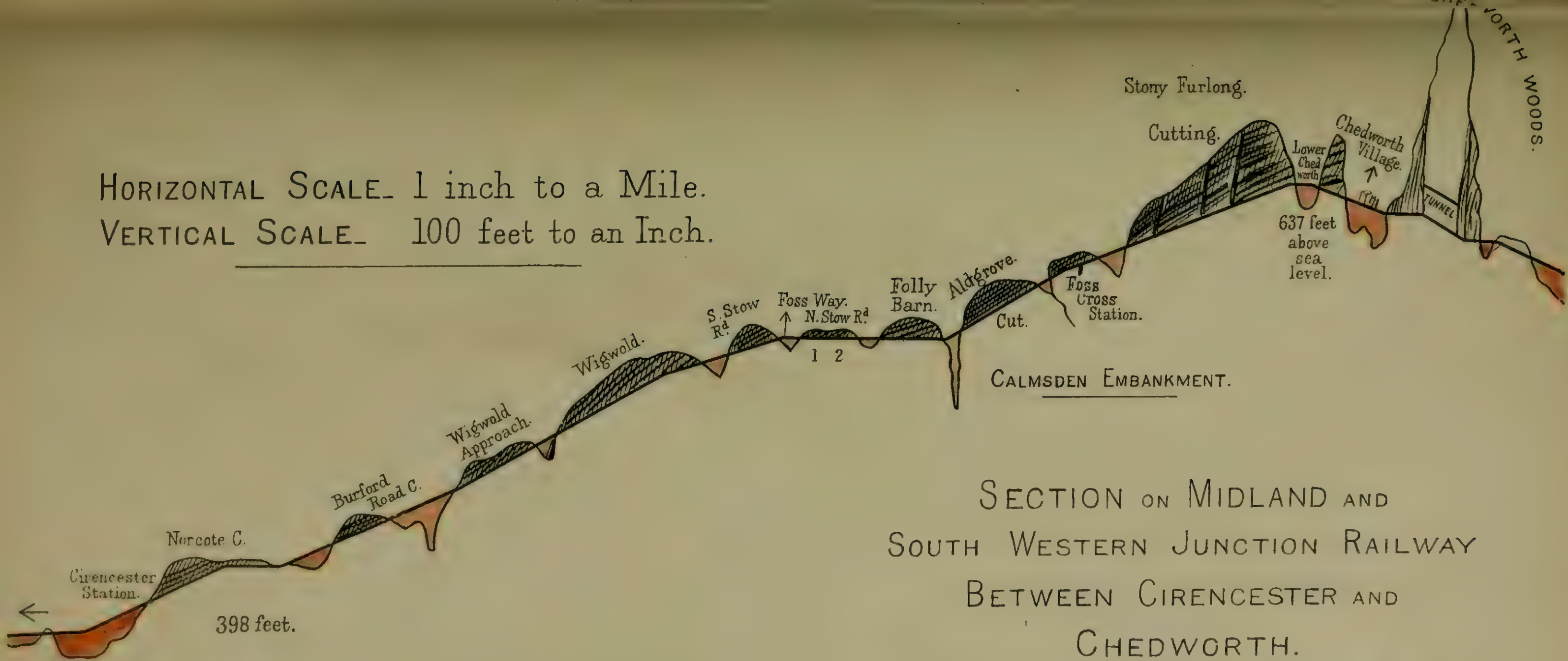
These cuttings have presented to the local geologist an unrivalled opportunity for the study, not only of the beds themselves and their relation to the surface configuration and agricultural features of the district, but also of some general problems in the geology of the Great Oolite formation, and some special developments it exhibits in its eastward extension in the Southern Cotteswolds.

In the present paper I propose to give a general account of the sections between Cirencester and Chedworth, and as full and detailed a description of each as I have hitherto been able to make.

The deepest, and by far the most important cutting, is not yet completely excavated, so that necessarily the account of it must be taken as incomplete and tentative. On two occasions the Club has visited portions of the line, as the sections have been completed.

From Cirencester the line runs almost due north to Andoversford, and a glance at the geological map (sheets N.E. 34 and N.E. 44) shows that it traverses the Forest Marble, the Great Oolite and Stonesfield Slate, and touches the Fuller's Earth at Upper Chedworth. These several beds have in this part of the county an outcrop almost due west and east, so that

HORIZONTAL SCALE_ 1 inch to a Mile.
VERTICAL SCALE_ 100 feet to an Inch.




SECTION ON MIDLAND AND SOUTH WESTERN JUNCTION RAILWAY BETWEEN CIRENCESTER AND CHEDWORTH.

*(Reduced from Drawings obligingly supplied by Mr. Shopland, Engineer to the Line.)*

Allen Harker, del.

The names of the Cuttings are those used in the paper.

To illustrate Prof. Harker's paper on the Geology of the Sections.

speaking very roughly, they are cut by the line at about right angles.

The undulating character of the Cotteswolds of this district, with its long bare rolling downs and deep dry sinuous valleys or combes, through most of which no water appears to have ever flowed, obliges the railway engineer to construct his line by alternate cuttings and embankments. For the purposes of the geologist nothing could be more fortunate, the cuttings reveal the rocks in their stratigraphical relationship, the embankments supply him with material for fossil hunting for years to come. A glance at the reduced section on the opposite page, (which I am enabled to give by the kindness of Mr Shopland, the Engineer to the Railway Company) shows this alternation of cutting with embankment, and is itself a fair index to the physical character of the South-eastern Cotteswolds. I have given local names to the various cuttings, obtained in some cases from conversation with those who live near them, suggested in others by well-known contiguous topographical marks.

The first cutting, about half a mile north of the Midland and South Western Junction Station at Cirencester, is the Norcote Cutting. It is also called by some of the local labourers the "Beeches" Cutting. It is through the middle beds of the Forest Marble. It was first excavated in 1885, and was visited by the Club on 20th July, 1886. From financial or other causes an interval of some years elapsed between the opening of this cutting and the rest of the line. It is interesting from a botanist's point of view to note how rapidly a luxuriant growth of wild plants has spontaneously covered the sloping sides of this cutting. A gorse bush, already from two to three feet high is well established in one spot; the water Figwort (*Scrophularia aquatica,*) and a great variety of *Juncaceæ* (Rushes) and *Cyperaceæ* (Sedges) have established themselves in the wet clay debris by the sides of the rails. Some of these plants are unusual in the immediate neighbourhood, and it is a matter of constant wonder how they so quickly appear on new ground which suits them. This is especially so with the *Juncaceæ* at this spot.

## NORCOTE CUTTING.

| | | ft. | ins. |
|---|---|---|---|
| 1. | Soil, and weathered rubble forming sub-soil ... ... 2 ft. | | |
| 2. | Band of shelly impure tile-stone ... ... ... ... | 0 | 1½ |
| 3. | Blue clay ... ... ... ... ... ... ... | 0 | 7 |
| 4. | Coarse tile-stone, locally called "Crap" ... ... ... | 0 | 1 |
| 5. | Blue clay ... ... ... ... ... ... ... ... | 0 | 7 |
| 6. | Yellow and Blue *Ostræa* Marble, with clay pockets ... ... | 2 | 8 |
| 7. | Blue clay parting ... ... ... ... ... ... | 0 | 3 |
| 8. | Blue *Ostræa* Marble, with clay pockets ... ... ... | 2 | 1 |
| 9. | Dark clay, with much wood ... ... ... ... ... | 0 | 6 |
| 10. | Close-grained pink speckled Marble, with Oolitic granules but no shells ... ... ... ... ... ... ... | 1 | 4 |
| 11 | Alternate bands of clay and Fissile Slaty Beds, each from one to four inches in thickness ; five bands of clay and five of the tile-stone ... ... ... ... ... ... | 2 | 5 |
| 12. | Dark blue clay, with thin harder marly bands ... ... | 1 | 7 |
| 13. | Alternate bands (six in all) of clay and coarse shelly beds ... | 1 | 11½ |
| 14. | Compact shelly stone, with abundant Oolitic granules ... | 0 | 7 |
| 15. | Dark blue clay ... ... ... ... ... ... ... | 0 | 9 |
| | | 15 | 6 |

The beds of Blue and Yellow *Ostræa* Marble (Nos. 6 and 8) are the typical shelly limestones which give the name of "Marble" to the formation. They take a beautiful polish, and, when compact enough, make one of the handsomest of ornamental stones. I have seen several examples of them in worked stones used in local buildings. A very interesting "Capital" worked from the blue bed, is in the possession of Mr James, Builder, Cirencester. It is unfortunately very difficult to get large blocks free from pockets of clay ; these of course render the stones useless for polishing purposes. These clay pockets are remarkable in having all the same shape, that of a short elliptical spindle somewhat like a closed bivalve mollusc's shell, though they are of different sizes. I make the suggestion that they represent the fillings in of the closed shells of various *Lamellibranchiata*, whose remains make up almost the whole bed, but I propose to discuss the question in a paper on the palæontology of the local Forest Marbles as a whole.

At the north end of this cutting, through a bridge which carries a local road over the line, there is a very shallow section, scarcely indicated on the plan, from three to four feet deep, of a bed of sandy marl capped by a thin fissile slate a few inches thick. It contains no fossils save a few branching *polyzoa*, but it is of interest since precisely similar beds occur at various places in the neighbourhood, and it appears to be a persistent member of the otherwise very variable marls and clays of the local Forest Marble.

The next cutting is just beyond where the Burford road crosses the line, so I have termed it the Burford Road Cutting. It is still in the Forest Marble, but is of a lower series than that at Norcote, and contains a greater percentage of Oolitic granules in its variable shelly limestones.

## BURFORD ROAD CUTTING

| | | ft. | ins. |
|---|---|---|---|
| 1. | Soil, very calcareous loam ... ... ... ... ... | 0 | 7 |
| 2. | Fissile brashy rubble, with disjointed irregular bands or patches of clay ... ... ... ... ... ... | 2 | 9 |
| 3. | Finer rubble beneath the clays .... .. ... ... ... | 1 | 3 |
| 4. | Clay or marl ... ... ... ... ... .. ... | 0 | 4 |
| 5. | Hard fissile plank ... ... ... ... ... ... | 0 | 5 |
| 6. | Very yellow sandy marl ... ... ... ... ... ... (Composition given below) | 0 | 9 |
| 7. | Hard shelly plank ... ... ... ... ... ... | 0 | 3 |
| 8. | Tile-stones, imperfect with partings of clay ... ... ... | 0 | 8 |
| 9. | Tenacious yellow clay ... ... ... ... ... ... | 0 | 7 |
| 10. | Tenacious blue clay ... ... ... ... ... ... | 0 | 6 |
| 11. | Coarse, hard shelly limestone, with *Ostræa* shells and small pockets of clay—Oolitic—and false bedded, splitting into slabs ... ... ... ... ... ... ... | 2 | 4 |
| 12. | Tenacious blue clay, with occasional limestone bands irregular | 1 | 2 |
| 13. | Compact shelly limestone, with abundant Oolitic granules and clay pockets ; splits horizontally ... ... ... | 1 | 9 |
| | | 13 | 4 |

The so-called "clays" and "marls" are exceedingly variable in colour and physical character, but all appear to contain carbonate of lime to about the same amount, while the proportions of silicate of alumina and quartz granules vary, as the beds are tenacious or friable. The yellow sandy marl No. 6 gave an analysis :—

| | |
|---|---|
| Ca $CO_3$ ... ... ... ... | 22 % |
| Sand ... ... ... ... ... | 34 % |
| Silicate of Alumina ... ... ... | 43 % |

It would be valuable to have a complete analysis of each of these beds, before speculating on the changing conditions of their deposition. None of the beds in this section contain perfect fossils, broken oysters and *Rhynchonellæ* being all one obtains.

The line next runs through a long shallow cutting which we have called for convenience the

## WIGGOLD APPROACH CUTTING.

| | ft. | ins. |
|---|---|---|
| Fissile sandy slate ... ... ... ... ... ... ... | 2 | 0 |
| Sandy marl ... ... ... ... ... ... ... | 1 0 – 1 | 6 |
| Shelly slabs resembling roofing tiles of the district ... ... | 0 | 6 |
| Clay ... ... ... ... ... ... ... ... ... | 0 | 6 |
| Shelly slabs ... ... ... ... ... ... ... | 1 – 2 | 0 |

This bears some resemblance to the Burford Road Cutting, but it is not so falsely bedded.

The whole series of cuttings, magnificent as they are, fail us in one particular. They nowhere give us a junction section of the Forest Marble and the Great Oolite, a desideratum in our local exposures. But if these beds of the Wiggold Approach section be not faulted, and I see no indications of such, they appear to constitute the bottom beds of the Forest Marble series; for at a distance of three hundred and fifty yards we enter the long Wiggold Cutting, which from its white freestones with abundant perfect fossils (*Lima* and *Brachiopoda*) appears to be in the upper beds of the true Great Oolite.

The Wiggold Cutting is three-quarters of a mile long, cutting through a broad high "down." It is crossed by three bridges, which afford good landmarks in plotting the section, and as some notable changes take place in the rocks here exposed, it will be well to have separate sections.

## WIGGOLD CUTTING.

At first a fine grained false bedded Oolite, nine feet; on passing deeper into the "down" between the first and second bridges, this is overlaid by higher beds, and gives a section as follows:—

| | | ft. | ins. |
|---|---|---|---|
| 1. | Thin fissile slates, much weathered by surface action ... | 0 | 6 |
| 2. | Marly clay ... ... ... ... ... ... ... | 2 | 0 |
| 3. | Fissile slates ... ... ... ... ... ... 1 6 – | 2 | 0 |
| 4. | Clay ... ... ... ... ... ... ... ... | 0 | 6 |
| 5. | False bedded fine grained Oolite ... ... ... ... | 4 | 0 |
| 6. | Fine grained compact Oolite, with abundant shells of *Lima* | 5 | 0 |

Between the second and third bridges an abrupt change takes place in the character of the beds, and at the north end the dip alters at a slight fault, from 1 in 160 to 1 in 100; the false bedded fine grained Oolite, No. 5, rises quickly and outcrops. A faulting brings down a thin bed of tenacious brown clay with apparently much organic matter in it.

This cutting is specially characterized by its many extensive "pipes" filled with sandy debris, probably of glacial origin. Beyond this cutting, just before crossing the Foss Way, there is a short section which I call

## THE STOW ROAD CUTTING,

| | | ft. | ins. |
|---|---|---|---|
| 1. | Rubble ... ... ... ... ... ... ... ... | 2 | 0 |
| 2. | Marl ... ... ... ... ... ... ... ... | 0 | 9 |
| 3. | Oolitic freestone, partially perforated by cavities ... ... | 1 | 6 |
| 4. | Marly parting ... ... ... ... ... ... ... | 0 | 1 |
| 5. | Loose rubbly Oolite ... ... ... ... ... ... | 0 | 9 |
| 6. | Brown clay ... ... ... ... ... ... ... | 0 | 4 |
| 7. | Loose rubbly Oolite ... ... ... ... ... ... | 1 | 4 |
| 8. | Marly partings ... ... ... ... ... ... ... | 0 | 4 |
| 9. | Thin compact Oolite *with corals* ... ... ... ... | 2 | 0 |
| | | 9 | 1 |

A little way into this cutting there occurs at the bottom a very puzzling bed of shelly limestone of a bluish colour, with abundant Oolitic granules, reminding one of typical Forest Marble.

The puzzle in this case is not anything remarkable in the stone itself, but in finding it in the position it occupies. It adds to the difficulty always felt by the student of these formations, in assigning a particular bed of Oolitic shelly limestone, blue in colour, to its proper stratigraphical position, since some such beds are undoubtedly in the Great Oolite proper, though they closely resemble the higher formation.

There are two small and shallow sections on the north of the Stow Road which give—

## FIRST.—NORTH STOW ROAD CUTTING,

| | |
|---|---|
| Brashy Oolitic rubble, full of fossils (casts of *Lamellibranchs*,) with thin marly partings ... ... ... ... ... | 5 ft. to 6 ft. |

## SECOND.—NORTH STOW ROAD CUTTING,

| | ft. | ins. |
|---|---|---|
| White Oolitic rubble, with their marly partings above ... ... | 5 | 6 |
| Compact hard Oolite, with irregular cavities (to bottom) all dipping from N. to S. at about 5° ... ... ... ... | 1 | 6 |

## FOLLY BARN CUTTING,

| | | |
|---|---|---|
| 1. Rubbly Oolite ... ... ... ... ... ... ... | 3 | 0 |
| 2. Friable marl ... ... ... ... ... ... ... | 2 | 0 |
| 3. Compact white Oolite ... ... ... .. ... ... | 1 | 3 |
| 4. Friable Oolite (marly), full of fossils, chiefly casts of *Lamellibranchs* ... ... ... .. ... ... ... ... | 3 | 0 |
| 5. Hard brown granular bed to bottom ... ... ... 3 0 – | 4 | 0 |

Further on, the friable marly bed No. 3, is divided into two separate bands by a parting of hard Oolitic freestone, so that another section gives—

| | ft. | ins. |
|---|---|---|
| Rubble ... ... ... ... ... ... ... ... ... | 3 | 0 |
| Marl ... ... ... ... ... ... ... ... ... | 2 | 0 |
| Greyish white compact Oolite ... ... ... ... ... ... | 4 | 0 |
| Marl full of brachiopoda and *Lima* and other *Lamellibranchs* ... | 2 | 0 |
| Highly compact granular stone, with occasional cavities in the upper layers about one foot in depth. ... ... ... ... | 6 | 0 |

The main feature of this section is the two distinct marls at the north end uniting at the south end, as the compact freestone parting thins out.

Here the line is carried over the Calmsden Valley by a high embankment, sixty-one feet from the rail to the bottom of the hollow.

The next cutting is a few hundred yards south of the Foss Cross Station, and may be called the

## ALDGROVE CUTTING.

| | | ft. | ins. |
|---|---|---|---|
| 1. | Rubbly Oolite ... ... ... ... ... .. ... | 4 | 0 |
| 2. | Thin sandy marl ... ... ... ... ... ... ... | 0 | 6 |
| 3. | Fissile planking bed .. ... ... ... ... ... | 0 | 6 |
| 4. | Hard bed, perforated by numerous irregular cavities ... | 1 | 6 |
| 5. | Grey compact freestone, apparently without any corals ... | 4 | 0 |
| 6. | Second hard bed, with numerous cavities ... ... ... | 1 | 6 |
| 7. | Grey compact freestone, same as 5 ... ... ... ... | 2 | 6 |
| 8. | Marl ... ... ... ... ... ... ... ... | 3 | 0 |

We note here that there exist two distinct bands of the beds I term "perforated," the lowermost thins out to the N. end of this cutting to one half its original thickness.

These so-called "perforated" beds have furnished a subject of much controversy and debate among local geologists, and it is admitted that they furnish the ornamental stone called Dagham stone. I confine myself here to recording the fact that there are several of them, and that they occupy different horizons in the Great Oolite, but I abstain from discussing their composition or possible origin. At one time I was aware of only *one* such bed, and I used it as an index to the position of the beds above and below it; but that idea is exploded by the sections now exposed, as well in this as in succeeding exposures.

In this cutting, in bed No. 7, there has been found a remarkable organism, which I will only briefly allude to, as it has not yet been thoroughly worked out. I have secured a fair number of specimens. It occurs in spheroidal masses about the size of a cricket ball, and is made up of concentric shells, or layers of different colour and texture. The alternate bands or rings are coloured, one of a very delicate but pronounced pink, and the succeeding one of yellowish white; each band one-third to one-half an inch in width. A preliminary microscopic section reveals undoubted organic structure reminding one of the *stromatopora*. A broken nodule is a very striking, not to say handsome object; and so far as I can learn it has not been described or observed before from the Great Oolite rocks. A full description is reserved for another communication.

A short way north of Foss Cross Station is the Stony Furlong Cutting, called by the contractor and his men, the "summit" cutting, from the fact that the highest point of the line is here, and is six hundred and thirty-seven feet above sea level. It is a little short of three-quarters of a mile in length, and is in places over forty feet in depth.

I think it no exaggeration to describe this as the very finest section of the Great Oolite exposed in the whole Cotteswold area, and its investigation may profitably occupy the geologists of the Club for some time to come. It is absolutely unique in some of its features.

The following account of it must not be taken as more than a rough preliminary survey, as at the time of writing it is not completely excavated, and access to the bulk of it is difficult, and to some parts of it still impossible.

The beds dip southwards as a rule at an angle of about 4 – 5°, and altogether a depth of strata of about sixty-five feet is exposed. There are three instructive faults in the cutting which are not quite clearly understood at present.

At some future time it will be necessary to supplement this account, when a more carefully detailed examination has been made. So far as it goes, however, it will be found fairly accurate.

## STONY FURLONG CUTTING.

| | | ft. | ins. |
|---|---|---|---|
| 1. | Rubble ... ... ... ... ... ... ... | 1 – 2 | 0 |
| 2. | Marl ... ... ... ... ... ... ... ... | 1 | 6 |
| 3. | Soft rag fissile ... ... ... ... ... ... ... | 6 | 0 |

## STONY FURLONG CUTTING (*continued*)

| | | ft. | ins. |
|---|---|---|---|
| 4. | Sandy parting ... ... ... ... ... ... ... | 0 | 4 |
| 5. | Compact bed, very hard, "perforated" ... ... ... | 3 | 0 |
| 6. | Falsely bedded Oolite, with very thin partings ... ... | 12 | 0 |
| 7. | Well marked bench top, a soft friable grey Oolite, probably two beds and parting ... ... ... ... ... | 4 | 0 |
| 8. | Compact rock, varying in character, but perforated throughout and crowded with fossils ... ... ... ... | 8 | 0 |
| 9. | Sand parting ... ... ... ... ... ... ... | 0 | 4 |
| 10. | Rock, "perforated" ... ... ... ... ... | 0 | 6 |
| 11. | Parting ... ... ... ... ... ... ... ... | 0 | 6 |
| 12. | Rock, Freestone ... ... ... ... ... ... ... | 3 | 0 |

Twenty yards north of the bridge these beds from No. 7 downwards are faulted ten feet down. There is a second and most important fault at about fifty yards N. from the bridge, *i.e.*, thirty yards from the small fault. Apparently a quite new set of beds are faulted either up or down, I cannot determine which, but as it was only newly excavated a few days ago, the following section is a rough one, and less likely to be quite so correct as those at the two ends, which have been longer accessible.

Section of faulted beds fifty yards N. of bridge.

| | ft. | ins. |
|---|---|---|
| Rock ... ... ... ... ... ... ... ... | 3 – 4 | 0 |
| Parting clay or marl ... ... ... ... ... ... ... | 1 | 0 |
| Hard "perforated" bed ... ... ... ... ... ... | 4 | 0 |
| Parting marl ... ... ... ... ... ... ... ... | 1 | 0 |
| Rock not determined ... ... ... ... ... ... ... | 3 | 0 |
| Clay parting ... ... ... ... ... ... ... ... | 1 | 6 |
| Rock "seggregated" ... ... ... ... ... ... ... | 2 | 0 |
| Clay parting ... ... ... ... ... ... ... ... | 0 | 6 |
| Very compact freestone ... ... ... ... ... ... | 3 | 6 |
| Parting marl ... ... .. ... ... ... ... ... | 0 | 6 |
| Hard compact Oolite, 4 feet thick at fault—but rising further on to and is a dense white Oolite with thin sandy partings | 14 | 0 |

Here apparently is the termination of the fault. Beneath this occurs a remarkable *band* which is persistent hence forward and easily recognized. It is absolutely unlike anything I am acquainted with in the Great Oolites. It consists of the shells of Lamellibranchs, chiefly Ostræa, embedded in a tenacious brown matrix of clay, with some apparently organic vegetable matter. The shells are all brittle, of calcareous material, crumbling almost at a touch. It reminds one of some post tertiary shell bands in the condition of the material. In working at the section we always called it the "organic band," though properly it is a shelly clay bed. Mr Wethered who has examined this bed chemically, tells me it does contain 10 °/$_{\circ}$ of organic matter, so that my naming of it was not altogether inappropriate. The shells apparently preponderate over the matrix in amount.

This most remarkable bed may, I think, be taken as the lowermost extension of the Great Oolite proper, the beds below it corresponding to the Stonesfield slates.

There is not in any of the sections anything like true Stonesfield slates, but beneath this well marked shelly clay, between it and the blue Fuller's Earth are twenty feet of beds, which may belong either to the equivalents of Stonesfield slates or to the upper limestone beds of the Fuller's Earth formation. The absence as yet of well preserved fossils, and my want of an intimate acquaintance with Fuller's Earth, renders it impossible to decide at present.

The difficulty is felt most acutely in the next small cutting through a hill in lower Chedworth.

## THE LOWER CHEDWORTH CUTTING

| | ft. | ins. |
|---|---|---|
| Oolite rubble ... ... ... ... ... ... ... | 6 – 7 | 0 |
| Band of shelly clay, corresponding probably to the shell band already noticed ... ... ... ... ... ... ... | 0 | 6 |
| Marly Oolite ... ... ... ... ... ... ... ... | 2 | 0 |
| Shelly limestones, with Oolitic granules, and occasional soft pasty masses of $CaCO_3$, and remains of *Ostræa acuminata* ... | 15 0 – 16 | 0 |

What these shelly Oolites are I will not here venture to determine. They resemble in petrological character the upper beds of Great Oolite, but their fossils are different.

On the first visit of the Club to this spot, I pointed out masses of blue shelly limestone made up of *Ostræa acuminata.* which the contractor's foreman repeatedly assured me came from this cutting. I never was fortunate enough to see them *in situ*, but they are undoubtedly Fuller's Earth limestones, and I am inclined to think did come from this spot, probably at a greater depth than is now exposed. They were said to occur in irregular masses of large size, and a member of the Club, Mr Smith, of Nailsworth, has exhibited similar rock specimens from Fuller's Earth, at Nailsworth.

I have also compared my specimens with specimens in the Jermyn Street Museum, of shelly limestones of the Fuller's Earth, and they are identical.

Across the valley of Chedworth about five hundred yards from this cutting the line enters the Fuller's Earth clays, and the tunnel continues in it for some distance, emerging in the upper beds of the Inferior Oolite. The clays are full of the shells of *Ostræa acuminata.*

It is a matter of common remark that the rocky sub-soils over the Cotteswold area bear a marked family likeness in their physical characters. They are generally called "brashy," consisting of rubbly masses of stone not unlike the rough irregular masses of unbroken roadstone. I may best illustrate this by quoting an observation frequently made to me, "How is it that the surface beds of stone in our quarries are all alike?" It is noticed in walking through the various sections on this line, that each bed as it rises near the surface and becomes the immediate sub-soil deposit, takes on this character. It is certainly due to the action of surface rain-water percolating through the soil, and by virtue of its contained acids disintegrating the limestones, naturally first of all along fissures, cracks and weak spots, thus gradually breaking a fairly compact stratum of limestone into a mere layer of separate bits of stone.

I have not given any account as yet of the various fossils which have been obtained from the rocks described in this paper. Their consideration may occupy us on some future occasion.

*The Sections exposed between Andoversford and Chedworth: a comparison with similar strata upon the Banbury line, by* S. S. Buckman, F.G.S. *Read February 25th,* 1890.

The Railway in course of construction between Cirencester and Andoversford has opened up a series of most interesting sections. In a former communication * to the Cotteswold Field Club, I gave an account of the Inferior Oolite between Andoversford and Bourton-on-the-Water; and, consequently, the homotaxous deposits exposed in the cuttings between Andoversford and Chedworth have attracted my attention. As, however, I now reside some distance from the locality, and have not too much spare time at my disposal, I could not, even if I wished, give an exhaustive paper on the strata in these exposures; but the chief idea of this sketch concerns the agreements and differences between the Inferior Oolite on the Cirencester Railway and the strata described in my former paper.

Commencing at Andoversford, the first cutting is at the new Station; and it shews nothing more than tumbled, and much broken, freestone rock, and a quantity of rubble. All this has slipped over upon some blue clay of the Upper Lias, which is exposed at the bridge crossing the road.

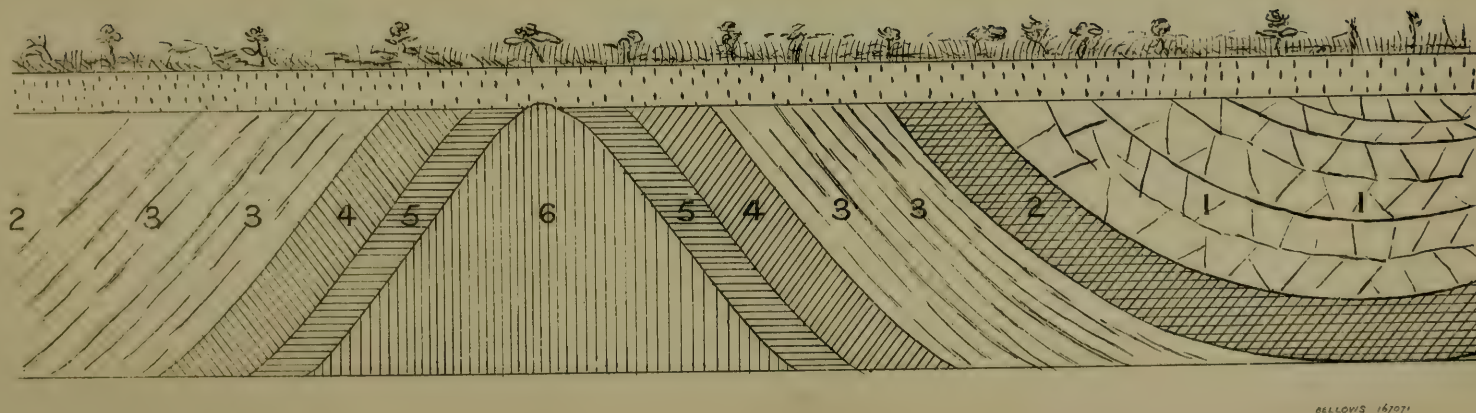
The second cutting affords the following section:—

Section I.—Second cutting from Andoversford.
(Peagrit series to Upper Freestone)

| | | ft. | ins. |
|---|---|---|---|
| 1. | Whitish freestone, with numerous white grains ... ... | | |
| 2. | Loose, incoherent, yellowish-brown, sandy Oolite, enclosing portions of harder white limestone ... ... about | 23 | 0 |
| 3. | Whitish freestone, with numerous white grains ... ... | 3 | 6 |
| 4. | Hard, shelly limestone, with white, rounded grains, and some larger flattened concretions. *Ludwigia Murchisonæ, Pygaster semisulcatus, Rhynchonella subdecorata* ... about | 20 | 0 |
| | | 46 | 6 |

* Proceedings, vol. IX, Pt. II, pp. 108-135, 1887.

SKETCH OF THE UPTHRUST IN THE THIRD CUTTING FROM
ANDOVERSFORD STATION.
MIDLAND & SOUTH WESTERN JUNCTION RAILWAY.



The series of beds put under the No. 4 are really the representatives of the Peagrit series of the classic Cotteswold sections. This series may be recognised not only by the fossils it contains, but by the presence of the flattened pisolites. Some of the beds are soft and sandy; but, in general, the beds of this series in this cutting are hard and crystalline. Bed 2 of the above section introduces a point of much interest. It is, evidently, exactly the same as the beds which I described in Section VII of my former paper *—a cutting at Syreford about three-quarters of a mile distant.

At that time I thought that these sandy beds (Syreford section, beds 1-4) represented the Harford Sands † resting on Upper Freestone; and I was anxious to know how they were connected with the Upper Lias. The exposure which I am at present dealing with shews that this was an error. Bed 4 is evidently the representative of the Peagrit series; and we may suppose beds 5 and 6 of the Syreford section to be about the same; while the sandy strata (beds 2-3; Syreford section, beds 1-4) are evidently the same. Their position, therefore, is above the Peagrit series, and below the actual Lower Freestone (bed 1 of the section). Similar sandy strata occupy the same position at Cleeve Hill, as the following generalized section will shew.

Section II.—Generalized section of Cleeve Hill.‡

| | | ft. | ins. |
|---|---|---|---|
| 1. | Ragstones ... ... ... ... ... ... ... | 33 | 7 |
| 2. | Sands and sandstones—Harford Sands ... ... ... | 12 | 6 |
| 3. | Upper Freestone series ... ... ... ... | 35 - 40 | 0 |
| 4. | Oolite marl series ... ... ... ... ... ... | 9 | 10 |
| 5. | Lower Freestone series ... ... ... ... ... ... | 36 | 0 |
| 6. | A series of beds — mostly yellowish-brown rubbly rocks, very conspicuous when fresh quarried ... ... ... | 26 | 6 |
| 7. | Peagrit series, beds mostly containing flattened pisolites ... | 26 | 8 |
| 8. | Thin beds, generally without pisolites, ... ... ... | 4 | 9 |

* *Op. cit.* p. 120

† *Op. cit.* p. 113

‡ This section is condensed from several very detailed sections made in the company of Mr E. Wethered, F.G.S.

The No. 6 in this section indicates the beds which are on the same horizon as the sandy beds in Section I.

The connection of these sandy beds, and the Peagrit series, to the Upper Lias clay is shown much more clearly by the third cutting from Andoversford. On account of an upthrust of the Upper Lias clay causing the strata to assume an anticlinal position, we are able to examine the different strata from the Upper Lias by walking along the cutting. (See sketch).

SECTION III.—Third cutting from Andoversford.

(Upper Lias to Peagrit series)

| | | | |
|---|---|---|---|
| 1. | Shelly and crystalline limestone, with large granules, *Tereb. submaxillata* ... ... ... ... ... ... .. | | |
| 2. | Limestone mixed with marl ... ... ... ... ... | 3 | 0 |
| 3. | Several beds of yellow sandy limestone, *Rhynch. subangulata*, *Rh. subdecorata* (large), *Rh. cynocephala* towards the base, *Tereb. perovalis*, *Tereb. Etheridgii*, *Pholodamya fidicula*. A line of *Belemnites* nearly at the bottom ... ... | 18 | 0 |
| 4. | Brown sands, passing into ... ... ... ... ... | 3 | 6 |
| 5. | Blue sands ... ... ... ... ... ... ... | 1 | 6 |
| 6. | Blue clay ... ... ... ... .. ... ... ... | | |

It may very reasonably be concluded that bed No. 6 in the above section represents what is known as Upper Lias, and probably may be considered to be on about the horizon of the *Commune*-zone. The blue and yellow sands (Nos. 4-5), measuring altogether five feet, are the only representatives of the one-hundred-and-fifty feet or so of the Cotteswold sands exposed in the neighbourhood of Frocester. The line of *Belemnites*, and *Rhynchonella cynocephala* at the base of bed 3, may be looked upon as a faint indication of the so-called Cephalopoda-bed developed in the same locality; and it may probably be said with safety that the base of bed 3 is on the horizon of the *Opalinum*-zone. The rest of bed 3 may be regarded as roughly equivalent to the "sandy ferruginous limestone" of the Stroud district, and as representing the upper part of the *Opalinum*-zone, with perhaps the base of the *Murchisonæ*-zone. Bed 1 is the Peagrit series; and thus the connection with Section I is obtained.

The fourth cutting introduces no new strata; but we have about ten feet of white, softish limestone, resting upon hard crystalline limestone, which is presumably the Peagrit series. In that case the limestone above may represent the sandy strata (bed 2 of Section I).

The fifth cutting is at the Withington Station, and is entirely through blue and yellow clay.

In the sixth cutting we again meet with the beds above the Peagrit series. Altogether about twenty-five feet are exposed. The arenaceous character appears to be less pronounced, and the strata are therefore more compact, partaking more of a freestone nature. It is quite a question how far the arenaceous character of these strata in the Section I may have been brought about by the solvent action of percolating rain water causing disintegration.

We have now a considerable break in the sequence of strata; because nothing of the Oolite marl was to be seen in the cuttings—at least during my visit. Neither did I detect any trace of the Upper Freestone, nor of the Harford Sands, which are both so conspicuous on the Bourton line. Apparently the lowest beds which are exposed belong to the Lower Trigonia-grit series, and are equivalent to bed G of the Bourton line (*Op. cit.* p. 110). These beds occur in the eighth cutting. It is, however, possible that the base of these beds might represent the Upper Freestone, and that the Harford Sands might be absent. The Oolite-marl series is not absent from the neighbourhood; because some years ago I found *Terebratula fimbria* in Withington Wood in an opening by the roadside.

Leaving the seventh cutting for the present, we will pass right into the eighth, and, commencing with the lowest beds, work out the sequence of strata up to the Fuller's Earth. This cutting, which is of noble proportions, presents the following section:—

SECTION IV.—Eighth cutting from Andoversford.

| | | ft. | ins. |
|---|---|---|---|
| 1. | White limestone in compact blocks ... ... ... ... | 25 | 0 |
| 2. | Rubbly limestone, with *Gryphæa sublobata* abundant ... | 12 | 0 |
| 3. | Marl parting ... ... ... ... ... ... ... | 0 | 9 |
| 4. | Hard limestone ... ... ... ... ... ... ... | 2 | 0 |
| 5. | Marl ... ... ... ... ... ... ... ... | 0 | 4 |
| 6. | Hard bluish-centred limestone ... ... ... ... ... | 1 | 3 |
| 7. | Rubbly limestone ... ... ... ... .. ... | 1 | 6 |
| 8. | Two bands of yellowish limestone, with brown grains. Several fossils especially Lamellibranchs :— *Trigonia formosa*, *Trigonia* (costate form). *Cucullæa*, *Modiola Sowerbyana*, etc. ... ... ... ... ... ... | 6 | 0 |
| 9. | Conspicuous blue, and bluish-yellow band of clay, containing a crush of broken shells, apparently *Ostreæ*, some of which retain the nacreous colour ... ... ... ... ... | 0 | 10 |
| 10. | White limestone in large blocks. This was being worked for use on the bridges, etc. ... ... ... ... visible | 9 | 0 |

The bed 10 I take, in the absence of evidence to the contrary, to be the lower part of the Lower Trigonia-grit; and I should expect to find the Harford Sands immediately beneath, that is, if they are developed in this neighbourhood. Above this mass of limestone lies a thin clay-band with a quantity of broken shells; and it is rather remarkable to find a clay-band intercalated in such a deposit as the Inferior Oolite. Bed 8 with its mollusca undoubtedly belongs to the Lower Trigonia-grit. The Gryphæa-grit (bed 2) attains the very respectable thickness of twelve feet—a thickness which is unusual, and is only equalled by the development at Stroud Hill.*

The bed (1) above the Gryphæa-grit is most interesting. It is the equivalent of what I called the Notgrove Freestone (*Op. cit.* p. 125). I was the first to point out the correct position of this bed in my paper on the Bourton line.

To obtain the further sequence of the strata, it is necessary to return to the seventh cutting. This gives the following section :—

* Witchell, Geology of Stroud, p. 55.

Section V.—Seventh cutting from Andoversford.

| | | ft. | ins. |
|---|---|---|---|
| 1. | Fuller's Earth clay ... ... ... ... ... ... | | |
| 2. | Clypeus grit series ... ... ... ... ... about | 20 | 0 |
| 3. | Hard shelly limestone, Upper Trigonia grit ... ... ... | 5 | 0 |
| 4. | Bored bed on the top of a hard, somewhat shelly, whitish limestone with white grains ... ... ... visible | 3 | 6 |

Bed 4 in this section is a continuation of bed 1 in Section IV; and the bored bed on the top of it may be compared with the bored bed which I found so constant in a similar horizon in the strata of the Bourton line (*Op. cit.* p. 118, etc.); but it must not be correlated with the bored bed of the Stroud area—a bed on the top of the Upper Freestone.

The Upper-Trigonia- and the Clypeus-grits (beds 3 and 2), are strata so well known that I need not refer to them here. More details concerning them, as well as concerning other strata dealt with in this paper, may be found in my paper on the Bourton line, already so often mentioned, as well as in the numerous papers by Wright, Lycett, Witchell and others in the volumes of the Club.

The connection of the Clypeus-grit with the Fuller's Earth can be seen in greater detail in the entry to the eighth cutting, where a downthrow inclines the strata at a steep angle, and affords the following section.

Section VI.—Eighth cutting from Andoversford. Enter a downthrow of Fuller's Earth clay and Clypeus-grit.

| | | ft. | ins. |
|---|---|---|---|
| 1. | Blue clay ... ... ... ... ... ... ... ... | | |
| 2. | Hard, reddish limestone, with darker grains ... ... ... | 0 | 7 |
| 3. | Clayey marl ... ... ... ... ... ... ... | 0 | 4 |
| 4. | Rubbly brown limestone, with coarse dark grains ... ... | 3 | 0 |
| 5. | Brown decomposed paste .. ... ... ... ... | 0 | 3 |
| 6. | Clypeus-grit, with *Tereb. globata* and *Clypeus Plottii* * ... | | |

It may be convenient to speak of the beds 2 - 5 connecting the Clypeus-grit proper with the Fuller's Earth clay as "transition strata;" and they should be compared with a similar

* *C. Plottii* is abundant only at the very top of the *Clypeus*-grit.

series shewn in the fifth cutting west of Bourton-on-the-Water Station (*Op. cit.* p. 123). It will be noticed that there is a very considerable difference between them, both in thickness and in general lithological details.

There are two more cuttings before the tunnel is reached; but as these cuttings only illustrate again the strata from the *Gryphæa*-grit upwards, they afford no fresh details.

It may be advantageous to give a generalized section of the strata which have been discussed in this paper. The letters for the beds are, to a certain extent, the same as those used in my paper on the Bourton line, so as to facilitate comparison.

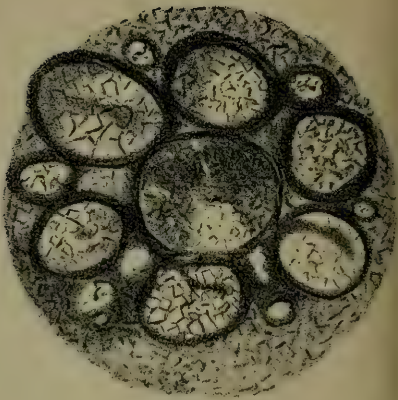
Section VII.—Generalized section of the strata between Andoversford and Chedworth.

| | | | |
|---|---|---|---|
| A | Fuller's Earth clay ... ... ... ... ... ... | | |
| B | Transition strata ... ... ... ... ... ... | 4 | 0 |
| C | Clypeus grit ... ... ... ... ... ... ... | 20 | 0 |
| D | Upper Trigonia-grit ... ... ... ... ... ... | 5 | 0 |
| E | Bored bed and the white limestone, "Notgrove freestone" ... | 25 | 0 |
| F | Gryphæa-grit ... ... ... ... ... ... ... | 12 | 0 |
| G | Lower Trigonia-grit ... ... ... ... ... ... | 13 | 0 |
| G | White limestone ... ... ... ... ... ... ... | 9 | 0 |
| H, I, J | Absent | | |
| K | White limestone, Sandy limestone ... ... ... ... ... ... | 23 | 0 |
| L | Peagrit series ... ... ... ... ... ... ... | 26 | 6 |
| M | "Sandy ferruginous limestone" ... ... ... ... | 18 | 0 |
| N | Brown and blue sands ... ... ... ... ... ... | 5 | 0 |
| O | Upper Lias clay ... ... ... ... ... ... | | |
| | | 160 | 6 |

Fig. 2

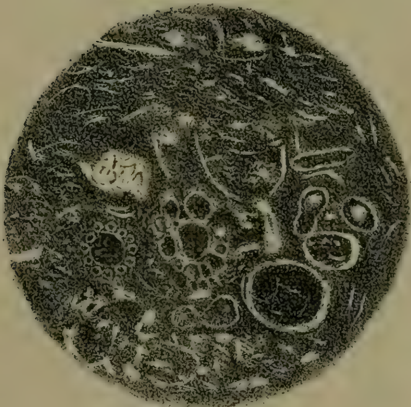
× 90 Diam.

Fig. 1



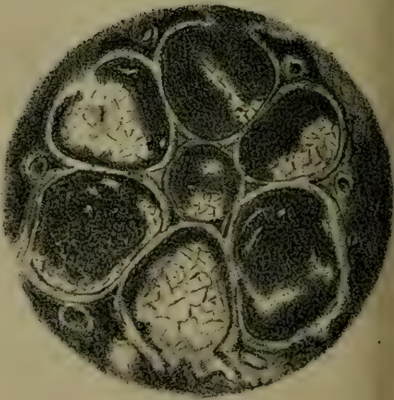
× 90 Diam.

Fig. 4



× 44 Diam.

Fig. 3



× 15 Diam.

Fig. 5

× 15 Diam.

Del et nat E. W.

*On the occurrence of fossil forms of the Genus Chara in the Middle Purbeck Strata of Lulworth, Dorset, by* EDWARD WETHERED, F.G.S., F.C.S., F.R.M.S. *Read April 1st*, 1890.

Among the plants included in the group of Algæ are those of the *Characeæ*. They are described by Professor A. Nicholson and Mr Lydekker * as a "class comprising a number of freshwater or brackish-water Algæ, of a green colour, and remarkable for having lateral appendages corresponding with leaves. The thallus consists of a central stem giving off whorls of leaves at intervals, which in turn give off secondary leaflets." The same authors state that fossil forms of the genus *Chara* occur in the Trias, Jurassic and Cretaceous formations, and are abundant in parts of the Tertiary series. Reference is also made to the occurrence of the genus in the chert of the Purbeck formation.

In Morrison's catalogue of British Fossils, published in 1854, (p. 4) the author mentions two species of *Characeæ* as occurring in Purbeck beds, in the Isle of Purbeck. The authority for the statement is Forbes, and the reference is "Records of the Geological Survey," but the page and number of the volume is not given. The reason of this omission is that the record of the finding of the fossils, and the descriptions, existed only in manuscript, and has never been published. I am also informed that the fossil specimens cannot be found. In the summer of 1888, I collected Purbeck limestone from Lulworth Cove, Dorsetshire, and on making thin sections, I discovered numerous vegetable remains, some of which proved

* Manual of Palæontology, Vol. 2, p. 1497, 1889.

to belong to the genus *Chara*. The names given to the two species discovered by Forbes were *Purbeckersis* and *Valdersis*. I cannot, of course, say that any two of those I have met with are identical with Forbes', seeing that his types cannot be found. I also think that it would be unwise to give names to these I am about to describe, as they may be fructifications of one and the same plant. At any rate I shall leave that to some person more capable than myself, and be content with simply recording the find and brief description of the specimens.

Fig. 1. This is the most common form of the genus which occurs. It consists of an axial cell and twelve cortical ones. The central cell is the largest, and the cortical ones consist of six superior and six secondary ones, with well preserved walls.

Fig. 2 This fossil shows a large or central cell, and twelve cortical ones of practically equal size. This figure may represent a section of a cerpogonium.

Fig. 3. This is much the larger specimen of the three, and the general arrangement of the cells is different from what we find in the specimens previously referred to. The axial cell is small and is surrounded by six large sized cortical cells, and at the points where these diverge from one another, there is a very small secondary cell.

The specimens were obtained from a crystalline light coloured limestone, largely made up of calcified vegetable remains, Figs. 4 and 5. The limestone also contained remains of *Planorbis* and occasional valves of *Ostracoda*.

On treating the rock with hydrochloric acid the usual evolution of carbonic acid takes place, and a residue is left consisting of crypto-crystalline silica and some grains of detrital quartz. The crypto-crystalline silica consists of fragments of casts of the organisms in the limestone, and also portions of *Characeæ*, the organic structure of which has been replaced by the silica.

With regard to the mineral conditions in which the *Characeæ* are preserved, I may say that in Figs. 1 and 3 the cells are in part filled with crystalline calcite, and in part by a dark substance containing some carbonaceous matter.

## DESCRIPTION OF PLATES

Figs. 1 and 2. Sections of Chara × 90 Diam.

Fig. 3. A sections of Chara × 15 Diam.

Fig. 4. Sections of Purbeck limestone containing *Characeæ* and fragmental remains of calcareous organisms × 44 Diam.

Fig. 5. Section of Purbeck limestone containing calcified vegetable remains, a small shell, and a section of Chara × 15 Diam.

VOL. X PART II

# PROCEEDINGS

OF THE

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CHELTENHAM



Contents



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AUTHORS MUST TAKE THE SOLE RESPONSIBILITY OF SEEING THEIR OWN PAPERS CORRECT FOR PRESS.

*Annual Address to the Cotteswold Naturalists' Field Club, read at Gloucester, April the 30th, 1891, by the President,*
Mr W. C. Lucy, F.G.S.

The Annual Meeting was held at the Bell Hotel, Gloucester, on the 29th April, 1890, when the President, Vice-Presidents, and Officers of the Club were re-elected.

Mr Jones, the Hon. Treasurer, presented the accounts, shewing a balance in favour of the Club of £57 2s. 10d., which were passed and ordered to be printed.

The following Field Meetings for the year were arranged:—

| | |
|---|---|
| Lydbrook and Symond's Yat ... | 27th May |
| May Hill ... ... ... ... | 24th June |
| Eastnor and neighbourhood ... | 29th July |
| Swindon and Avebury .. ... | 26th August |

The members adjourned to the Lecture Room of the School of Science and Art, where the President after reading his annual address, made a departure from the usual practice of his predecessors by giving a paper on "A slight History of Flint Implements, with especial reference to our own and adjacent areas," and which is printed in the last number of the Proceedings.

The members dined at the Bell Hotel.

Alas! how time is thinning our ranks! It is again my painful duty to record the death of another old and valued member. Dr. William Henry Paine, after a long illness, died on the 13th June last, at the age of 66, and was buried on the 18th, at the Stroud Cemetery. He became a member in 1860, succeeded me on my retirement as Hon. Secretary in 1866, and resigned this office in 1888, when he was elected a Vice-President. The Hon. Secretary of a Field Club requires courtesy, much tact, and judgment, all of which he possessed in an eminent degree. From a natural diffidence of manner, only those who were on terms of intimacy with him were aware of his sound and varied knowledge, and we have to regret that he did not contribute to our Proceedings. His arrangements of the Field Meetings were judiciously made, and their instructive and pleasurable character was mainly owing to his careful forethought; and I feel, as I am sure you all do, that in him we have lost an old and never-to-be-forgotten friend.

## LYDBROOK AND SYMOND'S YAT MEETING

On Tuesday, the 27th May, the members left Gloucester for Lydbrook *viâ* Berkeley and Lydney, and in passing over the Bridge the President exhibited and explained an elaborate section of the western side of the Severn estuary, made by Mr John Jones in 1858, during an excursion with Sir Wm. Guise, the Rev. W. S. Symonds, and the President.

On arriving at Lydbrook they were met by the Rev. F. J. Aldrich-Blake, the Rector of English Bicknor, who took them to the Church, a modern structure, erected in 1858 on part of the site of one built in the Fourteenth Century. The Church is dedicated to St. Margaret, supposed to be in honour of Margaret, Lady of Welsh Bicknor, the great grand daughter of Edward I., who married Lord Montacute, and who was the mother of the third Earl of Salisbury. There is an effigy in the Church said to be to her memory.

At the Rectory Mr and Mrs Aldrich-Blake gave an excellent luncheon, with some of the celebrated styre cyder for which the parish is justly celebrated.

Mr Aldrich-Blake shewed the members his very fine collection of paintings, including works by Rubens, Raphael, and other old masters, and also many works of the best modern school of painters.

Thence to Bicknor Court, the residence of the Rev. E. Machen. Mr Machen conducted the party through the celebrated Coldwell Woods, the most beautiful scenery in the Forest. Openings are made in different parts of the wood, from which the Wye below is seen to great advantage.

At Symond's Yat Mr E. Wethered gave an address on the Geology of the neighbourhood. He said we were standing upon the Carboniferous Limestone, and wherever it occurs in river districts, as Clifton, parts of Derbyshire, and elsewhere, it forms magnificent cliffs like those before us.

As to the origin of the limestone, each bed was formed underneath the sea, in which lived countless multitudes of organisms, with shells or skeletons of carbonate of lime, and their remains formed beds of limestone. In some beds he had found a remarkable organism named *Mitcheldeania*, which had puzzled him much, as it did not seem to belong to any other known form. At present it was classed with the *Hydrocorallinæ*, a name suggested by Professor Moseley for two groups of marine hydrozoa which produce a regular skeleton of carbonate of lime, and which were formerly referred to the true corals, the *Actinozoa*. The basement beds of the limestone resting on shales were mainly made up of foraminifera. Another remarkable feature in the Carboniferous limestone of the Forest of Dean he discovered in an examination made some years since. It was found to contain only 54 per cent. of carbonate of lime and 37·11 of carbonate of magnesia, while the usual proportion would be 85 per cent. of the former and less than 1 per cent. of the latter. This proved that the limestone had undergone chemical changes, and had been converted into and had become dolomotized, entirely altering the original character of the rocks.

Briefly alluding to the formation of the Wye gorge, which he attributed to several agencies, he referred to the Bone Caves which had been found at the Doward and other places. After a few remarks on Mr Wethered's address by the Rev. H. H. Winwood and Mr F. D. Longe, the members returned to a secluded spot, where the Misses Machen had provided a most acceptable tea, with refreshments.

The President thanked Mr Machen and his daughters for their kind hospitality.

In replying, Mr Machen wished to avail of the opportunity of expressing his desire to protect the woods, and also the rare plants, in all their natural beauty. A few years ago they suffered much from tourists, and he felt bound to impose a limited restriction by the charge of twopence for each person, and the money collected was given to the Children's Hospital at Gloucester.

The President said he thought Mr Machen had acted wisely—a remark applauded by the members of the Club.

## MAY HILL MEETING

Tuesday, 24th June—The members left the Gloucester Station for Longhope, where a quarry in the Ludlow limestone, near to the station, was examined. It was found to be highly fossiliferous, and some fine specimens of Rhynconella nucula and Chonetes striatula were picked up.

The Hon. Secretary, by the aid of diagrams, explained the position of the Ludlow beds in the Silurian system, and also the lower beds of the same formation, which would be inspected during the day.

From there to Dursley Cross, where a halt was made at some Crystalline Schists which form the core of May Hill, and the President requested Dr Smithe to explain what is known of their history. He said there was a conflict of opinion amongst Petrographers as to the origin of these changed rocks, and he referred the members to the researches of Messrs Bonney, Judd, and A. Geikie, as given in the Journal of the Geological Society.

Metamorphism in minerals and fossils afford an insight into the changes that had operated in the more ancient rocks. For instance, consider the change by which a fossil shell—once consisting of molecules of carbonate of lime—becomes altered, and the lime partly replaced by silica. The alteration may go on until every original particle is completely changed, the shape only being left.

This metamorphism is known as *isomorphism.* The difficulty in the case of rocks is two-fold—1, change of form; 2, change of molecular action.

The party then proceeded to the summit of May Hill, where Dr Smithe referred to the graphic remarks made there by Mr Hugh Strickland just forty years ago, and which will be found at page 19 in the History of the Club, by the President.

Dr Smithe called attention to the strongly marked cause of disturbance, as shown by the igneous rocks, faults, upheavals, contortions, foldings, and thrusts, as were seen in May Hill and Huntley Hill quarries.

He also referred to Salop, where the Brown and the Titterstone Clee Hills, with their Diorites piercing the coal measures and scorching the coal seams into cinders when they were in contact. Then the Abberley Hills, with their trap rocks; the igneous rocks at Malvern (of granulite) leptinite, of diorite and Syenite, upheaval and heavy faulting of the sequence of beds; next May Hill, with its dome formed by upheaval—showing no trap rocks, but enormous denudation of the upper Llandovery beds.

To the S.S.W. occur the amygdaloid rocks at Damory Bridge, Tortworth, and an extension of the same action in the igneous rocks of Charfield. But the direction of the force deflects at Tortworth, plunges under the Severn, and re-appears on the N.E. coast of Ireland.

The subject of the Upper Llandovery beds, or May Hill sandstone, was then dealt with, which he said were now considered by our own and Continental Geologists as the base of the Upper Silurian system. Their apparent unconformity with the Lower Llandovery, as well as the proof from the fossil contents, combined to shew great lapse of time—lost pages of the record.

He then referred to the rich fossil remains of the Upper Silurians, especially in Brachiopods.

The President remarked it was the determination of the beds of the hill upon which they were standing which led to the unfortunate estrangement between Sir Roderick Murchison and Professor Sedgwick, and he thought it was a fitting place to read part of the touching letter by the Professor to Sir

Roderick, on hearing of the death of Lady Murchison, which produced the reconciliation so long sought for by Sir Roderick.

"Sunday morning, Jan. 21st, 1869

"Dear Sir Roderick Murchison,

"I did not wish to intrude myself on your sorrows so soon. Indeed, such has been my life of solitude for the last two months, that incidents of the greatest interest to my heart have more than once passed away for a full week or ten days before their report reached me.

"You will, I know, believe me when I say that the first news of your beloved wife's death filled me with very deep sorrow. For many years Lady Murchison was one of the dearest of those friends whose society formed the best charms of my life. How often was I her guest! How often have I experienced her kind welcome, and been cheered and strengthened by it! In joy or in sorrow she was my kind and honoured lady friend; and have I forgot those bright and, to me, thrice happy days, when she and you were my guests at Cambridge?

"The present has comparatively little for me now. Hope I have for the future, and I trust that God will give it to me in the last hours of this world's life, whenever they may come. But an old man necessarily has his thoughts carried to the past.

"But, oh! how many of the dearest and sweetest remembrances of my life are now blended with clouds of sorrow! It must be so. It is nature's own law. May God teach you to bear your sorrow like a man. Of this I have no fear; but more than this, may His grace be given you to bear it like a Christian. His sustaining power is His precious gift, and it must be humbly sought for, by prostration of heart, while under God's afflicting hand. May He give you the comfort of Christian hope; compared with it all other comfort vanishes into mid-air, and if it indeed be given you, sorrow will lose its bitterness, and even be tempered with joy."*

I am indebted to Mr B. Matthews for the following list of plants found during the day:—

*Ophrys apifera.* (Bee orchis)
*Chlora perfoliata*
*Onobrychis sativa*
*Vicia cracca*
*Potentilla anserina*
*Cotyledon umbilicus*
*Echium vulgare.*

* Life of Sir R. Murchison, by Professor Geikie, Vol. II., page 337. At the time the letter was written Professor Sedgwick had nearly completed his 86th year.

The members, after visiting Mr and Mrs Miles at the Rectory, dined at the Red Lion, Huntley.

## LEDBURY MEETING

July 29th—The members proceeded by train from Gloucester to Ledbury, where carriages were at once taken for Eastnor Castle, visited by the kind permission of Lady Henry Somerset.

The fine Hall and Flemish armour, said to have belonged to the body guard of Charles V., were much admired.

An early luncheon was partaken of at the Somers Arms, which is conducted on temperance principles. Carriages were then taken for Bronsil Castle, of which very little remains. It has, however, two moats, and from the inner one Mr G. H. Piper, of Ledbury—who is an authority on the Archæology and Geology of the neighbourhood—gave an instructive address. He considered the Castle to belong to the middle ages, and was probably the most recent of that period in the County. It was taken in 1644, after a brief resistance, from Mr Thomas Cocks, by a small force of Roundheads under a younger son of Sir R. Hopton. Hopton's triumph was of short duration, for in a few days a party of Royalists from Hereford invested the place, to whom in less than twenty-four hours he was obliged to surrender, and with 40 foot and 20 horse was carried prisoner to that City, before General Massey could send aid from Gloucester.

On leaving Bronsil, *en route* to the Hollybush Pass, and close to the road, an old lava flow was examined. Mr Wethered remarked the Geology round Eastnor was of great interest from the antiquity of the rocks, and explained the views of Sir Roderich Murchison, who considered the axis of the Malvern Hills was of Syenite, but later investigations by Dr Holl shewed it to be Metamorphic, an opinion since accepted by Geologists.

An ascent was made of Hollybush Hill, from the summit of which is a grand view of the country, and Mr Piper read a paper on "The Camp and Ancient British Town on the Midsummer and Hollybush Hills." He referred to an earlier race inhabiting Wales, and whose existence has only lately been made known to us by the discovery of their relics. He mentioned the notice of Great Britain by Herodotus and Aristotle, but he believed the Phœnicians traded here for metals long before the Greek historians wrote.

The intercourse with foreigners naturally increased the wealth, civilization, and population. The people formed many tribes, and we learn from Cæsar they were no mean enemies, being trained in the arts of war. This would probably arise from their frequent conflicts with each other, as they had no foreign foes to encounter. This constant state of turmoil involved the use of entrenched camps, or fortified towns, and the spot we are standing upon is one of them, large enough to contain a whole tribe.

To treat such positions as this, Thornbury, Walls Hill, and many places in Herefordshire as merely military camps, is a great error—they were also places of refuge for the whole people. They were probably strengthened by stockades of timber, large gates guarding the entrances, the post holes of which are now traceable.

To assign a date to this Camp or Town, or say by which of the past races it was constructed, is at present impossible, but there are good reasons to believe that future exploration may throw much light upon the subject.

The length of the Camp is 2,000 feet, and its circumference 5,700 feet. The site of the old British Town, lying in the hollow between the hills, and over-lapped and protected by the Camp, is about 1.200 feet.

The height of the Midsummer Hill is 958 feet. It has on the Eastern side ten or eleven terraces, whereon as many as 244 hut hollows are visible.

Others may be seen on the Hollybush Hill and in the hollow between the two eminences. There is water here, rising from two springs, which was used by the people, and stored in four different tanks connected with each other.

On Hollybush Hill, within the walls of the Camp, is a barrow of symmetrical form, 150 feet long by 32 feet broad, and about three feet high, lying North and South, with a slight trench round it. In September, 1879, I was the means of having this barrow partially excavated.

Although on the top of the hill, where usually little soil is found, in every part opened it was four feet deep. It could not have accumulated upon such a spot, and evidence of this was seen by the fact that many pieces of quartzose grit, probably from Rowick, and some large angular pieces of Laurentian rock were found. Ten feet from the West side, at a depth of three feet, fragments of charcoal, two small pieces of burnt brick—one having the impression of a dog's foot—and a thin copper ring were discovered embedded in the black earth.

A few days after the excavation General Pitt-Rivers arrived here, who stated he had been present at the opening of similar mounds in Oxfordshire and elsewhere without results. At Dartmoor he had seen raised mounds which had been thrown up by rabbits in burrowing. Whatever may have been the case at Dartmoor, Mr Piper did not believe that at any period of the word's history men could have been found so foolish as to carry to the top of Malvern Hill sufficient soil to construct an earthwork 50 yards long, 10 yards wide, and three feet deep for the beatification of rabbits. He said Mr John E. Price, F.S.A., remarks that some significance must be attached to the relics in the long barrow, and the mound and its contents may be Roman—an illustration of a *Botontinus*, or one of the terminal marks which it was the practice of the surveyors of old to construct at the confines of territories. In defining the boundaries of land the *Agrimensors*, or land surveyors, selected various signs, the future discovery of which would make the lines of demarcation clearly significant.

My opinion that the Barrow is Roman or post Roman is unchanged, and, as history tells us, a great battle was fought on the Malvern Hills in the Tenth Century, when Athelstan drove the Cyrmry beyond the Wye, and the battle probably took place within these entrenchments.

The Science of these places has yet to be learned, and I quite believe a series of patient and careful diggings would reveal and make plain, much that at present is doubtful and obscure.

Mr Piper's remarks were followed by some discussion on the points he had raised, and a cordial vote of thanks was passed for the instructive information he had given during the excursion.

A descent was made to the Hollybush quarry, which contained some fine examples of igneous rock (Diabase.)

Carriages were resumed to Ledbury, which place was reached in time to catch the 4.31 train to Gloucester.

## AVEBURY MEETING

The 26th of August was the last meeting. It had previously been visited in the early days of the Club, May, 1849.

The members arrived at Swindon at 10.37, and drove over the Marlborough Downs to Avebury, where they were welcomed by the Vicar, the Rev. Bryan King, who shewed and explained to them his very interesting Church. In it are Saxon remains, and on entering the porch some blocks of that age of carved stone are seen embedded in the walls. One represents the Father giving benediction to the Son, who is embracing the Cross.

In the aisle is a window of the Saxon Church, never glazed, and has a "rebate" cut round it in stone for a shutter, and the external stonework is "axed" for the purpose of enabling the mortar, by which Saxon buildings were coated, to adhere to the stone.

The font, according to Mr Loftus Brock, is distinctly Saxon in its character, with Norman ornamentation subsequently added. On its West side is the figure of our Lord, or of a Bishop, holding the open Gospels upon his breast with the left hand, and "bruising" the head of a serpent with a pastoral staff with the right hand; whilst a serpent on the left is "bruising" his heel—an obvious allusion to the fall of man, and to the recovery of his lost estate through the mystical washing of Holy Baptism.

The Chancel is Fourteenth Century work, and there are some beautiful paintings of the Reredos lately executed in Munich. They are copies of paintings in Florence, by Fra. Angelica, and are framed in the remains of carved work taken from a Jacobean pew.

A brief historical description of the Church is given in a small pamphlet, written by the Vicar, of which I have largely availed.

Before inspecting the wonderful mound, camp, and large stones, a paper upon them by the Rev. W. Bazeley—who was unable to be present—was read by the President.

This paper Mr Bazeley has since amplified in the one he read at our last evening meeting.

A short walk brought the party to Silbury Hill, the largest artificial mound in Europe, more than equalling in size the second Egyptian pyramid.

When the Club visited Silbury in 1849 Mr Hugh Strickland said he had been on the top of the largest artificial mound known—the tomb of Halyattes, in Asia Minor, described by Herodotus—and Silbury reminded him very much of it.

The President gave a short account of the Geology of the district, with special reference to the Sarsen, Saracen, or Heathen stones. It had been suggested to him that the etymology of the word Sarsen is probably *ses*, plural *sesan*, Anglo-Saxon for a rock.

For a long time there was a good deal of speculation as to where such large blocks could have come from, and also by what agency they were brought. Even Stukeley's remarks shew how primitive scientific knowledge was in his day. He says "that this whole country hereabouts is a solid body of chalk, covered with a most delicate turf. As this chalky matter hardened at creation, it spew'd out the most solid body of the stones, of greater specific gravity than itself; and assisted by centrifugal power, owing to the rotation of the globe upon its axis, threw them upon the surface, where they now lie. This is my opinion concerning their appearance, which I have often attentively considered."

The literature upon the subject of these stones is voluminous, but probably the most exhaustive paper is by Professor Prestwich, in Vol. X. Quarterly Journal. He there shews that they occur in the Reading and basement beds of the London clay, but they are mostly derived from the Bagshot sands, and at one time the Eocene strata extended over the Chalk Downs of the South and West of England, and the Sarsen stones have been left by denudation not far from their parent source. They are formed of concretionary masses of hard Saccharoid Sandstone, full of small grains of quartz, and vary in colour from white, a pale grey, to brown.

Professor Rupert Jones mentions in the *Geological Magazine* for 1876 that one of the enormous upright sarsens (standing among the ricks of a farm) abounds with peculiar perpendicular rootlets, together with numerous horizontal casts of stems and other plant remains.

Mr W. Carruthurs, the distinguished fossil botanist, also states in the same work for May, 1885, that he has observed some roots of palms in the Avebury stones, but they are generally unfossiliferous, and contain some flint pebbles and stones only slightly rolled. Sarsens are used extensively for building purposes, as may be seen in the Parish Church and other buildings in the neighbourhood; part of Windsor Castle is also built of them.

Mr Ernest Sibree, of the Indian Institute, Oxford, was one of the party, and when on Silbury some discussion took place with him, the President, and the Vice-President (Mr John Bellows) as to the history of the hill and Avebury, and the President requested Mr Sibree to supply him with a few remarks on the subject. There is so much difference of opinion among Archæologists that any new light is gladly welcomed, and I thankfully introduce Mr Sibree's notes—

"NOTES ON AVEBURY AND SILBURY

"The name Avebury is probably connected with Avington, the name of a village lower down the Kennet, Av or Ave being possibly an ancient word for river. Abury is the shortened form of the name. Avebury would then mean the 'bury,' 'earthworks' (*not necessarily* a camp) on the Ave. Stukely, in his description of Avebury, has the following:—'This town is wrote *Aubury*, *Avebury*, *Avesbury*, sometimes *Albury*; 'tis hard to say which is the true. The former three names may have their origin from the brook running by, *au*, *aux*, water *awy* in Welsh: the Old German *aha* (sic). The latter points to *Aldbury* or *old work*, regarding its situation within the vallum. Nor is it worth while to dwell on its etymology. The Saxon name is a thing of so low a date, in comparison of what we are writing upon, that we expect no great use from it, unless Albury has regard to *al*, *hal*, *healle*—a *temple* or *great building*.' These different spellings of the name may be accounted for as follows:—We may start by assuming that there were two names for the place—Aubury and Avebury. Aubury would pass into Albury by the analogy of such place-names as Aldbourne, Aldworth, and more especially Oldbury, which are met with in that district. Avebury would become Avesbury by the analogy of Amesbury.

"With regard to Silbury the following points should be observed:—In discussing the etymology of English place-names it must be remembered that they are Saxon in form, that is, that where the name is descriptive the adjective precedes the substantive; whereas in Keltic districts the converse is the case. Names ending in 'bury,' which is a Saxon word, may be classed as English. The first part of such names is as a rule Keltic, as in the case of 'Avebury,' and may be regarded as an independent Keltic word. This is the case with Silbury. The question is what is this word? It is improbable that it is an adjective, according to the general rule. It is more likely that it is a noun, and that the ancient name was Sil—(the hyphen representing some unknown formative suffix, which has disappeared). Now there is a wide-spread root in the Keltic languages, sel, sil, syl, sul, sol, &c., which means to see, behold, look, gaze at, &c., and in all probability the name Sil meant 'the post of observation.' The English who invaded Britain, not knowing the meaning of the name, affixed to it the syllable 'bury,' meaning 'earthwork,' and called the mound Sil-bury, and when at a later period the meaning of the word 'bury' was lost, the name was further augmented by the addition of the modern word 'hill,' the result being the extended form 'Silbury Hill.' Another Keltic root 'edrych,' meaning 'to see,' was used in the same sense, and supplied the first part of the name 'Drakestone,' indicating the point of observation on Stinchcombe Hill (Bellows' *Forest of Dean*.) The Scandinavians introduced the root 'tot,' having the same meaning, and which is seen in such names as Toots (Selsley Hill,) Mythe Toot (Tewkesbury,) and Tothill. It is evident, however, that Silbury was not intended originally as a mound of observation, though standing, as it does, close to the Roman (or Romano-British) road, it may have been used for that purpose, as the surrounding high ground, such as Waden Hill, would afford ample means of observation. Consequently, we find attempts made to explain the name with reference to the rites performed at Avebury. Canon Taylor (Word and Places) refers the name to 'sel,' the root of the German word 'selig' meaning 'blessed, sacred, &c.' giving the signification 'holy-bury.' He sees the same root in Selly Oak, near Birmingham, 'sacred oak.' This etymology is apparently justified by the following con-considerations :—Stukely's explanation of the plan followed in laying out the temple and avenues at Avebury may be taken as substantially correct, namely, that we have here the representation of a serpent, the head of which was at East Kennet, at a place which is still known as the 'Sanctuary,' and the end of the tail at Beckhampton, while the Temple at Avebury represents the coiled-up middle of the body. But there are two circumstances left unexplained: (1) Why does the head lie at East Kennet and the tail at Beckhampton? (2) How is the direction of the head and tail determined? The answer to both these questions is, I think, to be sought for in the assumption of a certain connection between sun-worship and serpent-worship. Before going into the question as to the direction assumed by the head and tail, it may be conjectured that on the occasion of a great religious ceremony connected with sun-worship, the procession would be formed at East Kennet, where the first rites would be observed at sun-rise, and would then proceed to Avebury, where the chief ceremony would be performed when the sun at mid-day stood directly over Silbury Hill, finally making its way to Beckhampton, where the last rites would be gone through. The times at which the great ceremonies were held may be conjectured to have been the summer and winter solstices, and the vernal and autumnal equinoxes. The chief ceremony at Stonehenge, judging from the direction in which the temple stands, namely, due East, would take place at the vernal and autumnal equinoxes. At Avebury, where the avenues lie to the South-East and South-West respectively, one of the chief ceremonies would be performed at the winter solstice. In support of the theory that a great ceremony was also observed at the vernal equinox, it may be remarked that Stukely makes the following interesting observation :—'The country people have an anniversary meeting on the top of Silbury Hill on every Palm Sunday, when they make merry with cakes, figs, sugar, and water fetched from the Swallow-head or spring of the Kennet' (p. 43). In this it is easy to observe the survival of a pre-historic custom in connection with sun-worship, pointing conclusively to the time of the year at which one of the chief ceremonies was performed at the temple of Avebury. On calculating geometrically the point on the horizon at which the sun rises on the 21st of December in latitude 51·5°, I find it to be approximately 5° E. of S.E., that is, about 50° to the E. of the meridian. Now Stukely says that 'Silbury stands exactly South of Avebury, and exactly between the two extremities of the two avenues, the head and tail of the snake.' If then we take Silbury as the meridian point on the horizon, it will be found on calculation that the Sanctuary at East Kennet is 47° E. of that point, corresponding very nearly with the above figures. It may be conjectured, therefore, that the position of the minor temple at East Kennet, and of the end of the avenue at Beckhampton, was determined by the position of the rising and setting sun in reference to the greater temple at Avebury at the time of the winter solstice (Dec. 21.) The curve in the avenues may have been suggested both by the conventional form of the serpent and by the apparent course of the sun."

May we not hope that in course of time Archæological research will place the object for which Avebury and Silbury were erected on as firm a basis as our knowledge of where the Sarsens stones were derived from?

The members drove back to Swindon, and became disagreeably conscious of the force of the wind when it is blowing a gale over the Marlborough Downs.

Time only admitted of a cursory examination of the Swindon section, and it was resolved that it should form one of the meets for next year. Dinner at the Goddard Arms.

The first Winter Meeting was held on Tuesday, the 25th November, when our Hon. Secretary gave a paper on—"Evidence of the process of the formation of the Inferior Oolite deduced from Microscopic Examination," of which the following is a resumé:—

He referred at some length to the structure of the oolitic granules, which he contended were, in the main, of organic origin, and not concretionary, as generally supposed. This was illustrated by micro-photographs, in which some of the granules showed a tubular structure around nuclei. These Mr Wethered explained were the tubuli of the very interesting organism or plant known as *Girvanella*. The nuclei of the oolitic granules consisted of fragments of calcareous organisms, and round these the *Girvanellæ* collected, forming a granule. In some granules this tubular structure could not be seen, and then the granules showed either a granular or a crystalline structure. A concentric arrangement around the nuclei was sometimes seen, but not often. In these instances it might be contended that the chemical or concretionary origin of oolitic granules might be maintained, and possibly this might be so in some instances, though he doubted even this. He contended that in the granular and crystalline granules the original structure had been obliterated by molecular changes. This was found in some instances where the tubercles could be traced passing into the granular condition.

As to whether *Girvanella* was a plant or some other organism was a matter of doubt, and he would leave that part of the question to be decided by Botanists and Zoologists. It was, however, clear that the *Girvanellæ* had played a most important part in building up the oolitic rocks of which the Cotteswold Hills so largely were made up.

Reference was also made to the other organic remains which appeared in the Jurassic limestones in the hills. At the base, the remains of Echinodermata were very numerous. They were less in the beds above, and in the Gryphite Grit polyzoa had largely contributed to the formation of the rock. This fact could not be ascertained unless the sections of the limestone were placed under a microscope. To the eye the Gryphite Grit seemed to be full of the shells of *Gryphæa sublobata*, but the microscope showed that the apparently structureless grey limestone in which the shells were embedded was full of the remains of life. This was also true of many other beds in the Cotteswold Hills, and illustrated that there was still plenty of work to be done before we understood how the rocks of the Cotteswold Hills had been built up.

On Tuesday, the 27th Jan., 1891, Mr John Bellows read a paper—"The Roman Villas of Gloucestershire."

Professor Harker occupied the Third Meeting on the 24th Feb., with two papers—

1,—"On the Geology of Cirencester Town, chiefly as revealed by a deep boring by the Cirencester Water Company, and the local water supply generally."

2,—"On the discovery, in a Cotteswold stream, of one large Oligochaete, new to Britain; and another unrecorded in the County.

The Fourth and last Meeting was on the 24th March.

The first paper by the Rev. W. Bazeley was on Avebury.

The second by the Rev. Dr Smithe and W. C. Lucy—"Sections, Field Notes, and Remarks on Alderton Hill, Ashton-under-Hill, and Gretton."

The only reason why my name appears is that I accompanied Dr Smithe on the occasion of our visit there many years since, and assisted him in making notes, but the paper is really his.

As the valuable papers read at the three last meetings are all published in the Proceedings, I do not give an epitome of them, but I would call especial attention to the important discovery mentioned by Professor Harker of the occurrence of the Oxford clay at Cirencester.

The President's address appears to me a fitting place to record objects of interest which have come to his knowledge or been exhibited at the Club meetings, and which do not form part of an especial paper.

This year the following are of value, and were exhibited at the evening meetings:—

A Bronze Axe, sent by Sir James Campbell, which was found in the Forest of Dean some years since, about four to five feet below the surface, near Lydbrook, when a quarryman was "ridding" his ground to get at the stone beneath.

Also a bronze instrument, found at Lydney in a clayey soil, three feet below the surface, in front of the present offices of the Severn and Wye Railway Company, shown by Mr G. W. Keeling. It corresponds with the Palstave, figured in Mr Boyd-Dawkins' "Early Man in Britain," page 350, fig. 117, and which he refers to an early period of the Bronze age.

We are indebted to Mr G. Embrey, the County Analyst, for a careful analysis of the composition of these bronzes, the metals in which proved to be of unusual purity.

The results are as follows:—

| | Lydney | Lydbrook |
|---|---|---|
| Copper | 87·02 | 87·00 |
| Tin | 12·74 | 12·98 |
| Loss | 24 | 2 |
| | 100·00 | 100·00 |

An artificial Cone of Flint, exactly like fig. 188, p. 247, in Dr Evans' "Ancient Stone Implements": lent by our member, Mr A. E. Smith, of Nailsworth: found at Haslewood.

Our Field and Evening Meetings were never so largely attended, the discussions at the latter were full, and I trust the reputation of the Club has been well maintained.

*Geological Notice upon the Forest of Dean, by* H. D. Hoskold, M.E., F.G.S., *etc., Director General of the National Department of Mines and Geology, Buenos Aires, Argentine Republic.*

The Forest of Dean Mineral Basin has a favored position, and is situated in one of the most pleasant, interesting, romantic, and healthy districts of Gloucestershire, its surrounding scenery being varied and highly picturesque, and perhaps unequalled in any other mining part of the kingdom. It is, in fact, a place of great name, as well as fame, and history tells how, long centuries ago, its surface and mineral privileges were contended for and enjoyed by some of the great favorites during various reigns, and that its natural resources added, in a considerable degree, to national strength and security; indeed, so famous had the history of the Forest become in Europe, that blinded bigotry and jealousy were aroused to such an extent as to finally induce an attempted ignoble war, resulting in the defeat and destruction of the grand Armada, and humiliation and dishonour of the Court of Spain.

Here in a primitive forest, in obscure dells and mountain retreats, roamed in wild liberty and security—from an unknown date and during an unascertained period—the ancient British rulers, fathers of the Silures, and here also reigned the Romans and successive conquerors of the British Islands. But, no longer is the rush of armies, the wild battle cry, and the clashing of arms heard: no longer does the invincible Cæsar direct and encourage his valiant cohorts, or do Saxon or Norman warriors, Kings and Forester Fee—with his Knights in Green—range through tangled dell, sounding the horn and bending the bow in the wild excitement of the chase. All these grand old customs and charms of bye-gone ages have introduced a more peaceful era, leaving us to profit by the records of the past, and as the British, Romans, Normans, as others did, so can we, but in another form, enjoy and contemplate the grand old Forest of Dean amidst its varied associations. Some of the trees still mark ancient sites, and the rocks and monuments are still there; the Naturalist and Antiquarian may therefore enter upon those interesting and important researches as would best conduce to the personal recreation and utility of the age in which we live.

Unfortunately, however, the Geologist and Mineralogist will find that the elements for study in such useful branches of science are comparatively limited; still they are of an interesting and valuable character, because they form links of connection with the surrounding mineral districts, the whole of which must be studied in an extended form in order to understand and define the natural phenomena presented.

The Forest of Dean is no exception to the rule, *i.e.*, that in no given locality or district can the Geologist find all the known strata in a conformable condition or succession.

The whole has consequently to be studied, understood, and made up of the patch-work—so to speak—of the rocks as they exist and are presented under different forms and conditions, and in other places.

Doubtless all the recognised rocks forming the crust of the earth, from the most recent, or Pleistocene, down to the Cambrian and Laurentian, once existed over the whole of the British Islands, but the immense thickness of the Carboniferous strata, from the coal measures upwards, have been broken up and denuded to form other and newer strata. Consequently, those great periods or divisions of formations known as Tertiary, Secondary, and the upper member—Permian—of the Palæozoic, are entirely absent in the Forest of Dean, evidencing those forces which were exerted, probably over millions of years, in producing these changes.

From a general consideration of the circumstances and conditions which are presented in the surrounding districts, we are led to form the conclusion that the Forest of Dean Mineral Basin is only a small portion of the Mineral Basin of South Wales, once of greater extension, and that its preservation is mainly due to its having remained in a finally depressed condition in the form of a basin, and the eroding effects were reduced to a minimum.

It is an accepted fact that the Forest of Dean Mineral Basin was originally joined to that of Bristol and South Wales, and probably to other areas which extended to and beyond Gloucester.

It is not necessary at this moment to search for evidence, neither can it be attempted, in detail, but a few references can be made, in passing, bearing directly upon this question.

Professor Etheridge has shown that the Carboniferous Limestone exists at the base of his celebrated section of the Trias, Rhætic, and White Lias at Aust Passage, but the Permian, about 300 feet thick, the coal measures, and the Millstone Grit, which should be found to intervene between the Trias and Carboniferous Limestone, are absent, the New Red Sandstone being, in fact, in contact with the Carboniferous Limestone.

The Keuper marls of the Trias are again visible in the remarkable section at Garden Cliff, Westbury-on-Severn, and there the Rhætic, being capped from the upper portion with thin beds of White Lias, which latter probably extends under Gloucester. Vestiges of Permian rocks have been discovered at the Malvern Hills, and also at May Hill.

A portion of the New Red Sandstone is also to be found in the neighbourhood of Flaxley, deposited unconformably against intruded Silurian; consequently we have inferential evidence at least, that these measures extended over the Forest of Dean and far beyond. The Keuper and Rhætic beds incline in a South-Eastern direction from Garden Cliff, and at a very low angle of from two to three degrees, so that there ought to be a correspondence between the strata, or at least some portion of it, on both sides of the river Severn, and therefore if we place all the strata in an imaginary sense, conformably one above another, we could realize the depression and denudation they have undergone.

From these considerations, it is reasonable to infer that many of the known rocks were originally superimposed, and it is not difficult to conceive how these were removed in succession down to the present level during the many changes which have occurred during past Geological epochs.

The grand old historical Severn, with its varied but fertile valleys, is an interesting and graphic example of the final result of such active changes as were due to natural phenomena connected with the earth's history.

The Mineral Basin of the Forest of Dean is of an oval form, the narrowest part of which is situated near to Lydney. Nearly all the seams of coal contained in it are generally in a regular form, having their outcroppings pretty clearly defined, except at such places on the surface where sudden change of level and displacement by faults have more or less obliterated their continuity. The Trenchard seams are the deepest, and extend over the largest area, but whether others were formed below, we have, at present but little or no evidence.

The Coleford Hill delf seam is more general in its continuity, and more valuable than the Trenchard, but its outcroppings are within those of the latter, and consequently its area is somewhat less. All the other succeeding seams upwards have diminished areas until we arrive at the upper series, the Woorgreens. A cross section of these seams of coal, including the rocks, is very similar in appearance to a nest of irregular tea-saucers of various sizes and depths, fitted one into the other, the intervening spaces representing the beds of rock and shale which separate the seams.

The iron-ore measures extend beyond the limits of the coal formation, and have been estimated to extend over 39 square miles, or 25,000 acres, but another estimate made by the same party makes it equal to 16,000 acres.

The late Sir Warrington Smyth stated that the coal basin is about 34 square miles, or 21,760 acres.

Some years since, the writer made an estimation, using one of the Government maps for the purpose, and found that the Coleford Hill delf seam of coal extended over an area of

16,780 acres. It is probable that various maps may have been consulted by those who made the estimation of the area previously referred to, and this may have occasioned a disagreement between the various calculations.

The coal seams, generally speaking, are conformable to one another, and to the iron-ore measures below them, and dip at variable angles from all points of the outcroppings.

The iron-ore measures dip from the outcroppings on the Eastern side of the district at angles varying from 60°, 65°, and to 70° towards the centre of the basin, where the strata and coal seams are nearly horizontal for a considerable distance. The various beds are proved to be very regular in all the parts explored; we therefore know from experience the structure and constituents of the strata and minerals contained in them, even where no explorations by boring or pits have, as yet, been made.

The angles of dip of the measures are much greater on the Eastern than they are on the Northern, Western, and South-Western portion of the district. The maximum dip will be found to exist from a point half a mile or so to the North of the Howbeach Valley, passing through Shakemantle and to Westbury Brook Iron Mine.

There are, however, one or two other places on the Western side of the Forest where the dip is rather severe for limited distances.

The coal measures to which we shall refer more particularly further on, the strata in which the coal is found, consists principally of various beds of *arenaceous* and *argillaceous* sandstone rock, shale, and indurated clay. The thickest part of the sandstone called Pennant rock is situated in the Lower Series, resting upon the Trenchard coal and its associated sandstone shale and clay beds, all of which repose upon the Millstone Grit.

The Millstone Grit, the upper part of which consists of the Farewell rock, as it is sometimes called, is composed of a variety of beds of sandstone, conglomerate, shale, indurate clay, and a species of yellow ochre or coloured earth of no value.

Some of the beds of rock are coarse grained, while others are of a finer texture, and in the upper part of the series thin beds of conglomerate exist similar in nature to those found in the Old Red Sandstone, from the debris of which, doubtless, it was formed. The rounded pebbles of Quartz and Felspar contained in them are cemented together with fine particles of silicious, argillaceous, and ferruginous elements of a very tenaceous character. The shale, clay, and marle beds of this series predominate to a greater extent in some parts than in others. The thickness is also variable as we proceed in depth, for we find that some of these beds are in a more compact and rocky condition at deeper levels. The prevailing colours of the shale and marle beds are reddish, brown, dark purple, dingy yellow, chocolate, and claret. The distribution of a very large quantity of peroxyde of iron, held in solution during the period of the formation of these rocks, imparted the colours we now observe in them. This is beyond doubt, for we find deposited Hematite iron-ore of an excellent quality in this series and at some places such as at Saint Annals Iron Mine, China-Blind Meend, and to the Southern extremity of the Lower Oakwood Iron Mine level. In former years, ore of a poorer quality was also worked at the Southern extremity of Ruspidge Meend, near to Shakemantle. It has not, however, been worked in a general manner, or even searched for, a circumstance which has arisen chiefly because immense deposits of Hematite iron-ore have been found, and worked all round the Forest in the Carboniferous Limestone, situate at the base of the Millstone Grit.

Comparatively little water finds its way into the Millstone Grit series, because the beds of clay and shale act as a dam, throwing off the greater portion of the water periodically due to rainfall. The thickness of the Sandstone or Millstone Grit series varies in different parts of the Forest, and it has been stated to be from 273 to 455 feet.

At the Parkhill Colliery adit the thickness of the Millstone Grit, measured from the Lower Trenchard coal to the upper side of the Carboniferous Limestone, is 612 feet.

Near to Shakemantle Pumping Pit, on the Eastern side of the Forest, a portion of the Trenchard measures are exposed in a section of the railway cutting, and the thickness of the Millstone Grit in this neighbourhood, taken to the top of the Carboniferous Limestone, is 780 feet; this railway cutting exhibits a beautiful section of the upper beds of this formation. In the upper portion of the series beds of a very pure fireclay exist, and have been worked at some points. Similar beds also exist above the Trenchard seam of coal, and have been exploited for the manufacture of bricks at the Southern extremity of Ruspidge Meend and to the West of Shakemantle Pumping Pit, as also at Darkhill and Milkwall Meend. The same belt of clay is visible between the upper and lower Oakwood Mine levels on the South-Eastern side of the Forest.

At a point in the Millstone Grit, towards the South-East from Lambsquay House, and North-East from Gattles Cross, there exists fine beds of pure limestone which have been used for lime for many years. A bluish thin bed of limestone has also been worked at Oldcroft, near Soilwell House, but whether this is the remains of the Millstone Grit has not been ascertained. A sufficient number of sections do not exist by which it could be proved whether these limestone beds are general, *i.e.*, continuous in the Millstone Grit.

At a considerable distance to the South-West of Shakemantle Iron Mine, the Millstone Grit commences to thin out towards the Howbeach Valley, where there is no appearance of it, but the Pennant rock seems to rest upon the limestone.

The Carboniferous Limestone succeeds the Millstone Grit in a descending order, and the junction of the two series is distinctly marked by shale and a bed of limestone of from eight to twelve feet thick, of a fine texture, and slightly red in colour. This rock is the upper portion of the upper Carboniferous Limestone, and is locally known as the "Lid-stone," because it forms a cover to the iron-ore deposits, in fact, iron-ore is never found above it unless this rock had suffered fracture, and so formed an open joint into which ore may have intruded itself. Immediately below this bed of rock, a thick atratum of rock, from 30 to 40 feet in thickness, exists, called "Crease," in which the great deposits of Hematite iron-ore of the district occur.

This "Crease" consists principally of silica and limestone, is rough in texture, and frequently streaked with a reddish colour.

The particular bed of rock upon which the iron-ore is deposited is from 3 to 15 feet in thickness, and is very compact and highly crystalline. Iron-ore is never found below this rock unless cross joints exist in it. This base of the iron-ore measures is locally called "Underedge." From this point downward, the great mass of the Carboniferous Limestone commences, consisting of a series of hard compact beds of varying thickness, and of an imperfectly formed crystalline character. The general colours are mixtures of red, brown, and grey; the red colour, however, predominates in the upper and thicker beds down to the first shales.

In the Memoirs of the Geological Survey, Vol. I., p. 128, a section of the Carboniferous Limestone is given, and is said to have been obtained from near Lower Purlien. It is as follows:—

SECTION No. 1

| Description of Measures | Thickness in feet and inches | | Totals in ft. and ins. between each division | | Total depths | |
|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | ft. | in. |
| Marl ... ... ... ... ... ... | 0 | 6 | | | | |
| Gray impure and sandy limestone ... ... | 13 | 0 | | | | |
| Marl ... ... ... ... ... ... | 0 | 8 | | | | |
| Impure limestone... ... ... ... ... | 3 | 0 | | | | |
| Marl ... ... ... ... ... ... | 1 | 0 | | | | |
| Red sandstone, with calcareous matter... ... | 9 | 0 | | | | |
| Marl ... ... ... ... ... ... | 0 | 8 | | | | |
| Gray and red sandstone ... ... ... ... | 21 | 0 | | | | |
| Sandstone, with interstratified beds of shale ... | 37 | 0 | | | | |
| Red and soft sandstone ... ... ... ... | 20 | 0 | | | | |
| Soft sandstone, with thin beds of clay... ... | 20 | 0 | | | | |
| Hard sandstone ... ... ... ... ... | 19 | 0 | | | | |
| Sandstone, red with hematite veins ... ... | 49 | 0 | 193 | 10 | 193 | 10 |
| White, gray, and red limestone... ... ... | 90 | 0 | | | | |
| Limestone, with intermingled hematite extensively worked ... ... ... ... ... | 60 | 0 | | | | |

SECTION No. 1—*Continued*

| Description of Measures | Thickness in feet and inches | | Totals in ft. and ins. between each division | | Total depths | |
|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | ft. | in. |
| Gray, white, and blue compact limestone ... | 330 | 0 | 480 | 0 | 673 | 10 |
| Shale and limestone alternating ... ... | 107 | 0 | | | | |
| Gray argillaceous limestone ... ... ... | 2 | 0 | | | | |
| Gray shale... ... ... ... ... ... | 0 | 6 | | | | |
| Shale, limestone ... ... ... ... ... | 1 | 6 | | | | |
| Shale ... ... ... ... ... ... | 0 | 8 | | | | |
| Limestone ... ... ... ... ... ... | 11 | 0 | | | | |
| Gray shale, with thin beds of limestone ... | 10 | 0 | | | | |
| Argillaceous limestone ... ... ... ... | 1 | 0 | | | | |
| Shale, with thin beds of limestone ... ... | 1 | 0 | | | | |
| Argillaceous limestone ... ... ... ... | 1 | 2 | | | | |
| Shale and limestone alternating ... ... | 2 | 8 | | | | |
| Limestone ... ... ... ... ... ... | 1 | 1 | | | | |
| Shale ... ... ... ... ... ... | 0 | 8 | | | | |
| Limestone ... ... ... ... ... ... | 0 | 4 | | | | |
| Soft black shale ... ... ... ... ... | 0 | 6 | | | | |
| Limestone ... ... ... ... ... ... | 1 | 6 | | | | |
| Limestone and shale ... ... ... ... | 2 | 0 | | | | |
| Shale ... ... ... ... ... ... | 0 | 6 | | | | |
| Limestone ... ... ... ... ... ... | 0 | 9 | | | | |
| Shale ... ... ... ... ... ... | 0 | 6 | | | | |
| Limestone ... ... ... ... ... ... | 2 | 0 | | | | |
| Black shale ... ... ... ... ... | 0 | 6 | | | | |
| Limestone ... ... ... ... ... ... | 2 | 8 | | | | |
| Black shale ... ... ... ... ... | 0 | 6 | | | | |
| Brown limestone, with shale partings ... ... | 4 | 8 | | | | |
| Dark shale... ... ... ... ... ... | 1 | 0 | | | | |
| Limestone ... ... ... ... ... ... | 3 | 0 | | | | |
| Shale ... ... ... ... ... | 2 | 0 | | | | |
| Limestone ... ... ... ... ... ... | 0 | 8 | | | | |
| Arenaceous shale ... ... ... ... ... | 1 | 6 | | | | |
| Limestone ... ... ... ... ... ... | 1 | 7 | | | | |
| Sandy marl ... ... ... ... ... | 0 | 6 | | | | |
| Limestone ... ... ... ... ... ... | 4 | 0 | | | | |
| Dark shale... ... ... ... ... ... | 1 | 0 | | | | |
| Limestone ... ... ... ... ... ... | 2 | 0 | 164 | 9 | 838 | 7 |

On page 121 of the Geological Memoire it is stated that—
"From this section we learn that a total thickness of 2,338 feet "obtained on the Avon has diminished down to 791 feet; and "the lower shales, about 500 feet thick, near Bristol, are about "165 feet deep at Dean Forest; and that the upper mixtures of "sandstones, marls, and limestones of the Avon, 400 feet thick, "are represented at Purlien by sandstones, limestones, and

"marls, 146 feet in thickness. Thus the central portion of the "Carboniferous series, 1,438 feet in depth at Bristol, becomes "480 feet at Dean Forest." The depth of 480 and 165 feet are to be seen in the section, but it is not clear where we are to find the "146 feet," as the first division of the section is 194 feet nearly, or 48 feet in excess of the number stated. There does not therefore appear to be an exact agreement between the numbers in the section and the description appended to it. I apprehend the former has to be taken as being correct.

The late Mr David Mushet, whose memory is much revered in the Forest of Dean, published a section of that district in the "Transactions of the Geological Society of London," as far back as 1824, but he had not then the means at hand to construct an accurate section in all its details. It is as follows:—

SECTION No. 2

| | | | Yds. | Yds. |
|---|---|---|---|---|
| | | 1—Porcelain limestone ... ... | 6 0 | |
| | | 2—Dark grey limestone ... ... | 4 0 | |
| | | 3—Ball limestone in clay matrix... | 8 0 | |
| | Upper limestone shale | 4—Small blue beds ... ... | 1 0 | 76 0 |
| | | 5—Grayish blue limestone, with purple joints ... ... | 35 0 | |
| | | 6—White limestone ... ... | 6 0 | |
| Limestone | | 7—Iron-ore and marl, from 10 to | 16 0 | |
| | | 8—Great white cliff bed of limestone ... ... ... ... | 80 0 | |
| | | 9—Yellow clay limestone ... | 15 0 | |
| | Limestone | 10—Great blue limestone oolitic to the N.W. of Coleford, with clay ... . . ... ... | 8 0 | 146 0 |
| | | 11—Sparry limestone oolitic near St. Briavels, and slightly so near Coleford ... ... | 10 0 | |
| | | 12—Brownish red iron-ore, Swan-Pool or Cherry Orchard limestone ... ... | 8 0<br>25 0 | |
| | Lower limestone shale | 13—Beds of brownish red marl ... | 5 0 | 13 |
| | | 14—Straw coloured shale ... ... | 8 0 | |

The late Mr Atkinson also published a section of the Forest in 1851, and seems to have taken the thickness of the Carboniferous Limestone at about 710 feet. There is no agreement between the authorities quoted, but the data employed may not have been obtained from the same places in the district, and this may account for the difference. The Carboniferous Limestone may be traced as a continuous belt round the Forest of Dean, from the Howbeach Valley to Wigpool on the North, North-Western, Western, and South-Western outcroppings to Lydney Park, and is continuous half-way between the Red Hill and the Leech Pool.

From this neighbourhood, and along the South-Eastern croppings of the coal field to Howbeach Valley, the limestone is absent.

The lower coal measures overlap and repose upon the older rocks. Near Soilwell Farm, the Trenchard outcroppings are found nearly in contact with the Old Red Sandstone.

Buckland and Conybere, in a paper entitled "Observations on the South-Western Coal District of England," published in the Transactions of the Geological Society in 1824, considered that the absence of the limestone is due to a fault, but they do not explain how it was brought about. Maclauchan, in his paper published in 1833, took the same view, which appears to have been derived from the late Mr David Mushet.

It is very likely that the strata of the limestone along the line of the country mentioned was much dislocated in past Geological periods, and it is possible that a fault may also exist, but the entire absence of the limestone is more particularly due to the influences exerted throughout a very long period by denudation.

How far in perpendicular depth the limestone has been removed is a matter of conjecture at present.

Mr Maclauchlan's section shows it at a depth of over 300 yards below the surface, but whether he had sufficient reason for such an hypothesis is doubtful. At whatever level denuding influences ceased, there we may expect to find the limestone, and it is possible that the difference of level between the lowest point in the Old Red Sandstone, South of Lydney, as it existed at that time, and its outcroppings along the neighbourhood referred to, may give some clue to the probable depth.

Probably the limestone was thinned out from the Howbeach Valley along the ancient site now known as Cockshoot

Enclosure, and on towards Lydney, whilst the corresponding more massive part of it, from Howbeach Valley Northwards, passing through Shakemantle, and on towards Wigpool, remained less affected. Consequently great pressure exerted from the North, South, East, and West would tend to contract, fold, and break up the limestone in the line of least resistance, and so form dislocations and faults. This may have occurred when the beds of rock were comparatively horizontal, and possibly before the final uplifting of the Eastern boundary of the Forest Mineral Basin.

When the beds of rock from Howbeach to Lydney were raised their condition would have rendered them more susceptable to denuding effects.

The mass of Mountain, or Carboniferous Limestone has been divided by the Howbeach Valley, and in the open quarries there the action may be seen. At a distance of a few hundred yards Northwards, in Stapledge Enclosure, the limestone strata is conformable to the general direction or strike; consequently it must be somewhere from that point towards the Howbeach Valley where the contortion of the strata had its centre, or hinge upon which they have been folded out of their course. When the limestone beds are in their proper order, the average direction of the strike is about North 30° East, and South 30° West, but the limestone beds in the Howbeach Valley strike North 60° to 64° East, and South 60° to 64° West, dipping at an angle of from 70° to 75°. The rocks have consequently been thrown out of their proper course by an horizontal angle of 34°.

The displacement is, however, somewhat confused, rendering it difficult to determine the average direction. Supposing that all the forces which produced this effect were exerted from an Easterly direction, affecting the rocks at right angles from their present dip, we should expect to find the Old Red Sandstone rocks immediately below affected in a similar degree. We cannot, however, see far down into these, but an inspection of the section from Howbeach Valley to Blakeney does not appear to confirm such an idea, for the rocks are not contorted to correspond with the limestone.

This is a remarkable circumstance, and before coming to a definite conclusion it would be necessary to examine upon the ground itself all the existing sections in the Old Red Sandstone and other rocks from Blakeney to Lydney.

The whole of the iron-ore measures proper and the Millstone Grit series are absent in the Howbeach Valley, and there the Pennant rocks belonging to the lower coal measures rest immediately upon and are in contact with the Carboniferous Limestone. It is, however, curious to note that the direction of the strike of the Pennant rocks is about North 30° East, and South 30° West, and consequently are conformable to the direction of the general measures when not affected by displacement. There seems to be, therefore, strong evidence that the Pennant rocks, Trenchard and Coleford Hill delf seams, were deposited long ages after the Millstone Grit and iron-ore measures were removed by denudation.

The horizontal width of the Carboniferous Limestone is less from the Howbeach Valley to Wigpool Northwards, than it is in any other part of the district; for instance, if we drew a line to the West of the Lydbrook Valley, or in a Southern direction from Welsh Bicknor, to the coal measures, the limestone would be found to be spread out from the river Wye for a distance of 2¼ miles, but if taken across the measures, at right angles to the dip, the width from Stowes Field to the outcroppings of the coal measures would be 1¼ miles. The nearest approach of the river Wye to the coal field, taken in a line from Court Field to High Beach, is about 580 yards. Drawing a line through Blackthorns to Goodrich Cross, in Herefordshire, the distance from the coal measures to the river Wye is about 440 yards, and from the same point in the coal measures to the commencement of the Carboniferous Limestone, the distance is about 225 yards.

Taken along the same line the width of the limestone is about 1,100 yards.

If we produce a line from Blackthorns to Doward Camp, the distance from the commencement of the Carboniferous Limestone is about 320 yards; from this point to the river

Wye the distance is 220 yards; and from the latter point to the extreme edge of the limestone the distance is about 1½ miles.

The Wye crosses the edge of the limestone Westward at a point half-way between Doward Camp and Little Hadnock. At Staunton the width of the limestone is about half a mile.

Producing a line through the Beaches and Cherry Orchard, the distance from the outcroppings of the coal measures to the limestone would be about half a mile, and from the latter point it will be found to spread out to a distance of 1½ miles.

At Newland, Lower Redbrook, Lodges Farm, near Scatterford Wood, up to Ostridge Grove, by Bircham Grove, and as far South as Clearwell, a portion of the Carboniferous Limestone has been broken up, and denuded in an irregular patch down to the Old Red Sandstone, which latter is connected to the great mass of that series in Monmouthshire.

The continuity of the limestone adjacent to the coal measures has not been destroyed, for, opposite to this denuded patch, we find the limestone against the Millstone Grit, half a mile in width. The very irregular and horned appearance of the exterior edge of the limestone, from Howell's Hill to the neighbourhood of Hastridge Wood and Coxbury, is sufficient evidence of the effects produced by denuding influences. It is very remarkable that the isolated patches of limestone at Highbury and Penalt Common withstood such influences, and remains as proof of the extension of the limestone into Monmouthshire. These two patches of limestone are entirely surrounded by the Old Red Sandstone. Half a mile South of Clearwell the limestone attains a great width on account of its slow dip or flattened position, and if we were to draw a line through Elwood and Lodges Barn, the distance from the outcroppings of the coal measures is about 550 yards, and from this point the limestone spreads out 2¼ miles. Producing a line from Oakwood Mill Level to St. Briavel's, the distance from the coal measures to the limestone is about one-quarter of a mile, and from this point the limestone will have a width of 2¼ miles. The limestone is again broken up and denuded about a quarter of a mile North of Bream's Lodge, where the Old Red Sandstone comes in, extending to Priors Meend and Aylburton Common, and is separated into two irregular branches. The South-Western portion extends to the North of Bream's Lodge and St. Briavels, to Hewelsfield, towards Tintern, Chepstow, and Caerwent, where it occupies a considerable area, and continues still further to the South. The Eastern limit of the limestone nearly coincides with a line drawn from Bream's Cross through Tidenham House, as far as Tidenham. The other portion of the limestone branches off near Bream, and follows the coal measures as a narrow regular strip about a quarter of a mile in width to a down throw fault at Lodge's Kiln; it then extends a little further Southwards, and terminates at the place before referred to.

The connection that once existed between Dean Forest and the Monmouthshire and South Wales coal fields was destroyed, and the intervening limestone and Millstone Grit measures were swept away, except in a few patches marking the ancient or continuity connections of the districts.

The Old Red Sandstone entirely surrounds the Forest of Dean Mineral Basin, and upon it, as a base, the Carboniferous series repose. It may be traced to Lydney, Aylburton, Alvington, Woolaston, and Southwards to Tidenham, where it terminates against the New Red Marls on the East, Dolomitic Conglomerate on the South, and Carboniferous Limestone on the West. From Aylburton it runs Westward to the limestone for a distance of 2½ miles; from Lydney it extends in an irregular manner to Nass Cliff, on the Severn where it spreads itself Northward and forms the left bank of the Severn for a distance of 3¾ miles, and is separated from the Lower Lias Clay and limestone by a fault. Taking a Northern course, the Old Red occupies a considerable area in Herefordshire, Monmouthshire, Brecknockshire, and surrounds the greater portion of the Glamorganshire coal field. On the East, the Old Red is bounded by a fault commencing at a point previously referred to.

This line of fault takes a line through Paulton, Oakland's Park, Hayden Green, Culvert House, Elton, and passes a little to the right of the turnpike gate at the juncture of the Newnham and Flaxley turnpike roads.

Little to the West of this place it branches off to the North-West, still bounding the Old Red, and passes about a quarter of a mile East of Flaxley Abbey. It may then be traced through Woodgreen, Velthouse, to a point a quarter of a mile East of Longhope, and in the direction of Blaisdon and Huntley Hill.

This fault, with others, which branch from it, enclose a patch of Upper Silurian, consisting, in an ascending order, of May Hill Sandstone or Upper Llandovery rock, Woolhope Limestone, Shale, Wenlock Limestone, and Upper Ludlow beds. It is believed that the Old Red Sandstone is over 2,000 feet thick in the Forest of Dean, although near Tortworth it is only about 300 feet thick. This facts speaks eloquently as to the effects of denudation, and the general direction which it had.

A fine section of some of the upper beds of this series may be seen in the railway cutting at Soudley. Some of the middle beds are well exhibited in the open quarries at Bradley Hill, and they were further laid open in the railway tunnel driven under May Hill Estate. This tunnel commences on the Forest side, near the blast furnaces formerly belonging to the Great Western Iron Company, in the Soudley Valley, and terminates on the Eastern part of the May Hill Estate.

At a point a little to the North of the Hawthorns the turnpike road leading from Drybrook to Ross has been formed through the Old Red Sandstone for a considerable distance, and nearly at a right angle with the dip of the beds, which incline in an Eastern direction. Here the different beds of Rock, Shale, Clay, and Micaceous Sand may be traced to a point of contact with the lower limestone beds belonging to the Carboniferous series. This section offers a fine treat to the Geologist, as the conditions are somewhat unusual. Certain it is that there are but few places to be found where such a long length of section is laid open up to the superimposed limestone itself.*

The Old Red Sandstone has been much flattened and thinned out in the neighbourhood of Yorkley, Soilwell Farm, and Lydney.

If we construct a section from the Ebury River, in Monmouthshire, and continue it across the Forest of Dean towards the Severn, it will be seen that an anti-clinal line exists to the East of the outcroppings of the lower Carboniferous Limestone, and this same line of upheaval can be traced through the country for a considerable distance.

Buckland and Conybeare considered that an anticlinal line passed the middle of the valley of the Severn, and that it was the cause of separating Dean Forest from the Bristol coal field.

Murchison and Phillips concluded that the principal disturbance passed through Flintshire, Malvern, and then Southward into Somersetshire, and that the elevation of the Malvern Hills, the Eastern portion of the Forest of Dean, and the greater portion, if not all, of South Wales, is due to this cause.

The axis of the Malvern Hills is composed of Syenitic rock, and, according to the late Rev. W. S. Symonds, it is eight miles long and half a mile in width.† It is very probable that this upheaval took place after the formation of the Lower Silurian beds, and may have terminated with the close of the Carboniferous period. The general effect produced must doubtless have led to a series of elevations and depressions of the ancient sea level at a very early epoch.

The upheaving force exerted on the Eastern side of the Forest must also have been enormous, for if we construct a restored section of the removed strata we should find that the top of the Carboniferous Limestone was raised more than 5,500 feet above the present level of the water in the river Severn. The coal measures were consequently elevated as much as 8,000 feet above the same level, and the Old Red

* See section by John Jones and W. C. Lucy, Vol. IV. Cotteswold Club.

† See the works on the subject by Phillips, Hull, Rutley, and Callaway.

Sandstone must have had an elevation of 4,500 feet. According to this, the Silurian may be expected to be found at a small depth below the present level of the Severn, and it is possible that some portions of it may, upon a close examination, be visible. The course of one of the anti-clinals on the Eastern side of the Forest, and nearest to the mineral field, is fairly represented by the elevated ridge of Blaize Bailey, and there, at a distance of about a mile to the West, the Old Red Sandstone will be found to dip towards the Forest, or to the West on the one hand, and towards the river Severn or in an Easterly direction on the other. Former observers, among whom may be mentioned Mushet and Maclanchlan, have asserted that the Old Red Sandstone dips towards the Forest from the river Severn. This may be so, but not in a continuous order.

If we produce a line from Cinderford Bridge through the Temple on Blaize Bailey, we shall find that the distance from the exterior outcroppings of the Carboniferous Limestone to the anti-clinal line referred to is about 1,600 yards. The anti-clinal line is so well defined at the place named, that it may be seen to run nearly in a parallel course to that taken by the line of fault before described. Existing sections made of the strata are, however, too few to enable us to decide the course with certainty. The Geological section from Edge Hill, taken through Abinghall Church to Taynton House, shows the Old Red Sandstone to be much contorted, especially at a point near Brimpshill, but no anti-clinal line is shown, although it may be expected to run near this place.

At a distance of about 3½ miles from the exterior outcroppings of the Carboniferous Limestone, measured on the same section, an anti-clinal is shown running under May Hill, and the May Hill Sandstone, or Upper Llandovery rocks, are consequently much contorted and elevated. The rocks dip towards the Forest of Dean and towards the Malverns, the Upper Silurian, Woolhope Limestone, Shale, Wenlock Limestone, and Upper Ludlow beds dipping on both sides of the anti-clinal in succession. At the North-Eastern side, however, the Silurian is much broken up by faults. The great axial force being thus exerted so near the present outcroppings of the limestone is the primary cause of the very severe dip of the strata on the Eastern side of the district. The force of the upheaval on the Western side of the district seems to have been comparatively weak, unless, indeed, ultimately the rocks were depressed more on the Western than on the Eastern portion of the district.

Near Bircham Grove Hill, a distance of a little over a quarter of a mile from the Carboniferous Limestone, and at the axial line of force, it is not elevated more than 1,600 feet above the present level of the Severn, but the top of the coal measures at this point was elevated about 4,300 feet above the same level. The Old Red Sandstone was also raised to a height of about 900 feet. The coal measures were 3,700 feet higher on the Eastern than they were on the Western side, and the Carboniferous Limestone was also elevated 3,400 feet higher on the former than on the latter side.

About 1½ miles West of the river Usk, the principal axial force which raised the Eastern outcropping of the Monmouthshire coal field was apparently exerted, resulting in the upheaval of the Carboniferous Limestone to a height of 10,000 feet above the present level of the water in the Severn, but this main axial force was exerted at too great a distance from the Western outcroppings of the limestone in Dean Forest to affect it in a similar degree to that on the Eastern side. At the point referred to, West of the Usk river, the top of the coal measures must have been raised to a height of some 12,300 feet; the Silurian itself was thrust up some 3,200 feet above the same line of reference.

From this axial line, there has consequently been removed, by denuding and other influences, the astounding mass of material of 11,800 ft. in thickness. This influence has extended along the line of country from the Monmouthshire coal-field towards the river Severn, and further to the East and South-East. The materials removed from the Eastern side of the Forest by similar agencies must have amounted to 7,500 ft. in thickness.

It has been considered by Geologists that the central portion of the Monmouthshire and Dean Forest coal fields have not suffered to any great extent, and as far as the exploitation has gone in the latter this theory has held good.

The central portion of the Monmouthshire coal field is about 1,500 feet, and that of the Dean Forest 800 feet above the level of the Severn.

Similar Geological causes as those previously referred to have separated the Bristol coal field from that of Dean Forest, so that the identity of the corresponding seams of coal in these districts is a difficult question, and requires further investigation in order to arrive at correct deductions.

The late Sir R. I. Murchison considered that the sandstone from the Lower Trenchard coal to the Lower Churchway coal were identical with the central sandstones of Pontypool; and also that the beds above the central sandstone represent the Upper Shales of the Bristol coal field on the South, and appear to be equivalent in position to the various beds above the central sandstone of Neath, Swansea, and Llanelly; still there is not sufficient evidence collected to enable Geologists to decide this question definitely.

There are two patches of coal measures to the South-West of the Forest of Dean, and to the North-East of Chepstow, called Tidenham Chase and White Wells, but hitherto a difficulty has been experienced in determining whether the sandstone occurring there belongs to the Millstone Grit series or to the upper portion of the Carboniferous series. No particular attempt has been made to compare these small outlying patches with the measures of the Forest of Dean with a view to their identity. They are, however, marked on the Geological Map as Millstone Grit.

At Howell's Hill, to the North of the Forest and Bishop's Wood House, and on the West of Hope Mansell, another small patch of coal measures occur extending about 1¼ miles, and of an average width of about ¾ of a mile, and some coal has been worked from these measures, but they are now abandoned. A very peculiar feature connected with this patch of coal measures is, that it is found to repose directly upon the Carboniferous Limestone, except on the Eastern side, where there is an overlap, and in contact with the Old Red Sandstone. Mr Maclauchlan's section shows this, and his map also indicates that the limestone is absent for a distance of half a mile. The Geological map, however, does not show that it is missing for so great a distance. These coal measures are considered to be identical with those found in the Millstone Grit series of the Central and North-Western portion of Great Britain.

It has hitherto remained a question whether the Carboniferous Limestone, and consequently the coal measures of the Forest of Dean, have extended to Newent and the Malvern Hills. The patch of coal at Newent is hid for the most part by the New Red Sandstone, and is known to repose directly upon the Old Red; but whether it was deposited there anterior to the formation of the Carboniferous Limestone, or subsequently, has not been determined with any degree of certainty. The late Sir R. I. Murchison was of opinion that there was no destruction of the Carboniferous Limestone towards Newent before the deposition of the coal measures, but whether he believed that the limestone extended so far, or not, nevertheless there is strong evidence that it extended much farther. No traces of the Millstone Grit existed at Howell's Hill according to Maclauchlan, but it is marked upon the Geological map. Personally, however, the author has no evidence, but if ever it existed there, it must have been carried away, like we have shown is the case in other parts of the Forest. The same cause has partially removed and thinned out the Mountain Limestone, for the coal measures appear to be deposited partly on the limestone and partly on the Old Red, the remaining portion of the former coming in from the West like a wedge, and dying out towards the East, half way under the coal measures. It is evident that Murchison inclined to the opinion that the patch of coal at Howell's Hill belonged to the Millstone Grit series. If this theory could be fully established we should be justified in inferring that a similar deposit of coal took place over the entire Forest after the close of the Carboniferous Limestone period; but, in such a case, the coal must have existed in the first or upper beds of the Millstone Grit series, and that it was afterwards removed by denudation, with the exception of a small patch at Howell's Hill, which, however, remains as a remnant of what existed more generally in earlier times.

If we could determine with absolute certainty that the coal measures at Newent were originally deposited upon the Old Red Sandstone before the period assigned to the deposition of the Carboniferous Limestone, a point of no small interest and importance would have been gained. The late Rev. W. S. Symonds was of opinion that the Carboniferous Limestone extended to the Malvern Hills, and we have previously stated that the evidence is stronger for than against that theory, and consequently it must have covered the whole of the Newent district. The coal in the Newent patch is dissimilar to that in the Forest of Dean. We must therefore refer its formation to a different epoch. Coal appears to have been extracted from this field at different periods.

The Coal-field.—Hitherto shafts have not been made in any particular place in the Forest of Dean, directly through the whole of the coal measures; the sections therefore which have appeared have been constructed as previously noticed from data obtained from several different points of the district, but as the thickness of the strata varies with the locality, it is necessary that a general series of sections should be taken over various portions of the Mineral Basin before sufficient information can be obtained upon which an estimate of the average thickness of the strata can be made.

The appended section. No. 3, is a record of actual sinking at the Lightmoor Collieries, one of the deepest in the Forest, and fairly represents the strata in that neighbourhood.

The iron-ore deposits in the vicinity of Wigpool, situated in the Northern portion of the Mineral Basin, occupies the form of a horse-shoe or projection towards the North-East from the other parts of the mineral field, for a distance of at least 2,000 yards, taken from a point in the restored curved form, which it should have presented to join the outcroppings traced from Ruardean Eastward.

The iron-ore outcroppings are ill defined in the Lydbrook Valley, also to the North of Joyford, Farmers' Folley, The Hobbles, and further to the North-West, where apparently it must have curved to the Slaughter House. The iron-ore field between the two last preceding mentioned places seems also to have projected in the form of a horse-shoe, but as the outcroppings cannot be traced, how far this projection extended cannot be determined. The irregular form of the Mineral Basin existing in the Northern portion of the Forest, leads to the inference that the limestone and iron-ore measures once extended over a considerable area Northwards, also towards the East and West, and that the whole has been removed by the natural influences previously indicated. Some portions, however, had a greater tenacity and power of resistance than others.

When the Pumping Pit at Wigpool Iron Mine was sunk, a thin seam of coal, believed to be the Trenchard, was discovered at about 15 yards from the surface, and proved to be a good steam coal, but the roof consisted of hard clod, containing water, rendering it difficult and costly to work; consequently it was abandoned. At a little distance to the South of the Pumping Pit, a smaller shaft was sunk to a depth of 150 yards, but as the measures were much confused the seam of coal could not be traced.

Considering that this patch of coal is situated at a distance of about 1½ miles from the well-known outcroppings of the Trenchard seam on Harrow Hill, and at comparatively such a short distance from the outcroppings of the iron-ore measures, it is highly probable that the seam of coal in question is not identical with the Trenchard, but is more likely to belong to the Millstone Grit series, and possibly may have had some connection with the seam of coal at Howell's Hill. At all events this is the most North-Westerly point in the Dean Forest Mineral Basin where coal has been discovered. I am of opinion that seams of coal existed in the Millstone Grit measures over the entire Forest area, and this idea seems to be corroborated by the fact that in other English coal fields the Millstone Grit seams of coal have been worked extensively. For example, it has been proved that some of such seams of coal in Yorkshire had a thickness of from three to five feet. The Millstone Grit caps the hills of Yorkshire, and there is also evidence that coal has been worked in these measures from Silkstone to Chatsworth.

The writer has had no opportunity to examine the coal measures at Wigpool, and cannot therefore determine what period it belongs to; but the section No. 15 of the Geological Survey produces some evidence.

From the extreme Northern portion of the outcroppings of the Lower Limestone measures, the Millstone Grit measures have been completely denuded for a distance of 650 yards at least towards the South, but at that point it comes in as a thin edge of a wedge; attaining its maximum thickness further South, at the intersection of the Trenchard coal on Harrow Hill. The perpendicular thickness is about 480 feet, but near to Wigpool pit its thickness is no more than 120 feet. Restoring, therefore, the coal measures to their proper position on the Government Section referred to, the Lower Trenchard seam would have occupied a position of 360 feet above the present surface line. This, therefore, seems to prove that the seam of coal found at the Wigpool Pumping Pit exists in the lower part of the Millstone Grit series, and consequently must at one time have extended over the entire Forest.

It should, however, be observed that the deduction thus arrived at depends entirely upon the accuracy of the Geological Survey Section referred to. Future observers may, however, be able to verify existing data and determine the question.

In every mining district faults or dislocations, more or less extensive and troublesome, exist, but in the Dean Forest mineral field the known faults are of no very great extent, and the only effect has been to break up the continuity of the mineral deposited for limited distances. The most curious of these faults is that called the "Horse," first discovered in the Coleford Hill delf seam, on the Western side of the district. It seems to have first made its appearance below ground at a place called the "Whitehall Pool," the South-Western limits passing under the boundary stone No. 98 on the Government map, and then runs in an irregular and slightly curved form to New Fore Pit, continuing under the Lodge, crossing Hopewell Colliery, in Whimberry Bottom, Perch Enclosure, and onwards to the deep pit on Vallet's Level Colliery. It is again intersected by the Workings in Vallet's Level Colliery in Bram Hill Enclosure.

There is no certain evidence that it has been traced further than this, because no workings have hitherto been carried on in the Coleford Hill delf vein in the deeper parts of the basin.

The North-Eastern limits of this fault runs almost parallel with its other line of direction described, but it appears to be narrower as it penetrates the measures more in the deep.

It varies in width from 180 to 340 yards, and appears to be running in a South-Easterly direction, or towards the Howbeach Valley. A fault, also called the "Horse," is shown to be crossing the North-Western boundary of the New Fancy Colliery, having the same direction as that previously indicated, but I am of opinion that it is not the same fault.

Another fault exists between the Southern part of the Foxe's Bridge Colliery and the Northern portion of the Lightmoor Colliery, and has an average width of 300 yards. Traced from the Western portion of the district, it passes through the Rose-in-Hand Colliery; the line of its Northern limits runs under the boundary stone No. 125 on the Government index map in that Colliery. It then takes a South-Western direction, passing between the Foxe's Bridge and Lightmoor Collieries before referred to, and onwards towards Cinderford Bridge. The line forming the Southern limits of this fault runs nearly parallel with the line marking its Northern limits. That part of the turnpike-road opposite Lightmoor Colliery marks a perpendicular point in the fault below. This fault has a displacement, or down throw, of the measures of 96 feet, but there has been no opportunity to prove whether it extends to the lower coal measures, *i.e.*, Coleford Hill delf, &c.; but as such faults are known to affect all the seams in other coal fields, we cannot consider that the fault under consideration will prove an exception to the rule. Workings were formerly carried downwards in the Coleford Hill delf seam from a pit sunk at Quidchurch, in Stapledge Enclosure, a little to the West of Shakemantle Pumping Pit, and at a point a little to the South of Cinderford Bridge a fault of considerable thickness was reported to have been discovered running in nearly the same direction as the last preceding fault referred to, between Foxe's Bridge and Lightmoor Collieries, but the administration in connection with the working of the Quidchurch Colliery was not of such an order to permit of accurate observations, and as the works have been abandoned and are now full of water, no verification of facts referring to this fault can now be made. If the fault existing between the Lightmoor Collieries and Foxe's Bridge should continue in a perpendicular plane to all the coal measures below, which is highly probable separating the middle and lower series of coal seams as it has done in the upper measures, it would prove of great service, tending to dam back the water existing in the lower measures of the Northern portion of the Forest of Dean coal field, and consequently the drainage of the seams of coal existing in the deep in the Southern portion of the coal field would be diminished to a very considerable extent. Notions of insuperable difficulties in reference to a proper and economical drainage of the coal measures South of the Lightmoor fault would doubtless become more visionary than real.

A little to the North of the China Engine Pumping Pit, on the Western side of the Forest district, and at a short distance from the lower boundary line or fence of Heaven's Meadow, a fault or dyke filled with a reddish foreign rock, locally termed Duns, was found completely displacing the iron-ore measures in the China Engine workings, which were carried Northwards. Shallow exploring pits were made at various points along Heaven's Meadow, Northward, and at a few feet the top of the fault was laid open in each pit. The fault appeared to be running from the North-West to the South-East, crossing the iron-ore measures almost at right angles, and as its width was found to be very considerable, and taking into account that the great body of water retained or damed back towards the North as far as Coleford, by this fault would have flooded the works if they had been continued through the entire fault, the exploring headings for iron-ore, Northwards, were abandoned, and up to the present time have not been resumed.

Whether any connection exists between this fault and the dislocation of the strata in the Carboniferous Limestone at Howbeach, may, perhaps, never be determined, but it certainly does seem to run in that direction.

At St. Annals Iron Works, near Cinderford, the contortions of the strata were so great that the pit sunk there passed through the same bed of rock two or three times, which, without explanation, would appear to be very anomalous. The general dip should have been in a Western direction, taken from the outcroppings, but at certain depths the beds of limestone rock and iron-ore measures were perpendicular, and at others it had a reverse order of dip, or towards the East for limited distances in depth. For example, at a perpendicular depth of 175 yards, a cut-out or horizontal gallery was driven from the pit Eastward for a distance of 117 yards to the intersection of the iron-ore measures, but at a further depth of 44 yards, or a total from the surface of 219 yards, a second cut-out was also driven from the bottom of the pit towards the East for a horizontol distance of 118 yards, also intersecting the iron-ore measures. Thus it will be seen that for the last depth of 44 yards the dip was one yard out of the perpendicular towards the East, or equal to an angle of $1^\circ\ 18'\ 0''$. This is a very curious example of the lateral folding of the rocks caused by the immense forces which produced the anti-clinal lines previously referred to. It is probable that its occurrence was identical in point of time with the dislocations formed in the same measures in the Howbeach Valley, but of less violence.

Some distance to the West of St. Annals Iron Mine excavations were made in the Millstone Grit rocks, and there it is seen that the contortions in the limestone have also been communicated to this series. These beds of rock are affected in a similar manner as far Northward as Edgehill Iron Mine, but as we proceed still further North it has a diminished effect. Some portion of the Coleford Hill delf seam, worked in a colliery to the deep of Haywood Level Colliery, has been denuded seriously over limited areas; but the coal measures do not seem to have been affected by the contortions found in the limestone and Millstone Grit rocks at the St. Annals Iron Mine. These displacements must consequently have taken place long before the deposition of the coal seams.

Curious phenomena exist in reference to the formation of the Forest of Dean coal seams, but a full discussion of the subject would require more space than can be devoted to it in this communication. The elements contained in my appended sections are of the greatest utility, interest, and importance both to the Mining Engineer and the Geologist.

A comparison of these exhibits that a thinning-out of some of the intervening beds of rock and coal seams have occurred in various parts of the district, but such changes are, for the most part, local, and consequently confined to small areas. Sometimes the hard Argillaceous beds upon which grew the immense forests of trees and plants—from which the coal beds were formed—present sudden difference of level for limited distances, but in others they are less pronounced and more prolonged, causing a difference in the continuity of the thickness of some of the coal seams after they were deposited. Generally, such effects were produced by erosive action.

At Lightmoor Colliery we see by the section that the Churchway Hill delf had a thickness of 2ft. 10in., and that from the Breadless to the Churchway seam the intervening rock is 35 ft. in thickness; but the thickness of the same bed of rock, as exhibited in Mr Mushet's section, or No. 4, is 60ft. At some of the collieries the Churchway seam is divided into two distinct beds of coal of about 2ft. 3in. each, with 36ft. of rock between them, but at others they are found to be almost in contact.

At the Old Churchway Colliery, now abandoned, the partings between the Churchway seams were very thin, and at the Trafalgar Colliery the thick or double seam of Churchway coal existed as a single bed, extending over a considerable portion of its area. When the line passing through the boundary stones Nos. 27 and 28, marked on the Government map, and Cinderford iron furnaces, is approached from the workings in Crump Meadow Colliery, the bed which separates the two coals commences to thicken, rendering it difficult to work the lower and upper seams simultaneously. The increase in the thickness of the land of Argillaceous matter and shales separating the coal is gradual Southwards until we arrive at the New Fancy Colliery, where it amounts to 30ft. in thickness. At that colliery the Churchway seams have, according to repute, an aggregate thickness of 4ft. 6in., *i.e.*, 2ft. 3in. each.

It is also a curious circumstance that at this colliery the Lowery or Parkend Hill delf seam exists as a solid bed, but as it is traced Northward, or as far as Crump Meadow Colliery, it is divided into two distinct seams, so that in the two collieries mentioned we have an effect produced in different seams of coal of an opposite nature. So marked is this feature, that a little to the North of Crump Meadow Colliery the thickness of the debris between the Lowery seam is so great as to render it impossible to extract the two seams at the same time.

If we suppose that a given thickness of Argillaceous matter had been deposited upon a seam of coal which had been previously formed, and that a certain area of it had been denuded, leaving the remainder as a slow inclined plane, or in a wedge form, down to the seam of coal, any forest of trees growing upon it at that period would also have been carried away; then the coal formed upon the thin or wedge end of any such inclined bed of Argillaceous matter must have been derived from the margins of such parts of the forests on higher ground not washed away, the vegetable matter of which must have descended and been sufficient to cover the denuded Argillaceous area, and also that part of the preceding formed seam of coal from which the Argillaceous matter had been removed, and so from the thin end of the inclined plane, and consequently it would have united to form a seam of coal of greater thickness at some parts. Considering the present received doctrine of Geology, and accepting the general theory of the formation of coal, it would be difficult to explain this curious phenomena satisfactorily in any other mode. In one case, however, the extreme thinning-out of the Argillaceous matter between the beds of coal occurred towards the South, but in others it was towards the North. Doubtless this was occasioned by the continued action of floods descending into valleys or low levels which may have been formed, and resulting in rivers which were confined to one locality at one time, changing their positions and directions at other times. Various washing out examples of this class are on record, occurrences delightful from a Geological point of view, but disastrous in a mining sense. One of these wash-outs occurred in the Black Bed coal in Derbyshire, 250 yards in width, and has been traced for two miles. It was found on another occasion that a river wash-out of this class had heaped up the coal on one side 6ft. thick, and there was evidence that afterwards it had become squeezed down. We therefore see that the water that formed the channel in the coal measures had great force and velocity. From recent explorations it is known that this river extends a mile and a half. In other places, such as at Aldwack, the denuded part is more in the form of a lake. It would be untenable to suppose that vegetable matter, forming an upper seam of coal, grew upon the denuded parts of previously formed and lower seams with which it is now found in contact.

In the Bowson Colliery, section No. 5, the Upper Churchway coal had a thickness of 2ft. 6in., and the bottom part of the seam was reduced to 5in., the hard marl between the coal being 4ft. 6in. thick. The Geological Survey, section No. 6, exhibits another curious difference in the formation of the seams of coal, for the upper seam is divided into two parts by two thin beds of shale and marl. The lower seam is also divided into two parts by a thin bed of Carbonaceous shale, 6in. in thickness.

The Starkey coal also exists in a similar condition. It is not very clear what portion of the Forest is represented by this section, but it is highly probable that it has been made of portions of the measures from different localities, because the seams of coal referred to are not found in exactly the same form at the Lightmoor and some other collieries. It is very evident that the seams of coal were deposited at various periods, otherwise the intervening veins of shale could not exist. It is also clear that consequent upon denuding action the thinning-out effects of the same beds of rock have been variable, in fact they are formed as already indicated from a mere line in some places to 36ft. in others. It is difficult to form a correct opinion of the entire effects produced by denudation upon all the other intervening beds of rock and coal seams in all parts of the Forest; but if we assume that its influence lessened upwards from the Upper Churchway seams, then we should be obliged to conclude that the interval of time which elapsed, and represented by the thin beds of coal between the upper beds of rock, must have been too short to permit of the growth and decay of a sufficient amount of vegetable matter to produce thicker seams of coal.

On the contrary, it could be urged that the beds of rock, shale, and coal seams may originally have had any other thickness, and that a series of reductions or thinning-out may have taken place. The first assumption, however, is most probable, but in either case the question is as interesting as it is important, and the co-relation of the coal beds of the Forest of Dean with those in the surrounding coal fields of Bristol and Wales, is rendered all the more difficult, because we cannot suppose that vegetable growth has been subjected to any particular variation in places so closely situated.

There are more workable seams of coal in the South Wales coal fields than there are in the Bristol or in the Dean Forest district, and that fact alone ought to be sufficient evidence that similar conditions of coal beds once existed over the entire area of Gloucestershire, and their absence can only be accounted for, as we have previously indicated, on Geological grounds.

The South Wales coal-field is divided into three series, *i.e.*, the Upper Pennant, 500 ft. thick in some places, but as much as from 1,200 to 3,000 in others. The Lower Pennant series average about 1,500 ft. thick in the neighbourhood between the Taff River and Llanelly.

The third or White Ash series is estimated to have a thickness of 1,000 ft. in the centre of the basin, but thins out to about 500 ft. towards the Eastern side. If the distance between the South and North Wales and Bristol coal fields were too near the Forest of Dean to cause any difference in the vegetable growth for the formation of coal seams in the latter, then the explanation already given would have to be accepted, or some other theory sought for in order to agree with some of the phenomena presented to us.

There are various well-defined and interesting faults in the South Wales coal-field, some of which seem to run generally in an Eastern and Western direction. The North basin synclinal portion has two such prominent dislocations of the strata, and the coal measures on the Northern side of the most Northern of these faults has been elevated; but according to a section which has been consulted, on the opposite or Southern side of it they have been depressed as much as 450ft.; thus in remote Geological epochs some of the seams of coal in the Upper Pennant series were raised to the then surface, and afterwards denuded. More to the North on the line of section this effect is still more notable, for long before we come to the Dowlais great fault the Upper Pennant series of coal seams have vanished altogether. The Northern and North-Eastern portion of the South Wales coal field in the direction of the Forest of Dean has apparently suffered the most from denudation. The great fault, or anti-clinal, known to exist at Risca on the East, runs through the entire length of the coal field into Pembrokeshire, where it only affects the lower and older strata. Probably it had an augmented effect upon the measures to the North and North-East, and may have passed close to, or between the Bristol and Forest of Dean coal fields.

The Farewell Rock or Millstone Grit, of marine origin, occurs at the base of the lower coal measures in the South Wales coal basin. In fact, the lowest seams of coal in the White Ash series rests immediately upon it; then succeeds in depth the Millstone Grit series. The beds of coal corresponding most in position in the Forest of Dean appear to be the Trenchard seams, which are situated not far above the Millstone Grit series, but whether there is any analogy between the elements contained in the series referred to in the two districts, has not, as far as I know, been attempted to be proved.

Doubtless it would be exceedingly difficult to form a proper basis for correlation, but if it is ever attempted in a serious manner a larger number of accurate sections must be formed in each mining district, the petrographical character of all the beds of rock, shale, and clay determined, as well as an exhaustive chemical analysis of all the coal seams in each district. Such a work would be of great interest and value, supposing no definite correlation could be made. Probably it would be most convenient to take a well-defined point in the Mountain Limestone, or other rocks above corresponding in the various districts from which vertical measurements for a series of sections should be taken for correlative purposes.

It is probable that the middle and Southern portions of the Welsh coal field were much depressed, whilst that portion of it to the North-East and the Dean Forest may have been much more elevated, and consequently exposed to the severest effects produced by denuding and other natural influences long before a general equilibrium, and the present line of surface resulted.

The upper part of the coal field of Dean Forest must consequently have been swept away during the epoch when the anti-clinal or higher ridges of the Carboniferous Limestone appeared, and were broken up, which also had been planed down and remained in its present condition.

It is natural to infer that there were a series of anti-clinals and syn-clinals, producing a series of basin-like forms, the lowest part of which would consequently have been more or less protected, whilst the higher ridges, as has been previously indicated, suffered most. The limestone ridges now existing in the Northern portion of the South Wales coal field rise some 1,200ft. above sea level, but on its Southern outcroppings it is only about 500ft. The highest point in Dean Forest is also about 1,000ft. above sea level.

Geological evidence proves that the coal deposits existed in a more general form than is commonly supposed. It must, in fact, have extended over a considerable portion of England, Scotland, and Ireland before the intervening space between the two islands, and also that to the South-West of Land's End, became depressed as table-land a little below the sea level. Without doubt the French and Belgian coal-field, at least, were at one time joined to those of Great Bitain, the connecting link having been severed by various natural causes.

There is ample evidence to prove that in the time of the Ancient Britons the whole of the island now called England was covered by dense forests. If therefore that is an admitted fact referring to a thing which existed not further back than 2,000 years, how much more dense and general must have been those forests which existed during the latter part of the Devonian, Carboniferous, and more recent periods, when the surface of the earth and atmosphere offered better conditions for the growth of vegetation. It is difficult to accept the theory of some Geologists, which assumes that the isolated existence of some of the coal fields is due more to mere patches of forests—which they think were not continuous and general—than to any other cause.

The recent borings carried on at Dover to prove the nature of the rocks in connection with the formation of the proposed Channel Tunnel are said to have been carried into the coal measures, but of what age has not been stated. However, it has been reported that workable seams of coal were discovered, but this requires proof. It can easily be conceived that the discovery of such a coal field would prove to be of the greatest importance, not only in a commercial sense, but also as a scientific victory, which all true Geologists would hail with the greatest enthusiasm.

The period of duration of the English coal fields would then extend beyond the estimated period of 300 years, and the long night of decay and final extinction of many, if not all, the manufactures, and English commercial dominancy would be prolonged indefinitely. However, if the world continues as it is, long enough, such a calamity must eventually fall upon England, for without the ancient forests, as in the time of the British and Saxon periods, and at the Norman Conquest, and without a supply of coal, she must naturally descend to a condition similar to that through which she struggled for so many centuries, and before becoming the grand signal and guiding post in the advancement and civilization of the world.

If we estimate the total amount of coal to be extracted from the workable seams over one foot in thickness, there would exist in the Forest of Dean, in the year 1888, the quantity of 248,643,640 tons available for use. The amount of coal raised in that year amounted to 817,818 tons, being an increase on the production for 1883 of 93,936 tons.

At the same date the coal remaining for future extraction in the South Wales coal field amounted to 36,174,294,777 tons, and during that year the total output amounted to 19,594,507 tons.

This field therefore contains 145 times more coal than the Forest of Dean, and its output being 23·95 times greater.

Although the Bristol coal field contained at the same date 24·5 times more coal than the Forest of Dean, nevertheless the output from the latter was nearly double that of the former.

Supposing the general increment in the future to be constantly the same as it was between 1883 and 1888, the time of duration of these coal fields may be calculated to a considerable degree of accuracy, but if it should vary, then the time of duration would be extended or diminished according to circumstances.

However, I apprehend that the supply of the Dean Forest coal field will commence to fall off long before the South Wales coal field. The thicker, more accessible, and profitable seams of coal will naturally become exhausted first in Dean

Forest, and unless the deeper seams of coal are won before this occurs, it is highly probable that the falling off in the supply of coal will commence in about 30 years. Much, however, depends, as previously noticed, upon the average rate at which the coal field is worked.

When mineral elements are held in solution and suspension, as in the water of a lake or sea, the particles having the greatest specific gravity generally settle in the deepest part, the lighter ones floating longer, and finally settling at higher levels, or in places of repose in the ratio of the difference of their specific gravity; consequently it must depend upon the proof of this, or some other more rational theory of the deposition of metallic elements, whether a general mass of iron-ore will be found to occupy a large area in the centre of the Forest of Dean Mineral Basin or not. At present the workings in the Carboniferous Limestone have not been carried to a sufficient depth to definitely prove this question one way or another.

Formerly an idea was entertained by individuals residing in some parts of the Forest of Dean that the water from the River Wye percolated into portions of the iron-ore and coal field towards the North; but, considering the effect of the various beds of indurated shale and clay which are known to surround the entire mineral basin, it must be clear that such notions emanated from persons who had not studied or comprehended the Geological features of the district, and consequently such notions could have no foundation in fact.

All the water percolating into the belts of iron-ore and Carboniferous Limestone measures, as well as those belonging to the sandstone and to the coal measures, is derived from rainfall, and the quantity to be encountered in any given area underground can never be more than a certain proportion of so many rainfall inches annually falling upon a given percolating area at the surface, after making such deductions as may be necessary for areas of inclined ground, which, like so many inclined planes of different angles, tend to throw a considerable quantity of the water into the low level valleys and to the sea before it has had time to percolate.

The force of evaporation, with various other circumstances, would also affect the quantity of water to be pumped from any given depth and over a fixed area.

From this it is evident that the quantity of water likely to percolate into a given area of mineral land, and to be encountered below ground, may be determined with great approximation to the truth, and the power of the machinery necessary to drain it may also be ascertained before any work has been performed. The want of such determinations, based upon prolonged Geological and Engineering studies, have frequently led to the ruin of good mining adventures.

Circumstances have not permitted any reference to be made to the Palæontology of the Forest of Dean district, but the writer's views as to the value of that science may be gathered from the following quotation, which has been extracted from pp. 67 and 68 of the Spanish, and page 72 of the French editions of works, published by him in 1889, upon the Mines, Geology, Mining Laws, and Mineral Resources of the Argentine Republic:—

"To a man of Science it is to be lamented that the rocks "of the regions of Tamatina present so few traces of organic "remains of former epochs, because Palæontology is a Science as "profound in its bearing as it is useful, important, interesting, "and beautiful. In fact, it must in all truth be considered as "the twin sister of Geology, and consequently marches hand-"in-hand with it, illuminating the intelligence and dissipating "the dense obscurity surrounding the past and present, rending "asunder the dark veil which obscured the great truths of "Nature's secrets.

"Each page of the stupendous rocky book of God's creation "present to us in glorious and imperishable characters, brilliant "as the diamonds, transmitting the sublime history of the "creation, life and death of all the varied organic forms, the "existence of which has been preserved as fossil remains in "evident and palpable forms through the long lapse of those "obscure and mysterious periods of the past, the duration of "which can only be compared to the eternity of the future, the "sublimity of which transcends the capacity of the human mind."

## SECTION No. 3

### Section of Strata at Lightmoor Colliery

| Description of Measures | Thickness in feet and inches ft. | in. | Distance between each coal seam and water bearing strata ft. | in. | Total depth to ditto ft. | in. |
|---|---|---|---|---|---|---|
| Surface clay ... ... ... ... ... | 9 | 0 | | | | |
| Red clod ... ... ... ... ... ... | 17 | 0 | | | | |
| Soft clod ... ... ... ... ... ... | 2 | 0 | | | | |
| Red clod ... ... ... ... ... ... | 18 | 0 | | | | |
| Soft stone ... ... ... ... ... ... | 9 | 0 | | | | |
| Hard stone ... ... ... ... ... | 7 | 0 | | | | |
| Red clod ... ... ... ... ... ... | 22 | 0 | | | | |
| Blue clod ... ... ... ... ... ... | 32 | 4 | | | | |
| Rock ... ... ... ... ... ... | 7 | 0 | | | | |
| Stone and shale ... ... ... ... ... | 9 | 8 | | | | |
| Stone, with clod in middle of it ... ... | 15 | 0 | 148 | 0 | 148 | 0 |
| Little coal ... ... ... ... ... ... | 0 | 7 | | | | |
| Clod ... ... ... ... ... ... | 23 | 0 | | | | |
| Hard stone ... ... ... ... ... | 8 | 0 | | | | |
| Purple ground ... ... ... ... ... | 20 | 0 | | | | |
| Purple ground and clod, mixed... ... ... | 14 | 0 | | | | |
| Rock and clod ... ... ... ... ... | 25 | 0 | | | | |
| Clod ground ... ... ... ... ... | 11 | 0 | | | | |
| Rock, with water in it ... ... ... ... | 31 | 0 | | | | |
| Hard rock ... ... ... ... ... ... | 2 | 0 | | | | |
| Soft clod ... ... ... ... ... ... | 9 | 0 | | | | |
| Rock and clod, mixed ... ... ... ... | 7 | 0 | | | | |
| Strong drift ground ... ... ... ... | 21 | 0 | | | | |
| Rock, mixed with clod ... ... ... ... | 11 | 0 | | | | |
| Strong drift ... ... ... ... ... | 11 | 0 | | | | |
| Soft ground ... ... ... ... ... | 7 | 0 | | | | |
| Purple ground ... ... ... ... ... | 16 | 0 | | | | |
| Red ground ... ... ... .. ... | 15 | 0 | | | | |
| Blue shale, on top of the Big Stone ... ... | 4 | 0 | | | | |
| Big Stone, with water in it ... ... ... | 40 | 0 | 275 | 7 | 423 | 7 |
| Strong clod ... ... ... ... ... | 9 | 0 | | | | |
| Clod ground ... ... ... ... ... | 26 | 0 | | | | |
| Strong blue ground ... ... ... ... | 69 | 0 | | | | |
| Under earth ... ... ... ... ... | 5 | 0 | | | | |
| Purple ground ... ... ... ... ... | 3 | 0 | | | | |
| Blue ground ... ... ... ... ... | 11 | 0 | | | | |
| Blue clod ... ... ... ... ... ... | 48 | 0 | | | | |
| Clod ground ... ... ... ... ... | 8 | 0 | 179 | 0 | 602 | 7 |
| Coal ... ... ... ... ... ... | 0 | 8 | | | | |
| Shale ... ... ... ... ... ... | 11 | 0 | | | | |
| Crow delf rock ... ... ... ... ... | 30 | 6 | | | | |
| Coal (Hanfulls) ... ... ... ... ... | 0 | 2 | | | | |
| Under clod... ... ... ... ... ... | 11 | 0 | 53 | 4 | 655 | 11 |
| Coal (20 inch) ... ... ... ... ... | 2 | 0 | | | | |

## SECTION No. 3—*Continued*

Section of Strata at Lightmoor Colliery

| Description of Measures | Thickness in feet and inches | Distance between each coal seam and water bearing strata | Total depth to ditto |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Rock ground ... ... ... ... ... | 17 0 | 19 0 | 674 11 |
| Top foot coal ... ... ... ... ... | 1 2 | | |
| Rock and clod ... ... ... ... ... | 25 0 | 26 2 | 701 1 |
| Lowery coal ... ... ... ... ... | 2 10 | | |
| Blue rock and shale ... ... ... ... | 32 0 | | |
| Starkey Rock ... ... ... ... ... | 13 0 | 47 10 | 748 11 |
| Starkey coal ... ... ... ... ... | 1 5½ | | |
| Rock and hard clod ... ... ... ... | 7 0 | 8 5½ | 757 4½ |
| Little coal ... ... ... ... ... ... | 0 10 | | |
| Under-earth and clod ... ... ... ... | 15 0 | | |
| Rock and clod ... ... ... ... ... | 22 0 | 37 10 | 795 2½ |
| Rockery coal ... ... ... ... ... | 2 0 | | |
| Hard drift rock ... ... ... ... ... | 21 0 | 23 0 | 818 2½ |
| Coal (Breadless) ... ... ... ... ... | 0 10 | | |
| Hard drift rock ... ... ... ... ... | 35 0 | 35 10 | 854 0½ |
| Churchway high delf coal ... ... ... | 2 10 | | |
| Rock to no coal ... ... ... ... ... | 34 0 | 36 10 | 890 10½ |

## SECTION No. 4

Part of Vertical Section of the Strata of the Forest of Dean

(Published by the late Mr David Mushet, in 1824)

| Description of Measures | Thickness in feet and inches | Distance between each coal seam | Total depth |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Depth from surface to point where section commences... | | | 1258 6 |
| 1—Stone bind ... ... ... ... ... | 180 0 | | |
| 2—Little delf coal ... ... ... ... | 0 4 | | |
| 3—Cliff ... ... ... ... ... ... | 24 0 | | |
| 4—Crow coal ... ... ... ... ... | 2 0 | | |
| 5—Cliff and stone bind... ... ... ... | 24 0 | | |
| 6—Smith coal ... ... ... ... ... | 2 6 | | |
| 7—Cliff and stone bind... ... ... ... | 9 0 | 241 10 | 1500 4 |
| 8—Foot coal ... ... ... ... ... | 1 6 | | |
| 9—Cliff and stone bind... ... ... ... | 42 0 | 43 6 | 1543 10 |
| 10—Parkend high delf ... ... ... ... | 3 6 | | |
| 11—Cliff and stone bind... ... ... ... | 9 0 | 12 6 | 1556 4 |
| 12—Shifnil's coal... ... ... ... ... | 0 6 | | |

SECTION No. 4—*Continued*

Part of Vertical Section of the Strata of the Forest of Dean

(Published by the late Mr DAVID MUSHET, in 1824)

| Description of Measures | Thickness in feet and inches ft. | in. | Distance between each coal seam ft. | in. | Total depth ft. | in. |
|---|---|---|---|---|---|---|
| 13—Cliff and stone bind... ... ... ... | 30 | 0 | 30 | 6 | 1586 | 10 |
| 14—Starkey coal ... ... ... ... ... | 1 | 10 | | | | |
| 15—Cliff and stone bind... ... ... ... | 12 | 0 | 13 | 0 | 1600 | 8 |
| 16—Shifnil's coal... ... ... ... ... | 0 | 6 | | | | |
| 17—Cliff and stone bind... ... ... ... | 30 | 0 | 30 | 6 | 1631 | 2 |
| 18—Rockey coal ... ... ... ... ... | 2 | 0 | | | | |
| 19—Cliff and stone bind... ... ... ... | 12 | 0 | 14 | 0 | 1645 | 2 |
| 20—Breadless coal ... ... ... ... | 1 | 4 | | | | |
| 21—Cliff and stone bind... ... ... ... | 60 | 0 | 61 | 4 | 1706 | 6 |
| 22—Upper Churchway, or Oakenhill coal — These two coals unite and form the High Delf, or Churchway | 2 | 3 | | | | |
| 23—Cliff and stone bind... ... ... ... | 36 | 0 | 38 | 3 | 1744 | 9 |
| 24—Lower Churchway coal ... ... ... | 2 | 3 | | | | |
| 25—Cliff and stone bind... ... ... ... | 42 | 0 | 44 | 3 | 1789 | 0 |
| 26—Strong straw coloured rock ... ... | 12 | 0 | | | | |
| 27—Cliff and stone bind... ... ... ... | 9 | 0 | 21 | 0 | 1810 | 0 |
| 28—No coal ... ... ... ... ... | 1 | 6 | | | | |
| 29—Stone and cliff ... ... ... ... | 135 | 0 | 136 | 6 | 1946 | 6 |
| 30—Brazzily coal... ... ... ... ... | 2 | 0 | | | | |
| 31—Brazzily rock... ... ... ... ... | 150 | 0 | 152 | 0 | 2098 | 6 |
| 32—Nameless delf coal ... ... ... ... | 0 | 4 | | | | |
| 33—Nag's Head Hill rock ... ... ... | 240 | 0 | 240 | 4 | 2338 | 10 |
| 34—Yorkley coal... ... ... ... ... | 2 | 9 | | | | |
| 35—Gray rock or Pennant ... ... ... | 150 | 0 | 152 | 9 | 2491 | 7 |
| 36—Whittington coal ... ... ... ... | 2 | 6 | | | | |
| 37—Gray rock ... ... ... ... ... | 135 | 0 | 137 | 6 | 2629 | 1 |
| 38—Coleford High Delf coal ... ... ... | 6 | 0 | | | | |
| 39—Argillaceous shale, with iron-ore ... ... | 48 | 0 | | | | |
| 40—Trenchard: Gray rock ... ... ... | 78 | 0 | 126 | 0 | 2761 | 1 |
| 41—Upper Trenchard coal ... ... ... | 3 | 0 | | | | |
| 42—Gray rock and marl... ... ... ... | 45 | 0 | | | | |

SECTION No. 4—*Continued*

Part of Vertical Section of the Strata of the Forest of Dean

(Published by the late Mr DAVID MUSHET, in 1824)

| Description of Measures | Thickness in feet and inches | Distance between each coal seam | Total depth |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| 43—Gray rock, with alternating beds of clay, fire-clay, &c. ... ... ... ... | 24 0 | 72 0 | 2833 1 |
| 44—Lower Trenchard coal ... ... ... | 2 6 | 2 6 | 2 6 |
| MILLSTONE GRIT SERIES— | | | |
| 45—Fire-clay, red gritstone, or Farewell rock... | 30 0 | 225 0 | 3060 7 |
| 46—Red sandstone, with layers of red and white indurated marl ... ... ... | 75 0 | | |
| 47—Upper limestone ... ... ... ... | 30 0 | | |
| 48—Pure silicious red grit, with beds of pudding stone ... ... ... ... | 90 0 | | |
| 49—MOUNTAIN LIMESTONE SERIES—to Old Red Sandstone ... ... ... | | 705 0 | 3765 7 |

Mr Mushet states that this section was constructed from actual sinkings, and from observations made at the surface, but unfortunately he does not state where the sinkings were made, or to what part of the Forest his surface survey was confined.

The details of the limestone measures in Mr Mushet's Section No. 2 have already been given at page 132.

SECTION No. 5

Section of Strata sunk through at Bowson Colliery, in the Northern portion of the Forest of Dean.

| Description of Measures | Thickness in feet and inches | Distance between each coal seam | Total depth to each seam |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| 1—Clay and shale ... ... ... ... | 127 3 | 127 3 | |
| 2—Coal ... ... ... ... ... ... | 0 10 | | 128 1 |
| 3—Rock ... ... ... ... ... ... | 18 0 | | |
| 4—Drift ... ... ... ... ... ... | 5 7 | 23 7 | |
| 5—Coal crow delf ... ... ... ... | 1 2 | | 152 10 |
| 6—Drift ... ... ... ... ... ... | 6 0 | 6 0 | |

## SECTION No. 5—*Continued*

Section of Strata sunk through at Bowson Colliery, in the Northern portion of the Forest of Dean.

| Description of Measures | Thickness in feet and inches | | Distance between each coal seam | | Total depth to each seam | |
|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | ft. | in. |
| 7—Coal ... ... ... ... ... ... | 0 | 10 | | | 159 | 8 |
| 8—Sand ... ... ... ... ... ... | 1 | 6 | 1 | 6 | | |
| 9—Coal, twenty inch ... ... ... ... | 2 | 0 | | | 163 | 2 |
| 10—Shale and marl ... ... ... ... | 6 | 0 | 6 | 0 | | |
| 11—Coal Foot coal ... ... ... ... | 1 | 0 | | | 170 | 2 |
| 12—Strong drift and shale ... ... ... | 24 | 11 | 24 | 11 | | |
| 13—Coal, Lowery No. 1 ... ... ... ... | 1 | 4 | | | 196 | 5 |
| 14—Loamy sand, with shale ... ... ... | 14 | 10 | 14 | 10 | | |
| 15—Coal, Lowery No. 2 ... ... ... ... | 1 | 9 | | | 213 | 0 |
| 16—Strong drift ... ... ... ... ... | 9 | 7 | 9 | 7 | | |
| 17—Coal ... ... ... ... ... ... | 0 | 6 | | | 223 | 1 |
| 18—Soft clod ... ... ... ... ... | 1 | 0 | 1 | 0 | | |
| 19—Coal ... ... ... ... ... ... | 0 | 3 | | | 224 | 4 |
| 20—Strong drift ... ... ... ... ... | 11 | 4 | | | | |
| 21—Hard rock ... ... ... ... ... | 9 | 0 | 20 | 4 | | |
| 22—Coal, Upper Starkey ... ... ... | 0 | 10 | | | 245 | 6 |
| 23—Hard clay ... ... ... ... ... | 7 | 8 | 7 | 8 | | |
| 24—Coal, Lower Starkey ... ... ... | 1 | 7 | | | 254 | 9 |
| 25—Hard clod ... ... ... ... ... | 1 | 6 | | | | |
| 26—Rock ... ... ... ... ... ... | 6 | 0 | | | | |
| 27—Loamy sand ... ... ... ... ... | 4 | 3 | | | | |
| 28—Rock ... ... ... ... ... ... | 13 | 6 | | | | |
| 29—Drift and shale ... ... ... ... | 23 | 8 | 48 | 11 | | |
| 30—Coal, rocky ... ... ... ... ... | 2 | 5 | | | 306 | 1 |
| 31—Soft rock ... ... ... ... ... | 5 | 8 | | | | |
| 32—Hard rock partings ... ... ... ... | 0 | 10 | | | | |
| 33—Strong drift ... ... ... ... ... | 7 | 8 | | | | |
| 34—Rock, with coal leaders ... ... ... | 25 | 5 | | | | |
| 35—Drift ... ... ... ... ... ... | 15 | 9 | 55 | 4 | | |
| 36—Coal, Churchway high delf... ... ... | 2 | 6 | | | 363 | 11 |
| 37—Under-earth ... ... ... ... ... | 4 | 6 | 4 | 6 | | |
| 38—Coal, Lower Churchway ... ... ... | 0 | 5 | | | 368 | 10 |
| 39—Drift ... ... ... ... ... ... | 13 | 0 | | | | |
| 40—Rock ... ... ... ... ... ... | 24 | 10 | 37 | 10 | | |
| 41—Coal, No coal ... ... ... ... | 1 | 2 | | | 407 | 10 |
| 42—Rock ... ... ... ... ... ... | 51 | 9 | 51 | 9 | | |
| 43—Coal, Brazily ... ... ... ... ... | 1 | 9 | | | 461 | 4 |
| 44—Under-earth ... ... ... ... ... | 1 | 6 | | | | |
| 45—Gray rock ... ... ... ... ... | 6 | 0 | | | | |
| 46—Hard shale and clod... ... ... ... | 6 | 0 | | | | |
| 47—Soft drift ... ... ... ... ... | 6 | 0 | | | | |
| 48—Gray rock ... ... ... ... ... | 7 | 0 | | | | |
| 49—Soft drift ... ... ... ... ... | 9 | 0 | | | | |
| 50—Gray rock ... ... ... ... ... | 17 | 2 | | | | |
| 51—Hard clod ... ... ... ... ... | 1 | 9 | | | | |
| 52—Gray rock ... ... ... ... ... | 8 | 2 | | | | |
| 53— 〃 ... ... ... ... ... | 26 | 5 | | | | |
| 54—Blue rock ... ... ... ... ... | 1 | 5 | | | | |

## SECTION No. 5—*Continued*

Section of Strata sunk through at Bowson Colliery, in the Northern portion of the Forest of Dean.

| Description of Measures | Thickness in feet and inches | Distance between each coal seam | Total depth to each seam |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| 55—Gray rock ... ... ... ... ... | 8 8 | | |
| 56— " ... ... ... ... ... | 1 4 | | |
| 57— " ... ... ... ... ... | 30 11 | | |
| 58—Blue rock ... ... ... ... ... | 1 11 | | |
| 59—Gray rock ... ... ... ... ... | 4 7 | | |
| 60—Red clod ... ... ... ... ... | 13 2 | | |
| 61—Blue and gray rock ... ... ... ... | 36 10 | | |
| 62—Hard Pennant rock ... ... ... ... | 168 0 | 355 10 | |
| 63—Coal ... ... ... ... ... ... | 1 6 | | 818 8 |
| 64—Fireclay or under-earth ... ... ... | 1 6 | | |
| 65—Gray Pennant rock ... ... ... ... | 40 0 | | |
| 66—Hard Pennant rock ... ... ... ... | 6 0 | | 866 2 |

## SECTION No. 6

Section of the Coal Measures of the Forest of Dean

Taken from the Memoirs of the Geological Survey, 1856, Vol. I.

| Description of Measures | Thickness in feet and inches | Distance between each coal seam | Total depth to ditto |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| 1—Sandstone ... ... ... ... ... | 48 0 | | |
| 2—Red argillo arenaceous shale and ironstone | 30 0 | | |
| 3—Red argillo arenaceous shale ... ... | 51 0 | | |
| 4—Sandstone ... ... ... ... ... | 3 0 | | |
| 5—Blue and red shale ... ... ... ... | 24 0 | | |
| 6—Gray sandstone ... ... ... ... | 2 6 | | |
| 7—Red argillo arenaceous shale ... ... | 15 0 | | |
| 8—Sandstone ... ... ... ... ... | 2 0 | | |
| 9—Argillaceous shale ... ... ... ... | 15 0 | | |
| 10—Hard red arenaceous shale ... ... ... | 9 0 | | |
| 11—Soft argillaceous shale ... ... ... | 9 0 | | |
| 12—Reddish sandstone ... ... ... ... | 3 0 | | |
| 13—Argillaceous shale ... ... ... ... | 21 0 | | |
| 14—Red and gray sandstone ... ... ... | 2 6 | | |
| 15—Argillaceous shale ... ... ... ... | 22 6 | | |
| 16—Gray shale ... ... ... ... ... | 13 0 | 270 6 | 270 6 |
| 17—Coal ... ... ... ... ... ... | 0 3 | | |
| 18—Under-clay ... ... ... ... ... | 4 0 | 4 3 | 274 9 |
| 19—Coal ... ... ... ... ... ... | 0 6 | | |
| 20—Under-clay ... ... ... ... ... | 4 0 | | |

SECTION No. 6—*Continued*

Section of the Coal Measures of the Forest of Dean

Taken from the Memoirs of the Geological Survey, 1856, Vol. I.

| Description of Measures | Thickness in feet and inches | | Distance between each coal seam | | Total depth to ditto | |
|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | ft. | in. |
| 21—Argillaceous and arenaceous shale ... | 135 | 0 | 139 | 6 | 414 | 3 |
| 22—Coal ... ... ... ... ... ... | 0 | 6 | | | | |
| 23—Under-clay ... ... ... ... ... | 4 | 0 | | | | |
| 24—Argillaceous shale ... ... ... ... | 12 | 0 | 16 | 6 | 430 | 9 |
| 25—Coal ... ... ... ... ... ... | 0 | 8 | | | | |
| 26—Under-clay ... ... ... ... ... | 4 | 0 | | | | |
| 27—Arenaceous shale and sandstone ... ... | 4 | 0 | | | | |
| 28—Sandstone ... ... ... ... ... | 2 | 0 | | | | |
| 29—Argillaceous shale ... ... ... ... | 3 | 0 | | | | |
| 30—Sandstone ... ... ... ... ... | 5 | 0 | | | | |
| 31—Gray argillaceous shale ... ... ... | 6 | 0 | | | | |
| 32—Red argillaceous shale ... ... ... | 1 | 6 | | | | |
| 33—Sandstone ... ... ... ... ... | 4 | 9 | | | | |
| 34—Greenish arenaceous shale ... ... ... | 9 | 0 | | | | |
| 35—Argillaceous shale ... ... ... ... | 30 | 0 | 69 | 11 | 500 | 8 |
| 36—Coal ... ... ... ... ... ... | 0 | 8 | | | | |
| 37—Under-clay ... ... ... ... ... | 2 | 9 | | | | |
| 38—Shale and sandstone... ... ... ... | 91 | 0 | 94 | 5 | 595 | 1 |
| 39—Coal ... ... ... ... ... ... | 1 | 0 | | | | |
| 40—Under-clay ... ... ... ... ... | 1 | 6 | 2 | 6 | 597 | 7 |
| 41—Sandstone and shale... ... ... ... | 80 | 0 | | | | |
| 42—Argillaceous shale ... ... ... ... | 12 | 0 | | | | |
| 43—Hard gray thick-bedded sandstone ... | 40 | 0 | | | | |
| 44—Arenaceous shale ... ... ... ... | 90 | 0 | | | | |
| 45—Sandstone ... ... ... ... ... | 12 | 0 | | | | |
| 46—Coal (Crow Delf) ... ... ... ... | 0 | 8 | 234 | 8 | 832 | 3 |
| 47—Under-clay ... ... ... ... ... | 3 | 0 | | | | |
| 48—Black argillaceous shale ... ... ... | 30 | 0 | | | | |
| 49—Sandstone ... ... ... ... ... | 15 | 0 | | | | |
| 50—Coal and shale ... ... ... ... | 1 | 2 | | | | |
| 51—Under-clay ... ... ... ... ... | 3 | 0 | | | | |
| 52—Argillaceous shale ... ... ... ... | 9 | 0 | | | | |
| 53—Black carbonaceous shale ... ... ... | 30 | 0 | 91 | 2 | 923 | 5 |
| 54—Coal (Dog Delf) ... ... ... ... | 1 | 2 | | | | |
| 55—Under-clay ... ... ... ... ... | 2 | 9 | | | | |
| 56—Gray argillaceous shale ... ... ... | 44 | 0 | 47 | 11 | 971 | 4 |
| 57—Coal (Smith coal) ... ... ... ... | 2 | 6 | | | | |
| 58—Under-clay ... ... ... ... ... | 3 | 0 | | | | |
| 59—Argillaceous shale ... ... ... ... | 29 | 0 | 34 | 6 | 1015 | 10 |

SECTION No. 6—*Continued*

Section of the Coal Measures of the Forest of Dean

Taken from the Memoirs of the Geological Survey, 1856, Vol. I.

| Description of Measures | Thickness in feet and inches | Distance between each coal seam | Total depth to ditto |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| 60—Coal (Little Delf) ... ... ... ... | 1 8 | | |
| 61—Under-clay ... ... ... ... ... | 3 4 | | |
| 62—Sandstone ... ... ... ... ... | 2 0 | | |
| 63—Argillaceous shale ... ... ... ... | 18 0 | | |
| 64—Sandstone ... ... ... ... ... | 6 10 | | |
| 65—Argillo arenaceous shale ... ... ... | 6 6 | | |
| 66—Argillaceous shale ... ... ... ... | 12 0 | 50 4 | 1066 2 |
| 67—Coal (Parkend High Delf) ... ... | 3 7 | | |
| 68—Under-clay ... ... ... ... ... | 2 8 | | |
| 69—Argillaceous shale ... ... ... ... | 6 0 | | |
| 70—Gray soft sandstone ... ... ... | 10 0 | | |
| 71—Argillaceous shale ... ... ... ... | 3 0 | 25 3 | 1091 5 |
| 72—Coal ... ... ... ... ... ... | 0 6 | | |
| 73—Under-clay ... ... ... ... ... | 3 6 | | |
| 74—Sandstone ... ... ... ... ... | 1 4 | | |
| 75—Argillaceous shale ... ... ... ... | 26 0 | 31 4 | 1122 9 |
| 76—Coal ... ... ... 1 0 } Starkey coal | 2 6 | | |
| 77—Carbonaceous shale... 6 } Starkey coal | | | |
| 78—Coal ... ... ... 1 0 } Starkey coal | | | |
| 79—Under-clay ... ... ... ... ... | 3 0 | | |
| 80—Argillaceous shale ... ... ... ... | 10 0 | | |
| 81—Soft under-clay ... ... ... ... | 4 0 | 19 6 | 1142 3 |
| 82—Coal (Little coal) ... ... ... ... | 1 1 | | |
| 83—Under-clay ... ... ... ... ... | 0 7 | | |
| 84—Coal ... ... ... ... ... ... | 0 6 | 2 2 | 1144 5 |
| 85—Under-clay ... ... ... ... ... | 2 6 | | |
| 86—Argillaceous shale ... ... ... ... | 4 0 | 6 6 | 1150 11 |
| 87—Arenaceous shale ... ... ... ... | 10 0 | | |
| 88—Argillaceous shale ... ... ... ... | 15 0 | 25 0 | 1175 11 |
| 89—Coal (Rocky Delf)... ... ... ... | 1 9 | | |
| 90—Coal and carbonaceous shale ... ... | 0 8 | | |
| 91—Under-clay ... ... ... ... ... | 3 6 | | |
| 92—Argillaceous shale ... ... ... ... | 10 0 | 15 11 | 1191 10 |
| 93—Coal ... ... ... ... ... ... | 0 6 | | |
| 94—Under-clay ... ... ... ... ... | 3 0 | | |
| 95—Argillo arenaceous shale ... ... ... | 32 0 | | |
| 96—Under-clay ... ... ... ... ... | 2 0 | | |
| 97—Sandstone ... ... ... ... ... | 0 7 | | |
| 98—Marl ... ... ... ... ... ... | 0 6 | | |
| 99—Sandstone ... ... ... ... ... | 18 0 | | |

## SECTION No. 6—*Continued*

Section of the Coal Measures of the Forest of Dean

Taken from the Memoirs of the Geological Survey, 1856, Vol. I.

| Description of Measures | | | Thickness in feet and inches | Distance between each coal seam | Total depth to ditto |
|---|---|---|---|---|---|
| | ft. in. | | ft. in. | ft. in. | ft. in. |
| 100—Under-clay ... ... ... ... ... | | | 2 0 | 58 7 | 1250 5 |
| 101—Coal ... ... ... | 0 8 | Upper Church-way Delf | 4 2 | | |
| 102—Carbonaceous shale... | 0 9 | | | | |
| 103—Coal ... ... ... | 0 6 | | | | |
| 104—Under-clay ... ... | 1 6 | | | | |
| 105—Coal ... ... ... | 0 9 | | | | |
| 106—Under-clay ... ... ... ... ... | | | 1 0 | | |
| 107—Soft argillaceous shale ... ... ... | | | 4 2 | | |
| 108—Arenaceous shale ... ... ... ... | | | 1 4 | | |
| 109—Argillaceous shale ... ... ... ... | | | 28 0 | 33 8 | 1289 1 |
| 110—Coal ... ... ... | 1 0 | Lower Church-way Delf | 2 0 | | |
| 111—Carbonaceous shale... | 0 6 | | | | |
| 112—Coal ... ... ... | 0 6 | | | | |
| 113—Under-clay ... ... ... ... ... | | | 3 6 | | |
| 114—Argillo arenaceous shale ... ... ... | | | 33 0 | | |
| 115—Sandstone ... ... ... ... ... | | | 12 0 | | |
| 116—Argillo arenaceous shale ... ... ... | | | 9 0 | 59 6 | 1248 7 |
| 117—Coal (Shafnels Delf) ... ... ... | | | 0 6 | | |
| 118—Under-clay ... ... ... ... ... | | | 2 0 | | |
| 119—Sandstone and shale ... ... ... | | | 90 0 | 92 6 | 1341 1 |
| 120—Coal (Brazilly) ... ... ... ... | | | 1 9 | | |
| 121—Under-clay ... ... ... ... ... | | | 2 6 | | |
| 122—Sandstone ... ... ... ... ... | | | 380 0 | | |
| 123—Arenaceous and argillaceous shale ... | | | 21 0 | | |
| 124—Sandstone ... ... ... ... ... | | | 18 0 | | |
| 125—Arenaceous shale ... ... ... ... | | | 9 0 | 432 3 | 1773 4 |
| 126—Coal (Yorkley seam) ... ... ... | | | 2 9 | | |
| 127—Under-clay ... ... ... ... ... | | | 3 0 | | |
| 128—Sandstone ... ... ... ... ... | | | 150 0 | 155 9 | 1929 1 |
| 129—Coal (Whittington Delf) ... ... ... | | | 2 6 | | |
| 130—Under-clay ... ... ... ... ... | | | 3 0 | | |
| 131—Sandstone ... ... ... ... ... | | | 134 0 | 139 6 | 2068 7 |
| 132—Coal (Coleford High Delf) ... ... | | | 5 0 | | |
| 133—Under-clay ... ... ... ... ... | | | 4 0 | | |
| 134—Sandstone ... ... ... ... ... | | | 120 0 | 129 0 | 2197 7 |
| 135—Coal (Upper Trenchard) ... ... ... | | | 2 0 | | |
| 136—Under-clay ... ... ... ... ... | | | 3 0 | | |
| 137—Sandstone ... ... ... ... ... | | | 26 0 | | |
| 138—Marl ... ... ... ... ... ... | | | 1 0 | | |

SECTION No. 6—*Continued*

Section of the Coal Measures of the Forest of Dean

Taken from the Memoirs of the Geological Survey, 1856, Vol. I.

| Description of Measures | Thickness in feet and inches | | Distance between each coal seam | | Total depth to ditto | |
|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | ft. | in. |
| 139—Sandstone ... ... ... ... ... | 42 | 0 | 74 | 0 | 2271 | 7 |
| 140—Coal (Lower Trenchard) ... ... ... | 1 | 4 | | | | |
| 141—Under-clay ... ... ... ... ... | 2 | 0 | | | | |
| 142—Hard sandstones ... ... ... ... | 28 | 0 | | | | |
| 143—Red marl ... ... ... ... ... | 1 | 6 | | | | |
| 144—Red sandstone ... ... ... ... | 30 | 0 | | | | |
| 145—Marl ... ... ... ... ... ... | 1 | 6 | | | | |
| 146—Hard gray sandstone ... ... ... | 30 | 0 | | | | |
| 147—Soft sandstone ... ... ... ... | 39 | 0 | | | | |
| 148—Sandstone ... ... ... ... ... | 7 | 0 | | | | |
| 149—Marl ... ... ... ... ... ... | 1 | 6 | | | | |
| 150—Sandstone ... ... ... ... ... | 11 | 0 | | | | |
| 151—Marl ... ... ... ... ... ... | 1 | 4 | | | | |
| 152—Gray and white sandstone ... ... | 54 | 0 | | | | |
| 153—Marl and sandstone ... ... ... | 1 | 6 | | | | |
| 154—Sandstone ... ... ... ... ... | 14 | 0 | | | | |
| 155—Marl ... ... ... ... ... ... | 1 | 6 | | | | |
| 156—Sandstone ... ... ... ... ... | 2 | 0 | | | | |
| 157—Marl ... ... ... ... ... ... | 0 | 6 | | | | |
| 158—Light gray sandstone ... ... ... | 8 | 0 | | | | |
| 159—Marl ... ... ... ... ... ... | 1 | 4 | | | | |
| 160—Sandstone ... ... ... ... ... | 32 | 0 | | | | |
| 161—Gray and red impure limestone ... ... | 8 | 0 | 277 | 0 | 2548 | 7 |



(SEE OVER)

## SECTION No. 7

Compiled from a Section published by the late Mr John Atkinson, taken at about the centre of the Forest of Dean.

| Name of Seams of Coal, Iron-ore, etc. | Thickness between each seam | | Thickness of each seam obtained from another source | | Depth from surface to bottom of each seam | |
|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | ft. | in. |
| Smith coal ... ... ... ... ... ... | | | 2 | 0 | 735 | 0 |
| | 28 | 10 | | | | |
| Little Delf... ... ... ... ... ... | | | 1 | 2 | 765 | 0 |
| | 22 | 4 | | | | |
| Parkend Hill Delf or Lowery ... ... ... | | | 2 | 8 | 790 | 0 |
| | 48 | 2 | | | | |
| Starkey ... ... ... ... ... ... | | | 1 | 10 | 840 | 0 |
| | 38 | 0 | | | | |
| Rockey ... ... ... ... ... ... | | | 2 | 0 | 880 | 0 |
| | 62 | 4 | | | | |
| Lower Churchway ... ... ... ... | | | 2 | 8 | 945 | 0 |
| | 38 | 8 | | | | |
| No Coal ... ... ... ... ... ... | | | 1 | 4 | 985 | 0 |
| | 50 | 6 | | | | |
| Brazilly ... ... ... ... ... ... | | | 2 | 6 | 1038 | 0 |
| | 249 | 6 | | | | |
| Yorkley ... ... ... ... ... ... | | | 2 | 6 | 1290 | 0 |
| | 127 | 6 | | | | |
| Whittington ... ... ... ... ... | | | 2 | 6 | 1420 | 0 |
| | 120 | 6 | | | | |
| Coleford ... ... ... ... ... ... | | | 4 | 6 | 1545 | 0 |
| | 98 | 0 | | | | |
| Upper Trenchard ... ... ... ... ... | | | 2 | 0 | 1645 | 0 |
| | 73 | 8 | | | | |
| Lower Trenchard ... ... ... ... ... | | | 1 | 4 | 1720 | 0 |
| | 125 | 0 | | | | |
| Sandstone vein of iron-ore ... ... ... | | | 5 | 0 | 1850 | 0 |
| | 40 | 0 | | | | |
| Upper side of Mountain Limestone ... ... | | | | | 1890 | 0 |
| | 90 | 0 | | | | |
| Upper Limestone vein of iron-ore ... ... | | | 30 | 0 | 2010 | 0 |
| | 164 | 0 | | | | |
| Lower Limestone vein of iron-ore ... ... | | | 6 | 0 | 2180 | 0 |
| Blue Limestone ... ... ... ... ... | | | | | 2250 | 0 |
| Black Limestone ... ... ... ... ... | | | | | 2330 | 0 |
| Lower side of Mountain Limestone ... ... | | | | | 2510 | 0 |

## SECTION No. 8

Section of Dean Forest Coal Field, taken at the lower point of Mineral Basin.

| Name of Coal Seams | Thickness between each coal seam | Thickness of each seam | Depth from surface to bottom of each seam |
|---|---|---|---|
| | ft. in. | inches | ft. in. |
| Unproved—about... .... ... ... ... | 80 0 | | |
| Upper Woorgreens seam... ... ... ... | | 24 | 82 0 |
| | 42 0 | | |
| Lower Woorgreens seam... ... ... ... | | 24 | 142 0 |
| Unproved—about... ... ... ... ... | 260 5 | | |
| Coal ... ... ... ... ... ... | | 11 | 387 4 |
| | 73 0 | | |
| Coal ... ... ... ... ... ... | | 4 | 460 8 |
| | 122 0 | | |
| Coal ... ... ... ... ... ... | | 8 | 583 4 |
| | 57 0 | | |
| Coal ... ... ... ... ... ... | | 5 | 640 9 |
| | 119 1 | | |
| Crow Delf or Dog seam ... ... ... ... | | 18 | 761 4 |
| | 30 0 | | |
| Smith coal... ... ... ... ... ... | | 24 | 793 4 |
| | 18 0 | | |
| Little Delf... ... ... ... ... ... | | 14 | 812 6 |
| | 24 0 | | |
| Lowery Delf ... ... ... ... ... | | 32 | 839 2 |
| | 33 0 | | |
| Starkey Delf ... ... ... ... ... | | 22 | 874 0 |
| | 39 0 | | |
| Rockey seam ... ... ... ... ... | | 24 | 915 0 |
| | 60 0 | | |
| Churchway High Delf ... ... ... ... | | 32 | 977 8 |
| | 54 0 | | |
| No coal ... ... ... ... ... ... | | 16 | 1033 0 |
| | 54 0 | | |
| Brazilly seam ... ... ... ... ... | | 30 | 1089 6 |
| | 261 0 | | |
| Yorkley seam ... ... ... ... ... | | 30 | 1353 0 |
| | 120 0 | | |
| Whittington seam ... ... ... ... | | 30 | 1475 6 |
| | 132 0 | | |
| Coleford seam ... ... ... ... ... | | 54 | 1612 0 |
| | 126 0 | | |
| Upper and Lower Trenchards ... ... .. | | 30 | 1750 6 |
| | 144 6 | ft. in. | |
| Sandstone vein of iron-ore ... ... ... | | 5 0 | 1900 0 |
| | 100 0 | | |
| Upper side of Mountain Limestone ... ... | | | 2000 0 |
| | 70 0 | | |
| Upper Limestone vein of iron-ore ... ... | | 30 0 | 2100 0 |
| | 94 0 | | |

SECTION No. 8—*Continued*

Section of Dean Forest Coal Field, taken at the lower point of Mineral Basin.

| Name of Coal Seams. | Thickness between each coal seam | Thickness of each seam | Depth from surface to bottom of each seam |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Lower Limestone vein of iron-ore ... ... | | 6 0 | 2200 0 |
| | 100 0 | | |
| Blue Limestone ... ... ... ... ... | | | 2300 0 |
| | 100 0 | | |
| Black Mountain Limestone ... ... ... | | | 2400 0 |
| | 200 0 | | |
| Lower side of the Mountain Limestone ... | | | 2600 0 |
| | 400 0 | | |
| Old Red sandstone ... ... ... ... | | | 3000 0 |

## SECTIONS OBTAINED FROM ACTUAL SINKING AT THE UNDERMENTIONED COLLIERIES

### Section No. 9—PILLOWELL LEVEL PIT

| Name of Coal Seam | Thickness between each coal seam | Thickness of seam | Depth from surface to bottom of each seam |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Yorkley seam ... ... ... ... ... | | 2 9 | 164 9 |
| | 78 3 | | |
| Whittington seam ... ... ... ... | | 2 6 | 245 6 |
| | 144 6 | | |
| Coleford High Delf ... ... ... ... | | 4 6 | 394 6 |

### Section No. 10—SPEECH HOUSE HILL PIT

| | | | |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Starkey seam ... ... ... ... ... | | 2 6 | 251 6 |
| | 57 6 | | |
| Rockey seam ... ... ... ... ... | | 2 0 | 311 0 |
| | 79 0 | | |
| Churchway High Delf seam ... ... ... | | 3 3 | 393 3 |

## SECTIONS OBTAINED FROM ACTUAL SINKING AT THE UNDERMENTIONED COLLIERIES—*Continued*

### Section No. 11—FOXES' BRIDGE PITS

| | | | |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Twenty-inch seam ... ... ... ... | | 1 6 | 657 0 |
| | 90 6 | | |
| Lowery seam ... ... ... ... ... | | 2 6 | 750 0 |
| | 40 8 | | |
| Starkey seam ... ... ... ... ... | | 1 4 | 792 0 |
| | 46 0 | | |
| Rockey seam ... ... ... ... ... | | 2 0 | 840 0 |
| | 62 4 | | |
| Churchway High Delf seam ... ... ... | | 3 8 | 906 0 |

### Section No. 12—FLOWER MILL PIT

| | | | |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Yorkley seam ... ... ... ... ... | | 2 8 | 42 0 |
| | 178 6 | | |
| Whittington seam ... ... ... ... | | 2 6 | 223 0 |
| | 178 0 | | |
| Coleford High Delf ... ... ... ... | | 2 0 | 404 0 |

### Section No. 13—PARK HILL PIT

| Name of Coal Seam | Thickness between each seam of coal | Thickness of seam | Depth from surface to bottom of each seam |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Yorkley seam ... ... ... ... ... | | 2 10 | 240 10 |
| | 169 2 | | |
| Whittington seam ... ... ... ... | | 2 9 | 412 9 |
| | 155 3 | | |
| Coleford High Delf ... ... ... ... | | 4 6 | 572 6 |
| | 135 6 | | |
| Trenchard seam ... ... ... ... ... | | 3 11 | 711 11 |

### Section No. 14—TRAFALGAR PITS

| | | | |
|---|---|---|---|
| | ft. in. | ft. in. | ft. in. |
| Crow Delf... ... ... ... ... ... | | 1 6 | 391 6 |
| | 16 6 | | |
| Smith coal... ... ... ... ... ... | | 2 0 | 410 0 |
| | 22 0 | | |
| Lowery ... ... ... ... ... ... | | 2 11 | 434 11 |
| | 39 1 | | |
| Starkey ... ... ... ... ... ... | | 1 4 | 475 4 |
| | 40 8 | | |
| Rockey ... ... ... ... ... ... | | 2 2 | 518 2 |
| | 59 10 | | |
| Churchway High Delf ... ... ... ... | | 2 7 | 590 7 |

## SECTIONS OBTAINED FROM ACTUAL SINKING AT THE UNDERMENTIONED COLLIERIES—*Continued*

### Section No. 15—HORSE ENGINE PIT

| | ft. in. | ft. in. | ft. in. |
|---|---|---|---|
| Smith coal... ... ... ... ... ... | | 2 6 | 62 6 |
| | 12 0 | | |
| Little Delf... ... ... ... ... ... | | 1 4 | 75 10 |
| | 51 0 | | |
| Parkend High Delf ... ... ... ... | | 3 0 | 129 10 |
| | 36 0 | | |
| Starkey ... ... ... ... ... ... | | 2 6 | 168 4 |
| | 54 0 | | |
| Rockey ... ... ... ... ... ... | | 1 6 | 223 10 |

### Section No. 16—NEW ENGINE PIT

| | ft. in. | ft. in. | ft. in. |
|---|---|---|---|
| Lowery ... ... ... ... ... ... | | 2 10 | 257 10 |
| | 42 2 | | |
| Starkey ... ... ... ... ... ... | | 2 2 | 302 2 |
| | 57 10 | | |
| Rockey ... ... ... ... ... ... | | 1 7 | 361 7 |
| | 88 5 | | |
| Oaken Hill, or Churchway ... ... ... | | 1 8 | 451 8 |
| | 64 4 | | |
| Brazilly ... ... ... ... ... ... | | 2 8 | 518 8 |

Other useful data for comparison may be obtained from the appended Sections not specially referred to in the body of this paper.

The connection between Geological studies and Mining Engineering is very close, and has an important bearing, for whilst the former science explains the mode of occurrence, age, and change of the different formations, being, in fact, an index to the nature and extent of mineral deposits, the latter exhibits the proper and economical modes of extracting and determining the commercial value of each class of mineral. Probably, therefore, no apology is needed for the introduction of a peculiar, and at the same time interesting mining legal case, which took place in the year 1875, in Dean Forest, upon which a diversity of legal and mining opinions were expressed.

In the case referred to the writer was called in as one of the principal technical witnesses, but when it was introduced before a Circuit Judge, at Gloucester, he suggested that it was more proper that the parties should agree to send it for arbitration; and this advice was accepted by the litigants.

The dispute arose between two mining proprietors, whom we will call, for convenience, No. 1 and No. 2, the former claiming under the Dean Forest Mining Award all the iron-ore mineral from a certain defined water line drainage level, or Horse Road, in the Parkhill Iron Mine, situated in the South-Western part of the Forest, up to a similar water drainage line in the Lower Oakwood Mill Level Iron Mine, 220 perpendicular feet above the former, No. 2 proprietor claiming all the iron-ore mineral under the same Award from the last-mentioned drainage line upon the inclination of the strata up to the surface (see diagram) No. 1 upon which the outcroppings of the Underedge and lid-stone are represented. In each case the drainage level tunnel becomes the working road by which the extracted mineral was transported to the surface.

In a technical, or mining engineering sense, No. 1 proprietor had, under the said Award, absolute right to extract the mineral from his deep boundary line, *i.e.*, the Level, or Horse Road in Parkhill Iron Mine, for 220 perpendicular feet, up to the level water drainage line, or Horse Road in Oakwood Iron Mine.

Diagram No. 1 represents a lateral or cross section of the iron-ore measures, taken from the Western outcroppings towards the East, or in the deep, and supposing that the iron-ore measures existing between the Underedge and Lid-stone were full of deposits of mineral, all such deposits of iron-ore would be exhausted by extracting the triangular area of mineral marked A, corresponding to each deposit, but this would result in the destruction of that part of the Level Horse Road belonging to proprietor No. 2 resting upon each mineral deposit.

Consequently a serious impediment would arise, interfering with the rights of No. 2 proprietor in the transport of his mineral to the surface, and bring about an action for damages.

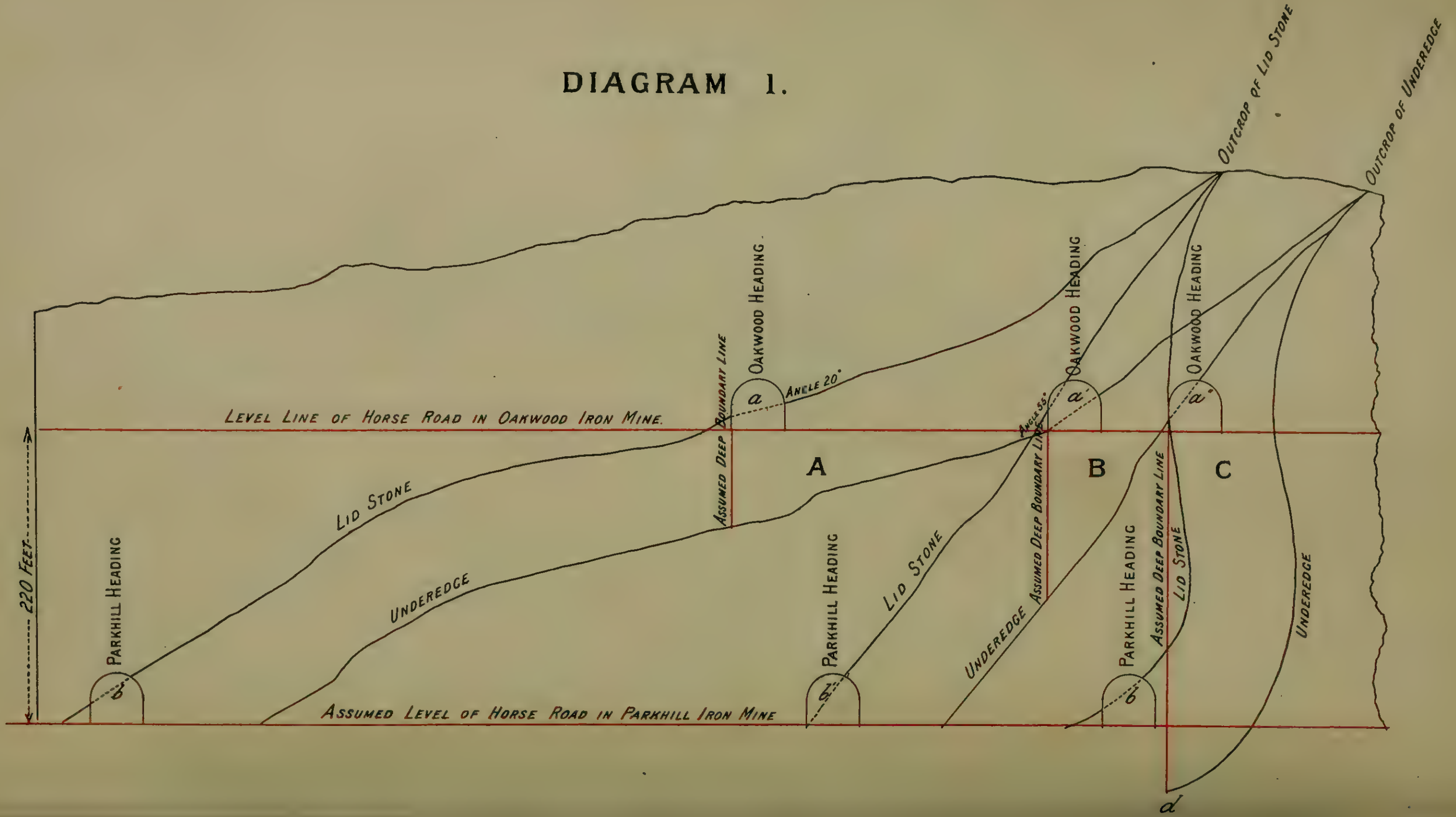
This being the case, very able, ingenious, and long legal arguments were advanced, and a number of technical witnesses called in to prove that both sides were right.

It will be observed that the Dean Forest Commissioners made no provision in the Award to protect the drainage level or Horse Road when it rested upon any iron-ore deposits belonging to a proprietor immediately in the deep, as in the case of No. 1 already cited. One of the Counsel for the plaintiff argued in very forcible terms that the limits of each property below the water level should be determined by a perpendicular line, which in the diagram is marked as the "assumed deep boundary line." This would have given a triangular area of iron mineral, represented by A, to the proprietor No. 2, although under the Commissioners' Award it belonged to No. 1.

In evidence the writer pointed out that as the angle of depression of the iron-ore measures below the horizon was very variable, such a definition of the deep boundary line would have an injurious effect upon mining generally in the Forest of Dean, being, in fact, against the terms of the Commissioners' Award. For example, at the Oakwood Heading above the horizontal line at *a*, above the triangular area A, the angle is 20°, but if it were 55°, as exhibited at Oakwood Heading at *a′*, above the line and triangular area B, then the assumed deep boundary line would intersect the Underedge at *c*, or at a considerable depth below the drainage level, and the triangular area at A would have been changed in form and occupied that at B, taking away a large area of mineral merely to support the Oakwood Heading above it, belonging to proprietor No. 2, and further that when any Geological contortions of the strata occurred, such as were experienced at the St. Annals Iron Mine (see diagram No. 2), then in certain extreme cases the triangular area of mineral at B would be exchanged for that at C, and thus the whole of the property belonging to proprietor No. 1 would be entirely lost if such an argument were to hold good, because a perpendicular boundary line let fall from the East side of the Oakwood Heading situated at *a″* above the "assumed deep boundary line," would intersect the Underedge at the point *d* below the Level Horse Road in Parkhill Iron Mine.

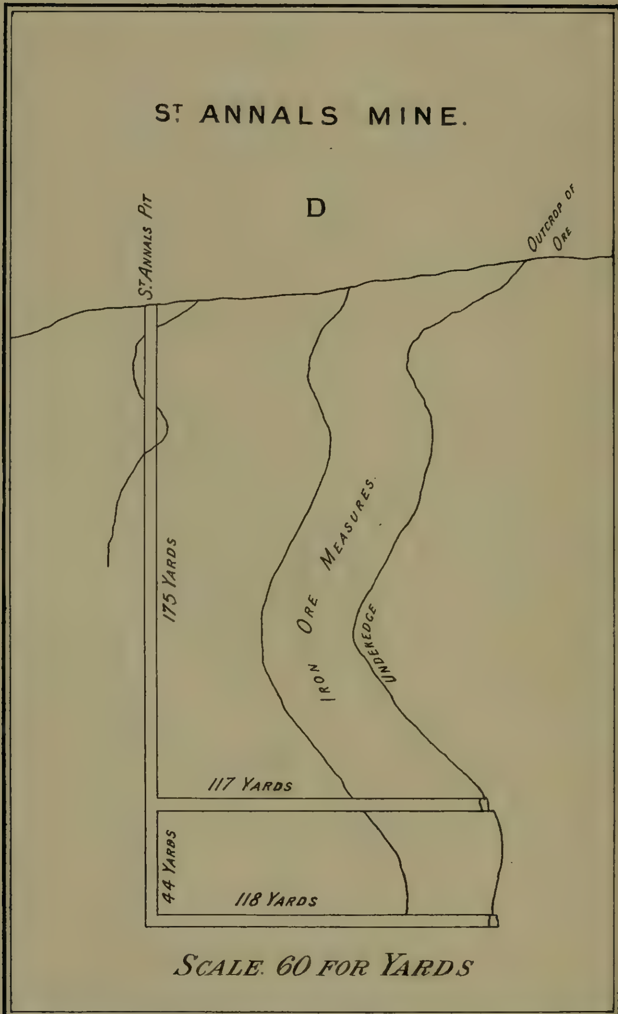
Thus it was proved that such legal opinions were not only in conflict with the Commissioners' Award itself, but also with

# DIAGRAM 1.



Outcrop of Lid Stone
Outcrop of Undereedge
Oakwood Heading.
Angle 20°
a
Level Line of Horse Road in Oakwood Iron Mine.
Assumed Deep Boundary Line
A
Lid Stone
Undereedge
Parkhill Heading
b
220 Feet
Assumed Level of Horse Road in Parkhill Iron Mine
Oakwood Heading
Angle 55°
Assumed Deep Boundary Line
B
Lid Stone
Parkhill Heading
Undereedge
Oakwood Heading
C
Assumed Deep Boundary Line
Lid Stone
Parkhill Heading
Undereedge
d

DIAGRAM 2.

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the proper usages of modern mining engineering, and consequently were untenable; but it was with the greatest difficulty that the legal gentlemen, as well as the arbitrator, were at last convinced that difference in the angles of depression and contortions of the strata, such as those which occurred at St. Annals Iron Mine, could affect the boundary lines of iron mines in the Forest of Dean.

The sectional headings, $a$, $a'$, and $a''$, in the Oakwood Iron Mine are identical, but might occupy either of these positions as indicated laterally in the same mine, depending upon the variable angle of depression of the strata. The same remark holds good with reference to the heading $b$, $b'$, and $b''$ in the Parkhill Level Iron Mine.

*On the Geology of Cirencester Town, and a recent discovery of the Oxford Clay in a deep well boring at the Water Works. By* Allen Harker, *Professor of Natural History at the Royal Agricultural College. Read 24th February,* 1891.

The town of Cirencester, looked at from the physical geographer's point of view, is situated on the gently sloping floor of an expansion of the Churn valley, which here widens out into a long irregular spindle shape, bending near its centre towards the South-West. The pre-historic course of the river through this plain can now only be guessed at. Its old bed is probably hidden beneath the ruins of the many cities that have stood here since palæolithic man hunted the mammoth through the reeds and osiers by its banks, and left his rude flint implements on the slopes at Trewsbury, or the tusks of his game in the gravels of the stream by Siddington and South Cerney.

The river has been diverted, certainly many times, to suit the exigencies of former inhabitants—Celts, Romans, Romano-British or Saxons, and has finally been treated in a characteristically modern fashion, and covered out of sight for a great part of its course. It is only by laborious reference to old maps and histories, and to the memory of "the oldest inhabitant," that one can follow the underground branches and their deviations, though they are of great interest and importance in a study of the water supply.

All around this expanded valley floor (on which the town is built), except at the entrance and exit of the stream, which are comparatively narrow, the ground rises by more or less gradual and gentle slopes to the higher downs on the North and West, and the more gentle undulations to the South and East.

A 6 in. ordnance survey map, with the contours marked, and the rising grounds around the town coloured, leaves the spindle formed valley itself well marked off, and amply illustrates its physical geography. [Such a map was exhibited at the reading of this paper.]

The general trend of the hill slopes is S.S.E., and the *dip* of the beds which compose the hills is similar in direction, though at a greater angle. On this account we rise geologically the further we descend the Cotteswolds towards Swindon, successive higher beds outcropping as the lower ones dip under the horizon. The main body of the rocks composing these rising grounds around the town is Great Oolite, but all the hills around are capped by Forest Marble, or by those junction beds between these horizons, which present constant difficulties to the local student.

Our evidence of this paramount importance of the Great Oolite around is abundant, but I lay exceptional stress on it in this part of my argument for a reason which will be presently developed.

The evidence is afforded firstly, by the quarries, and secondly, by the well sinkings in the neighbourhood.

Avoiding for the moment the question of what exactly is Great Oolite, and what Forest Marble, we may say generally that all the heights around the town are Great Oolite, with cappings here and there of true Forest Marble. The various quarries have been described and sections given from time to time, chiefly by the late Professor Buckman (in an important paper to be presently alluded to), and subsequently by Hull, Witchell, and myself.

The evidence afforded by the deep wells in the neighbourhood, so far as I can ascertain, has not been collected or recorded in any way. It may prove useful to some future workers at Cotteswold Geology to have what is known placed on record. I refer solely to wells which undoubtedly cut through the Great Oolite and find their water supply in the Fuller's Earth below, and the situation of these wells on the rising grounds around the town gives their history an important bearing on the subject of the Geology of the town itself.

## Well at the R.A. College Farm.

We have some brief account of this well in our own transactions. In the annual address on Jan. 27, 1857 (Proceedings of Cotteswold Club, Vol. II.,) Professor Buckman, describing an excursion to the College Farm buildings, says:—

"The Geologists examined the well-sinking through the Great Oolite into the Fuller's Earth, a depth of 140 ft. The whole of this shaft was carried through beds of a more or less porous oolite, without a break either lithological or palæontological, a circumstance which gave rise to some discussion between Mr Hull, of the Ordnance Geological Survey, and the Secretary—the former gentleman considering a large portion of the shaft as representing the Forest Marble; the latter considering it as wholly belonging to the Great Oolite, and contending that certain clay beds which occur higher in the series, where the true Bradford clay is absent, present a natural division, and one which can be carried out through a wide extent in this district. At a later period of the meeting the Secretary presented a section of this well, with others of the neighbourhood, and read a paper on the geology of the water bearing beds about Cirencester."

It is very much to be regretted that no record appears to have been preserved of the paper here alluded to, or of any of the sections, for after careful search and enquiry I am unable to find any such. The depth mentioned, 140 ft., is somewhat greater than other evidence would have led one to expect; but we are ignorant of how far into the Fuller's Earth the sinking was carried.

## Well at Further Barton.

This well is about 120 ft. deep. There is no record of the actual section, but most systematic records have been kept over a long series of years of the varying height of the water in the well. There can be no doubt, from these records, that it taps the Fuller's Earth at about the same depth as the R A.C. Farm well. It has never been dry.

## Well at the Bacon Factory.

A plentiful supply of water is here obtained at a depth of 89 ft. The well itself is 73 ft. deep, and there is a further bore of 16 ft. The height of the water was 11 ft. above the well floor three days ago.

### Well at Oakley Villas.

This is from 80ft. to 90ft. deep, and affords a never-failing supply. Mr James Habgood, of Cricklade Street, Cirencester, to whom I am indebted for much valuable information on old wells, says this well was cut through solid rock. It has a high local reputation for purity on account of its great depth; but is "suspect" from surface contamination.

### Earl Bathurst's Trial Boring at the Barton, 1872.

This section is very fully described in Mr Taunton's paper in the Hydrology of the Cotteswolds, and is reproduced in the accompanying illustrations.

### Well at the Beeches.

Mr W. Newcombe, builder, &c., of Cricklade Street, kindly informs me that this boring reached a total depth of 96 ft. From an examination of the triturated material of the boring, which Mr Newcombe allowed me to see, I am of opinion that the boring went through a greater thickness of Forest Marble Clays than any of the previously described borings, and finished still in the freestone of the Great Oolite.

I have several other accounts of old deep well borings in the town and neighbourhood, but no specimens or particulars of the materials obtained in excavating them: their value as evidence is therefore but slight.

### General Testimony of the Wells.

Taking these various wells and sections, the information they supply corroborates that of the neighbouring quarries, and, as a general summary, we may conclude that they indicate a thickness of Great Oolite of about 100 ft., overlying the impervious strata of the Fuller's Earth, whence their water is obtained.

We now come to the consideration of the sub-strata of the town itself. What rocks fill and form the floor of the valley? If we suppose for a moment that the valley did not exist at all, or was but a narrow combe, like scores of others on the Cotteswolds, the strata of Oolitic rocks continuous from side to side, then the town's foundations, the bottoms of its deepest cellars, would be occupied by the white beds of the Great Oolite; and assuming there were no break of continuity, the lower part of the valley towards Siddington would run over the Forest Marble on to the Cornbrash. Well, this is certainly not the case, as may be seen on a consideration of the wells and water supply of the town itself. I draw a sharp distinction between the "town" wells and those already described, which are all on the outskirts of the town, beyond the area of the valley floor.

The opportunities of getting a general section in the bottom of a valley on which a town is built, are necessarily few; they are exceptionally so in the case of Cirencester. The excavations for solid foundations for masonry fail to carry us much below the debris of Roman Corinium. The strata explored are only those of ancient civilizations. The sinkings of the town wells are almost our only data. These are, however, numerous and instructive.*

Taking first the public pump in the Market-place. This water supply has a history and a reputation of an honourable character. Artistically, the pump is not a thing of beauty, but its water is pure and unfailing. In the course of many enquiries and much conversation on the subject of local water supply, I have heard many stories of the reliability of this source, a matter of no small consequence in times of drought in such a district, and especially in days when general artificial supplies of water were less common.

I have been told of times of drought when the supplies of water in the surrounding country villages having given out, crowds of vehicles, with all manner of water-carrying utensils, have filled the streets in the vicinity of this pump, waiting their turn to fill up with the precious liquid from its perennial fount. The depth of the well is 25 to 26 ft.; after passing through

* I am indebted to Mr W. H. James for a valuable list of the shallow wells of the town, and for much other useful information regarding its water supply.

7ft. to 8ft. of made ground, there is about 20ft. of gravel (which holds the water) resting on thick beds of impervious clays. The history and reputation of this well constitutes it an important piece of evidence in any study of Cirencester waters.

Not far away—150 to 200 yards—in the Brewery of Messrs Cripps, a well of 25 ft. in depth supplies an equally pure and unfailing quantity of what is doubtless the same water. There are reasons for supposing that this was originally a Roman well.

The bed of gravel, with its succeeding clays, appears to underlie the whole town. Deep excavations show the Roman houses and walls to be built upon it. Much of it has been dug and carted for use, but almost anywhere it would seem that a well sunk to depths of from 7 ft. to 25 ft. will fill with water and give a more or less continuous supply. The shallower ones give out soonest in dry weather, and the quality of the water varies considerably, no doubt from local contaminations. On some other occasion I propose to endeavour to trace these shallow well waters to their origin, and will then give the information collected on this head.

It is, however, quite plain that at a depth of not more than 25 ft. below the present level of the valley floor a great subterranean water supply, well filtered by the beds of local gravels, has for many generations, probably for centuries, proved continuous, and is now existing. A consideration of this most important fact, for such I think it is, first led me to the investigation of the problem presented by our local geology, here followed out.

Buckman, in his important paper on the Geology of the neighbourhood (*Quarterly Journal of the Geological Society*, May, 1858, p. 118), speaking of the Forest Marble generally, says:—

> "In the neighbourhood of Cirencester nearly all the heights are capped with this stratum."

He then goes on—

> "And as the town rests in a *valley of depression*—to be more fully explained hereafter—it will be seen that Forest Marble clays are the water bearing beds of the town, as shown in the sections through Cirencester."

Unfortunately, he does not appear to have ever "more fully explained" what he actually intended by this expression. Certainly not in the paper in question; nor can I find any further allusion to the question in his subsequent writings. We have fortunately his admirable section from Birdlip to Swindon, passing through Cirencester, the lines of which are taken along the Roman roads through the town. [The original coloured drawing is in the collection of diagrams and sections of the Royal Agricultural College.]

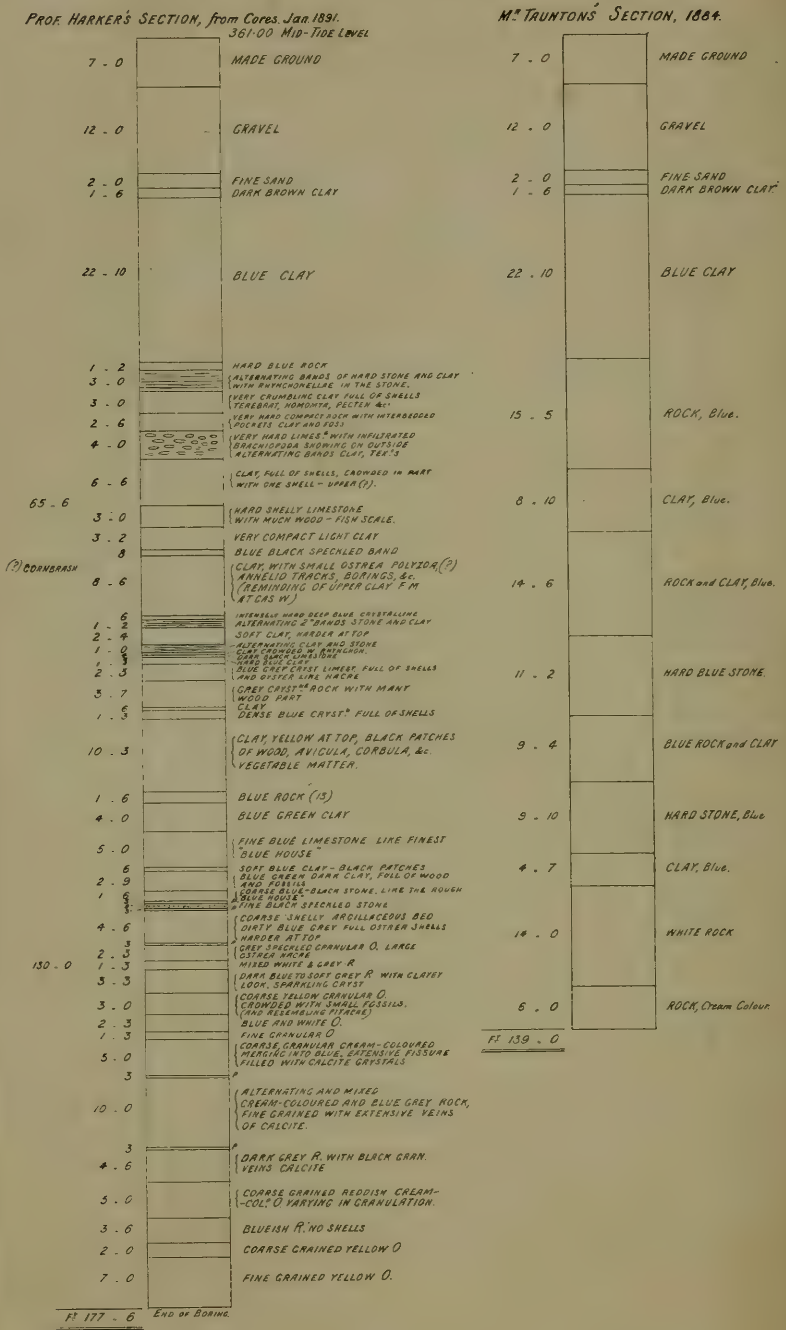
This section represents the fault at Stratton as throwing down the Great Oolite and Forest Marble some 25 ft. to 40 ft.

It seems pretty clear that by the term "valley of depression" he intended no more than to graphically describe this faulting down of the clays of the Forest Marble to form the floor of impervious rock beneath the gravels that underlie the town.

For the past eight or nine years I have been gradually collecting materials for a more exhaustive study of the Forest Marble of the district than has yet been made, and the clay floor of the valley has always presented an unsolved puzzle.

The opinion of Buckman, as expressed by his general section, is that which has been generally followed by subsequent writers, though there has always been a minor conflict on the question of the Junction Beds of the Great Oolite and Forest Marble. I have been informed by a student of the late Prof. John Morris that he held the view that the shallow subterranean water of Cirencester was derived from the Fuller's Earth, and that this opinion was founded on the chemical composition of the water. He has, however, left no writing on the subject, and in the absence of reasons we are precluded from entertaining this idea. It may be that he felt dissatisfied with Buckman's explanation. Whether that be so or not, I had for some years formed a strong opinion that the faulting down of the Forest Marble alone was not a satisfactory explanation of our shallow town-well supply. My reasons were chiefly these. The more one becomes acquainted with the Forest Marble, the more variable and unstable do its numerous clay beds appear. At Kemble, as described by Buckman *(loc. cit.)*, the top-most bed

# SECTIONS AT LEWIS LANE, CIRENCESTER.

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of Forest Marble Clay is 17 ft. thick. But at Ampney Crucis I find this bed varying from only 4 ft. to 6 ft., and elsewhere it becomes still thinner. It is true, on the other hand, that just below the gas works there is a thick bed, from 18 ft. to 20 ft., of this upper clay. The section has never been described, and it is the only one on this line that has escaped record: so that its insertion here will not be out of place.

Section on Midland and South-Western Junction Railway (S.E. of the Cirencester Gas Works).

| | ft. | in. |
|---|---|---|
| Cornbrash, crowded with characteristic fossils, at S.E. end of cutting ... ... ... ... ... ... ... ... | 8 | 0 |
| Forest Marble Clay, very dark grey, no fossils found except bits of branching *Polyzoa* or *Hydroids*, at N.W. end of cutting | 18 | 0 |

I could not regard these irregular clays as sufficiently accounting for the practically impervious support of so large a body of water. Yet I had up to last year no other hypothesis to suggest.

About 1882-3, our fellow member, Mr Taunton, informed me that he was boring at Lewis Lane, close to the old brewery-well there, and was passing through beds of clay. This was an ordinary chisel boring, but I procured a large quantity of the triturated material brought up, and with the aid of some of my students carefully washed and decanted a good deal of it, and submitted it to a thorough examination. We found nothing but broken fragments of *Ostrea* and other shells, and remained still in the dark as to what these clays actually were, though their presence tended to confirm my suspicions that Buckman's explanation did not satisfy all the conditions of the problem.

The Well at Lewis Lane (Bowly's Well)

which I have purposely held over for consideration, was sunk some fifteen years ago, (in consequence, I have been told, of doubts having been thrown on the purity of a former shallow supply,) and was a chisel boring to the depth of 130 ft. A constant supply of water had been obtained from this source; the further borings being carried out by Mr Taunton, were for the purpose of obtaining an increased supply. The proprietorship of the well had, I believe, changed hands, and was now vested in the Cirencester Water Works Company. In 1885 Mr Taunton published in our Proceedings (Vol. IX.) his paper on the Hydrology of the Cotteswolds. Although this paper is mainly occupied with a valuable and careful record of observations on the varied problems embraced rather by a hydrological than a geological aspect of the question, I acknowledge my great indebtedness to it for assistance in attempting to unravel the geological clue which the case presents, and desire to testify to its very great interest and value as a work of reference. It contains the section at the Barton, "Trial-boring, 1872," already referred to (p. 52), and also the new and important section at Lewis Lane, the chisel boring from which the clays I had examined, were obtained.

A reference to this section shows beneath the surface sand and gravel, 120 ft. of alternating blue clay and rock before a white rock is reached. I believe Mr Taunton, quite naturally following Buckman and his successors, took this to be all Forest Marble. I could not, however, regard it as resembling any development of those beds of which our district furnished examples, and it tended to confirm the view that the "valley of depression" meant something more than the faulting-down shown in Buckman's section. Mr Taunton told me he had kept some fossils taken from a new shaft which he had sunk near the old boring, and about June, 1890, I paid him a visit, mainly for the purpose of examining them. In my diary of that date I find this observation on these fossils:—"Struck at once by the fact "that these fossils are Kellaway's Rock and Oxford Clay, and "not Forest Marble at all. *If this be correct, then the town of "Cirencester is situated on an extensive down-throw of the Oxford "Clay."*

This quite unexpected discovery, if such it should turn out to be, would, I saw at once, explain all the difficulties, and would also harmonize with Buckman's views, his "valley of depression" only being some 60 ft. to 100 ft. deeper than he anticipated. It would also explain Mr Taunton's chisel-boring section, as the samples of triturated Kellaway's Rock and Oxford Clay would sufficiently closely resemble Forest Marble to be taken for it. Mr Taunton was good enough to send his specimens at once to the Geological Survey at Jermyn Street, and their determination by Mr G. Sharman, which Mr Horace B. Woodward was good enough to send me, confirmed most fully my opinion of them. They were the following:—

| | feet |
|---|---|
| Avicula inæquivalvis ... ... ... ... | 30-34 |
| Ostræa or Gryphæa (young forms) ... ... | 30-34 |
| Myacites recurva... ... ... ... ... | 32 |
| Ammonites macrocephalus ... ... ... | 39 |
| Belemnites Oweni ... ... ... ... | 39 |
| Modiola bipartita ... ... ... ... | 39-45 |
| Waldheimia ornithocephala ... ... ... | 45 |
| Terebratula intermedia, fragment | |

All are known from Lower Oxfordian—Oxford Clay and Kellaway's Rock. The lithological character of the rock also favoured this view, as Mr Woodward pointed out.

At about this time it was in contemplation to make an extensive diamond boring from the bottom of the new shaft at Lewis Lane, and as this would be sure to confirm or modify my conclusions, we agreed to wait for such revelations as a study of the cores would afford.

In July last the boring ($8\frac{1}{2}''$ diam.) began, and I watched daily with keen interest the progress through the alternating clays and blue and black limestones, and at 128 ft. to 130 ft. was rejoiced to see the fine cream-coloured freestones of the Great Oolite. The boring was carried on to a total depth from the surface of 177 ft. 6 in., and for several reasons, which need not here be related, was abandoned. It may be noted that some short time afterwards a plentiful supply of water filled the well, and has since continued very regular. The task now remained to work out systematically the cores brought up by the borer. These represent 132 ft. in depth, and weigh about eight tons. The long and often repeated examination of these cores would have been impossible without not merely the permission to inspect them, but the elaborate facilities for numbering, placing in boxes, and subsequently storing them, which has been generously carried out by the Chairman of the Water Works Company, E. W. Cripps, Esq. The thanks of all Cotteswold Geologists are due to Mr Cripps for placing these cores at my disposal, for without such assistance this investigation could not have been completed.

There is still much work to be done, microscopic and chemical, on the abundant material furnished by these cores, but the following section, the result of examinations carried out in conjunction with some of my students, may, I believe, be taken as generally correct. A comparison of it, with Mr Taunton's chisel-boring section shows almost complete identity in broad outline.

Section through the Floor of the Cirencester Valley, from the Shaft and Diamond Boring at Lewis Lane.

| | | ft. | in. |
|---|---|---|---|
| Mr Taunton's Record | Made ground ... ... ... ... ... ... ... | 7 | 0 |
| | Gravel ... ... ... ... ... ... ... ... | 12 | 0 |
| | Fine sand ... ... ... ... ... ... ... | 2 | 0 |
| | Dark brown clay ... ... ... ... ... ... | 1 | 6 |
| | Blue clay ... ... ... ... ... ... ... | 22 | 10 |
| | In this were found the fossils mentioned at page preceding. A typical specimen has been presented by Mr Taunton to the Gloucester Museum. | | |
| | 1.—Hard blue limestone ... ... ... ... ... ... | 1 | 2 |
| | 2.—Alternating bands of limestone and clay, full of *Rhychonellæ* | 3 | 0 |
| | 3.—Crumbling clay, full of shells (*Terebratulæ, Homomya, Pecten,*) | 3 | 0 |
| | 4.—Hard limestone, with clay pockets; many fossils ... ... | 2 | 6 |
| | 5.—Very hard blue limestone, with Brachiopoda shells, partly hollow or infiltrated with carbonate of lime, resembling Kellaway's Rock at South Cerney ... ... ... ... | 4 | 0 |
| | 6.—Clay, crowded with imperfect bivalve shells (? Mlodiola) | 6 | 6 |
| | 7.—Hard shelly limestone, with much wood—a fish scale ... | 3 | 0 |
| | 8.—Compact light clay ... ... ... ... ... ... | 3 | 2 |
| | 9.—Bluish-black speckled rock ... ... ... ... ... | 0 | 8 |
| | 10.—Clay, with *Ostræa*, *Polyzoa*, tracks and borings ... ... | 6 | 6 |
| | This bears a close resemblance to the Upper Forest Marble Clays at the Gas Works. If it should be the equivalent bed the Cornbrash above is not well represented. | | |

| | ft. | in. |
|---|---|---|
| 11.—Intensely hard blue crystal. limestone ... ... ... | 0 | 6 |
| 12.—Alternating bands clay and limestone ... ... ... | 1 | 2 |
| 13.—Soft clay ... ... ... ... ... ... ... ... | 2 | 4 |
| 14.—Alternating clay and limestone ... ... ... ... | 1 | 0 |
| 15.—Clay, with *Rhynchonellæ* ... ... ... ... ... | 0 | 4 |
| 16.—Very dark limestone ... ... ... ... ... ... | 0 | 3 |
| 17.—Hard bluish clay ... ... ... ... ... ... | 1 | 3 |
| 18.—Blue grey crystalline limestone, with shells and nacre ... | 2 | 3 |
| 19.—Grey crystalline limestone, with much wood ... ... | 3 | 7 |
| Clay parting ... ... ... ... ... ... ... | 0 | 6 |
| 20.—Compact blue limestone, full of shells ... ... ... | 1 | 3 |
| 21.—Yellowish clay, with much wood and broken shells ... | 10 | 3 |
| 22.—Blue limestone ... ... ... ... ... ... ... | 1 | 6 |
| 23.—Bluish green clay ... ... ... ... ... ... | 4 | 0 |
| 24.—Blue limestone of fine texture, resembling a foraminiferal limestone at Blue House ... ... ... ... ... | 5 | 0 |
| 25.—Soft blue clay ... ... ... ... ... ... ... | 0 | 6 |
| 26.—Bluish green clay, with wood and fossils ... ... ... | 2 | 9 |
| 27.—Rough blue shelly limestone ... ... ... ... ... | 1 | 6 |
| These last four or five beds very closely resemble the section at Blue House. | | |
| Clay parting ... ... ... ... ... ... ... | 0 | 3 |
| 28.—Blackish speckled limestone ... ... ... ... ... | 0 | 9 |
| Clay parting ... ... ... ... ... ... ... | 0 | 3 |
| 29.—Coarse shelly limestone, full of broken oyster shells ... | 4 | 6 |
| Clay parting ... ... ... ... ... ... ... | 0 | 3 |
| 30.—Greyish Oolitic bed, with large oysters ... ... ... | 2 | 3 |
| 31.—Mixed cream coloured and grey Oolitic rock ... ... | 1 | 3 |
| These two beds appear to mark the advent of the Great Oolite, or the Junction beds. | | |
| 32.—Dark blue limestone, sparkling with Calcite crystals ... | 3 | 3 |
| 33.—Coarse yellow granular Oolite, with innumerable broken shells ... ... ... ... ... ... ... ... | 3 | 0 |
| This is a well-known bed in the district, and marks the upper beds of the Great Oolite. | | |
| 34.—Variegated blue and white Oolite ... ... ... ... | 2 | 3 |
| 35.—Fine yellow freestone ... ... ... ... ... ... | 1 | 3 |
| 36.—Compact bed, with fissures filled by Calcite crystals, cream coloured to blue ... ... ... ... ... ... | 5 | 0 |
| Parting ... ... ... ... ... ... ... ... | 0 | 3 |
| 37.—Variegated cream coloured Oolite, with Calcite veins ... | 10 | 0 |
| Parting ... ... ... ... ... ... ... ... | 0 | 3 |

| | | ft. | in. |
|---|---|---|---|
| 38.—Dark grey Rock, with black gran. veins Calcite | ... ... | 4 | 6 |
| 39.—Coarse grained reddish cream-coloured Oolite, varying in granulation | ... ... ... ... ... ... ... | 5 | 0 |
| 40.—Bluish Rock, no shells ... | ... ... ... ... ... | 3 | 6 |
| 41.—Coarse grained yellow O. | ... ... ... ... ... | 2 | 0 |
| 42.—Fine grained yellow O. ... | ... ... ... ... ... | 7 | 0 |
| | | 177 | 6 |

The fossils obtained in the first 15 ft. from the bottom of the shaft—45 ft. to 62 ft.—are chiefly *Myacites recurva* and *Modiola bipartita*; the rest, which undoubtedly are of the Forest Marble and Great Oolite, are still to be worked out. The horizon, which is not yet satisfactorily identified, is that of the Cornbrash. It may be necessary to break up the whole cores in that part of the section to define its exact position.

There appears to be no further room for doubt that the retentive clays of the valley floor are those of the Kellaway's Rock and Oxford Clay, and that a down-throw fault of not less than 100 ft. in vertical extent exists along probably both sides of the valley. In the future the local Geologist will look with eager interest for any opportunities that may arise for corroborating the data here recorded, and for observing the extent of the area affected by this fault.

### Light Thrown on Forest Marble.

Besides what I will venture to call this slight addition to our knowledge of the stratigraphy of the South-Eastern Cotteswolds, and its bearing on our water supplies, the section furnishes us for the first time in this district with a complete view of the Forest Marble Beds, on which a few considerations seem worthy of note.

The many writers on the Geology of the Cotteswolds have generally travelled no further South-Eastwards than the edge of the Great Oolite.

The writings of Murchison, Wright, Buckman, Hull, Lucy, and Wethered on the Inferior Oolite, and Lycett and Witchell on the Great Oolite, are familiar to the Cotteswold Club.

Buckman, in 1858, remarks that the Jurassic Rocks up to the Great Oolite inclusive may be considered as having had no small share of attention bestowed on them by different observers. But the Forest Marble has met with too scant a treatment at our hands. The paper of Buckman to which I have frequently referred, and a short allusion by Witchell in a paper in our Transactions (Vol. VIII., p. 265), are almost all the authentic observations on the subject. Buckman makes the Great Oolite and Stonesfield Slate 110 ft. in thickness, proved by well sinking in the neighbourhood of Cirencester. But of the Forest Marble he gives no section of more than 16 ft., except at Kemble Junction, where he makes it 39 ft. Hull, in his Geology of Cheltenham, gives 45 ft. I had long ago come to the conclusion that 60 ft. to 70 ft. more nearly represented the local development of this horizon, if it could be seen in its entirety. This section gives such a view, and bears out the conclusion. It further affords an opportunity for studying, with thoroughness, the junction beds of the Great Oolite and Forest Marble at this spot. The actual source of the top water supply, as well as the deeper storage remains a problem still to be worked out; but its solution is simplified by the facts furnished by this important boring.

There are still many aspects that have not been touched upon wherein the local Geologist may find this fortunate boring fertile in suggesting new directions for investigation, or throwing new light on uncompleted researches.

*Abury and its Literature, by the* Rev. William Bazeley, M.A. *Read March* 24, 1891.

In accordance with the wish of our President, I have endeavoured in the following paper in the first place to describe Abury as it appeared to the members of the Cotteswold Field Club who visited it last summer; and secondly to epitomize the opinions of some eminent writers with regard to the purposes for which this and similar ancient monuments were erected.

A level space of about 28 acres is enclosed by a ditch 28 ft. deep [Mr Long says 33 ft. deep*] and 9 ft. wide at the bottom. Outside the ditch is a mound or rampart raised from 25 ft. to 35 ft. above the level of the surrounding fields. At Stonehenge the mound is inside and the ditch outside. The mound or rampart does not abut on the ditch; a belt of the original surface of the ground, in some places 12 ft. wide, has been left between the ditch and the foot of the mound, thus forming a kind of terrace half-way up the incline.

The area enclosed by the ditch is not quite circular, being 1,170 ft. wide from N.W. to S.E., and 1,260 ft. wide from N.E. to S.W.

Scattered in all directions on Abury Field and the Marlborough Downs are countless Sarsen stones, unhewn and of varied size and form.† These stones were formerly known as "The Grey Wethers," from their likeness to sheep in the dusk of evening. Those which remain in Abury Field are but a scanty relic of the menhirs which were seen by John Aubrey 250 years

* *Abury.* By W. Long, Esq., M.A., *The Wiltshire Archæological and Natural History Magazine*, Vol. IV., p. 327.

† For the origin of these stones, and their name, see *History of the Sarsens.* By Prof. T. Rupert Jones, F.R.S., *Wiltshire Archæological and Natural History Magazine*, Vol. XXIII., p. 122.

ago; for fire and water, the crowbar and the spade, have never ceased destroying, removing, or concealing them.

Within the area surrounded by the ditch may be seen at the present time twenty-nine Sarsen stones, seventeen upright and twelve recumbent; but many of these are little more than stumps. It was thought a few years ago that these were all that remained of three, or, I may say, five circles. But this is fortunately not the case; for although many Sarsens have been broken up and removed [the church and the houses of the village, to say nothing of the walls and highways, are constructed of menhirs] eighteen more Sarsen stones have been lately discovered lying several feet below the surface. And in addition to these, the able explorers of Abury—the Rev. A. C. Smith and the Rev. W. C. Lukis—have found pits containing fragments of destroyed Sarsen stones to the number of thirty-three.* Thus the positions of eighty stones are now known. These recent discoveries all tend to confirm the surmise of Dr Stukeley, of whom I shall say more directly, that there was an outer circle of stones, one hundred in number, erected at an average distance of from 27 ft. to 30 ft. from the inner edge of the ditch, and that within this outer circle there were two smaller groups: the group to the North consisting of an outer circle of thirty, an inner circle of twelve, and within this inner circle three stones, forming an obtuse-angled triangle, and standing upon an arc of a circle; the group to the South consisting of two similar concentric circles, composed of thirty and twelve stones respectively, with a menhir in the centre.

Mr Lukis has discovered the fact that these inner groups were of unequal size, the Northern measuring 270 ft. and the Southern 320 ft. in diameter.†

Two roads, one running S.W. to Beckhampton, and the other running S.E. to Kennet, now cross one another within

* *A Hundred Square Miles round Abury.* By Rev. A. C. Smith, M.A., pp. 137-148.

† See Report of Rev. W. C. Lukis, F.R.A., on the Prehistoric Monuments of Stonehenge and Avebury: *Proceedings of the Society of Antiquaries*, Vol. IX., pp. 141-157 and pp. 344-346.

the enclosed area, and the visitor's view of the remaining Sarsens is obstructed by the houses and gardens of the village of Abury.

On the West side of the road leading from Abury to West Kennet are a dozen upright or fallen menhirs, and there are others beyond West Kennet, between the main road from Bath to London, and the brook Kennet. These are believed to be the relics of one hundred Sarsens which formed an avenue extending from Abury S.E. to West Kennet, and from thence in a more Easterly direction to a circle on Overton Hill, close to the spot where an ancient trackway, running due South, meets the Bath and London road.

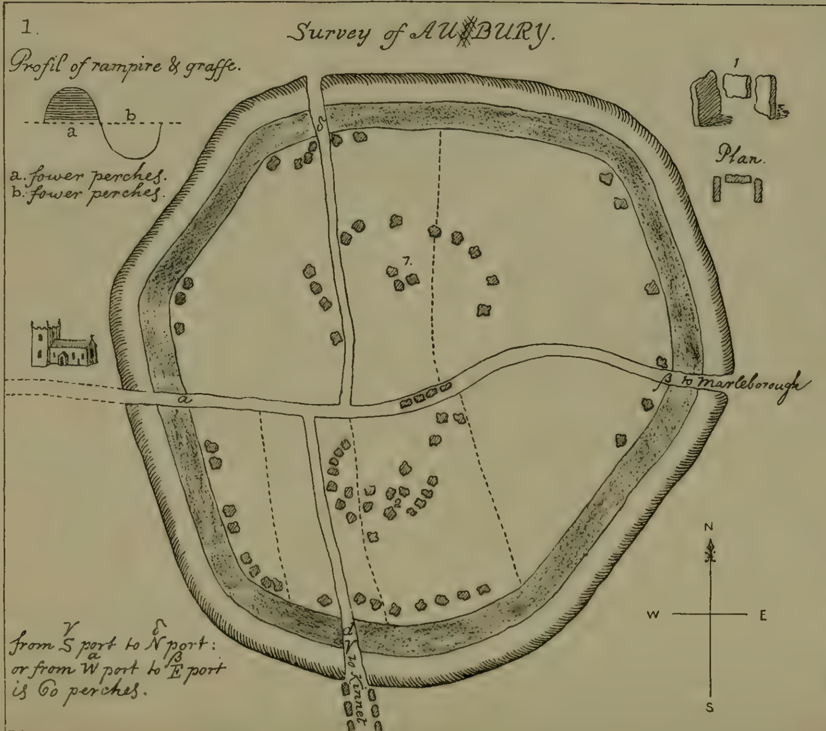
Stukeley believed that another avenue ran along the North side of the road which leads from Abury to Beckhampton and terminated in a menhir. Only four stones of this supposed avenue remain, and Ferguson, Lukis, and others have been very sceptical as to its existence. Nearly one mile to the South of Abury, and midway between the supposed extremities of the two avenues, rises up Silbury Hill, the largest artificial mound in Europe, and equal in cubic dimensions to the second Egyptian Pyramid. Three miles and a half South of Abury, Wansdyke passes from East to West, following the bends of the hills, and joining a Roman road on Calstone Hill.

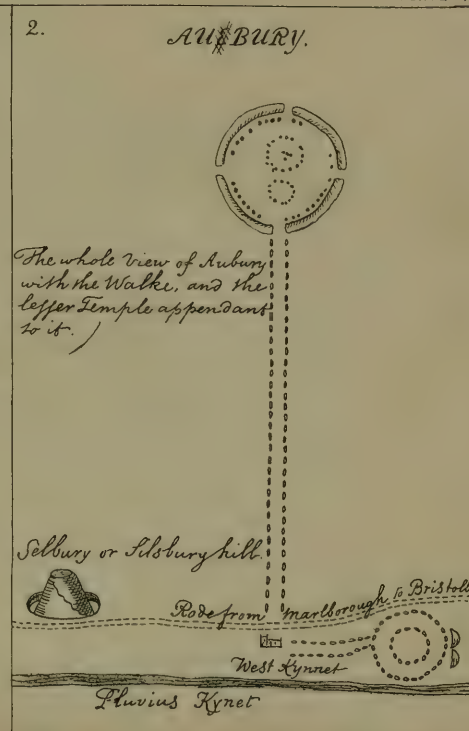
Such is Abury at the present time. The questions which at once suggest themselves to the mind of the inquiring visitor are:—What was it in the past? What was the object of its builders? For what purposes was it used by our forefathers? Was it a fortress, a temple, a place of popular assembly, a burial place, or a memorial of some great victory?

In Leland's *Itinerary*, written about 1542, he says:—"Kenet risithe N.N.W. at Selberi Hille Botom, where by hathe be Camps and Sepultures of Men of Warre, as at Aibyri a mile of, and in dyvers Placis of the Playne."*

I think we may at once dismiss the notion of a camp, although Leland, 350 years ago, probably heard such a tradition. A fortress would have had its ramparts inside its ditch.

* Leland's *Itinerary*, Vol. VII., fol. 66 b.

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PLAN OF ABURY, ABOUT A.D. 1663; FROM A RUDE SKETCH BY JOHN AUBREY.

Drayton makes no allusion to Abury or Silbury in his *Poly-olbion,* and Camden does not seem to have been aware of their existence; but Dr Philemon Holland, the first translator of Camden's *Britannia,* in 1637, says:—"Within one mile of Silbury is Abury, an uplandish village, built in an old camp, as it seemeth, but of no large compass. It is environed with a fair trench, and hath four gates, in two of which stand huge stones as jambs, but so rude that they seem rather natural than artificial, of which there are some others in the said village."*

In January, 1648-9, John Aubrey, the celebrated Wiltshire Antiquary, happened to be staying at Marlborough with Mr Charles Seymour, and to be hunting with him in the country of the Grey Wethers. In 1663, King Charles II., who had heard John Aubrey's account of Abury, and his statement that "it doth as much exceed Stonehenge as a Cathedral does a Church," paid a visit to the place on his way to Bath, and commanded Aubrey to write a description of it.

Aubrey made some rough sketches of what he saw. These sketches are reproduced in Mr Long's exhaustive paper on Abury in the 4th volume of the *Wiltshire Archæological and Natural History Magazine.* [See Plate I.] It will be seen that he gives thirty-one stones of the outer circle, and forty-one of the two inner groups or concentric circles. The three menhirs, forming what Dr Stukeley calls the Cove of the Northern group, and the single one, which he calls the Obelisk or Ambre of the Southern group, were then standing. Aubrey also gives an account of the stone circle on Overton Hill, and of the avenue, or "Solemne Walk," which connected it with Abury. He suggests that Abury was a corruption of Oldbury—the old borough; and expresses his belief that this antiquity was an Arch Temple of the Druids.†

* *Wiltshire Archæological and Natural History Magazine,* Vol. IV., p. 310.

† *The Topographical Collections of John Aubrey:* Edited by Rev. J. E. Jackson, for the Wiltshire Archæological and Natural History Society, 1862, pp. 314-330.

Pepys relates in his diary that he passed through Abury in 1668, and was told by "a countryman of that town" that Silbury derived its name from one King Seall, who was buried there. He also noticed the circle on Overton Hill.*

Mr Thomas Twinning, in 1723, published a work entitled "Avebury, in Wiltshire, the remains of a Roman work erected by Vespasian and Julius Agricola during their several commands in Brittany." He believed Abury, with its avenues, and Silbury to form a temple to Terminus. From its form of a wedge he called it Cunetium. Twinning gives a plan of this temple, which has afforded much amusement to Antiquaries on account of its evident inaccuracy and absurdity.† The Roman *Cunetio*, moreover, stood between Mildenhall and Savernake Forest, seven miles East of Abury.

It remained for Dr Stukeley, in 1743, to give to the world a plan upon which, as he believed, the Temple of Abury was constructed. He frequented the place for years and took careful measurements of every detail. The whole figure he believed represented a serpent—the enclosed space at Abury being the body, the Kennet avenue the neck, the Overton circle the head, and the supposed Beckhampton avenue the tail. [See Plate II.]

He believed that the three large stones within the Northern group formed the Adytum or Cove of the Temple, and that the victim to be offered up in sacrifice was fastened to the holed menhir which formed the centre of the Southern group.‡

A survey of Abury was made by Mr Crocker for Sir Richard Hoare, in 1812, and appears in his "Ancient Wiltshire." At that time the three stones of the Northern group and the single one of the Southern group were still standing.||

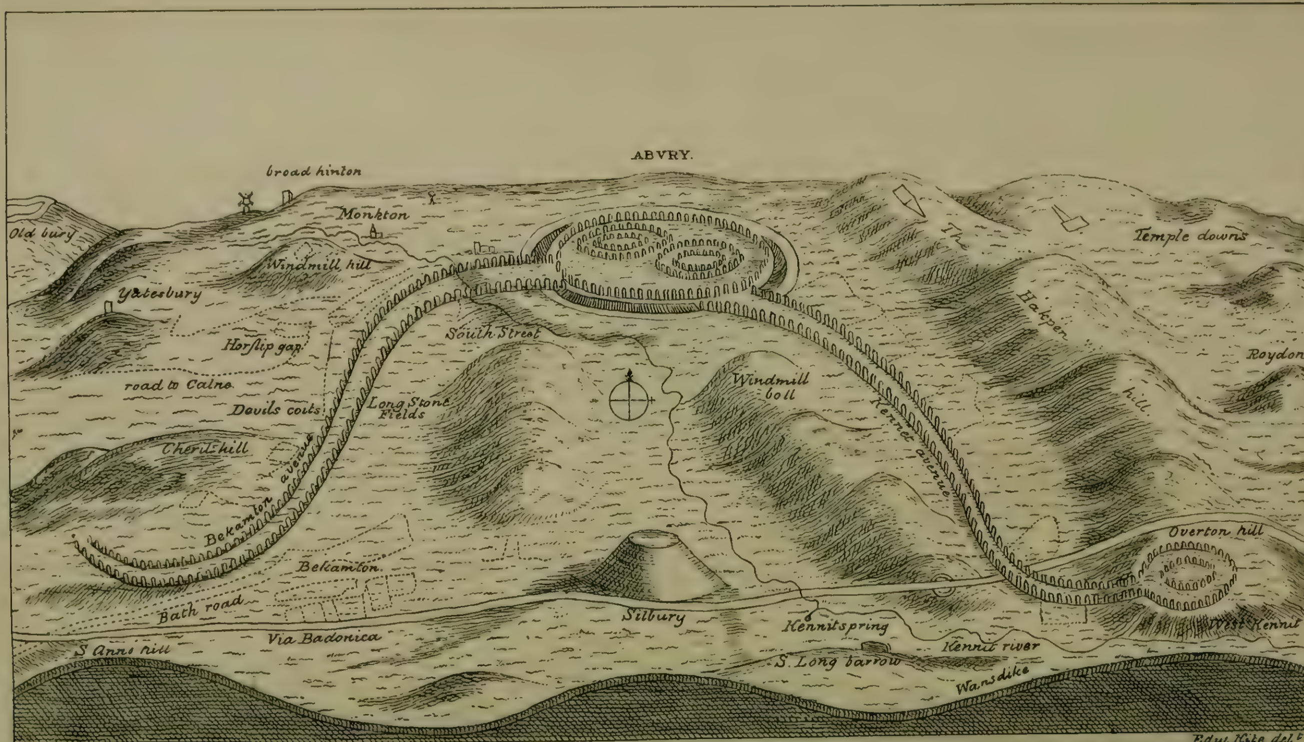
Mr Long published his account of Abury in 1858. I gather from it that he accepts Dr Stukeley's theory of a Temple in

* *Memoir of Samuel Pepys, Esq., M.D.* Chandos Ed., pp. 520-1.

† *Wiltshire Archæological and Natural History Magazine,* Vol. IV., pp. 319-321.

‡ *Wiltshire Archæological and Natural History Magazine,* Vol. IV., pp. 322 et seq.

|| *Id.*, pp. 324-326. [For a Restoration of Abury see Plate III.]

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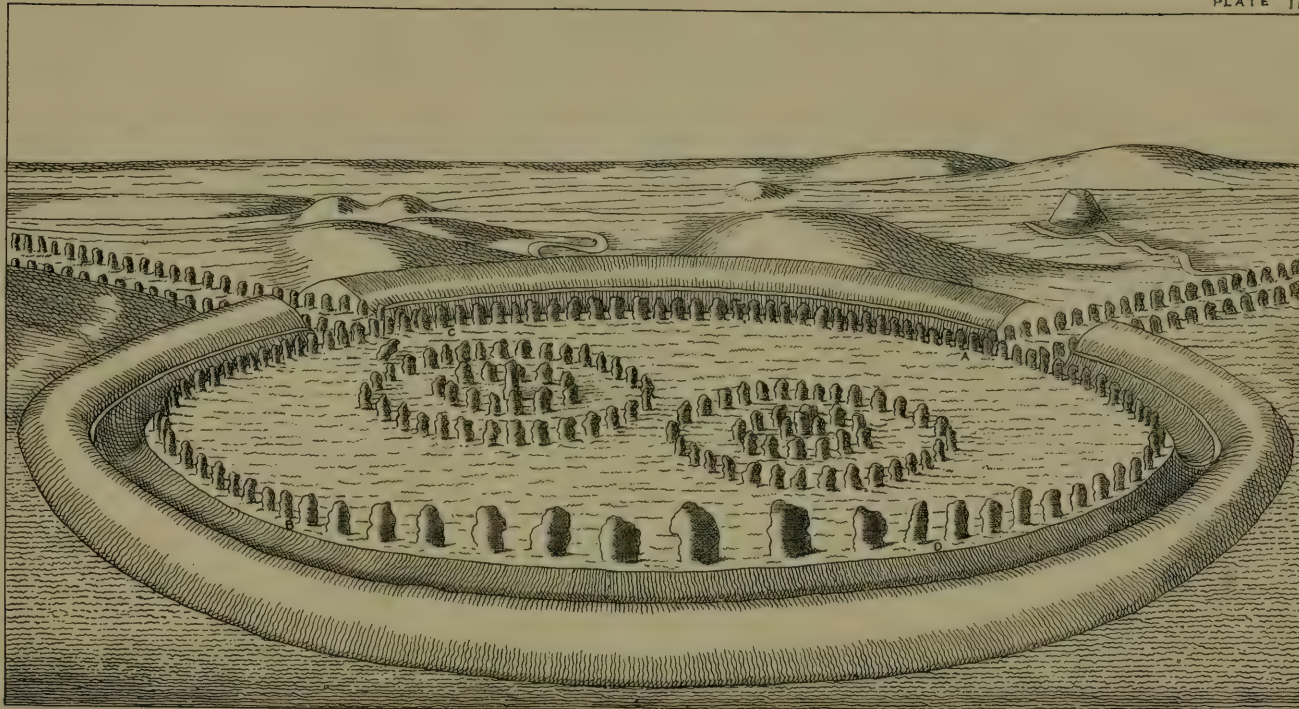
ABURY, IN ITS ORIGINAL STATE, AS SUPPOSED BY STUKELEY.

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ABURY, RESTORED, AFTER STUKELEY AND HOARE _ VIEW FROM THE NORTH.

*Area within the Ditch, 28½ Acres. Circumference on ridge of Vallum, 4442 Feet. Diameter, A to B 1260 Feet; C to D 1170 Feet.*

the form of a serpent, and his supposition that the spectators stood on the terrace or sat on the mound, and beheld from thence the sacred rites performed by the priests within the great circle.

In 1872 Ferguson published his well-known work entitled "Rude Stone Monuments," in the third chapter of which he treats of "Avebury and Stonehenge." This author favours the opinions of those who have considered Abury to be a burial place, and quotes a charter of King Athelstan, dated 939, in which the boundaries are given of the manor of Overton—"Then by Collas barrow, as far as the broad road to Hackpen, thence Northward up along the Stone Row, thence to the burying places."* There is no doubt that the "Stone Row" refers to the Kennet avenue, and "the burying places" to the great enclosure of Abury. We may certainly gather from this passage that A.D. 939, as in Leland's time, 600 years later, Abury was traditionally a burial place.

Ferguson also quotes, in favour of this opinion, a statement of Dr Stukeley's, that when the vallum or rampart near the Church was levelled by Lord Stowell at the beginning of last century large quantities of bones were found. Dr Stukeley, however, adds: "They were the remains of sacrifices." Another fact is in favour of Ferguson's opinion: outside the concentric circles on Overton Hill were discovered, in 1678, a vast number of skeletons lying close together, skull touching skull, with their feet towards the so-called Temple. Dr Toope, of Marlborough, who records this discovery, says: "I really believe the whole plaine on that even ground is full of dead bodies."

But, in opposition to Ferguson's theory, when the enclosed area of Abury was carefully excavated by the Rev. A. C. Smith and the Rev. W. C. Lukis, in 1881, not a human bone was discovered.

Ferguson ridicules the idea of Abury being a Temple, as it is, he says, utterly unlike any known Temple in the whole

* Codex Ae. Sax., v., pp. 238, No. 1120.

world. He rejects also the theory of a place of popular assembly. The population on these downs, he says, could never have been greater, or so great, as that which now exists; how unlikely then that a Temple or a Meeting-place would be constructed, capable of holding 250,000 within the enclosure, and half a million standing or sitting on the mound.

Ferguson believes Abury to be the burial place of those who fell in a great battle. He says that it is just such a monument as a victorious army of 10,000 men, with the assistance of their prisoners, could erect in a week with a few rollers and ropes. He suggests what battle it was, *i.e.*, the last and greatest battle fought by King Arthur against the Saxons at Badon Hill, A.D. 520.*

The Rev. W. C. Lukis, the well-known writer on the megalithic remains of the Channel Islands, Brittany and Cornwall, in a paper read before the Society of Antiquaries in 1882, rejects the serpent theories of Stukeley, but refrains from bringing forward any of his own.

The Rev. A. C. Smith, the author of *A Guide to the British and Roman Antiquities of the North Wiltshire Downs in a Hundred Square Miles round Abury*, published in 1885, quotes the opinions of these writers to whom I have referred, and declares that he is not shaken by anything hitherto adduced against the theory that Abury was a Temple of the Ancient Britons. Then he proceeds to give a very careful account of the researches and discoveries made by the Rev. W. C. Lukis and himself, in 1881.

The latest contribution that I have seen to the Archæology of Abury is a Public Lecture, given in the Ashmolean Museum, Oxford, on December 6th, 1888, by Mr A. J. Evans, and printed in the *Archæological Review*, Vol. II., pp. 312-330. Mr Evans is of opinion that Abury and similar megalithic circles are closely connected, directly or indirectly, with the burial of the dead and the religious rites which followed. He believes that each of the two concentric circles at Abury had central cists, which

* *Rude Stone Monuments.* By James Ferguson, B.C.L., 1872, Chap. iii.

were used for interments. This opinion of Mr Evans is supported by the fact that Mr Pratt, whose garden at Abury now occupies the site of the Southern circle, found in 1880, near the centre of the circle, an urn full of bones.*

Mr Evans believes that the stone circle surrounding a central dolmen or stone cist which once contained the remains of the dead, such as may be found in every part of the world, had its origin in the subterranean dwellings of man during the epochs of the Cave Bear and the Reindeer. In the Lapp Gamme such dwellings are still in use, with ring stones propping up the turf-covered mounds, and low entrance galleries leading to the chamber within.†

The Native Australians are constructing sepulchral monuments at the present day of a similar type.

Mr Evans suggests that the ring of stones, placed round the grave mound, became a stone circle; and the subterranean cist an exposed dolmen. The avenue is a lineal descendant of the underground gallery which led to the sepulchral chamber.

It has been often noticed that our stone circles have an opening to the East or North-East. This orientation, as time went on, may have become connected with the worship of the sun; but we find its origin in the Laplander's house. In the far North, where during a great part of the year the hours of daylight are very few, and therefore very precious, it is a common custom to construct the openings toward the East, so that the inmates of the subterranean dwellings may be awakened by the first rays of the rising sun.

But if the megalithic circles were originally sepulchral, and such is the universal tradition, they may also have been in some sense Temples, not for serpent worship, but for the cult of the dead. An incense cup was found at Stonehenge, near

* *A Hundred Square Miles round Abury.* By the Rev. A. C. Smith, p. 142.

† Compare the ground-plans of subterranean dwellings extant at Chapel Euny, in the parish of Sancreed ; at Chysoister, in the parish of Gulval ; and at Bosporthenis, in the parish of Zennor, in Cornwall. *Prehistoric Stone Monuments of the British Isles, Cornwall,* plates xxxv.-xxxix.

one of the triliths, and from a barrow at Abury came a beautiful specimen of what is known as the Nodulated or Grape Incense Cup.*

On removing part of the rampart at Abury a vast quantity of bones of domestic animals was found which appeared to have been offered up in sacrifice.†

These discoveries are evidence in favour of Mr Evans' theory.

Mr Evans, following in the footsteps of Mr Petrie, whose notes on Stonehenge I have not seen, is of opinion that the large stone circles were constructed gradually, and at intervals of time.

The Khasis of North-East Bengal, whose stone circles have been described by Dr Hooker and Major Godwin-Austen, build their monuments piecemeal, raising a batch of stones now and again to appease the spirits of the dead, just, I suppose, as pilgrims throng to the shrine of some popular saint in Italy or France, and hang up around her image their votive offerings, when her special aid is needed, or some new wonder has been wrought by her intercession.

Aristotle tells us that the Iberians set up pointed stones around the grave of a departed hero, each stone representing an enemy that he had slain. We find a similar tradition at Carnac, in Brittany. The avenues of grey stones stretching away towards the sea are, in the minds of the Bretons, a flying host of pagans whom St. Cornelly has thus transformed.

Mr Evans returns to the old explanation of Sarsen, and connects it with Saracen, *i.e.*, Pagan. The name of the Breton dolmen, known as *Four du Sarasin*, shows that the word is not peculiar to our country. At Ashdown, on Salisbury Plain, amongst the Derbyshire hills—wherever we find these rude monuments—traditions are lingering amongst the inhabitants of pagan armies turned to stone.

Of course, as time rolls on, traditions change, and accommodate themselves to new phases of social and religious usages.

* See Drawing and Description in the Rev. A. C. Smith's *Abury*, p. 145

† Page 197.

The Paynim of the Carloman age, and the pagans who fought with Alfred at Ashdown, took the place of foes who had long been forgotten.

I may mention that there is a tradition connected with the stone circle at Bolleit, in Cornwall, which cannot be more than three hundred years old in its present form. The nineteen stones which once surrounded a sepulchral cromlech or dolmen are nineteen maidens who were turned to stone for dancing on the Lord's Day; and two menhirs, the relics, it may be, of an avenue, are the pipers who played the inviting tune. The same tradition is attached to the circles of Boscawen-Un, Tregaseal, and Wendron. But now and then the older story crops up; and the unshapen granite pillars are the foes with whom Good King Arthur contended, or giants who lived and fought in Britain before the coming of Brutus and his Trojan crew.

Mr Evans winds up his very able lecture with the suggestion that the central object of worship within these megalithic circles was an oak tree. He gives examples in Greco-Roman art of triliths like those at Stonehenge, or rude unshapen stones, such as we have at Abury, standing in front of a sacred tree. At Rome Jupiter Feretrius was worshipped on the Capitol as a lofty oak; before it stood an altar, and around the tree and the altar was the sacred enclosure. The special sanctity of the oak amongst Celtic races, and hence the origin of the name "Druid" for a Celtic priest, is often referred to by ancient classical writers. Maximus Tyrius (Disc. 38) says:—Κελτοι σέβουσι μὲν Δὶα, ἄγαλμα δε Διος κελτικόν ὑψηλὴ δρῦς. The Celts worship Zeus, and the Celtic form of Zeus is a tall oak.

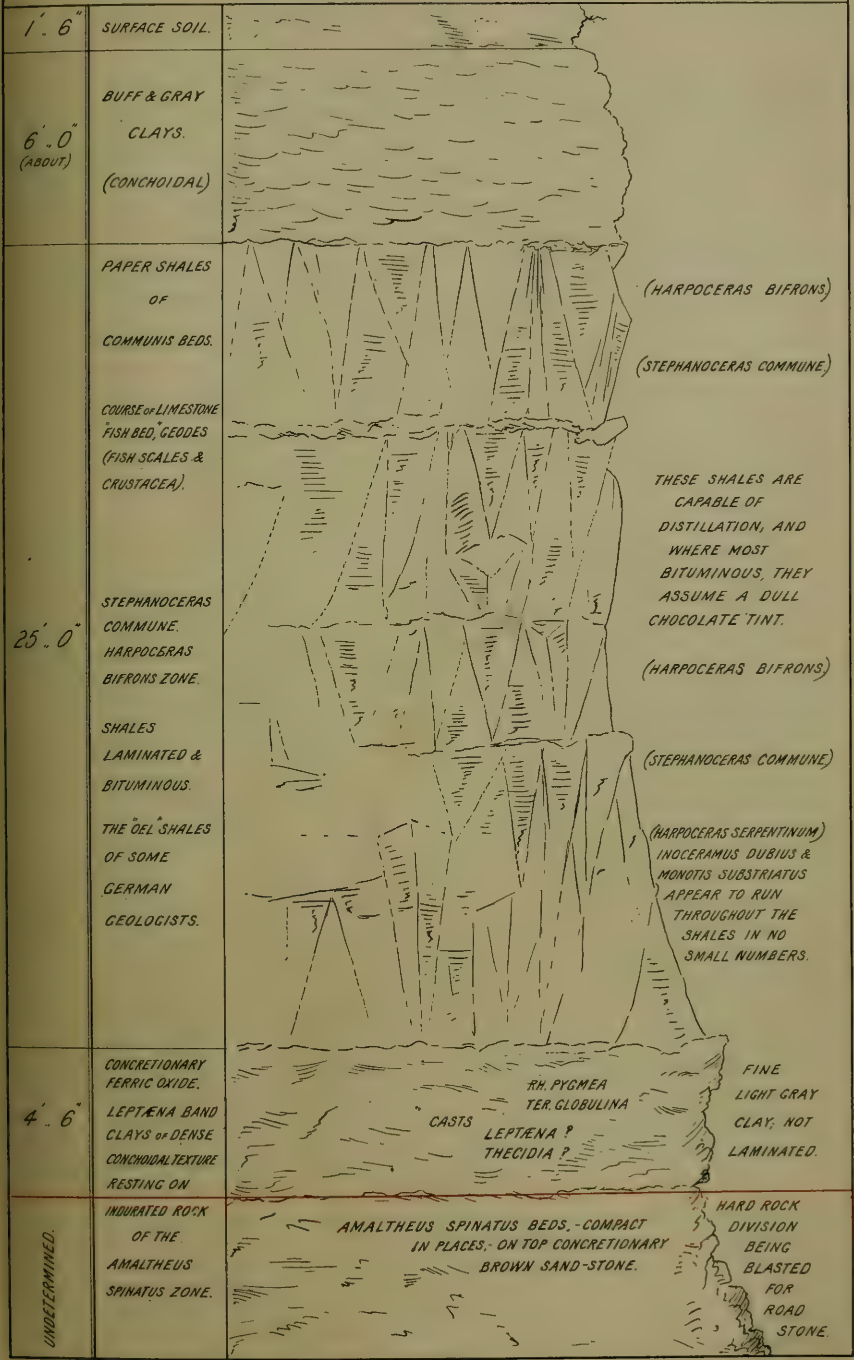
As in religion, as in dress, so in Archæology it would seem that every new phase is to some extent a return to what has gone before. The challenge of Ferguson is at last accepted. The conceits of Borlase and Stukeley are not altogether so mythical as we have lately been taught to consider them. Until another and more brilliant theory develops itself, we may cling to our Druids, and our Mistletoe, and, as before, let the weird Sarsens and Granite boulders conjure up the shades of heroes who fought and died before our English forefathers had left the primeval forests of central Germany.

*Some Remarks on the Geology of Alderton, Gretton, and Ashton-under-Hill, by* FREDERICK SMITHE, F.G.S., &c., *and* W. C. LUCY, F.G.S.

In the summer of 1879 the Lias quarries of Alderton and of Gretton were examined by the Geologists of the Cotteswold Club, and afforded instructive sections; and some time after a visit was made to the exposure of Lias rock at Ashton-under-Hill. All these quarries were then being worked, and the notes, sections, and observations made by the authors on the spot, have helped to contribute to this report of the geology of at least Alderton, less so of Gretton, and least of Ashton-under-Hill, the varying proportion of time given to each place being mainly due to circumstances, such as untoward weather. The excursion made to Alderton was immediately after a heavy fall of rain the previous night, the water well nigh filling the quarry to the brim, and cutting off, to some extent, access to the uppermost strata of the shales of the Upper Lias, and of the junction line underlying them, which was a point of special moment. Against this drawback, two advantages were scored in favour of the working Geologists—one was, that close by the quarries stood some large and inviting stacks of the Marlstone of the Spinatus beds, rich in fossils, as well as a goodly spoil bank of the overlying seams of Upper Lias shale, which the quarrymen had removed to enable them to get at the solid Middle Lias rock. Besides this gain, it was no small advantage to observe the manner in which the water was percolating through some 20 ft. to 30 ft. of the Paper shales, working through the joints of the rock, and over the cleavage planes, so that the beds were dripping and streaming in every direction, the whole forming an imposing and instructive sight, which we shall have occasion again to refer to. Notes have been made on the spot, and have since been put together, and that jointly, as it has been suggested that they may be of service to those who have not had

## ALDERTON HILL SECTION.

QUARRY FOR ROAD METAL

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the opportunity of working the upper portion of our Lias. It is a consideration of some weight that many quarries—formerly worked for fairly useful stone, whether for road metal, or for building—are now abandoned, especially in our own neighbourhood, having been superseded by stone brought from a distance; so that Lias Marlstone has been re-placed, successively, by Carboniferous Limestone, and this last material has been set aside for the Clee Hill basalt for road making. We may learn from these facts that where instructive sections of our Jurassic rocks can be obtained and studied by the geologist, they should be duly recorded and appreciated, and, however slight and unpretending, be found, if useful, a place in the "Proceedings."

## 1.—ALDERTON

The position or orientation of the hill is peculiar from the fault which traverses it between the quarry in question and the Alderton Woods. Its course is N.W. to S.E., running parallel to the heavy faulting of the Southern range of the Cotteswolds below Guiting, and with a small throw, and these faults are repeated, always preserving the same parallel direction Southwards to the important heavy fault through Cranham to Brimpsfield and Renwick, leaving its mark upon the oolitic quarries at Cooper's Hill, and powerfully shattering them. Much rolled and broken oolite is met with South of Bredon Hill, and the oolitic capping beds of Alderton Hill, like those of Chosen Hill, have been sheared off. At the village of Alderton is a pit with about a foot of oolite gravel resting upon 8 ft. of quartzose sand, and both extend to Little Washbourn and Beckford, resembling the skeins and seams to the N.W. of the hill of Churchdown. Broadly speaking, Alderton has about 30 ft. of the Upper Lias clay reposing upon the uppermost beds of Middle Lias, known as the Spinatus beds. The break between these divisions is evidenced by palæontological as well as lithological proofs. These will be again referred to. Through the lowermost clay beds, Commune Zone of the Upper Lias, conchoidal in texture, and contiguous to the Spinatus rock, runs a course of concretions termed the Fish bed or Insect bed of P. B. Brodie, F.G.S. This course of geodes is persistent, equally occurring at Churchdown, and with the same contents: broken bits of shells and of crustacea, containing also fish remains and insects in some places, though none of the latter were met with at Alderton.

## LITHOLOGY

The so-called "Paper Shales," forming the capping of Alderton Hill, are of a dark puce colour, nearly black; their origin is clearly from the "smatches" of the coal measures up country from the Clee Hills and Forest of Wyre district. They are more or less bituminous, as well as carbonaceous, and uniformity and regularity of the thin films would denote a quietly deposited sediment, free from disturbing currents. It has been noticed by Sorby that fine grained mud obtained from a depth of 2,600 fathoms in the South Pacific, possesses the following remarkable property, which throws light upon the formation of the concretions known as the Fish bed, or by Brodie as the Insect bed. The grains of sand do not separate from the finer mud and subside, but gather the finer particles about them into a compound granule, and this process rapidly clears the water. It has been determined by experiment that the solid matter in such muds only amount to eleven per cent., while in shales the solid matter is at least seventy-five per cent., so that when pressure squeezes the water out of these clays they may be reduced to one-sixth of their original thickness; and this change would tend to develop in the bedding planes exactly such a fissile structure as we witness in the "Paper shales" of Alderton Hill. These shales are traversed by joints, which are not quite vertical in direction, but which cross each other at a small angle. The cause is due to the direction of the mechanical stresses, and the result is clearly seen in the section of the blocks of clay, the blocks forming neither cubes, nor parallelograms, but from the oblique direction of the stresses the result is, that the forms produced by their intersections give us rhombs or rhomboidal figures; and these, together with the jointings as apart from cleavages, also common to the Marlstones below, powerfully contribute to shoot off and discharge the waters of the rainfall. It is from the circumstance that these corresponding beds of the Upper Lias at Churchdown or Chosen Hill are of such a slight thickness, together with the limited area of the catchment forming the upper strata, that the water supply of Churchdown is so often deficient, and occasionally on the S.E. side of the hill and around it the ground is at times really parched up.

The section of the Upper Lias clays indicate on the top 6 ft. of Buff and Gray clays, and at the base, lying on the upper rocks of the Spinatus Zones, 4 ft. 6 in. of Leptæna clays. In both instances the fracture is conchoidal, a fact attributed to impressed force from above acting upon the mass of clay when it contained next to no moisture, approaching to a rigid condition of the substance. In any case, the conchoidal fracture would imply a changed set of conditions, tantamount to such a break inferred from palæontological proof, which latter would signify lapse of time.

## PALÆONTOLOGY

The following tables of the fossils of the Alderton section, although procured in the face of difficulties, are fairly representative. Of the leading genera some few only of the five ammonites that now assert themselves for the first time are here entered. Access to the faces of the shales having barred our work upon the "Paper shales."

(SEE OVER)

# ALDERTON HILL, GLOUCESTERSHIRE

## TABLE I.—FOSSILS OF THE UPPER LIAS

(THE COMMUNE AND SERPENTINUM ZONES)

### PISCES.

Dapedius, scales

### MOLLUSCA.

CEPHALOPODA.

*Ammonoidea.*

| | |
|---|---|
| Stephanoceras commune | (Sow) |
| Harpoceras serpentinum | (Sow) |
| 〃 annulatum | (Sow) |
| 〃 bifrons | (Brug) |
| 〃 lythense | (Y. & B.) |
| 〃 radians | (Rein) |
| Aptychus. H. lythense. | (Y. & B.) |

### BELEMNITIDÆ.

| | |
|---|---|
| B. cylindricus | (Simp) |
| 〃 paxillosus (junior) | (Schloth) |

### BRACHIOPODA.

| | |
|---|---|
| Ter. globulina | (Davids) |
| Rhyn. pygmea | (Moore) |
| Thecidea. | |
| Leptænæ | (Casts) |

### GASTROPODA.

| | |
|---|---|
| Euomphalus minutus | (Schübler) |

### PELECYPODA.

| | |
|---|---|
| Inoceramus dubius | (Sow) |
| Plicatula spinosa | (Sow) |
| Harpax calvus | (Desl) |
| Lima toarcensis | (Desl) |
| Limea acuticosta | (Goldf) |
| Cardinia lævis | (Y. & B.) |
| Leda ovum | (Sow) |
| 〃 galathea | (d'Orb) |
| 〃 minor | (Simps) |
| 〃 subovalis | (Goldf) |
| Monotis substriatus | (Münst) |

### MISCELLANEA.

Crushed members of small crustacea, and hooklets of the arms of cephalopods, found in the geodes, with bits of shell. These fragments were the rejected food of fish of predaceous habit.

# ALDERTON HILL, GLOUCESTERSHIRE

## TABLE II.—FOSSILS OF THE MIDDLE LIAS .

(THE SPINATUS AND MARGARITATUS ZONES)

### REPTILIA.

Fractured rib of Saurian.

### CRINOIDEA.

| | |
|---|---|
| Extracrinus subangularis | (Miller) |

### MOLLUSCA.

#### CEPHALOPODA.

*Ammonoidea.*

| | |
|---|---|
| Amaltheus spinatus | (Brug) |
| Philoceras Zetes | (d'Orb) |
| Harpoceras aalense | (Ziet) |
| Amaltheus margaritatus | (Mont) |
| 〃 Engelhardti | (d'Orb) |

### BELEMNITIDÆ.

| | |
|---|---|
| B. paxillosus | (Schloth) |
| 〃 breviformis | (Voltz) |

### GASTROPODA.

| | |
|---|---|
| Pleurotomaria amalthei | (Quenst) |
| Pitonellus sordidus | (d'Orb) |
| Turbo cyclostoma | (Ziet) |

### BRACHIOPODA.

| | |
|---|---|
| Ter punctata | (Sow) |
| 〃 Edwardsi | (Davids) |
| Waldheimia Mariæ | (d'Orb) |
| 〃 cornuta | (Sow) |
| Rhynch. acuta | (Sow) |
| 〃 tetrahedra | (Sow) |

### PELECYPODA.

| | |
|---|---|
| Ostrea cymbium | (Lmk) |
| 〃 submargaritacea | (Brauns) |
| Avicula inæquivalvis | (Sow) |
| 〃 species | |
| Modiola subcancellata | (Brug) |
| 〃 scalprum | (Tqm) |
| Pecten æquivalvis | (Sow) |
| 〃 priscus | (Schloth) |
| 〃 substriatus | (Röm) |
| 〃 lunaris | (Röm) |
| 〃 acuticostatus | (Goldf) |
| 〃 species | |
| Unicardium globosum | (Moore) |
| Lima gigantea | (Phillips) |
| Hinnites tumidus | (Ziet) |
| Myaconcha decorata | (Goldfuss) |
| Modiola numismalis | (Oppel) |
| Saxicava spec. | |
| Gresslya ovata | (Röm) |
| 〃 intermedia | (Simp) |
| 〃 Seebachii | (Brauns) |
| 〃 donaciformis | (Phil) |
| 〃 striata | (Brauns) |
| Pleuromya costata | (Y. & B.) |
| Arcomya arcacea | (Seebach) |
| Pinna Hartmanni | (Ziet) |
| Pholadomya ambigua | (Sow) |
| Gervillia ærosa | (Simps) |
| Protocardium truncatum | (Sow) |
| Ceromya bombax | (Quenst) |
| 〃 petricosa | (Simp) |

### MISCELLANEA.

Fucaceæ—stems, such as of Laminaria

Drift wood of exogeneous and of endogenous structure

Calamites spec.

In addition to the preceding list of fossils, a specimen of Nautilus astacoides (Young and Bird) must be included as found in the Stephanoceras commune Beds. Also, the writers have to thank many members of the Society for working with such alacrity and spirit to collect in so short a time, at one visit only to the quarry, such a rich illustration, in quantity and kind, of the life of the periods of the Middle and Upper Divisions of our liassic deposits. The palæontological evidence of the fossils points to a great flux of geological time that must have elapsed between the close of the deposition of the Amaltheus spinatus Beds, followed by erosion to an enormous extent, and then to the deposition under new conditions of the dark grey clays above those beds, derived from the coal measures as before stated under the heading of Lithology. And with the new sediments, there followed modified forms of life, as is always the case. The subject is tempting to linger on, but passing from it to touch upon the visit to Gretton, and subsequently to Ashton-under-Hill, we would call attention finally to these points:—(1) The line on the section parting the Ammonites Beds, namely, that of the Amaltheus spinatus, and that touching the base of the Stephanoceras commune Zone. This line marks clearly the great planes of erosion of the upper portion of the Middle Lias deposits. (2) Besides the physical changes that ushered in the re-appearance of an ancient brachiopod, viz., Leptæna (Dalman), which migrated from its Carboniferous home, and is so strangely met with in the Leptæna Band of the Upper Lias (first discovered in Somersetshire by a member of the Cotteswold Club, and afterwards in Gloucestershire by another member of the same Association), (3) We would not omit the considerations of physical geology, instanced in the formation of the singular course of geodes or of ovate concretions which, known as Fish Bed, or Insect Bed, is so constant in its occurrence, though not unique, for a similar course of concretions is found very constantly present in the Aegoceras Ibex Zone of our Middle Lias. One example at this moment is near the writer: it is an ovate concretion from the Ibex Zone, which contains a large and fine gastropod, Eucyclus undulatus (Phill). The geodes of the zones of the Upper Lias more often enclose light objects, frequently bits of the armature of young cephalopods, or fragments of small bivalve shells, portions of fish, or of small ammonites, which have been crushed between the palatal teeth of predacious fishes, and after due suction of the soft parts the hard fragments have been rejected. A curious instance in point, as peculiar, is from one of the lias beds in Normandy, correlating with those of our present section, namely, the Stephanoceras commune Zone. These beds contain large oblong or ovate concretions, which the peasants name "Miches," from their likeness to the cakes of their country bread. These geodes not infrequently enclose small fishes, and amongst the contents of their stomachs certain tiny ammonites are frequently met with; the species is the young of Harpoceras cecilia (Reinicke)—perhaps the young of Harpoc. serpentinum. The writer has a similar example from the concretionary course, or Fish Bed of the Stephanoceras commune Beds at Chosen Hill, but the French species of ammonite referred to were devoured by fishes, and the young ammonites are found inside them, with the last whorl or body chamber of their shell often exceptionally well preserved, which is a feature much prized by the palæontologist. Before quitting the subject, we would adduce here—but also as exceptionally abundant in the concretions at Gretton in the Upper Lias—the little Euomphalus minutus. This small gastropod literally swarms at Gretton. We take them to be the young of that species, not many days old, especially as they are crowded together in groups, and are tiny things. It is probable that the fry was deposited on the surfaces of delicate algæ, like the membranaceous fronds of the genus Ulva, a tender seaweed, which has decomposed and left the young Euomphali to vouch for its existence; because the young of all the genera of the Turbinidæ feed on algæ.

## GRETTON

There is a good exposure of the Spinatus Zone in a quarry a little distance from the Inn; here we find the Upper Lias beds of the Stephanoceras commune reduced to comparatively small dimensions, still presenting in the Fish Bed concretions the minute fossils usually found in them, and conspicuously, in great abundance, the young shells of the gastropod before mentioned, Euomphalus minutus (Sow.) In the coarse foxy Marlstone of the Amaltheus Spinatus division the contents are fairly representative, and first we cite the ammonite often found at Gretton, the Phylloceras Zetes (d'Orb.) Our specimen from the sandstone of this quarry is five inches in diameter, and is a shell that some palæontologists have confounded with the Phylloceras heterophyllum (Sowerby). We transcribe from a note made many years ago the following:—"Quenstedt (*Der Jura*, I., p. 172): A. heterophyllus. *Wen. d'Orbigny zu trauen wäre* (*Prod.* I. page 246, &c.)" Prof. Quenstedt is altogether wrong, and Alcide d'Orbigny right about A. Zêtes. I have compared true A. heterophyllus, from Whitby, with the A. Zêtes of d'Orbigny, fine specimens of which have been yielded by the Middle Lias of Gretton, near Winchcomb, and the differences between the two shells are distinct and specific:—1. In the sutures. 2. In the umbilicus. The management of the points at issue is cleared up in a succinct and masterly way in the monograph of our late friend, Dr Wright, after whom we may write *cadit questio*, so far as this subject is concerned. See pages 422 and 424 of the *Monograph of the Lias Ammonites of the British Islands*, and carefully examine the excellent plates of the respective species. Palæontographical Society, 1883.

Amongst other fossils gathered on this occasion from the Amaltheus spinatus beds we note: Phylloceras Zêtes (d'Orbigny), Amaltheus spinatus (Brug), Arcomya longa (Buvignier), Pleuromya granata (Simpson), Pecten lunaris (Roemer), Gervillia œrosa (Quenstedt), Rhynchonella tetrahedra (Sow), Pleurotomaria rotellaformis (Dunker), Gryphea cymbium, var. depressa (junior), and Myoconcha decorata (Munster); also many common characteristic forms of the spinatus beds. We must not omit the number of smaller crustacea, Ostracods, that appear in this part of the Middle Lias at Gretton, and also at Ashton-under-Hill; Cytherea and Cytherina, genera which also occur on the same horizon of the Middle Lias in Germany, at Liebenburg, and Salzgitter.

## ASHTON-UNDER-HILL

This hill, lying under Bredon Hill, has not retained any of its Upper Lias deposits. They have been completely swept away, though the quarry we visited had been lately worked, and some quantity of the Marlstone of the Spinatus Zone of the Middle Lias was stacked, and easy to examine. The inclemency of weather prevented our taking advantage of the opportunity, and we can only observe that the brown rock of the Spinatus beds contained numerous leading fossils of the upper beds of the Zone, comprising good specimens of Amaltheus spinatus, and also swarms of Ostracoda, examples of which we preserved; and it was with reluctance that we beat a retreat from Ashton-under-Hill.

VOL. X PART III

# PROCEEDINGS

OF THE

# Cotteswold Naturalists' FIELD CLUB

**For 1891—1892**

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THE COUNCIL OF THE CLUB WISH IT TO BE DISTINCTLY UNDERSTOOD THAT THE AUTHORS ALONE ARE RESPONSIBLE FOR THE FACTS AND OPINIONS CONTAINED IN THEIR RESPECTIVE PAPERS.

### Contents



PUBLISHED BY JOHN BELLOWS, GLOUCESTER S 177037

*Annual Address to the Cotteswold Naturalists' Field Club, read at Gloucester, April the 30th, 1892, by the President,*
Mr W. C. Lucy, F.G.S.

On Thursday, April 30th, 1891, the Annual Meeting took place at the Bell Hotel, Gloucester; and after passing the Hon. Treasurer's Accounts, shewing a credit balance of £57 3s. 8d., the retiring Officers of the Club were re-elected.

The Field Meetings for the year were fixed as follows:—

| | |
|---|---|
| Woolhope... ... ... ... | May 21st |
| Silchester... ... ... ... | June 23rd |
| Midland and South Western Extension Railway (Cirencester) | July 28th |
| Newland and St. Briavels ... | September 17th |

A large party of the Members afterwards dined at the Bell Hotel.

## WOOLHOPE MEETING

This Meeting was held on the 22nd of May—a day after the date fixed at the Annual Meeting.

The weather in the morning was most unfavorable, but a small party—not deterred by the elements—left the Gloucester Station for Hereford, where they were met by Mr H. C. Moore, the Hon. Secretary of the Woolhope Club, and Mr G. H. Piper, of Ledbury, who were the guides for the day.

Carriages were taken, and the first place visited was Bartestree. In a quarry of Old Red Sandstone there, is a considerable upthrust of Trap Rock "Diorite," and where it is in contact with the Old Red beds they are altered so much by heat, as to make them friable. The Trap Rock seems to have escaped the observation of the Geological Survey, as it is not marked in the map of the district.

About two miles further, Mr Moore directed attention to a remarkable land-slip which occurred in 1844, carrying forward three acres of ground—with forty oak trees upon it—a distance of 200 yards.

In Perton Lane, the cutting through the Aymestry Limestone beds of the Upper Ludlow was examined. In places the beds are nodular, and when the nodules are broken open there is generally found in the centre of each, either the fossil *Lingula Lewissi* or *Atrypa reticularis*, which forms the nucleus of the nodule.

Through the kindness of Lady Emily Foley, the members were permitted to go by her private drive to St. Ethelbert's Camp, on the summit of Backbury Hill, where, according to tradition, Ethelbert, King of the East Angles, went to "Offa the Terrible," King of Mercia, at Sutton Wells, and while there, courting Offa's daughter, he was murdered A.D. 792.

Mr Piper pointed out that the Camp was doubly entrenched on the North side, and was more oblong than circular in shape, with an area of about four acres, and the highest point was 767 feet above the sea. Standing upon what is called Adam's Rock, Mr Piper—with the aid of some beautifully executed diagrams—gave a very clear explanation of the Woolhope Dome, and referred to the works of Sir Roderick Murchison and Mr Symonds on the subject. He especially called attention to the enormous denudation which must have taken place in removing and carrying away the central dome.

So much has been written upon Woolhope in all the best text books, and it is so classical a spot in Silurian Geology, that I do not think it necessary to enter into details. I would, however, remark that the Trap Rock at Bartestree may be found to have an important bearing in determining the time when the beds were uplifted from the horizontal position in which they were deposited.

Thence through some narrow lanes to Mordiford, where Mr Piper gave the following history of the village:—

"At the Norman invasion the Manor was held by Almit—a free Saxon—by lease from Ethelstan, Bishop of

Hereford, to which See it belonged. William the First gave it to Henry de Ferrers—a Norman Baron of great wealth and position—who fought at Hastings, and was one of the seven Commissioners who had charge of the great Domesday survey in the year 1086. His son, Robert de Ferrers, for valiant services at the battle of Northallerton in 1138, when King Stephen defeated David, King of Scotland, was created Earl of Derby. In the reign of Henry the Third, Robert de Ferrers, having displayed persistent animosity to the King, his Castles and lands were forfeited and given to Prince Edward. After he had been imprisoned three years the Prince restored the Castles and Estates, on payment of £50,000, which sum was guaranteed by eleven great Barons, to whom the Earl conveyed his Estates as a security. One of these friends was Sir Bartholomew de Sudeley, of Sudeley Castle, near Winchcombe, then High Sheriff of Herefordshire; and, as money was not forthcoming for the redemption of the Estates, they eventually became fully vested in the Prince, and some still form part of the Duchy of Lancaster. Sir Bartholomew was instrumental in conveying the Manor of Mordiford to Henry de Hereford, whose descendants, bearing the same name, still own the Manor and Estates; and therefore the Herefords have been in possession of the property for more than 500 years.

"The Advowson of Mordiford Rectory was given to the Abbey of Gloucester, and to its Priory of St. Guthlac, by Henry de Hereford; and on the suppression of the religious houses was granted to John ap Rice, a member of the Royal Household. At the close of the 17th century it was purchased by Paul Foley, Esq., M.P., with whose successors at Stoke Edith the patronage has since remained."

The Rector, the Rev. Robert Hereford, met the members at the Church, and pointed out the place where the Dragon of

Mordiford was depicted, and which was obliterated when the repairs were made in 1811. Mr Piper gave a full account of the story, and those who are curious to know more should consult an article by Judge Cooke, in Duncumb's *History of Herefordshire.* The tradition of the Dragon is still believed by some of the Villagers. The Vicar said that quite recently two old women in the parish, having seen a newt, came to the conclusion that it was a seed of the Dragon, and forthwith killed it; and there is still in the Village a lane called Serpent's Lane. In the Porch of the Church is a slab recording a tremendous storm which occurred on the 27th of May, 1811, between 7 and 9 p.m., by which the little River Pentaloe was swollen in some places 180 feet in width, with a depth of 20 feet. It swept away a large barn, cider mill, and a cottage adjoining, in which were four persons, who were all drowned. Above the village, just on the road leading to Woolhope, many hundred tons of rock were torn up and carried through the Mordiford village, by which several houses of the inhabitants were much injured, and their gardens nearly destroyed.

Carriages were resumed to Hereford, where the party dined at the Green Dragon.

## SILCHESTER

On Tuesday, June 23rd, the Club made an unusually distant excursion by visiting the old Roman City of Calleva, which is situated a few miles from Reading. We were fortunate in having the guidance of Mr George Fox, F.S.A., who kindly went over the ground, and by his lucid explanation enabled us to realise how important a place this must have been during the Roman occupation of this country.

Mr Fox, in conjunction with Mr W. H. St. John Hope, M.A., has written a valuable paper entitled "Excavations on the Site of the Roman City of Silchester, Hants, in 1890," which was communicated by them to the Society of Antiquaries.

To do justice to Silchester, requires more knowledge than I possess, and I shall therefore confine myself to a few brief observations, mainly gathered from Mr Fox's paper, and a notice which appeared in the *Times* on the subject.

The situation is well chosen, being on elevated table-land, occupying about 100 acres. When Lord Jeffrey visited it many years ago, he wrote:—

> "It is the most striking thing I ever saw, and the effect of that grand stretch of shaded wall, with its antique roughness and over-hanging wood, lighted by a low, autumnal sun, and the sheep and cattle feeding on the green solitude at its foot, made a picture not soon to be forgotten."

Now much of the old city, which was covered up at the time Lord Jeffrey wrote, has been laid bare, and the plan of the principal buildings, characteristic of a Roman town, as the Forum, the Basilica, the lines of streets, and basements of the houses, can be clearly followed. The Gates are most interesting as they are the only ones of a Romano-British City which have been thoroughly investigated, and the Gate of the West shows a striking resemblance to the Stations of *Cilurnum* (Chester's) and *Ambloganna* (Birdoswald) on the Roman wall.

The great eastern gateway, being the main exit to the London road, fell back in a curve from the wall abcut 9 feet, within the thickness of which were guard rooms, and the opening measured 28 ft. 6 in., wide enough for two chariots to pass each other abreast. Outside the walls there was a fosse, or ditch, of about 100 ft. in width; and therefore it must have been a strong fortress. There is a Museum on the ground, in which everything of interest is carefully placed, to be ultimately removed to the one at Reading. An inspection of the museum revealed the articles used by the Romans in their every-day life, as Samian ware, lamps, grid-iron, or portable cooking stove, scale-beam, axes, hammers, gouges, chisels, plough coulters, blacksmith's anvil, tongs, files, rasp, a so-called hippo-sandal, carpenter's plane, pins of bone and bronze, an iron stylus, fragments of glass vessels, querns, bones of the horse, ox (*bos longifrons*), sheep or goat, of the pig very abundant, and of the dog, red deer, roebuck, and perhaps fallowdeer; also oyster shells in great numbers. The plane, grid-iron and lamp are of rare occurrence in Roman remains. Perhaps the most valuable discovery was a Roman Legionary Eagle, now in the Duke of Wellington's possession.

The white of the tesseræ, Dr Woodward thinks, was derived from beds of white lias, or Great Oolite, but I believe it is from the latter, and it is probably, as Mr Witchell suggested, from the compact limestone of Sapperton or Bussage, which he recognised when the Club visited Uriconium and Cranham. as occurring at those places.

A great deal of ground is still unexcavated, but owing to the interest taken in the work by the Proprietor, the Duke of Wellington—who has entrusted what has to be done to the Society of Antiquaries, who, in their turn, have the loving services of Dr Fox and Mr St. John Hope—we may rest assured that every care will be given in the further prosecution of the excavations.

In comparing Silchester with our Roman remains or Woodchester, Lydney, and Chedworth, it appeared to me from the coarser character of the tesseræ, that in the former we have the remains of a large station, whose inhabitants belonged more to the trading class; whilst the latter, from evidence of greater luxury, were occupied by those of a higher rank.

With regard to its older history, it was a city of the Atrebates—a Celtic tribe of Gauls—who had dispossessed the earlier British inhabitants, Sægontii. The Chief, or King, was Cornmius, Cæsar's friend, whose coinage is still in existence. Caer Sægont became Calleva, and Calleva, Silchester, but how it became the latter there is much difference of opinion. The prefix, ' Sil', was ably dealt with in the notes on Silbury, given to me by Mr Ernest Sibree, which will be found at page 117 of our last proceedings. The writer in the *Times* suggests that "its source is to be sought in Saxon rather than in Roman times, This would make the etymology of Silchester " Sel Caestre," of the Camp in the woods. And whosoever has visited the place, hemmed in on one side by the dark pine forests of Tadley, and on the other by the broad oaks and noble elms of Strathfield-saye, will acknowledge the appropriateness of the name bestowed by our Teutonic forefathers.* "

The members drove back to Reading, and dined at the Queen's Hotel.

## MIDLAND AND SOUTH WESTERN EXTENSION RAILWAY (CIRENCESTER)

The third Meeting took place on July 28th, and the Members were met at the Station at 10.25 by Professor Harker, who was the guide for the day.

Close to the Station is the Ashcroft Estate, now being laid out in new streets for building, by Mr E. W. Cripps. The ground lies within the walls of the old Roman City of Corinium, and in the excavations several streets, pieces of tesselated pavement, and the columns of a Temple have been found—also large quantities of Samian ware and pottery of almost every known make, many bronze ornaments, bone pins, counters and coins—the latter representing nearly the whole of the Roman occupation from Claudius to Arcadius.

A brief visit was made to the excellent Museum, the contents of which were explained by Mr C. Bowly.

From there to the Brewery where, through the kindness of Mr Cripps, Professor Harker shewed the 8 inch cores taken from the well-boring at Lewis Lane, to a depth of 177 feet, of which he has given a section in the last number of our Proceedings at page 185.

It will be remembered it was owing to this boring that the Professor was able to shew conclusively the presence of the Oxford Clay, underneath the town of Cirencester.

The next visit was in brakes to Chedworth, *viâ* Baunton and Rendcombe, passing over high ground, which enabled Professor Harker to point out and explain the Physical aspect of the country. Several sections were looked at on the Midland and South Western Railway, some of which have been

* John Bellows suggests the meaning as "Boundary" Camp: as in Silures, the "Borderery" [in England.]

described in our Proceedings by Professor Harker and Mr Buckman.

It may safely be assumed that the formation at the mouth of the tunnel is the upper part of the Fuller's Earth; the rubbly beds which overlie would then be Stonesfield Slate. Then succeeds a bed, much broken up, of a sandy nature, and in the cutting there is a slight anti-clinal, the beds dipping on either side away from each other, and this continues more or less until a short distance into the long cutting. Afterwards the Great Oolite comes in, but the question is do the beds below belong to that formation or the Stonesfield Slate? This leaves an interesting piece of Geology to work out.

The Members then drove to Cirencester, and dined at the King's Head Hotel.

## NEWLAND AND ST. BRIAVELS

The fourth and last meeting was held on September 17th, and it attracted the large number of 30 members, who travelled by the Great Western Railway to Lydney, where a special train was in readiness to convey them over the Severn and Wye line to Coleford. In driving to Clearwell Meend a rude roadside cross was examined, of the history of which little is known, but it has suffered from some jovial Foresters having got the shaft out of it in the hope of finding gold.

Thence to Clearwell to see the "Scowles"—a name given in the Forest to hollows and fissures, where iron ore was worked during the Roman occupation, if not at an earlier date.

Mr W. H. Fryer, who has considerable knowledge of the Forest, and experience in mining, gave the following explanation:—

"The ore occurs in crystalline limestone, belonging to the upper part of the mountain limestone. The beds vary from 10 to 20 yards in thickness, and are locally called the 'crease' or vein. The ore is found in chambers, termed 'churns.' They are very irregular in shape and extent, often widening into caverns, and narrowing to very small strings or 'leads.'"

The ore shews from 15 to 60 per cent. of metallic iron in the form of a hydrated peroxide. It was deposited by infiltration from above, and very often the excavation of the channel and the deposition of the ore went on concurrently—a view in which Mr Wethered and I concurred. To enable the ore nearest the surface to be raised, the overlying soil is removed, and as the deeper deposits become worked the surface subsides, or as the Foresters say "scowls in"—hence the term Scowles, derived from a British word meaning a hollow.

Within historic times the men who worked the ore were called the King's miners. They seemed to have been liable to military service in part consideration for their tenure of the mines; and among other services they rendered they were employed by Edward III. at the siege and taking of Berwick. Mr Fryer suggested that they may have been the originals of our sappers and miners. Even now miners, born within the hundred of St. Briavels, may qualify themselves to be registered as free miners by working a year and a day in the mines, which entitles them to a free grant of mineral ground from the Crown.

The early history of the working is involved in obscurity, but it probably dates as far back as the Celts.

Thence to St. Briavels Castle, the residence of Mr Hinton, by whose kind permission it was inspected. The Rev. W. Tapnell Allen here became our guide. He said there is no romantic incident attached to the Castle, and historically its chief interest is rather connected with the people who have held it. There are no records to shew when it was erected, but the date is generally fixed at 1131; and Walter Fitz Milo, of Gloucester, is believed to have been the builder, and it was designed to check the inroads of the Welsh. In later years the Constable of the Castle was also Warden of the Forest of Dean, and amongst many eminent men who have held the office were the Duke of Bedford, Regent of France, whose widow became the wife of Sir Richard Woodville, and the mother of the Queen of Edward IV., and Warwick, the King maker. In a room formerly used as a prison, and on the splay of the windows rude inscriptions have been cut or scratched by prisoners, and the following is one :—

> "My glas is roon, tis time twas gone,
> "For I have lived a gret space,
> "And I am weary of the place."

The prison is mentioned by Howard, in his work on *The Lazarettos of Europe.*

He relates that a man had been imprisoned here a year for a debt of only 3/-, which had been heavily increased by costs. At the beginning of the present century the Court and Jury Rooms were used for the parochial school.

On the way to Newland a circular Camp leading to Bigsweir was inspected. It is described by Mr G. F. Playne in Vol. 6, page 236, of our Proceedings, as follows :—

> "The position is well suited for defence, the headland having a steep back round it, but the plateau is under cultivation, and there are no traces of entrenchments left."

It was from the summit of this hill that Wordsworth composed his beautiful poem, "On revisiting the Banks of the Wye a few miles above Tintern Abbey in 1798," and as the first few lines describe so accurately the appearance of the country, I am sure you will pardon my giving them :—

> "Five years have passed ; five summers with the length
> Of five long winters ! and again I hear
> These waters, rolling from their mountain springs
> With a sweet inland murmur. Once again
> Do I behold these steep and lofty cliffs,
> Which on a wild secluded scene impress
> Thoughts of more deep seclusion ; and connect
> The landscape with the quiet of the sky.
> The day is come when I again repose
> Here, under this dark sycamore, and view
> These plots of cottage ground, these orchard-tufts,
> Which, at this season, with their unripe fruits,
> Are clad in one green hue, and lose themselves
> Among the woods and copses, nor disturb
> The wild green landscape. Once again I see
> These hedge-rows, hardly hedge-rows, little lines

Of sportive wood run wild ; these pastoral farms
Green to the very door ; and wreaths of smoke
Sent up, in silence, from among the trees !
With some uncertain notice, as might seem,
Of vagrant dwellers in the houseless woods,
Or of some Hermit's cave, where by his fire
The Hermit sits alone."

At Newland the celebrated Oak was the first object of interest visited. The girth at its base is 46 feet in circumference, and at six feet from the ground it is 43 feet.

Thence to Newland Church, where the Rev. W. H. Bagnall-Oakley, Lecturer of Jones's Almhouses, read a paper giving its history. He said:—

"It is a noble edifice, consisting of nave, chancel, two nave aisles (or chanting chapels), a chanting chapel on the south aisle, a porch and tower. There is no Norman work which is easily accounted for, as the parish was not formed until the reign of Edward I., when Newland was a dense forest. The styles of architecture are Decorated and Perpendicular, and, with the exception of a few trifling additions, the Church now stands as it left the hands of its builders, about the end of the fourteenth century. It is the mother church of Coleford, Bream, and Clearwell, and these parishes originally formed part of Newland, and were only provided with chapels for their religious services. King Edward I. gave the advowson of the Church to the Bishop of Llandaff, and on the 9th of February, 1304-5, he granted him license to appropriate it to himself and his successors for ever.

"The great tithes remained in the See of Llandaff until 1856, when an exchange took place whereby St. Wooler, Newport was transferred from Gloucester to Llandaff, and Newland to Gloucester Diocese, and the Bishop of Gloucester has now the patronage of the living.

"The font is of great interest, being a good specimen of very unusual date—1661. When the Gloucester and

Bristol Archælogical Association visited this Church in 1881, Mr Middleton drew their attention to an aumbry existing at the west end of the north aisle, which probably shewed the original position of the font. The use of the aumbry was to hold the salt and oil used at baptism.

"In the churchyard, on the north-east side, lies the effigy of Jenkin Wyrall, a Forester-of-fee of the 15th century, which—with the exception of one at Pershore Abbey—is the only effigy in hunting costume in the Kingdom. He wears a peculiar loose cap, folded in plaits, and tied together towards the top. A small portion of an inner garment appears under a loose frock or jupon with full sleeves, and a short skirt which was put on over the head—it is slit at the sides—as there is no opening down the breast. He has trunk-hose fitting closely to the legs, and low boots which are only open at the ankles on the outside. The horn is of the usual shape, but small, and the hanger or hunting sword, which is slung by a double strap, has what appears to be a small scabbard or knife attached to the "larger." Jenkins' feet rest on a brache or hunting dog. The inscription on his tomb is:—

'Here lythe Jenk (in) Wyrall Forester of Fee, ye which dysesed on the VIII day Synt Lauroc, the year of our Lord MCCCCVII. on His Soule God Have Mercy. Amen.'

"It is remarkable the inscription should be in English at this date.

"On the south-west side of the churchyard cross stands a monument of a cross-bowman. The figure is nearly life size, incised on a slab in a dress of Jacobean type. As a bow-bearer it was his duty to attend His Majesty with a bow and arrow, and six men clothed in green whenever His Majesty should be pleased to hunt within the forest, and it is interesting to note that at the present time the body-guard of Her Majesty in Scotland consists of archers of the guard."

Mr and Mrs Bagnall-Oakley entertained the members to a sumptuous afternoon tea, and shewed them their fine collection of coins found in the neighbourhood, and their beautiful garden most picturesquely situated.

## CELTS

Only one has been brought under my notice, which was shewn to me by Professor Harker. It is a fine beautifully worked Javelin or Spearhead, and was found in a field near the bacon factory at Chesterton, just outside the town of Cirencester on rising ground. It measured $2\frac{3}{4}$ inches in length.

## EVENING MEETINGS

Were well attended, and we are indebted to the following members for excellent papers on the subjects upon which they treated.

On December 1st the Hon. Secretary gave the first: "A Microscopic Study of the Carboniferous Rocks," which was illustrated by Lantern Micro-Photos shown by Mr Embrey.

The second, on January 12th, was by Mr C. Witchell: "Bird Song and its Scientific Teaching."

On February 23rd, Mr S. S. Buckman's paper: "The Laws of Heredity, and their application in the case of Man."

At the concluding meeting of March 22nd, the Rev. Dr Smithe gave an "Account of the Bucklandi Beds of the Lower Lias at Churchdown Hill, their position relatively to the overlying and adjacent Strata, and the fossil contents of these deposits," and which was followed by Mr J. H. Taunton, "Notes on the Dynamic Geology of Palestine."

These papers, with the exception of part of Mr Buckman's and a condensed account of Mr Taunton's, are published in the Proceedings, and I think it more courteous to the Authors to refer you to them than to offer any abstracts of my own.

In conclusion, I wish to call your attention to a paper in the proceedings by the late Mr John Jones, which was read at the Tewkesbury Meeting, on the 9th May, 1854, being "Notes on certain Superstitions prevalent in the Vale of Gloucester."

From some unexplained reason the paper was published separately, and I feel sure you will be glad that, through the kindness of Mr Ernest Hartland, of Barnwood, from whom I obtained a copy, it now forms part of our Transactions.

In the address last year I mentioned at page 121 that Mr Bellows' paper on "The Roman Villas of Gloucestershire" would be found in the proceedings.

The author, with that modesty which forms so pleasing a part of his character, thought it was too fragmentary to be published, but I have prevailed upon him to allow me in some measure to supply the omission by including the following epitome in this address:—

He began by pointing out that rightly to understand the Roman Villas in Gloucestershire we should divide them into three classes. Firstly, the Government farms for the supply of horses to the posting stations, and the official residences of officers in charge of signal stations. Secondly, the stations along the roads for the government service of posting, and similar, but less important buildings for the use of private persons travelling. Thirdly, farms that belonged to private owners.

The great building at Woodchester must be classed apart from either of them, its proportions making it evident that it must have been the palace of some man of high rank; such as, perhaps, the governor of the province, or the *comes stabuli.*

In support of the idea that some of these Villas, like Witcomb or Chedworth for example, were government farms, a rescript of Valentinian was instanced, which ordains the establishment of such farms at convenient spots not far from the road stations; the latter being placed at distances of every 5 or 6 miles along every main road in the Roman Empire. At every such principal posting station not fewer than forty horses were to be ready at call day and night; and to ensure this number being *bona fide* and not a mere list on paper, very stringent rules were made, forbidding any employment of the government horses for private purposes: even the governor of a province being forbidden to use them except officially.

This Valentinian rescript gives curiously minute details to be observed at the stations to facilitate the journey of express messengers and officials; the provisions to be found for an Imperial Envoy; or in case of the Emperor's own passage, for himself and his suite; one item in the latter case being one pound by weight of oil of cloves for the Emperor's bath. A temple was required as one of the buildings in the official hostelry, in which on the Imperial progress seven little pigs were to be sacrificed for the Monarch's safe journey.

In the light of Valentinian's rescript for establishing farms everything becomes clear in a Villa like Witcomb, which situated in the midst of good pasturage and beautiful scenery, within a mile of the horsing station at Birdlip, or that for the "Cheval de renfort" at the foot of the hill, fulfils all the required conditions of such a farm, with its small suite of good apartments, and numerous rooms of a lower class for slaves or labourers. The temple at Witcomb, noticed by Lysons as if it corresponded to a chapel in one of our private mansions, is fully accounted for by the order just alluded to: while at Chedworth the pigs of iron indicate smith's work connected with building or repair of carriages; and, probably horse-shoeing. He touched upon this as a disputed point, but mentioned recent discoveries of horse-shoes in Romano-British buildings, as in Bucklersbury, London; or as described by William Ransom, of Hitchin; by our late colleague, J. D. T. Niblett, etc. Besides these proofs he instanced a Roman equestrian statue at Orange, in France, where the upturned foot of the horse shows the marks indicating the shoe nails. The usual argument against the theory that the Romans shod their horses is that no word for horse-shoe is found in Classical Latin: a weak point which really disappears if we refer to Suetonius' Life of Vespasian, in which a story is told of a muleteer in the Emperor's train stopping the Imperial party in order to afford a friend of his an opportunity of handing Vespasian a petition: the protest being that one of the mules needed a smith to attend to him. It seems whimsical to contend that mules were shod, but not horses: especially when we remember the speed at which the express messengers drove along the hard paved roads; a treatment that would quickly destroy the hoofs of any animal unless they were so protected.

A number of details were given showing the working of the posting system, which was brought to a high degree of perfection. The changes were next described that must have taken place in the military system, consequent on the revolt of Carausius: and the evidence of coins shows that the re-conquest of Britain by Constantine was not a complete one; the mining district of the Forest of Dean, excepting Lydney affording no sign of occupation, later than that of the Carausian period.

Passing on to the withdrawal of the Roman Government from Britain in the fifth century, J. Bellows showed how the system they had left determined the forms of the one that followed it; the autonomy of great towns like Gloucester enduring through the several changes of Saxon and Norman occupation: while in the country districts the larger Villas, which under a settled government needed no other protection than that of the law, would in the period of unrest only retain their existence by fortifying themselves and becoming "moated granges," of which we still have so many traces.

The part of the paper which elicited the most discussion was that in which J. Bellows inferred a very large effect on the composition of the nationality of the English people from the number of troops sent here and maintained here from the Continent. In Professor Hübner's *Römische Heer in Britannien*, there is a summary given of some 90 different Cohorts or Alae or other military bodies, concerning whose connection with Britain we have epigraphic or other evidence; and John Bellows maintained that if we take into account the Roman system of deportation of the young men, natives of this Island, for foreign military service, while for hundreds of years bodies of men of nearly every nationality in Europe settled here in permanence, we cannot but see that the parentage of the British people must have been largely affected by the mingling of such nationalities with the Celtic stock inhabiting the Island.

The paper was illustrated at several points by diagrams and the use of the black board.

*Notes on certain Superstitions prevalent in the Vale of Gloucester, read to the Cotteswold Club, at the Tewkesbury Meeting, May 9th,* 1854, *by* JOHN JONES, *Gloucester.*

The favor with which the papers upon Archæological subjects were received, at the last Cirencester Meeting of the Club, induces me to offer it one of the same character.

The rapidity with which the superstitions of our land are beginning to disappear, and the interest they possess in an ethnological or psychological point of view, render it desirable, that those which can still be procured, should be preserved in a tangible form.

The nature of the superstitions to which I would direct your attention, may be most briefly exemplified by the relation of two somewhat remarkable instances, which have fallen under my notice within the last few years.

Calling upon a person who had just removed to a new residence, I found him in his garden, and amongst other alterations, ordering a bed of parsley to be immediately removed from the place where it then grew to another. This order, it appears, had before been given more than once, and as the person addressed still seemed to pay no attention to it, he was asked the reason, and at once replied that he had no intention of doing anything of the kind. He was quite willing to root it up and destroy it entirely, but transplant it he would not, and said, moreover, that he did not know anyone who would willingly take upon himself the consequences of such an act. Such effect had his remonstrances, and so contagious is superstition of this kind, that the bed was allowed to remain undisturbed, and I have no doubt that, if in the same possession, it so remains to the present day.

We, of course, cannot ascertain, or expect to know all that the ancients believed of the properties and virtues of sacred plants, nor why these should have been attributed to them, but in the case of that under consideration, we have considerable information derived from themselves to guide us. Parsley was chiefly used by the Greeks in the garlands with which they decorated tombs, and was also eaten by them at funeral feasts; its use upon these occasions having given rise to a saying in reference to anyone sick past hope, which has come down to us "δεισθαι Σελινον," "He needs nothing but Parsley."

The purposes to which it was applied, prepare us to expect, that auguries deducible from it must be of sinister and disastrous import, and we find accordingly that Timoleon ascending a hill near Syracuse, to obtain a view of the Carthaginian army, having met some mules laden with Parsley, his soldiers regarded the event as most unfortunate and ill-boding, and declined to attack their enemies.

I am not aware of any positive authority upon the point, but I think it probable that this herb was dedicated to Persephone, as Queen of the Dead, presuming her to be identical with Hecate or Selene, the resemblance of its Greek name—Selinon—to that of the last named divinity at once suggesting its direct derivation from her and the correctness of this supposition is supported by other etymological considerations.

On examining the appellation of this plant, in such languages as I have at the moment an opportunity of referring to, I find that with remarkable uniformity, its old Greek name is preserved, with the prefix of Peter or its diminutive, thus excepting the

| | |
|---|---|
| Archaic Greek. | Σελινον. |

ITS OTHER NAMES

| | |
|---|---|
| Latin | Petroselinum |
| Romaic | Πετροσελινον |
| Italian | Petroselino, Petrosemolo<br>Petrosillo |
| Portuguese | Perrexil |

| | |
|---|---|
| Spanish | Perejil |
| Illyrian | Petrussín |
| German | Petersilie |
| Danish | Persilie |
| French | Persil |
| Welsh | Perllys * |
| English | Parsley |

may be all freely translated as "Peters" Moon Plant, &c. The connection of the name of Peter with it, is suggestive of the policy, by which the established prejudices of the rude people amongst whom Christianity was first introduced were met and modified, in the transference of objects of reverential regard from the tutelage of long honoured Pagan divinities to that of Christian Saints.

As St. Peter, in his character of door keeper of Paradise, and receiver of souls, must naturally have been regarded as the successor of Charon, and the offering of pence is still made to him in the same manner and with the same object as was that of the Obolus to his gloomy prototype, it is not altogether strange, that the plant under consideration, evidently consecrated to some of the deities who presided over the death of mankind, should have been assigned with others of their attributes, to him.

I am imformed by Greek, Illyrian, and Dalmatian friends that this superstition exists in their respective countries in as great force, and as commonly as in the Vale of Gloucester.

The other instance to which I referred was the following: Some men were employed in removing an old hedgerow, partially formed of Elder trees. They had bound up all the other wood into faggots for burning, but had set apart the Elder, and enquired of their master how it was to be disposed of. Upon his saying that he should, of course, burn it with the rest, and ordering it to be faggoted, one of the men said with an air of undisguised alarm, "that he never *heard* of such a thing as burning *Ellan Wood;*" and, in fact, so strongly did

* "Per" a diminutive of Peter, as in Perkin.—"Llys," a plant, herb.

he feel upon the subject, that he refused to participate in the act of tying it up.

The name used by the man here referred to for this wood, is worthy of remark, as being pure Saxon; and is, I believe, the ordinary word for it, through a considerable portion of the Vale of Gloucester.

This fact is sufficient to indicate with precision the ethnological source of the superstition; and what Grimm in his "Deutsche Mythologie" says of it is so interesting, that I translate and give it entire, embodying, I may remark, some of his notes in his text.

After mentioning the reverence paid to other trees in Scandinavia and Germany, he says:—

> "The Elder (Hollunder) also received distinguished honour. Hollan, indeed, signifies a tree or shrub, as in the Anglo-Saxon Cneovholan. Russius. Butcher's broom. In low Saxon the Sambucus nigra is called Ellhorn. Arnkiel unsuspectingly relates, 'Our forefathers also held the Ellhorn holy, wherefore whoever need to hew it down, (or cut its branches,) has first to make the request: 'Lady Ellhorn give me some of thy wood, and I will give thee some of mine, when it grows in the forest;" the which with partly bended knees, bare head, and folded arms, was ordinarily done, as I myself, have often seen and heard, in my younger years. Thereafter are mentioned superstitions respecting Elder wands, Elder trees before stables, the shedding of water under them, and the Elder-mother, a Danish superstition.
>
> "The God Puschkait, a Lithuanian Deity, dwelt under this tree, and the Letts laid bread and beer for him near it.
>
> "The Saxon canons published during the reign of King Edgar, speak of the magic practised in "Ellenum and eác on odrum mislícum treovum (Ellan, and oak, and various other trees.")

To say nothing of the virtues still attributed to the juice of its berries as a wine, of its flowers as a cosmetic, and of its pith and bud as a cure for ringworm, which are generally known: by favour of Lord Ducie, another of its valuable qualities, of which I was not previously informed, has come to my knowledge. A small piece of it cut from a young shoot just above and below a joint, so as to leave the bud projecting at each end of it after the fashion of a rude cross, borne constantly about the person, is a most *certain* and effectual cure for Rheumatism. I produce two pieces of the proper form, of which, anyone is quite at liberty to take notice; but, in order to prevent any contention for them amongst gentlemen afflicted by that very distressing affection, I. will at once state that, *these* pieces, although perfectly orthodox in cut, are not in the slightest degree to be depended upon, as they did not grow in a *churchyard;* only the trees growing in consecrated ground, being endued with the property indicated.

As Lord Ducie's neighbourhood is highly favoured by the existence of such a tree, applications have been repeatedly sent to the person who gave me these slips, from a considerable distance for the like; and some of their recipients it is said, are able and willing to give it a good character, of fourteen or fifteen years standing,

The reason why supernatural power or influence, should have been ascribed to any plant or tree, does not at first consideration, appear to be very near the surface; but, if we go back to the Anti-Christian era, and examine the various forms of religion then prevailing, the mystery will soon, to some extent, explain itself.

The idea appears to have been once almost universally entertained, that all nature was animated, and endowed with sensibility, in fact, it almost forms the soil in which mythology is rooted.

The grand old Gods of Egypt, for example, with their meaning attributes, and majestic titles, which for our purpose, may be regarded as the archetypes of all which followed them, resolve themselves under the searching gaze of modern criticism, into mere deified powers of nature, the active vivifying principles, and the passive media of reproduction, which, in the vain attempt to render comprehensible to pure intellect, confined on every side within material boundaries, the infinite and inscrutable, are shadowed forth to us, in the guise of male and female forms like our own. Although the higher orders of priests, amongst the Egyptians, probably never lost sight of the true origin and signification of these symbolical forms, that the system degenerated into mere idolatry with the masses, cannot be doubted, and many inferior divinities were introduced, but these were few indeed, when compared with those adopted by the nations who took the lead in power and civilization, upon their decadence.

The extent to which the lively imagination of the Greeks led them in this respect is so beautifully pictured in Schiller's poem on Die Götter Griechenlands.*

Da der Dichtung zauberische Hülle
Sich noch lieblich um die Wahrheit wand—
Durch die Schöpfung floss da Lebenfülle
Und was nie empfinden wird, empfand.

*  *  *  *

Wo jetzt nur wie unsre Weisen sagen,
Seelenlos ein Feuerball sich dreht,
Lenkte damals seinen goldnen Wagen
HELIOS in stiller Majestät.
Diese Höhen füllten Oreaden,
Eine Dryas lebt' in jenem Baum,
Aus den Urnen lieblicher Najaden,
Sprang der Ströme Silberschaum.

---

Then did Poetry its magic veil,
Gracefully o'er tbe True and Actual throw,
Then did all things within creations pale,
Now senseless deemed with life and feeling glow.

*  *  *  *

Where we but now as modern sages say,
A lifeless soulless Fireball behold,
HELIOS in tranquil majesty,
His golden chariots career controlled ;

* I venture to translate these lines as literally as possible.

By Oread's were filled the heights of heaven,
A Dryad dwelt in every tree of earth,
And from a lovely Naiads urn,
Every silver-foaming stream had birth.

This state of things existing, it was not difficult to believe, as Grimm remarks, that "to animals comprehension of human language; to plants sensibility; and to all creatures, power of manifold changes of form might be attributed, and that some should be invested with higher qualities (werth) than others, until they were at length elevated to an idolatrous degree of veneration. Gods and men were changed, or changed themselves into trees, plants, or animals; spirits and elements took upon themselves material forms, and it was in the spirit of the system of which they were part, not to deprive their manifestations of their attributes, though changed in appearance. Under these circumstances the adoration of plants or animals seems nothing strange, and becomes unintelligible, only when the higher being, vanishes from human consciousness behind its assumed form, and the latter alone, remains as its substitute."

In proof of the universality of the idea respecting plants and trees, which is all I at present wish to call your attention to, I need only refer to the mysterious trees of life and knowledge, connected with the fall of man; the ash Yggdrassil under which the Gods of the North held their court, and which appears to be identical with those just named; the sacred groves of Baal so frequently mentioned in Scripture; those of the Western nations, Celtic, Germanic, and Scandinavian; the Oaks of Dodona; the sacred lotus of Egypt, India, Tibet, and Nepaul; the Pine Cone and sacred tree of the Assyrian sculptures; the Verbenæ, or sacrificial plants of the Romans, (one of which was peculiar to every God); the fable of the Golden Bough; the sacred tree of the Lombards, destroyed by St. Barbatus; and other instances of such superstitions, recorded by various authors. In the 96th Psalm, I may make the passing remark, occurs also this curious passage, relating to my subject, after a similar invocation of the heavens, the earth, and the sea, and "all that therein is." "Let the field be joyful, and all that is in it; then shall all the trees of the wood rejoice before the Lord," and in the 148th Psalm again occurs, "Praise the Lord upon earth ye dragons. Fire and hail, snow and vapour, wind and storm, fulfilling his word."

"Mountains and all hills, fruitful trees and all cedars, &c., &c."

In fact, not to needlessly multiply quotations, we may refer to portions of our own liturgy, adopted in the time of St. Athanasius, if not long before, as for example, the "Benedicite omnia opera Dei," otherwise known as the "Song of the Three Children," of the morning service, or the 98th Psalm, "Cantate Domino," of the evening service, which contain invocations enough to various natural objects, to join in the praise and glorification of the Supreme Being, to satisfy the veriest Pantheit, and it is difficult to imagine, that such an offering of praise and thanksgiving, as the canticles named, could have been made to the purely spiritual God of Christians, by persons to whom the phraseology, if not the idea clothed in it, was not familiar. As these canticles are now very seldom used, it is not unreasonable to suppose that they have been practically withdrawn, from an intuitive sense of their want of harmony, with the feelings of enlightened and spiritual worshippers.

If other members of the Club are acquainted with any superstitions, however apparently ridiculous, of similar character to those which I have brought before them this day, by collecting and collating them in the same manner, I imagine that they may render good service.

To those who have paid no attention to the subject, and have unthinkingly esteemed them to be merely fantastic in their origin, and unworthy of notice, I take the liberty of endeavouring to show that they are not so, but that they originated, in the highest feelings of veneration which could be inculcated, by the legitimate teachers of those religious systems, which once prevailed, in all those countries where the Christian faith now predominates; systems of which the traces have been so nearly swept away by the dispersing floods of centuries, that the best epitome of our knowledge of them will probably be formed from collections made in our own times, of such imperfect and mutilated relics as those which I have presented to your notice this day.

By such labours it can be demonstrated that, despite the teachings of Christianity, the spread of intelligence, and the cultivation of the intellectual powers amongst all classes, the dread of the malign influence of discarded deities and demons of the old world, whose names alone were probably never heard by their present votaries, is still exhibited in adherence to immemorial customs by professed, and doubtless sincere Christians, to whom it has been handed down from periods beyond the reach of history, not by the loud voice, but by the low and secret whisper of tradition; it can be shown that despite the great changes and refinement which our language has undergone during the time required for the amalgamation of the various tribes of which the population of *England* is composed, in some of its quiet vales, may still be heard from the lips of sturdy husbandmen, the accents of the mighty sea-roving vikings, for echoes of which, the dales of their own Scandinavian homes have listened in vain for ages; we can even show, on consideration of our peculiar provincial modes of speech, that in the clumsy attempts at a refinement of language generally made by our yeomen and country folk while addressing superiors, instantly abandoned for a different and well marked dialect of uncouth phrases, and other grammatical forms, amongst themselves and their dependants, we have a striking instance of the enduring sympathy inherent in *race*, and an infallible mark, wherever it may occur, of a people once numerically predominant, but eventually subjugated and incorporated with another. I think the facts by which we arrive at these conclusions are as interesting, and as remarkable, in connection with the history of human kind, and human mind, as any which are ordinarily cared for by students of nature, and therefore do not hesitate to lay them before the "Cotteswold Natural History Club."

*Bird Song, and its Scientific Value.* *By* Charles A. Witchell. *Read January* 12*th*, 1892.

The habits of animals are equally with their construction worthy of investigation, for movement, especially aberrant movement, is the forerunner of new habits, and may therefore be termed the parent of physical development. It forecasts a possible future, just as structure recalls a certain past. Habit is also valuable as indicating the extent to which the multiplication of certain species may affect human interests; and in this it excels physical structure. It is better for us to learn what are the seeds devoured by finches, rather than the number of feathers of which their tails are composed; yet the books, while scientifically accurate in regard to the last feature, usually give no more than a vague generalization on the former. Aberrations of habit, or even the usual specific signs of anger, love, or of hunger, have not generally been recorded by ornithologists, who, nevertheless, have pursued with fatal activity any specimen which differed, however slightly, in colour or in form from a common type.

We know that during comparatively recent years a change of habitat, partial or general, has occurred in certain animals; *e.g.* the beaver in North America has become solitary; the house-sparrow has become parasitical on the abode of man, and in that of the martin; the house-mouse is generally dependent upon man for food; and the meadow-vole and long-tailed field-mouse have adopted walls for a residence.

But there is another feature in a change of habit, which is much more important than its effect upon the distribution of species, and this is its suggestion of a mental process akin to, or identical with, that which we call reason. The Nuthatch (*Sitta Europœa*) affords an illustration. This bird is said to crack its favourite food, a nut, after placing it in a crevice, as in a vice, for convenience of fracture; but I have observed this to be not its invariable habit. Less than a month ago I saw one, as I had previously seen another, engaged in striking a small spherical object, probably a nut, which was held by the bird's feet against the perch. The question therefore arises: is the nuthatch's use of a cleft for a vice an accidental occurrence, or the result of a more or less direct mental process?

The object of investigating fauna is not, surely, the mere recording of occurrences, or destruction of individuals, or an elucidation of the physical history of creation; it must also embrace the character of the relationship between man and the so-called lower animals. I am aware that this is a subject of which there is no record in the Proceedings of the Club; but an aberration of habit in some Garganey Teals which lived at Elmore, was made the subject of a paper by the late President, Sir William Guise. I venture to express a hope that notwithstanding the distinguished position which the Club occupies in the geological world, it may be the means of inducing some of its members to observe the habits of animals more closely than is at present customary.

The anatomy of these creatures may reveal to us the exact physical processes by which they move, but it is movement, free from the trammels of habit, which suggests the animal will or mind; and which indicates a possibly existent evolution of habit and consequently of body. One of the chief features of interest in fossils or other relics of animals, is the evidence they afford of the habits of the creatures which they represent; just as the physical characteristics of existing species derive half of their importance from their suggestion of corresponding characteristic habits.

It can be only by observing and recording the habits of animals that we shall ever acquire accurate knowledge of animal psychology; and let us hope that before the approaching extinction of some of our rarer animals has been accomplished, observers will have recorded not only the bare incidents of their local distribution and nidification, but also something of their domestic life and manners.

By such means only shall we discover the degrees of mental elaboration which guide their actions, and—an infinitely more valuable fact—man's true position in regard to them. I venture to suggest that the Club should annually devote one or two pages of its transactions to a record of aberrant habit in animals. There is always passing from our memories a rich harvest of such experiences, from which none glean.

Twenty years ago, I was familiar with the habitual songs and cries of the commoner birds, such as finches, crows, thrush and blackbird, wren and hedge-sparrow, &c. In the year '81 I listened, on 18 almost successive nights, to a nightingale which sang about two miles from Stroud, and I clearly detected in its song certain notes which were closely like those of other wild species of my acquaintance. Before this time I had been quite familiar with the imitativeness of several kinds of caged birds, and especially that of the thrush and blackbird, both of which I had trained.

In the spring of 1885 I was helping to nurse a sick relation, and all day long a thrush sang in the top of an acacia tree in the garden. I had abundant opportunities of watching this bird, and of timing its periods of song, which, in one day, amounted to the enormous extent of sixteen hours. The bird watched for food from its perch; it generally flew at once to the spot where it fed, and often began to sing when only halfway back again. This thrush imitated freely notes of the partridge, brown wren, linnet, greenfinch, house-sparrow, and chicken. Guided by this experience, I listened for and readily detected a great number of imitations, by various birds, of cries which I knew very well; and in the autumn of 1887 I began to record what I heard, by writing down the names of the singers, and the notes which they reproduced. This I did at every opportunity, from dawn to midnight, and by giving up usual summer amusements I made such opportunities occur, outside of office hours, almost daily. After working in this way for eighteen months, I began, for the first time, to make comparisons between my records; and they afforded clear indications of local variation in bird songs. In many instances the variations were in accord with local variations of habitat. I then wrote a statement of the whole matter and sent it to Professor Harker. He was most kind, and spent several hours going through it with me, and showing me how to arrange it scientifically. Mr S. S. Buckman also looked over the M.SS. This paper appeared in the *Zoologist*, for July and August, 1890, and was quoted by the *Globe*, and the *Pall Mall Gazette*. I have read very carefully the following works, and have concentrated in a ledger the whole of the information upon my subject which they contain.

It is impossible to become acquainted with the whole literature of the subject: this is infinite; and the greater part of it absolutely worthless. It often consists of nonsense, which describes how some bird, say a lark, sings; how it soars on eager, or some other kind of wings; and how it sings to its loving mate; but the story never relates how, in early spring, the lark concludes his song with long-drawn whistled notes, which are almost exact, though prolonged, reproductions of the call-notes of the young, and which therefore suggest that the song is then a call to the mate; it does not say that the lark flies during song, more often in early spring than when the young are hatched—after which event the song is frequently uttered from the ground; nor are we told how the lark imitates more than any other bird the songs of its frequent companions, the yellow bunting and common bunting, and even the bleat of the sheep. These things are not mentioned; we are told instead that the little bird is full of admiration for the dawn: so he may be, but he also utters a chattered song when he fights.

The works which I have studied are these: "Animal Intelligence," by Romanes; Bechstein's "Natural History of Caged Birds"; "The Birds of Sherwood Forest," by Sterland; "Birds of Herefordshire," by Dr Bull; "Birds of Middlesex," by Harting; "A Familiar History of Birds," Edward Stanley; "The Expression of the Emotions," by Darwin; Sir W. Jardine's "Birds of Great Britain and Ireland"; "Our Rarer Birds," by Charles Dixon; Morris' "History of British Birds," 2nd Edition; "Our Summer Migrants," by Harting; Yarrell's "British Birds," 1st and 4th Editions; Adam White's "Popular History of Birds," "Domestic Habits of Birds," by the Society for Diffusion of Useful Knowledge; White's "Selborne"; Knapp's "Journal of a Naturalist"; Layard's "Birds of South Africa"; Wilson and Bonaparte's "American Ornithology"; Gould's "Handbook of the Birds of Australia"; Bree's "Bird's of Europe, not found in Britain"; Wood's "Illustrated Natural History," Vol. II. (Birds); several other ornithological works which contained nothing worth noticing; the *Zoologist* from 1862 to 1874. The *Field* for the last ten years; and some other and less important publications.

Few people have been at the trouble to attempt any scientific investigation of bird-song; and nearly all of those persons have erred in generalizing from observation of a few individuals. Let me give three illustrations of this defect. The first relates to the distinctive cry of the Marsh Titmouse, (*Parus Ater*). Sterland, in his "Birds of Sherwood Forest," p. 86, says "their cry resembles the words 'chika, chika, chika,' repeated 4 or 5 times in succession, and ending with a shorter syllable, 'chike.'" Dr Bull, in the "Birds of Herefordshire, p. 31, quotes Mr Johns as saying: "the double note of the Marsh Tit may be compared to the syllable 'if he, if he,' rapidly uttered and repeated in the imitation of a sob." Dixon, in "Our Rarer Birds," p. 68, alludes to its "peculiar cry of 'tay, tay, tay,' a note unlike that of any other bird." Yarrell, in his first Edition, Vol. I, p. 347, has "the call-note of this species is a single sharp chirp, like that of the other tits, and this bird is only to be distinguished from them by its voice when it puts forth a rapid succession of notes, more remarkable for chattering gaiety than for quality of tone."

Bechstein says that during the pairing season its call is "diar, diar, hitzi, ailtz, ailtz," "Nat. H. C. Birds," 280. White, of Selborne, remarked that about February, "it begins to make two sharp notes which some people compare to the whetting of a saw." Each of these descriptions differs somewhat from the others, and conveys to me but slight suggestion of the note by which I recognize the Marsh Tit in this district, and which is either a cry like "cheeuu-ha-ha-ha," (Example 1, Post,) or a full, rapid upwardly swerved whistle, (Ex. 2) occupying about the interval of a major fifth. Thus far the call-note of the Marsh Tit. What do writers say of the Chaffinch?

The Rev. J. G. Wood, in his "Illustrated Natural History," Vol. II. p. 465, observes: "the call-note is very musical and ringing, somewhat resembling the word 'pinck,' which has therefore been applied to the bird as its provincial name."

Yarrell, (1st Edition, 1, 462) mentions that "the common name of 'Pink' by which this bird is known provincially, has reference to the sound of its call-note."

My observations on this bird invariably tend to show that the cry "pink, pink," is not the call-note. There are, apparently, three call-notes. The most important of these is a quiet cry, closely resembling the common cry "chirri," of the male house-sparrow. This cry is used as a call between the sexes at pairing-time. It is the call for food, &c., by the fledged young to their parents. Another call-note of the chaffinches is, in spring, often used during flight, the great occasion on which calls are employed by birds; and it is not addressed only to the mate. It may be pronounced "twit," or whistled in a rapid, upward swerve in the interval of a major sixth. (Ex. 3, post).

The other cry is used generally in autumn, and descends briefly in the interval of a 2nd (Ex. 4).

The cry "pink" is sometimes, at any rate, a battle-cry; twice I have heard it used in winter by chaffinches when fighting; it is a note of alarm employed when chaffinches are disturbed, and in the winter it is employed more particularly during the first few bright hours. Mr Herbert Playne informs me that it is employed as a menace to the owl, and as an expression of alarm by chaffinches disturbed on the nest.

The author of "Domestic Habits of Birds," (p. 248) records that some chaffinches cried "pink, pink" at a pine-marten which they had discovered in some bushes. An adult female chaffinch, saved by me from starvation, uttered the same cry when I approached her cage. The bird was then much alarmed. Mr H. C. Playne informs me that the same cry is uttered when the bird is driven from its nest.

Bechstein, (p. 2) alludes to "two or three species of shrike, which, from their surprising memory can imitate the songs of other birds, so as to be mistaken for them." Yarrell, (1 Ed. 1 p. 151) repeats what may be termed the story that the butcher bird imitates the notes of other birds for the purpose of attracting the species upon which it preys. In contradiction to these remarks, J. R. in "Domestic Habits of Birds," p. 325, states, "we have now ascertained that the flusher (red-backed shrike) utters no call that has the most distant resemblance to that of any other bird." I have heard it utter notes closely like some of those of the brown linnet and house-sparrow. It then appeared to be singing.

Lastly, the Rev. F. O. Morris, in his "British Birds," (2nd Ed., Vol. III. p. 23) says of the starling: "Even in the wild state they have been known to endeavour to imitate the notes and cries of different birds and animals." He does not say that he has observed this endeavour, hence we may conclude that either he had listened to no starlings, or was by no means familiar with the notes of common birds, which are always imitated by the wild starling.

These inaccurate statements are quoted from standard works: they suggest very plainly that bird song, as I said, has received but slight recognition as a study by ornithologists, who have in this matter generalized from limited observations.

It may be urged against the discussion of variations in bird-voice, that the human ear is not capable of detecting all the inflections which may actually occur; but against this plausible statement may be adduced the fact that sometimes the birds themselves are deceived, or at least attracted, by the imitations of their cries, which bird-catchers employ. It may, however, be replied that the birds do not necessarily mistake the imitation for the voice of their race, but for that of some bird which is secure and without fear; hence, in desirable circumstances. The fact of birds of different species being mutually aided, as they are, by their various alarms, when danger approaches, is evidence of their being influenced by the utterances of their unrelated companions. If influenced by alarms, why not by songs?

There is one fact which speaks volumes in favour of diversity and meaning of tones in the voices of birds, and this is the wonderful amount of vocal exercise, or possibly of vocal expression, which exists amongst gregarious species. House-sparrows, titmice, linnets, and starlings in flocks chatter for hours every day, and it is utterly nonsensical to suppose that, while every habit of body serves some purpose in the lives of individuals, this abundant interchange of sounds between birds is a meaningless consequence of an instinctive impulse.

Though we shall never be able to translate all the inflections in the voices of birds, yet there are certain widely distinct recognisable character-sounds about which we may be tolerably certain, and upon these principally have my observations been founded. For example, the common domestic fowl, when extremely terrified, utters a loud, repeated yell, "cah, cah, cah." We may fairly say that this cry is a character-sound which, when uttered by any fowl excited by extreme fear of death in the hands of man, has always practically the same intonation. Yet even this cry is modulated in an infinite variety of degrees of vehemence. The young chicken utters it when looking closely at a bee, or a wasp; the adult hen, when pecked by another, expresses alarm or distress by the ejaculation of this cry, but with a degree of force directly proportionate to the extent of suffering endured; and the adult barn-door cock employs the same yell to signal the approach of a flying bird of which he is afraid. Thus there is every grade of this cry, from a chirp to a loud yell; yet in every individual the yell sounds much the same, and conveys to our minds the idea that the bird which utters it is greatly afraid.

In my papers in the *Zoologist* I stated that the voice might have been originally produced accidently by contortion of the body during combat, in which event it might have tended towards the preservation of the individuals by which it was employed. If an outcry increased the chance of victory in combat, the inclination and ability to exclaim would become permanent, and cries would be habitually uttered in the tones most easily produced, or most effectual in its result.

My suggestion that voice was produced by contortion was founded on my own observations on the three common newts and the snake. The newts are always silent unless writhing in the grasp of some enemy, upon which occasion a distinct croaking sound is emitted. Air is retained in their lungs, as in those of snakes, by the contraction of the glottis: hence, in both animals, the escape of air from the lungs is attended with some frictional vibration at this point.

In Vol. 1 of "The Naturalists' World," pp. 160 and 180, will be found letters from four persons who had heard newts squeak when held with the fingers. Under other conditions the newt is silent. Further, on two occasions I have heard an immature frog, which could not croak, scream when seized by a snake; and here we have another instance of vocal sound being first produced during what may be termed combat.

Darwin says ("Expression of Emotions," p. 83), "When the sensorium is strongly excited, the muscles of the body are generally thrown into violent action; and as a consequence, loud sounds are uttered, however silent the animal may generally be, and although the sound may be of no use. Hares and rabbits, for instance, never, I believe, use their vocal organs except in the extremity of suffering; as when a wounded hare is killed by a sportsman, or when a young rabbit is caught by a stoat. Cattle and horses suffer great pain in silence, but when this is excessive, and especially when associated with terror, they utter fearful sounds, (Page 84). Involuntary and purposeless contractions of the muscles of the chest and glottis, excited in the above manner, may have first given rise to the emission of vocal sounds."

It may be remarked generally that animals do not, when enduring internal pain, utter vocal sounds, unless such may possibly be of use; they are silent when poisoned: hence we may infer that the utterance of sound was first occasioned by combat, in which it is, at the present time, most widely employed; and that it was used, if not as a defiance, at least as a plea for mercy—like the cry of a fowl or that of a dog defeated in fight. We may be certain that the perception of a threatened attack was only a mental anticipation of the combat which experience—personally acquired, or inherited—suggested to be a probable consequence of the approach of an enemy: thus a combat-cry might well be uttered before the fight was commenced, and it would then be a danger-cry, or alarm-note. The influence of mutual aid amongst gregarious species would have tended to a variation of the danger-cry, which would have been constantly employed for the protection of the community; and would thus have been varied in degrees of force co-extensive with the danger which called it forth.

The call-notes, which I consider to have arisen partly from the retention of distress-cries uttered as calls for food by the young, would in the past have been, as they now are, similarly varied, especially for the purpose of expressing desire for the companionship of another bird.

It is probable that the emotions have played an important part in the development of bird-voices. In solitary birds, fear, unless acute, always produces silence; and it may account for the lack of song amongst the larger kinds of birds, which are always so conspicuous that they are compelled to be vigilant. Love obviously has brought about the abundant use of call-notes; these, in the breeding-season, are uttered with great frequency by the males, sometimes continuously, and so as to constitute a phrase or song. They constitute the entire songs of some species. Call-notes are also uttered in the songs of several other birds.

The influence of hate or anger is seen in the defiant cries of many rasorial birds. Many birds of this order are polygamous, and among such the selection of mates is greatly dependent upon combat. But vocal defiances are not confined to birds of this order: the songs of the robin, thrush, hedge-sparrow, and wren, at least, are occasionally of this character.

Gregarity has a great effect on the frequency with which common cries are uttered by birds, as the manners of our starlings, sparrows, finches, and hirundines clearly prove; but this may be counterbalanced by fear, as it is in the columbidæ, which survive by the agency of their timidity and great fecundity. Isolation has an equally apparent effect in limiting the cries of birds. The lonely bird may sing, but he never is garrulous. These facts greatly support a hypothesis that the voice, and especially in the production of call-notes, is generally employed as a means of inter-communication between birds.

The influence of population and its relation to difficulty of obtaining food, is indicated even in the notes of birds; for these creatures, when not periodically destroyed by cold, as they are in temperate climates, are kept in check by enemies, or by lack of food; in either case they lose that abundant leisure or opportunity to sing, which is necessary to the development of all songs.

The development of the eye in the search for food may, when not counterinfluenced by size, have disposed certain species towards the preferment of brilliancy of colouring rather than excellence of voice in their mates; and conversely, birds dwelling in the obscurity of thick foliage would detect by ear rather than by eye the approach of their enemies; and they might thus acquire a delicacy of hearing which would be gratified by sweet songs.

Darwin perceived that the language of some birds is artificial, in relation to certain enemies.

The Hon. Daines Barrington educated or rather reared young linnets under various birds, for the purpose of discovering whether their songs were hereditary, or were acquired by imitiation; he found that they were perpetuated through the latter agency. He mentioned many instances which, as he says, "seem to prove, very decisively that birds have not any minute ideas of the notes which are supposed to be peculiar to each species"; and that the notes descend from parent to fledgling, because of "the nestlings attending only to the instruction of the parent bird, while it disregards the notes of all others which may perhaps be singing around him." Barrington found that a young house-sparrow, taken when fledged, and placed with a linnet, but where it could also hear a goldfinch, uttered a mixture of the linnet's and goldfinch's songs. His other experiments showed "it to be very uncertain what notes the nestling will most attend to, and often their song is a mixture, as in the instance I have before stated of the house-sparrow." There is not any doubt that each of his trained birds, if brought up by parents, would have had only their proper notes.

These experiments, and the fact that the young of certain wild birds, (*e.g.* the nightingale) acquire the idea of their songs while yet unfledged, proves that the receptivity of such fledglings must be very great: may it not be related to things as well as to sounds, and account for the perpetuation of modes of nidification?

Both call-notes and alarm-cries have sometimes diverged from common types. Particular sounds are sometimes employed to suggest the approach of a certain kind of enemy. Darwin observed that when the mother turkey sees a kite approaching, high in air, "she shows her fears by her gesture and deportment; she uses a certain exclamation, 'koe-ut, koe-ut,' and the young ones afterwards know that the presence of their adversary is denounced, and hide themselves as before." (Syst. Nat.; D. H. B., 250).

The common cock announces the arrival of a bird of prey overhead by uttering his loud yell of distress, and not by the cackle employed to tell that a dog or cat approaches. I have observed that in Gloucestershire the house-sparrow announces the similar discovery of a hawk by uttering a cry "tourrr," which is distinct from every other of its notes. When I hear starlings utter a particular cackle, which I know, I am sure, from experience, that they see a hawk. This cry is quiet distinct from their ordinary call, but often is uttered by them when fighting. However, it is probable that the suggested relation of alarm-cries to particular enemies is due to vehemence, and that a cry may, by reason of its violence or intensity of meaning, suggest the approach of some much-dreaded enemy, not necessarily of any particular kind.

Now, having regard to fact that the young of certain musical and also of certain unmusical species learned their notes, not by any influence of heredity, but purely by imitation; and to the importance of alarms, and of call-notes, which I have elsewhere shown to be the foundation of many songs. Is not the prevalence of a peculiar cry among the birds of species physically allied but living apart, perhaps in different hemispheres—valuable evidence that these allied species descended from a common ancestor? It may be asked: do such widely diffused cries exist? Here are instances of their occurrence: The American Ferruginous Thrush (*Turdus rufus*) utters notes which Wilson says "have considerable resemblance to the notes of the song thrush of Britain." Am. Ornith., Vol. I, 234.

The Cape robin, or Cape chat thrush (*Cossypha Cafra*) sings like our robin, and has similar manners in hopping and flirting its tail. Layard, "Birds of S. Af.," 224.

The southern grey-headed sparrow, closely like our common bird, has a note which resembles the "chissick" of the English sparrow. Layard, id. 480.

The European rock sparrow (*Passer petroina*) has a tone of voice similar to *passer domesticus*. Bree's "Birds of Europe, not found in Britain," Vol. 3, p. 123.

The shore-lark of America, when in flocks in autumn, "at this time," Wilson says, "they have a singular cry, almost exactly like the skylarks of Britain." Am. O. 1, p. 85.

The Abyssinian larks are said by Bruce to sing like those of Europe. "Dom. Hab., Bds.," p. 300.

The South African black and white cuckoo, (*Coccystes jacobinus*) "has a true cuckoo's note." Layard, id. 164.

The pigeons of Europe, America, and Australia are equally persistent in cooing, and equally limited to that tone. *Vide* Works of Yarrell, Bree, Wilson, and Gould.

The Australian swamp-quail, *Synoicus Australis,* of Gould, is said to be a nearer ally than the quail to the common partridge, which it resembles in many points of its economy. He says: "Its call is very similar to that of the common partridge." "Handbook of Birds of Australia," II., p. 193.

The American snipe (*Sc. gallinaga*) has the same flight as that of Europe, the same bleating note and occasional rapid descent. Wilson 2, 223.

These are one or two instances picked from some hundreds recorded by the writers above mentioned.

My personal observations convince me that the cries of allied young are more closely alike than those of adult birds; that the voice is generally, but not always, employed much more by the male than by the female, and that in the male it diverges most from specific types.

A similarity existing between the cries of most birds which are physically allied, is a matter of common observation; but it is a subject which appears to have never been investigated.

In the Corvidæ, we hear a low croak in the Raven, a loud "corrr" in the crow; a somewhat similar "caw" in the rook; all of which are habitual sounds. The jay has also a loud "caa," much modified, which appears to be always an alarm; the jackdaw utters a low, prolonged "cah," as an alarm to its fledged young: its ordinary notes are short, much varied, and often resemble the words "jack" and "jock." The starling employs a loud "cah" when tending its nestling young; and it is important that the young call to their parents in a cry which very closely resembles the nest-cry of the young rook, and which differs much from the ordinary call-notes employed between adult starlings; but the adults employ "cah" as their most vehement alarm. Macgillivray renders the note of the hooded crow as "crāă," (Brit. Bds. 1, 352), and he employs "khraa" (id. 544) to represent that of the rook; we may therefore infer that the cries are alike.

Yarrell (4, 2, 239) describes the ordinary notes of the nutcracker as sounding like "crah, crah, crah," or "crŭ, crŭ, crŭ"; and he adds that "when alarmed, it has a harsh cry, which by many is compared to that of the missel-thrush." I have heard a missel-thrush utter "cah," (like a jay) when carrying food, apparently for its young. We have thus in the Turdidæ a trace of a cry, common to the Corvidæ; and probably that trace might be increased by more extended observations.

The starling has a singular song-note, dissimilar to those of its closest allies, but resembling fairly the migratory call of the redwing, which is a typical cry of the British true thrushes. During the breeding-season the starling always ends his phrases with some harsh, high, squealing, but unmusical notes, which are then almost invariably accompanied by a flapping of the wings. He utters these sounds when his mate flies towards him, or when he approaches her—that is, when he is disposed to sing, and not on every occasion. These sounds are like the call of the migrating redwing, and constitute another link, however slight, between the species; for they are common to every starling (*S. vulgaris*) which sings, although they are rarely uttered in August or September, and only occasionally until February.

The cry of the redwing is heard almost exactly repeated on the same occasions by the blackbird, and it is replaced by a much shorter note, but one similar in tone, in the song-thrush. The blackbird, when suspicious of danger, utters at intervals a very abrupt whistle, almost like the bark of a dog; the redwing, upon the same occasions, utters an almost precisely similar sound. Sometimes the blackbird, as his fear increases, slowly quickens the repetition of this sound, which under the influence of vehemence betrays the common feature of a rise in pitch; and we then see that the whole of the blackbird's rattling alarm is insensibly graduated from this intermittent sound. The alarms of the missel-thrush, fieldfare, and ring-ouzel are all of much the same character as that of the blackbird: that of the ring-ouzel is practically identical with it, but is less varied in pitch.

When the blackbird's nest has been disturbed he utters a prolonged, very high, wailing note, which evenly descends about a half-tone in pitch. This cry is also uttered occasionally before heavy weather in autumn, or during severe frost.

In the same circumstances, the robin utters a note differing from this one only in lack of force, and perhaps also in its higher pitch. The rattling alarm of the robin is uttered on precisely the same occasions as that of the blackbird, but is less often uttered during flight. In both birds it is often accompanied by a flirt of the tail. The common call-note of the robin is a short, somewhat plaintive squeak, never rapidly repeated; and this sound is continually employed towards the young. The common flycatcher employs towards its young a squeak so similar that I have often been unable to identify it, when both species with their young were in close proximity. The flycatcher also employs towards its young a short, sharp "chick," closely like the "chick," often doubled to "chick ick," which is used by the redstart to its young.

The last species prefixes the cry with a little whistle, which may be written "tewy," (Ex. 5). This whistle is an alarm of the whitethroat; it is *the* alarm of the chiffchaff and willow warbler, and is likewise the call-note of the last two; it is uttered in the songs of the nightingale, redstart, blackcap, whitethroat, and sedgewarbler.

The nightingale sometimes elaborates his well-known long notes from a repetition of this cry. (A representation was given, and Mr John Bellows immediately confirmed the statement, he having observed the same incident. See Ex. 6).

Rennie remarks, "We have ourselves, in many instances, observed what might be not inappropriately called a different dialect among the same species of song birds in different counties, and even in places a few miles distant from each other. This difference is more readily remarked in the chaffinch, dunnock, and yellow hammer, than in the more melodious species." (Edin. Mag., Jan., 1819).

I have observed local differences in the songs of the starlings, chaffinches, and dunnocks or accentors.

Numerous authors record occasional variations in the notes of birds; these are a few species mentioned: the nightingale, by Barrington and Bechstein, N. H. Bds., 214 and 219; Robin, by C. F. Archibald, of Rusland Hall, Ulverston, letter to me;

Willow Wren, Bds. Middlesex, 52; Chiffchaff, 53; Redstart, White of Selborne, 55; Blackcap, Bds. Middlesex, 49; Bottle-tit, Wood II., 306; Marsh Tit, Dixon, Rarer Bds., 68; Hooded Crow, 1 Yar., 2, 85; Rarer Bds., 120; Fish Crow, Wilson, Am. O., 2, 119; Chaffinch, Bechst. N. H. B., 135; Cuckoo, B. Middlesex, 119.

I am enabled to bring before the Club a notable instance not only of imitative variation in a bird's song, but also of the falsity of an important authoritative statement.

In the "Domestic Habits of Birds," p. 319, may be found this remark upon the supposed imitativeness of the sedge-warbler: "and among some hundreds of these birds which we have listened to in the most varied situations in the three kingdoms, all seemed to have very nearly the same notes, repeated in the same order; a fact which appears to us to be fatal to the inference of the notes being derived, not from one, but a number of other birds. For if this were so, it is not possible that these imitated notes should all follow in exactly or very nearly the same order in the song of each individual imitator in distant parts of the country. The close similarity of the notes thus alleged to be imitated cannot be denied; but taking all circumstances into account, we think it much more probable that these remarkable notes are original to the song of the sedgebird, and that we might, with equal justice, acuse the swallow and the skylark of borrowing from it."

This careful statement is sufficiently rebutted by a letter received by me from Mr O. V. Aplin, M.B.O.U., and author of "The Birds of Oxon"; he says: "In May, 1889, I listened to the most accomplished sedgewarbler I ever came across. It began several times with the 'tut-tut-tut' of the blackbird, and produced the following: green woodpecker, call—starling—blackbird, alarm and call-notes—corn bunting, (*E. miliaria*) song, exact (N.B.—This bird is fairly common there)—lark, song,—chaffinch, song and 'pink'—greenfinch, double and single,—sparrow, call,—swallow, song,—redstart, alarm-note,—partridge, call,—nightingale, full bubbling notes."

Mr Aplin continues: "Over and over again I listened to these notes produced with the utmost fidelity. It was almost impossible at first to believe that the birds themselves were not there. It is almost needless to say I made quite certain that it *was* the sedgewarbler which produced them all. The odd thing about it was that we have no nightingales in this parish, (Bloxham) but it might have heard them in a previous year elsewhere. The other birds imitated are all common. The sedgewarbler does carry notes from year to year, because I heard one once giving the notes of Ray's wagtail very accurately, immediately on the arrival of the former in spring. I noticed this because, although the sedgewarbler *always* imitates a good many birds, I never before heard it produce this particular note."

In a subsequent letter he adds that he must have heard thousands of these birds.

My records of the sedgewarbler's song are somewhat similar to those made by Mr Aplin.

I have observed many instances of variation; not only in musical species. A male house-sparrow living near my bedroom took up with a note like the "twit" of the chaffinch, but very loud; it appeared to be a kind of shout; and the bird continued to utter it during about two weeks. He seemed to be very pleased with the performance; while chirping he looked about with an air of consequence. I have twice heard a chaffinch, once at Stroud, and once at Dursley, utter many times in slow succession a cry so closely like the common call, "chissick," of the pied wagtail, that I was for a short while completely deceived. At Chalford, on May 31st, 1890, I heard a chaffinch interrupt its song with a phrase exactly like the full song of a greenfinch, which then repeatedly sang near it.

Mr A. H. Macpherson has heard great tits in Scotland utter the "pink, pink" cry of the chaffinch; in Gloucestershire they have the same cry, and I have heard it uttered by five of them which were fighting together.

Birds vary their songs, not only towards imitating the notes of others, but also in intervals of pitch, constructing as it were, a kind of music, which is, I believe, often derived by imitation from musical notes heard in the gurgling of streams, or sometimes from human music. A friend who is much interested in birds informed me that a parrot in his possession learned to whistle the four notes of the common chord, (Ex. 7); and that a wild starling which lived upon the same premises reproduced the notes, being heard by several people to utter them in the same time and with the same accent as the parrot.

Mr Arthur H. Macpherson informs me of a starling which sang near the Quadrangle at Oxford, and which not only imitated the sound of the chapel bell, but also swayed its body from side to side in imitation of the movements of the bell.

In 1888 a pair of blackbirds reared their brood in a nest within a few feet of my dining-room window; and the young must have heard for an hour or two every day the notes of a piano, and sometimes those of other instruments which were played there.

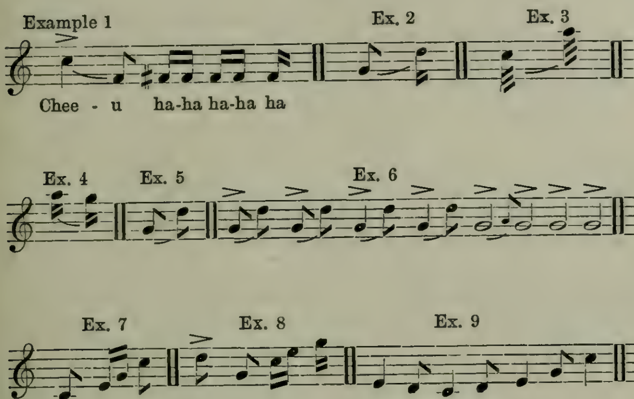
In 1889, in the garden, a blackbird born in 1888, sang hardly more than one phrase, which he would repeat for minutes together without variation. (Ex. 8).

Mr F. A. Chambers, of the Thrupp House, Stroud, when staying with a friend, was told that in the garden a blackbird sang the first two bars of "Two lovely black eyes," a song which was frightfully popular a few years ago. Mr Chambers saw and heard the bird sing them so incessantly as to be unpleasant. (Ex. 9).

The occurrence of such instances as these is very frequent, and the recital of them might be much extended; I trust, however, that I have said enough to show that bird song is a subject which hitherto has been undeservedly neglected, and to suggest the value of vocal utterance in birds, as bearing on the theory of a common origin of species, and an equally wide subject, mind in animals.

The following examples are referred to in the preceding paper. They are intended to represent intervals rather than actual pitch, which, in the cries to which they relate, is always an octave higher (sometimes much more) than the notes here given. They should be whistled with the mouth.

Since this paper was read, a work on bird song (by Simeon Pease Cheney: Boston) has appeared. This treats elaborately of the musical intervals sung by American birds; but it accords only the most scanty references to imitation; and resemblances between the voices of allied species are even more neglected.



*Some Laws of Inheritance; and their application to Man, by* S. S. Buckman, F.G.S. *Read February 23rd,* 1892.

## PREFACE.

The substance of a considerable portion of the first part of this Paper was written early in the year 1891;* and the Paper itself was read before the Cotteswold Field Club, on February 23rd, 1892. In the subsequent discussion, objection was taken by Professor Harker that I had not considered the views of Weismann; and I have accordingly added at the end a short argument concerning his theories. Some other additions, the result of fresh observations, or to make the arguments clearer, have been incorporated in the Paper since it was read before the Field Club. All such additions have been enclosed in square brackets; and these brackets will shew that, in works studied since the paper was read, I have found confirmation of several of my surmises.

In the main, the laws of Heredity set forth are based on a study of the morphological phenomena of Ammonites; but they have had to be extended, in many cases, to meet the necessities of a wider field.

The laws of "earlier inheritance and its limitations" have from time to time been stated in a condensed form in my Monograph: here they are all fully considered together.

* See Monogr. Ammonites; Palæont. Society. Vol. for 1891, p. 290

Although these laws were given as the result of my own observations on Ammonites, I can claim no originality as regards the law of earlier inheritance; having, as it happens, been anticipated both by Hyatt,* and by Würtenberger, who had also independently arrived at the same conclusions—the former from a study of Liassic, the latter from Upper Oolite Ammonites. Even they, however, had been forestalled by Professor Cope (*teste* Hyatt).

It is curious that an extinct group like Ammonites should

ERRATUM.

COTTESWOLD FIELD CLUB, VOL. X.

In page 258, line 1, for "*Inheritance*" read "*Heredity*."

## PART I.—THE LAWS.

### Heredity.

In regard to Heredity the usual formula is "Like produces like." This is true enough in a general sense; it is decidedly untrue in a particular sense. Not only are "sports" of various kinds directly contrary to the law that "like produces like;" but, even in homogenesis, the offspring is never exactly like its parent was at the same time of life. Neither is it exactly like other offspring of the same parent. Nevertheless there is a definite tendency on the part of the offspring to exhibit the

* In addition to the works to which reference is made in this Paper, I must acknowledge my indebtedness to Professor Hyatt's grand volume, "The Genesis of the *Arietidæ*;" Smithsonian Contrib. Knowledge, 1889.

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It is curious that an extinct group like Ammonites should have yielded such important results; but it must be remembered that they offer exceptional facilities for the study of Heredity. They not only preserved their own ontogenetic record in a most complete manner, but they developed very quickly, lasted a fairly long time geologically, are very diversified in form, and are preserved in considerable numbers in fairly complete sequence.

The importance, in the origin of species, of the law of earlier inheritance which they illustrate will, I hope, become apparent from a perusal of this Paper.

May 31st, 1892.

## PART I.—THE LAWS.

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parental form in a general way, even down to very minute characteristics which may be peculiar to the parent as an individual.

Theoretically, then, it may be assumed that like ought to produce like, for after all the offspring, whether the product of fission or of sexual union, is but a detached portion of the parent;* and according to Darwin's theory of pangenesis † there is no real distinction between reproduction by fission or by sexual union—the latter is only the former more specialized.

When, however, the new organism is in the smallest degree unlike its parent it can be assumed that the failure of "like to produce like" is due to some change of environment affecting either the parent or the offspring. It may then be supposed that "like produces like if the conditions of environment be absolutely and continuously uniform;" but since the conditions of environment never do absolutely conform to these requirements, and sometimes very widely depart from them, it may be said that "like produces like so far as the conditions of environment will allow." ‡ The differences between parent and offspring may, then, be presumed to depend on the greater or less diversity of environment, and the greater or less susceptibility of the organism. § It follows from this that there is more

[*The phenomena of alternation of generations do not conflict with this statement. Neither in homogenesis nor in heterogenesis is the offspring at once like its parent—it only becomes like by passing through successive cycles of changes similar to those by which its parent was produced. The correspondence of the cycles of the offspring to those of the parent fulfil the statement of "like producing like."]

[† In his "Essays on Heredity," Weismann rejects Darwin's theory of Pangenesis. It may be a faulty theory; but it seems to fit in very intelligibly with observed facts. The consideration of this matter must be left over for the present.]

[‡ Professor Harker remarked to me that the little difference in the species of the genus *Lingula* from the Cambrian to the present day might be ascribed to the practical uniformity of pelagic conditions.]

§ And in the product of sexual union the heterogeneity of the parents would be another factor.

chance of difference between parent and offspring in highly-developed than in lowly-developed organisms. It may also be remarked that great change of conditions—as for instance, cultivation—causes considerable diversity among the descendants of a common ancestor.

## Variation.

I wish to define Variation in a very restricted manner, and to confine the term to the difference between parent and offspring, when exactly the same age of each is compared.

[Many phenomena are roughly classed as Variation, and it becomes necessary to make a distinction. Usually it is regarded as a departure from a normal standard, or from a given specific type; but this idea is entirely unsuitable when a phylogenetic series is under review. Palæontology illustrates a wonderful inconstancy among species. It impresses one with a sense of constant change on the whole—a change slower in some groups than in others—and slower at some times than at others in the same genetic series. In a quickly developing group like *Ammonites* anything like the same form can only have endured for comparatively few generations, except in the case of the radical stocks.

Practically speaking there was no normal type—practically speaking there was change in every generation. The same may be supposed to be theoretically true in slow-developing series—only the changes may have been and may be so slight as to be hardly perceptible.

Little or great, it is these differences between parent and offspring at the same age which I wish to define as Variation. Why I insist on the same age is that the youthful offspring may differ very considerably from the adult parent, but such unlikeness is not Variation, as now defined. In the course of its ontogenetical development an individual may change very considerably, passing through the same cycles of changes as its parent did. Such changes may be distinguished, not as "variations due to age" as is sometimes done, but as ontogenetic changes. These ontogenetic changes may so exactly correspond and synchronize with the ontogenetic changes of the parent that there may be no Variation between parent and offspring at the same age.

I fear that in many cases ontogenetic changes are confounded with Variations—the differences due to inequality of age not being properly considered. The unlikeness between non-coeval individuals is often due to their not being in the same stage of ontogeny. Differences between coeval individuals of different parents might be due to a slight disproportion in relative development from a phylogenetic point of view (negroes and Caucasian, agricultural labourers and peers); and such differences might be termed phyletic unlikeness.* This avoids any argument as to whether the parents belong to different species, sub-species, or incipient species in any cases.

Between different offspring of the same parents, between different members of the same litter, there are differences:

1.—*Sexual*, as between the two sexes.

2.—*Individual*, as between members of the same sex. Differences from the same-sexed parent at the same age would be Variation as I wish to define it.

Changes in the plumage of birds in connection with the breeding-time, as in the Ruff, are sometimes called Variations; but if such changes are inherent in all individuals of the species, they are not Variations, even if the term were used in its widest sense. They may be called "genital changes."

* In a field of daisies it may be noticed that in some flowers the petals are much more strongly tinged with pink than in others, in some cases the younger flowers are more pink than the older, in some cases the petals are scarcely tinged at any age. These are not variations, even if the term were used to indicate departure from a normal type; because it would be impossible to indicate the normal type. The fact is that the differences are, in part, ontogenetic as regards different-aged flowers of the same plant, and, in part, phyletic unlikeness as regards different plants. The daisy is probably retrograding from an entomophilous to a more complete anemophilous condition—the red petals being the remains of a more perfect entomophilous stage—the "phyletic unlikeness" indicating differing degrees of retrogression.

Genital changes are not uncommon in the animal kingdom; and the flowering of plants ought to be put in the same category.

Moulting in birds, change of leaf in trees, white winter coats of Arctic animals might be called "periodic or seasonal changes." *

Changes which are not genital, and not seasonal, such as the voluntary change of colour in the chameleon, and in certain frogs, and the involuntary change of colour in Man—blushing—might be termed simply "occasional" or "temporary" changes.

The above phenomena will suffice as illustrations of what I wish to class as otherwise than Variations. The palæontological illustrations of the inconstancy, in so many cases, of what are termed "species" lead to the assumption that change from generation to generation is the rule, only that it differs in degree—in some cases is so slight as to be unappreciable even in very extensive genetic series. In any case I can only define as Variation the amount of difference between offspring and parent when compared at the same age.†]

Such Variation may be considered under different headings in relation to the the causes by which it is produced.

I.—*Abnormal Variation.* This may be subdivided :

(1) *Variation due to disturbance of the economy of the parent.* This is further divisible into :

(*a*) *Very extraordinary disturbance. (Monstrosities, and to a less extent supernumary digits and the like*).

(*b*) *Less extraordinary disturbance.* (*Birth marks and any alteration of disposition or features.*

* White hair in man is a senile ontogenetic change. Instances of white hair in adolescent man or in children are pathological cases due probably to general constitutional debility, or to local disturbance of economy.

† In Heterogenesis the number of the generations would also have to be taken into account.

(2) *Variation due to disturbance of the economy of the individual, in consequence of sudden changes of environment.* Such changes may be considered as favourable,* and as unfavourable; and the unfavourable changes may be divided into those occasioned by disease, and those brought about by injury and mutilation.

II.—*Normal or developmental Variation,* that is, gradual functional modifications induced in the individual by the necessities of its environment.

The ontogenetic changes by which an organism reaches maturity, or even later, are really developmental Variations inherited from the parent; the further ontogenetic changes, by which an organism responds to its environment are, strictly, developmental variations proper to the organism.†

To a great extent the difference in the lines of thought adopted by Darwin and Spencer in regard to the origin of species, is that the former lays the greater stress on Abnormal, or as he calls it, Spontaneous Variation having suddenly produced some feature which gave its possessors superiority in the struggle for existence; while the latter regards Normal Variation (use and disuse) as the important factor. I shall have something to say on this point presently.

## The Law of Earlier Inheritance.

I have said that it may be assumed "like produces like so far as the conditions of environment will allow;" but this does not meet the facts of the case, because the offspring only becomes like its adult parent by continual growth and change. Therefore it might be said: "the offspring at its various stages of life tends to assume what was the parental form at these

* The luxuriant growth of wheat when top-dressed with nitrate of soda—the broader leaves and the darker colour.

[† Ontogenetic changes refer to the individual's stages in relation to each other; developmental variations refer to them in their relation to the parent.]

various stages of life, so far as the conditions of environment will allow."

If this were absolutely true—if the organism were like what its parent was at exactly the same age—it is difficult to understand how the dictum that ontogeny repeats phylogeny can be true.

In order that ontogeny should repeat phylogeny it is evident that there must be a concentration of development. If the various phases of ontogeny represent the various developments of the generations of species included in the genealogy of the individual, it is obvious that to find the various phases successively exhibited in the immature stages of the individual implies that they must have been inherited at an earlier and earlier time in the lives of individuals in successive generations. The more highly developed an organism is, the more stages must it pass through in order to reach maturity; and if these various stages each represent mature stages of less-developed forms it follows that the mature stages of earlier species become the immature stages of later species—in other words, that the adult stages of earlier species become adolescent stages of later species, and embryonic stages of still later species.

What obtains in the successive species of a phylogenetic series must obtain, too, in the successive generations of a species. At the same time, it must be remembered that earlier inheritance would only be perceptible where there are developmental changes. In an organism which shews, practically, no difference between, say, its adolescent and adult stages, except in the way of size, it is impossible to mark earlier inheritance; but for all that, it is reasonable to assume that the same law holds good as in the case of an organism in which there are marked differences to distinguish the various stages of life. Similarly it is an obvious fact that if the law of earlier inheritance be admitted to act in the phylogenetic series it must also be admitted to act in the generations of the species.

Granting then that the law of earlier inheritance, as illustrated in successive Ammonite-faunas, is a fundamental assumption for the doctrine of evolution, this law may be defined as follows *:—

*The offspring tends to exhibit the various successive phases of the parent's life at a slightly earlier age, provided that the environment be somewhat approximately the same.*

## The Unequal Action of Earlier Inheritance.

If the law of earlier inheritance acted with equal force with regard to every stage inherited by the individual, we should find that in accordance with the law just laid down, there would be, in the development of a phylogenetic series, a gradual and successive replacement of the various stages, that is to say, the embryonic characters of the earlier species would gradually disappear from the later species, the infantile characters of the earlier species would become the embryonic characters of the later species, and the adolescent, adult, and senile characters of the earlier species would become infantile, adolescent, and adult characters respectively of the later species.

Again, if there were such a gradual and successive replacement as this, ontogeny could not repeat phylogeny,

[*In order to afford a better understanding of this law of earlier inheritance, it is necessary that I should introduce two terms. The features of an adult, A, become by this law adolescent in the later species, B, infantile in C, and so on. Therefore I wish to call the adolescent B the "morphological representation" of adult A, and infantile C the "morphological representation" of adolescent B, or of adult A. In the opposite manner, adult A may be spoken of as the "morphological prefiguration" of adolescent B, or of infantile C, and so on Thus with Hyatt's "morphological equivalent" we obtain three terms in connection with the relations of the individual. It is a "morphological representation" with regard to the past, a "morphological prefiguration" with regard to the future, and a "morphological equivalent" of other species of other genetic series which have reached the same degree of development. The accuracy of these terms is not impaired by the limitations to the law of earlier inheritance which I am now going to discuss.]

except in part. A highly-developed organism would shew in its embryonic stages no trace of the lowly-devoloped form from which the phylogenetic series had originated; but it would exhibit the adult stage of a later—and therefore more-developed—being. In fact, instead of ontogeny being an epitome of phylogeny, it would be only a record of the fag-end of the individual's genealogy.

Since, however, there is no such successive replacement in this manner, it is necessary to suppose that "the earlier inheritance of a given character is always diminishing;" and since ontogeny shews how a most highly-developed organism commences with a most simple form—since, in fact, there is a remarkable fixity of the embryonic form, while there may be no such fixity in the mature form in a phylogenetic series, it is necessary to suppose an "unequal action of earlier inheritance." It is necessary to imagine that earlier inheritance acts most strongly upon the latest-acquired characters, and gradually decreases in potency in respect of earlier-acquired characters. Therefore, while the earliest embryonic stages are practically unaffected by the law of earlier inheritance,* there is a tendency of the earlier infantile stages to become later embryonic stages; there is a greater tendency for the earlier adolescent stages to become the later infantile; there is a still greater tendency for the earlier adult stages to become the later adolescent; and so on increasingly in proportion to the lateness of the stage. As it is impossible to mark earlier inheritance, except when different characters accompany different stages, the law may be stated as follows:—

*The earlier inheritance of a given character diminishes from generation to generation.*

Under these circumstances, however, it is reasonable to conclude that though ontogeny repeats phylogeny in a general way it cannot repeat it with truth; because if, in the phylogenetic series, a short but very pronounced stage were followed

* The starting point being always the same.

by a stage during which no great change occurred for a long time, the latter stage would, in successive generations, encroach upon the former stage more quickly than the former stage encroached upon its predecessor; and ultimately the short stage must disappear. Thus there would be gaps in the ontogenetic record of phylogeny.

### The Elimination of Dissimilar Stages.

The unequal action of the law of earlier inheritance would appear not to be the only cause of such gaps in the ontogenetic record. The influence of economy also plays a part. When the phylogenetic series, by some developmental change—as for instance, reversion—acquires characters different to its last stage, but approximately similar to some preceding stage—when, say, the adolescent and senile stages are practically similar, while the adult stage is dissimilar—there is a tendency in the later members of the phylogenetic series to dispense with the dissimilar stage by the law of economy of growth; and in the course of their ontogeny, by passing directly from one similar stage to the other similar stage, to avoid the double change which would be required by the production of the dissimilar stage. This tendency becomes very potent when the dissimilar stage has been considerably shortened by "the unequal action of the law of earlier inheritance." This phenomenon may be referred to shortly as the "elimination of dissimilar stages."

### The Modification of Earlier Inheritance.

There is yet another phase of the laws connected with earlier inheritance to be alluded to; and it obviously depends on a similar force to that which governs the "eliminiation of dissimilar stages." Ontogenetical investigations have shewn me that although the embryonic and infantile stages of life are the morphological representations of what were the adult stages of some more or less remote ancestors, yet that, in certain cases and under certain conditions, they do not represent these formerly-adult stages with complete accuracy.

It happens that certain characters of these formerly-adult stages are suppressed in the embryonic and infantile stages, although the other features of these formerly-adult stages are faithfully reproduced. Such phenomena may be explained by supposing that such suppression was due to a modifying or controlling action guided by the requirements of the individual; and that such action was therefore adaptive, and to the advantage of the individual at the time. These ideas may be expressed as follows:—

"*The embryonic and infantile stages may not always exhibit all the characters of the stage of development of which they should be the morphological representations, but they may only exhibit such features as are suitable to the individual's requirements, suppressing those unsuitable, especially when such suppression, whether temporary or permanent, is to the advantage of the individual on the score of economy.*"

The conclusions now arrived at may be summed up as follows:—

So far as the conditions of environment allow, the offspring tends during development to exhibit the various phases of its parent's life at an earlier age than the parent exhibited them*—the tendency to earlier exhibition increasing in proportion to the lateness of the character; that the offspring tends to direct development by eliminating dissimilar stages of growth on the score of economy; and for the same reason it is wont to suppress or modify, in its embryonic and infantile stages, characters unsuitable or not absolutely necessary to its development at the time.

## Progression and Retrogression of Development.

Developmental variations may be divided into progressive and retrogressive, as Ammonites very conclusively shew. When a phylogenetic series is developing successive new

* In the case of one or a few generations the "earlier inheritance" may be practically disregarded. Heredity may be summed up as "Ontogeny should repeat ontogeny."

features which are further elaborations of former features, and when such developments indicate greater and greater vigour, the inference is that the members of such a series are in a progressive state. On the other hand, when a phylogenetic series shews continued reduction and loss of those features by which it was formerly distinguished, and when such reduction is accompanied by appearances of decreased vigour, the members of such a series are assumed to be retrogressive or degenerating.

It may be advisable to briefly consider the causes which would affect progression and retrogression.

When vitality is maintained by the lowest possible expenditure of force, and there remains over a considerable surplus of force beyond what is required to sustain life, progression would be the result; while under opposite conditions there would be retrogression.

Change in the temperature, and change in the composition of the medium by which the organism is surrounded may entail upon it a greater or less expenditure of force in order to maintain life, and so may affect it favourably or the reverse. Similarly the quantity and quality of the food supply, and the difficulty or ease with which it is obtained entail a greater or less expenditure of force favouring retrogression or progression as the case may be.

Without, however, assuming any great change in the environment of an organism, the laws which would govern the appearance or elaboration of a new character may be stated as:—

1.—Increased use—the character is of advantage to its possessor for use or ornament. Increased use means that more than its due share of nourishment must be received by the part used, and greater nourishment means increased proportionate growth.

2.—The transmission of the character in accordance with the laws of heredity laid down, and with the laws which regulate the transmission of variation.

On the other hand, the laws which govern the degeneration and disappearance of a character are :—

1.—Decreased use—the character being less serviceable requires a less amount of nutriment; and a less amount of nutriment being received the character is not elaborated in proportion to the other characters of the organism.

2.—Economy—the character being less serviceable or ornamental it is deprived of nutriment in order that such nutriment may be more advantageously used elsewhere.

3.—The transmission of the character in accordance with the laws of heredity laid down, and with the laws which regulate the transmission of variation.

It may be remarked that among Ammonites progressive features occur in a definite successional order; while retrogression which may commence at any time is the reversal of the order of progressive acquirement—an individual or a phylogenetic series as it grows older, losing the progressive features one by one, in the reverse order to which they were acquired. There may also be retrogression in certain features and progression in others going on at the same time; and, further, retrogression and progression may be alternately shewn in the phylogenetic series.

When retrogression and progression go on together, the loss of features, in the reverse order to which they were acquired in progression, takes place of course only in relation to the part affected by the retrogression, or rather, degeneration. I shall notice the operation of this important law in the case of the hair of Man—the hair of the body being in a progressive state, and the hair of the head retrogressive: it is the hair of the head which degenerates in reverse order to acquirement —that is, "the last to come is the first to go." This is, in fact, the law of retrogression, only it is necessary to distinguish local retrogression from general retrogression.

Local retrogression may be due to alteration of habits and environment, or may be the economical accompaniment of local progression in another direction; but general retrogression arises from impaired vitality, and is usually—at least so Ammonites shew—the prelude to extinction. But when retrogression is local and arises say from disuse, while there is progression in other features more suitable to the organisms environment, a higher degree of development may thereby be obtained. It is reasonable to suppose that the more complex the organism the more likely is it to shew simultaneous progressive and retrogressive features.

The laws which govern progression and retrogression among Ammonites are certain to hold good in evolution generally, although they may become more complex in relation to more complex organisms. Some illustrations of their operation I shall give presently.

## On the Laws governing the Transmission of Variations.

From the facts given by Spencer* concerning the transmission of such abnormal Variations as supernumary digits, it may be gathered that there is no certainty in regard to their appearance in the offspring. They may not be transmitted at all; they may appear in the next generation in some members, and not in others; and they may skip a generation entirely, to reappear in some members of the next. Further, these variations when transmitted are not confined to one sex, but may appear in either sex.

Of pathological variations I have mentioned two classes—one due to injury, the other due to disease. Whether variations due to injury—mutilation for example—are inherited there is little evidence to shew. Darwin † has one or two remarks on this head, which are not altogether convincing. I may say that among Ammonites are many cases in which

* "Principles of Biology," p. 258; quoted from an Essay by Dr Struthers.

† "Descent of Man," 2nd Ed., p. 60.

injury has altogether altered the ornamentation of the shell. Such injury has invariably caused reversion—the ornaments of a fairly remote ancestor appear in consequence of the injury; and this has led me to say in my Monograph that Atavism is a consequence of diminished vitality, whether such enfeeblement is due to old age or to injury. But so far as the inheritance of variations due to injury is concerned I have not yet noticed anything of the kind.

Of variations due to disease—the word being used in a wide sense to include the effects of any suddenly unfavourable conditions of life—Ammonites furnish several examples; although it is not always easy to distinguish between the effects of disease and long-continued retrogression. In the latter, however, there are definite stages to be passed through; but if some of these stages be omitted and the Ammonite shews any abnormal features it may be considered as influenced by suddenly unfavourable surroundings. *Oecotyptius refractus* appears to be an instance of variation due to disease being inherited.* Concerning *Oecotraustes cadomensis* (d'Orbigny) I am not so certain; because to produce this form retrogression had proceeded regularly, and the abnormal whorl-shape may only be the further continuation thereof. The lopsided Ammonites of the Lias, which d'Orbigny called *Turrilites*, are certainly variants due to disease or unfavourable conditions; but whether this peculiarity was inherited, or whether it was simply the

[* I extracted the following from the 50th Report (1891) Bristol Distr. Institution for Deaf and Dumb, p. 14, Bristol, 1892, (kindly sent by Mr Lucy.) It is of interest in connection with Abnormal Variation and its inheritance.

"From cases investigated it was found that there were 46 children born whose parents were pupils at the Institution, and none of those suffered from the physical infirmities of their fathers or mothers. There were 12 instances of deaf and dumb couples, 13 where the husband only was deaf and two where the wife was deaf and dumb. Out of 138 cases enquired into of pupils received at the school it was discovered that with one exception their parents were not similarly afflicted. The causes of this sad affliction are various, but 60 % are born deaf and dumb. Variation I., 1, p. 263. And the next most prolific cause is scarlet fever." Variation I., 2, p. 264.]

effect of the same unfavourable conditions on the various members of the species cannot be stated definitely.

Coming to normal or developmental variations everything seems to point to the conclusion that they are regularly transmitted from one generation to another—that, in fact, developmental variations are regularly inherited—subject to the laws of earlier inheritance which I have laid down. There is, however, a limitation attached to this. The transmission of developmental variation is apparently confined at first to the sex in which it appears, but, afterwards, that is when by the operation of the law of earlier inheritance it has come to appear early in life, it is transmitted to the other sex also. At what time of life it makes its appearance in the other sex in consequence of such transmission I cannot say, but I am inclined to think that it would be late in life. It would then tend to become earlier and earlier in that sex also, and would in course of time become a fixed character, transmitted to both sexes equally.

The above surmises are warranted by the facts which Darwin has brought forward in "Descent of Man," and especially by the conclusions which he has derived from those facts; although he seems to have been guided by the idea that a variation nearly always appeared at the same time in succeeding generations.

The law of transmission of variations which he lays down (p. 232, 2nd Ed.) is: "the variations which first appear in either sex at a late period of life tend to be developed in the same sex alone; whilst variations which first appear early in life in either sex tend to be developed in both sexes."

The latter remarks apply, in so far as they relate to first appearance, to abnormal variation about which I have remarked above (p. 272); but considering the laws as a whole, especially in connection with the facts Darwin gives about the time of appearance of horns, I think developmental variations would be transmitted as I have said. Such transmissions would, so to speak, account for several facts—for sexual characters such as horns being confined so often to one sex—for their appearance in both sexes by supposing that they had been acquired earlier in the phylogenetic series, and had been transmitted for a longer time than those which appear in one sex only—for the occasional appearance of male characters in aged females, as the cock's crow and feathers in an old hen, or the more than incipient hairiness of the chin and lips sometimes shewn by women of our race.

That in Man the mental qualities of the male are superior to those of the female is explained by the sexually-limited inheritance of the latest-acquired characters; that on the other hand man has not become "as superior in mental endowment to woman as the peacock is in ornamental plumage to the peahen"* may be explained by equal transmission of characters which have come to appear early in life. If this law—sexual limitation in the transmission of adult characters, equal transmission of earlier characters—hold good, it will be of considerable importance in predicting the future development of species.

## How the Transmission of Variation would affect the Origin of Species.

It is not difficult to understand the origin of species if the surmises that I have submitted, concerning the transmission of developmental variation, are correct. The greater and greater elaboration of any particular features, in, say, an adult male, as functional modification necessitated by environment, are transmitted to the male sex alone, and appear earlier and earlier in that sex. The greater and greater elaboration of these features results in the course of time in the formation of a marked and distinguishing character in the male sex; and this character being transmitted in accordance with the law of earlier inheritance ultimately appears early in life in the male. Then the character tends to appear in the female sex also,

* Darwin, "Descent of Man," 2nd Ed., p. 565.

though why it does so is not clear. By such process, however, there arise both males and females which possess characters different to those which their ancestors possessed.

By the time that this character, influenced by the law of earlier inheritance, appears at an age early enough to be transferred to the female, the male has probably either further elaborated this character—which further elaboration is at first transmitted to the males only—or he has elaborated something else so much that it seems like a new character, which is transmitted in the same way. In course of time this further elaboration, or this new character as the case may be, is transmitted also to the females; and so it becomes plain how, merely by the gradual transmission of developmental variations, both sexes of what may be called an incipient species, beginning with a slight variation in one sex alone, are able to diverge wider and wider from the original stock.

The same laws of transmission would of course hold good if the developmental variation arose in the female in response to changes of environment; while if both sexes were exposed to the same changes of environment necessitating the same functional modifications to be acquired to bring them into better adaptation with their surroundings, it is reasonable to conclude that the result would be the production of a greater difference in a shorter space of time.

Thus it is clear that the gradual accumulation of slight developmental variations transmitted in accordance with the law of earlier inheritance would be sufficient to cause the origin of various species; and at the same time there can be little doubt that this cause has also been assisted by both Natural and Sexual Selection in the production of diverse species from one original stock. I am inclined to think that developmental variation has been more important in the origin of species than has abnormal, or as Darwin calls it "spontaneous" variation. The transmission of such abnormal variations as supernumary digits seems to be so much more uncertain than the transmission of developmental variation; while practically speaking the origin of Ammonite-species seems to be almost entirely attributable to developmental variation.

Specialized structures like the long neck of the giraffe and the proboscis of the elephant, to take familiar instances, are, in my opinion, developmental variations. They did not arise, in the first place, in certain members of the pre-giraffian or pre-elephantine species, as abnormal or "spontaneous" variations which gave their possessors such great superiority over their fellows in the struggle for existence, that those possessors survived by the law of Natural Selection. These features began imperceptibly—the neck and the nose grew more in proportion to other features during the lives of the individuals, on account of the habits of the animals; and they may be compared in this repect to the enlarging skull of civilised Man.

As the features of the adult become in course of time features of the adolescent by the law of earlier inheritance, the elongation of nose and neck would become exaggerated from one generation to another. I do not see any reason to suppose, at any rate at first, that the giraffian or elephantine ancestors were the favoured individuals of the community, and that the other members died out because they did not possess elongated necks or noses. I do not suppose that all the members of the species possessed these features in the same degree; but I do imagine that a gradually increasing elongation was more or less common to all the members of the pre-giraffian or pre-elephantine species as a result of their habits.

To take the case of the giraffe alone, for the sake of clearness—it is hardly necessary to suppose occasional droughts during which those members of the community with the longest necks would survive, while others starved because they were not able to reach such high branches as their longer-necked fellows. An extra inch or so of neck could not make so much difference as this.*

[* The adults would have the best of it in a drought on account of their larger size. Therefore if there were a long-necked "sport" among the young pre-giraffes it would have no chance against the adults unless its neck were of a preternatural length.]

I do not say that the giraffe or its ancestors have not had the best of it when there was a struggle for existence, and that natural selection has not played its part; the fact of the giraffe's existence is proof enough that it was better adapted to its environment than some of its competitors; and the longer the neck grew doubtless the greater superiority the animal would possess.

As to the short-necked forms which would connect the present giraffe with the stock from which it originally came, their dying out is not difficult to explain. The law of earlier inheritance allows us to imagine a small beginning becoming more accentuated in all members of a species as time goes on; and as the shorter-necked forms were really the parents of the longer-necked forms the disappearance of the former would be due, as the lawyers say of a lease, to effluxion of time.

Arising from and co-existing with developmental variation there seems to be another factor important in differentiating species; and this is the time when the offspring is produced.

Offspring produced early and offspring produced late in the life of a parent shewing considerable developmental changes between early and late maturity, or between early maturity and senility, would in all probability differ to a certain extent. It is, I think, reasonable to suppose that if there were, say, a decline of vigour after a certain period of the parent's life, the offspring produced after this time would be more likely not only to be somewhat less vigorous altogether, but would probably exhibit declining vigour at an earlier age than those produced before any decline of vigour set in.

This seems to be a reasonable deduction from what is observed in phylogenetic series of Ammonites, where from the same stock arise one series which continue to progress, another series which retrograde, though both lived together and were presumably subject to the same environment.

More marked still would be the effects if from any cause there arose a difference among members of a species as to the time in their lives when offspring were produced. There is the case in Man—the professional classes defer marriage till late in life, agricultural labourers marry very early.

These surmises illustrate what may be supposed to be accomplished in the differentiation of species by the transmission of developmental variations in accordance with the law of earlier inheritance. Further consideration will shew that, if some members of a species acquire, on account of environment, habits necessitating the increased use of one part, and other members acquire other habits with different results, and so on, there would, in course of time, arise from one original stock two or more species very different to each other or to the parent form—simply because their small initial differences had been constantly increased by the action of the law of earlier inheritance.

# PART II.

## THE APPLICATION TO MAN.

### Characters of Man—Hair.

I have now given some laws which seem to govern inheritance: I wish to apply them to Man. Just as I should take an Ammonite in hand to point out its ancestry from a study of its earlier whorls, and its posterity from observation of its later whorls, so would I take Man with the same intentions. There is, however, this difference—a very important difference. Man does not, like an Ammonite, furnish the record of his own ontogeny. It is necessary to have specimens of all ages; and this introduces a danger—that the differences may be phyletic and not merely ontogenetic.

To trace Man's ancestry it is necessary to study the earlier stages of his life, because by the law of earlier inheritance they should be the morphological representations of adult ancestors of earlier periods—though there would be limitations as I have pointed out, (p. 268); to speculate on his future the later stages must be examined, because they are the morphological prefigurations of future adolescent, and other stages—in fact, what are senile stages to-day will in process of time be the adult stages presently, will become the adolescent stages of a more distant future, and the infantile stages of a very remote time to come—if the race last long enough. Natural selection may check but cannot stop this inevitable process.

The human fœtus, then, becomes the first matter for consideration; but, as this is necessarily a subject beyond my experience, I can only refer the reader to Darwin's remarks thereon in his "Descent of Man,"*—to the analogies which he finds between the human fœtus and the fœtus of animals, and to what he says of the development of the fœtus generally. One fact, however, I would notice—that the fœtus during the sixth month is covered by a fine wool-like hair—"the whole surface including even the forehead and ears is thus thickly clothed, but it is a significant fact that the palms of the hands and the soles of the feet are quite naked." †

Turning now to our infants, a most curious series of facts with regard to hairiness is met with. The infant is rarely born with long hair, though cases are recorded, Darwin says. Generally the infant is more or less covered with a fine short down, which is noticeable on the face, forehead, and shoulders; but there is variability in this respect. On the scalp, sides and back of head there is usually found a distinct covering of hair, sometimes as much as an inch in length.‡

Within about three months after birth very appreciable changes in the hairiness take place in our infants. There is a most decided reduction in the hairiness or woolliness of the body—so much so that only by very close attention can any hair be detected on many parts, for the skin appears to be smooth. On the forehead, however, there is a distinctly woolly coat; there is also a certain woolliness on the shoulders, and the back is more woolly than the chest and abdomen, but scarcely so woolly as the shoulders.

In the first or second month after birth there is a very perceptible reduction of the hairy covering of the scalp—in fact the hair is sometimes shed to such an extent that the scalp appears quite bald, and this is the condition in which our

[ * Also to Haeckel's "Anthropogenie," for very full details.]

† "Descent of Man." 2nd Ed., p. 19, 1888.

[ ‡ In the two-months'-old female child of a neighbour the forehead was rather thickly clothed with short hair, which grew upwards; by the side of the temples it grew sideways. The eyebrows were little more hairy than the forehead. There were short black whiskers reaching to the lower jaw. The forearms were singularly hairy inside.]

infants are generally noticed by the public. But the hair on the sides and back of the head is not shed in this manner—so that there remains a hairy band which starts from just in front of the ears, and passing above them continues round the back of the head. The shedding of the hair from the scalp and the persistance of this hairy band give to the infant's head the same appearance as that of a bald old man.

Soon after the shedding, in fact almost before it is completed, a second growth of hair can be detected. This second crop, which is usually regarded as the first, grows with considerable rapidity; but, while it is growing, there is a very noticeable difference between the hair of the scalp and the hair of the sides and back of the head. The scalp-hair grows quicker than the rest, and soon becomes longer. It is brought to a point over the forehead; but for some months after birth there is nothing more than down on the temples. The covering of the temples with hair is a much later process. The growth of eyebrows, I may remark, corresponds with the second growth of hair—in a very young infant there are usually no eyebrows noticeable.

Observations on some children between one and ten years old has brought to light the following curious facts about hairiness. Up to about six years old the back and shoulders are decidedly woolly, while the legs and arms are almost completely bare; and the front of the body is decidedly smooth. After this age there is a noticeable decrease in the hairiness of the back and shoulders, while the arms, backs of hands, and the legs are becoming hairy. Beneath the arms it is noticeable that there is a complete absence of hairiness or woolliness.

Continuing the subject—I believe I am right in saying that hair appears under the arms rather before sexual characters and accompanying puberty are acquired. In the males only, still later in life, the masculine character of hair on the face is obtained. The hair on the lower limbs and trunk still continues to increase, and last of all hair grows on the chest.

Before all this progressive growth has been completed the male begins to lose hair from the head. It starts at the temples, on which, as I remarked, it appears last in an infant, thus illustrating the law of retrogression; then the scalp gradually becomes more and more bare; and finally only a fringe of hair is left round the lower part of the head. The resemblance, between the bald head of old age at this stage and the head of the infant after what may be called its moult, is extremely curious; and it illustrates the law of retrogression—the part affected loses the latest acquired characters first (page 271).

From the variations of hairiness above detailed, the following surmises may be made. The very complete hairiness of the fœtus points to descent from an animal completely clothed with hair. The loss of hair during early infancy is a retrogressive character, indicating the fact that the hairy ancestors of man lost their hair. This loss of hair was no doubt analogous to the baldness of the head at the present day. Now baldness presumably arises from the increased use of the brain—the extra nourishment required by the brain is afforded at the expense of the hair and scalp. Possibly for the same reason—some correlations of growth on the score of economy—man's hairy ancestors began to lose their coats. It would commence as a developmental variation in maturity; it would pass by the law of earlier inheritance to immaturity, and presently to infancy. Such loss of hair may have been assisted by sexual selection—it may have been the fashion to prefer husbands or wives distinguished by being less hairy; but, without sexual selection, developmental variation and earlier inheritance would have caused this loss of hair in time.

It is possible to surmise the places from which this hair went first. The front of the body in children is conspicuously smooth, while the back is hairy. Now although Man is descended from an animal completely covered with hair, yet going further back, the abdomen and chest of quadrupeds—the underside of the body—is nothing like so hairy as the back—which is the upper and more exposed side. It may be assumed then that the hairy front of man's ancestors became more completely coated when it became exposed to the elements equally as the back; and in that case the hair on the front—supposing it to have been as thick as on the back—is the more recent character so far as regards any great quantity. In retrogression the latest acquired characters disappear first.

Following this law again, it may be assumed that the hair on the front, the insides of arms, and of legs disappeared first, then the hair from the limbs generally, then probably the hair from the face; while on the forehead, back, and scalp, the hair became very much reduced, but apparently there was a band of hair remaining over the ears and on the back of the head.

Somewhere in the history of the human phylogenetic series these changes were probably spread over the life-time of individuals—the loss of hair from the chest and belly, which had once been an adult character,* had come, by the law of earlier inheritance, to belong say to late infancy; and the other changes followed, in order, to, say, late maturity.

Then a change occurred.† For some reason—evidently the reason which makes the body and chest of an adult male become more hairy with advancing age at the present day—the scalp of Man became more hairy again. That the hair on the scalp has a different history to that at the sides of the head may be known because, when it reappears after the infant's temporary baldness, it grows very considerably quicker than the hair at the sides, and soon passes that in length. A friend tells me that in some members of his family the hair on the scalp grows upright, whereas the hair at the sides of the heads grows in the usual manner—another piece of evidence to the same point.

[ * In an adult Gorilla in the British Museum, and in an old Yellow Baboon in the Zoological Society's Gardens, the chests are considerably denuded of hair. These facts also illustrate the law of retrogression.]

† The following remarks only apply to our own race. Other races, though obviously progressing in the same manner, have not preserved the same relative proportional development of characters.

This reversion—growing hair again on the scalp—was, at first, an adult feature; and it became earlier as the phylogenetic series progressed. Not improbably it was aided by sexual selection. Later still, hair made its appearance on other parts of the body and limbs—notably, however, where hair had probably been very feebly developed in the earlier members of the phylogenetic series. As an instance of this take the hair beneath the arms—a place very bare in quadrupeds.*

Still later in the phylogenetic series the moustache and beard reappeared in the male. Finally, there is an appearance of hair on the chest; and a loss of hair from the head. The latter is principally confined to the male, which fact makes it possible that the female first acquired this ornament. The hair departs from the head where it appears latest in the infant, and, therefore, presumably latest in the phylogenetic series—namely, the temples. Then the scalp becomes affected.

In considering the various appearances and disappearances of hair from Man it is worth noticing how little the popular explanations of baldness—wearing hats, machine-brushes, and other absurd reasons—can have affected the matter. Not only do the classes—who are bald—wear hats much less than the masses, who are but little affected in this way; but in spite of wearing a continuous covering like clothes, Man becomes decidedly more hairy on the body as he grows older.

### The Direction in which Hair grows.

I have a few words to say concerning the arrangement of hair in Man. In the first place, however, it is necessary to consider the laws which would govern the direction assumed. These would be :—

1.—Gravity.

2.—Influence of surrounding media.

3.—Muscular action, and the amount of secretion.

4.—Heredity.

[* It is curious that the parts almost bare when the others where hairy should become hairy when the others are bare. The inside of thighs is another example. It looks like compensatory development.]

Gravity requires little explanation. That, in the absence of other influences, hair would tend downwards, on account of the ever-present force of gravity is obvious; but, as hair is a light substance, the pull of gravity would not be strong, except in the case of long hair. The influence of surrounding media must be considered under two headings:—

1.—The direction either through air or water which the animal usually takes.

2.—The direction which air or water takes with regard to the animal.

It is obvious that an animal moving head-first through air or water would have its hair arranged to point backwards. Whether the hair always retained this direction would depend on the constancy of the motion and the potency of conflicting influences. The direction of the hair on a rabbit plainly accords with its motion through the air—even the hair on the ears grows towards the tips.

Under the second heading, if an animal were to be stationary and retain the same position, at any rate frequently, with regard to the direction of wind, or the flow of water, its hair would obviously become directed the way of the wind or water. But the influence of rain must also be reckoned as flow of water, and, as rain flows off an animal in accordance with gravity, it is obvious that the assistance of rain will tend to point the hair in the same direction as gravity tends to pull it.

Roughly-speaking, then, rain and gravity pull the hair perpendicularly; while motion through the air tends to arrange the hair horizontally. If one set of forces be in the ascendant the hair will assume a position in accordance; but if the forces are nearly equal the hair would assume a curve, either horizontal-perpendicular, or perpendicular-horizontal, according to conditions.

Muscular action can overcome other influences, and give to the hair, say, an upright position, as in the familiar instance of an angry cat, or the human being under influence of fright. But it would require a great amount of force to be expended to overcome the opposing influences permanently; so when this is necessary extra secretion is brought into play, and the hair is made of sufficient stiffness in proportion to its length to stand the strain of a position contrary to incident forces. The so-called whiskers of the cat, rabbit, etc., are familiar examples: they are made of sufficient strength to withstand the pull of gravity, while the animal has the muscular power to turn them so that they may not impede its movements.

In the same manner the ornamental arrangement of hair on the top and around the heads of certain monkeys must be sustained in its position contrary to the pull of gravity, and contrary to the flow of rain by the strength of the secretion.

Lastly, to come to Heredity. The hair, having on account of the various forces by which its direction is controlled, assumed a definite lie with regard to the body, would retain that position by the force of heredity, even when the animal's descendants had permanently acquired a different carriage of the body, which changed the relationship of the hair in with regard to incident forces. It is, however, plain that as the strength of heredity would be a diminishing quantity, while the strength of other forces would be constant or increasing, the hair would in time tend to assume a direction in accordance with the newer conditions to which it might be exposed.

In Man the position of the hair would not be affected by any motion through air or water in a general way, nor, except in very savage nations, would it be influenced greatly by the flow of rain. On the other hand, in Man's pre-human ancestors such forces must have acted upon the hair, and influenced its direction; and such direction would have become hereditary.

On Man's head the hair grows, roughly-speaking, from the crown to the forehead, and from the crown to the nape of the neck. The latter is in the direction which would be expected; but the former is, to a certain extent, opposed to gravity—at any rate, in regard to such hair as lies between the crown and the top of the skull.

In a woman the hair is made to grow in one direction, namely, from the forehead to the neck; but this is not what would be called its natural position. It has been made to assume this position in order that it may not cover the face, which it would do if it grew in the same direction as in the male. A woman's long hair is so much under the influence of gravity, on account of its length, that it would fall off the head in any direction in which it might be placed.

A female infant shews that the hair growing *from* the forehead is a recent acquirement, because here the hair grows from the crown over the skull *to* the forehead, as in the male. (See Plate, fig. 1.)

The growth of the hair towards the forehead is directly contrary to what would obtain in any quadruped which had to run swiftly; and as the contrary direction—namely, from the forehead—is found in such different animals as the rabbit, cat, cow, dog, pig, etc., I am inclined to think that the backward direction must have become a well-established character. On the other hand, the forward position must have been acquired for ornament. It may be an hereditary mark of a time when the hair came to the forehead and then rose up in a frill (for ornament), or some such arrangement as shewn in Darwin's "Descent of Man," 2nd Ed., p. 549, in his figures of monkey's faces. The notion of the frill is supported by the fact that with little persuasion children's hair assumes such a position, known as a "*brutus*"—a word of which I will not venture the etymology.

The fact that the short hair on a child's forehead grows upwards further supports the idea of a frill. That the hair grows upwards, which is contrary to gravity, is due to inheritance—to grow from the eyes backwards must have become a firmly established feature in quadrupeds owing to windage; and it would be retained by inheritance in slow-moving descendants, unless altered for ornament or by gravity.

The reason why hair should grow in a kind of circular manner as it does on what is called the crown of the head is not clear to me. It is the result of the hair growing different ways; but why the hair should not radiate from one point instead of assuming a kin l of circular twist is not obvious.

There is such a crown on a cow's face, between the eyes, and the circular growth is often strongly marked. The hair below—on the nose—grows downwards to the nostrils; the hair above—on the forehead—grows up and back to the horns. The hair grows the same in a cat, but there is no definite crown.*

Darwin has remarked on the growth of the hair on the arms—that it grows upwards to the elbow on the hinder part of the forearm; and he suggests "that this is due to a habit of Man's ancestors sitting with their hands over their heads to keep off rain, as some monkeys do who have the hair arranged in the same way."

In quadrupeds the direction of the hair on the limbs should be downwards, in obedience to flow of rain; but on the forearm of a dog and a pig there is a very similar arrangement to what obtains in man—in the former, in fact, quite a slight upward turn at the equivalent of the elbow.†

It may be that Darwin is to a certain extent correct in his surmise, but the explanation hardly seems sufficient. It is necessary to explain the direction of the hair on the dog's and pig's legs; and rain does not seem the cause for this.‡

Further, in Man the downward growth of the hair on the inside of the arm and back of the hand does not accord with this idea of the hands clasped over the head, for in such a position the hair ought to grow on the backs of the hands in the same direction as on the forearm.

[* In the Bonnet monkey there is a very distinct crown on the back of the head; on the forehead and scalp the thin hair falls sideways from a central parting.]

[† There is on the forearm of *Cebus fatuellus*, Capuchin monkey, the same arrangement of hair as in Man.]

[‡ Motion through the air having more effect than rain, on account of its greater frequency, or any habits of seeking shelter might be a cause.]

## Characters of Infants, and what they point to.

In early infancy the baby is distinguished by its receding forehead, pouch-like cheeks,* and protruding jaws,† in fact, the whole face slopes outwards from the top of the forehead, so that the jaws are really the most prominent feature. The nose is short, much depressed, almost flat with the face,‡ except the end which is rather suddenly protruded. The end is well described in popular language, which compares it to a little button; it is obliquely truncate; the nostrils are large and open, rather widely separated from one another, so that the end of the nose is very broad comparatively.

When born, our infants have rather large heads; their shoulders and arms are much more pronounced in proportion to their size than in an adult; while on the contrary the buttocks and legs are of miserable dimensions. It is noticeable that growth is most pronounced in the legs after birth—which is not surprising, considering the shape the child has to attain.

Dr Louis Robinson in a recent number of the "Nineteenth Century"§ has given some curious facts with regard to infants. As the result of experiments on about 60 infants he found that "in each case, with only two exceptions, the child was able to hang on to the finger or a small stick three-quarters of an inch in diameter by its hands, like an acrobat from a horizontal bar, and *sustain the whole weight of its body*, for at least ten seconds. In twelve cases, of infants under an hour old, half-a-minute

* See Plate, fig. 1.

[†Certain African monkeys (*Cercopithecus*) have cheek pouches each side of the lower jaw, in which they stow food, as visitors to the Zoological Gardens may often notice. The baby's cheeks may be relics from a monkey which had cheek pouches rather higher up.]

[‡ In young infants there is very little bridge to the nose. Throughout life there is a progressive elevation of the bridge of the nose, (see Plate) while there is practically no growth in width.]

§ Nov., 1891, p. 838.

passed before the grasp relaxed, and in three or four nearly a minute." The strength increased with age up to two or three weeks, one infant of the latter age hung on "for *two minutes, thirty-five seconds*." He further remarks that "invariably the thighs are bent at right-angles to the body." *

The difficulty of opening an infant's closed hands is a matter of common knowledge; and, in the light of the above detailed experiments, the account of the infant Hercules strangling the two serpents sent to kill him in his cradle is not so mythical as might be supposed. It is noticeable than in early infancy the baby always keeps its hands either very tightly clasped with the thumb inside, or half-closed in the form of a broad hook. Its fingers are nearly all of the same length, the length of the hand is short compared to the breadth—in fact the length of the middle finger is equal to the width across the knuckles, while in an adult it equals half as much again. Further, the power which an infant has over its hand and fingers is extremely small, so far as flexibility is concerned. It cannot flatten its hand out, but can only open it to a semi-clasped position; it appears to have no ability to spread out its fingers or to bend its wrist to any degree. It is very awkward in moving its arms; and has so little power to guide them that it is unable to put its food directly into its mouth: it first hits itself in the eye and then turns the head to bring the mouth up to the hand.

Turning to the feet and legs, which are, so far as size is concerned, really in what might be called an undeveloped condition, it is remarkable to find that with them the infant can perform movements of which an adult is practically incapable. In fact, the infant has more power over the muscles of its toes and feet, and greater flexibility in its joints than an adult, yet it is unable to support even part of its weight on its legs. Without moving any other part of its legs the baby can so twist its foot that the outer edge shall be in a direct line,

* The whole article is worth reading, but the facts in connection with infants acrobatic performances are extremely curious.

transversely, to the legs—the soles of the feet being brought flat together.* Further, the baby can move its toes one by one, it can spread its toes out fan-like, it can move each toe laterally to make a V between any of them—a movement which many an adult cannot accomplish with his fingers—it can separate the big toe particularly far from the next—there being already a well-marked space between them; it can retract the big toe with the last joint bent in the same way as an adult can retract his thumb; in fact, it can move the big toe just as an adult can his thumb.†

Now the ability to perform all these varied movements is lost as the child grows older, instead of becoming more marked as it gains in strength; and just in proportion as the ability to move the toes decreases so does the power over the muscles of the hand increase.

If we make enquiry among people in general as to why a baby differs so much in structure, intelligence, and habits from an adult one receives answers not altogether to the credit of the general intellect. "Because it is a baby"; "because it must have shape and habits of some kind"; "because if it did not differ it would not be a baby," are some of the answers I have obtained. Such answers are no explanation at all.

If, however, the law of earlier inheritance hold good among the human race as among Ammonites—and if it does in the latter it must in the former—the explanation of the baby's difference in structure, habits, etc., are, as in the case of the infantile Ammonite: the various phases of babyhood are approximately the morphological representations of various adult ancestors; these phases acquired the characters of these ancestors by the law of earlier inheritance.

* The shape of an infant's foot should be noted. The toes nearly all of the same length—the second, however, being longest of all—the front part of the foot almost square across; while, behind, the heel is extremely small and attenuated.

[† The big toe and the thumb are the only digits in which normally the last joint can be moved independently of moving other joints.]

The hairy coat, the short tail, and the arms as long as the legs* of the human fœtus point to a quadrumanous or quadrupedal, tailed, hairy ancestor—in fact, a monkey. Much of the hairy coat is shed before birth;* but very much of it remains to be shed in the next three months. The lower limbs are rather longer than the upper when the infant is born, but are in an undeveloped state compared to the adult. The short tail has disappeared, but a rudiment exists in the skeleton. Nowhere, however, have I seen it stated that when the infant is born it bears on its body what must be regarded as excellent evidence of descent from tailed ancestors; but such is the case. At the very base of the vertebral column, exactly where the continuation of the vertebræ—the tail—would be protruded through the flesh, there is a small, deep, circular depression, extremely noticeable in newly-born children. This depression is exactly like the scar which would be left if an animal's tail had been amputated at the root—when the wound had healed. That this circular depression marks the place where the tail protruded is shewn by its position; and that it is due to the muscles not having occupied the space left vacant by the withdrawal or loss of the tail is very plain. This circular depression, or tail-mark, which is sometimes quite a quarter-of-an-inch deep in the infant, becomes shallower as the child grows older. In a girl of five years, however, what I may call the tail-mark is still very noticeable; but in older children it has practically disappeared.†

It may be concluded that in Man's ancestors the tail was considerably shortened before the hairy coat was lost; and that in later generations, when the body became smooth, the tail had practically disappeared. The loss of the tail no doubt began with disuse.

* Louis Robinson, *op. cit.*

[† In an adult female Gorilla, in the British Museum, the tail-mark is as large as a florin. Its persistence is probably accounted for by the Gorilla not having attained the upright carriage.]

I cannot agree with Darwin's method of accounting for the loss of the tail—that the monkey found it in the way when it sat down, that the tail became injured and abraided in consequence of its sitting-down habits; and that such mutilations were inherited, resulting in a shorter and shorter tail.*

The effects of disuse, including what I may call non-requirement—the tail from some cause, not growing in full proportion to the rest of the body—possibly also economy of growth on account of the material being required elsewhere—would account, by the law of earlier inheritance, for the gradual shortening and final disappearance of the tail in the generations of ancestors preceding Man.

Loss of hair I presume to have arisen, as I said before, as a correlation of growth on account of changed habits; † but the loss of hair might very likely have been accelerated by sexual selection. I am also ready to admit that the tail may have come under the same influence.

It must, however, be remembered particularly that in neither case would sexual selection be the first cause of failing hair or shortening tail. Sexual selection would certainly not come into operation until some other causes had reduced the hair and tail so as to render certain members of the community conspicuous in these respects.

If sexual selection did come into play it would cause those who exhibited tail and hair in full vigour to be looked down upon by their less well-furnished companions. The compliment would, no doubt, be returned; and then contempt might become active in inducing hatred and feuds between the rival parties. In this connection it is curious to notice that beings for which Man wishes to express scorn, as well as those which he hates because he fears them, are represented as having tails.

* Darwin, "Descent of Man," 2nd Ed., p. 59, 1888.

† Or from economy—the material which maintained hair being more urgently required elsewhere, as in adult Man's scalp to-day.

The devil of the Christian religion will at once occur to mind; but the Satyri of the Roman religion are still more interesting. They are represented with bristly hair, pointed ears, and a tail among other features; they inhabited woods and were greatly feared by travellers. Not at all improbably there was constant war between the smooth-skinned, tailless ancestors of Man, and their less-changed, hairy cousins, whom they looked upon with contempt for their shape, as well as a wholesome fear for their wilder ways; and the memory of these wild cousins has very probably been handed down and become the foundation of such creatures as Satyrs and Devils, though lapse of time has altered and added to their characteristics somewhat.

I have remarked on the ability of an infant with its toes. Such ability is lost among our children in less than eighteen months, even if the child have never worn boots; but it is impossible to think that this ability was always confined to the infantile stage. It is of no possible use to the child; and many of the movements are those which would not be performed in walking. But these movements become intelligible by the theory of earlier inheritance. Looking at monkeys and their manner of using their hind limbs explains the child's movements. The power to twist the soles sideways would be necessary in tree-climbing; the use of the big toe as a thumb and other movements have been often enough explained.

No doubt as the monkey-ancestors grew older they became more and more expert with their feet, just as we become more and more expert with our hands; and the ability of the adult monkey with its toes has become the ability of the human infant to-day.*

The loss of this ability, and the movements of a child before it can walk correspond to the manner in which the pre-human, tree-climbing quadrumana gradually lost their cunning with their hind-hands, through using these more and more as their only means of support. When the infant is first stood by its mother on her lap, it always stands on the outer edges

* An infant monkey, it is asserted by many writers, is a helpless animal.

of its feet, or rather of the front part of the foot—the heel is not put down; and when the child first tries to walk it always does so on its toes—the ankle and heel which correspond to the monkey's hock and *os calcis* being elevated and kept off the ground, as in monkeys walking on a branch. Further, the child is more or less bow-legged—the result of its ancestors' tree-climbing habits; it turns its feet in, and it curls its toes, especially the big toe, as if to grip the carpet—just as a monkey would have to do to grip a branch. Often at this stage the child will progress for a while and then support itself on all fours. Only at a later stage does the heel touch the ground, while the feet are turned straighter in front. By this time our children have almost entirely lost that peculiar ability to move the toe- and ankle-joints, which they had just after birth.

All these processes represent the manner in which the adult monkey-like ancestors must have acquired the power of walking. Just as a man does not acquire the character of a definitely-formed hand-writing until nearly mature—and even after that gains greater and greater speed with practice—so it is reasonable to imagine that the monkey-ancestors, or whatever one calls them, were, at one stage of the phylogenetic series, unable to bend their hocks sufficiently to touch the ground until they became mature, and had had much practice. So to walk as we are able to do now must have been an accomplishment only acquired by adults at a still later date in the phylogenetic series.* During all these stages, too, there would have been a gradual reduction in the length of the metatarsus, as the enormous leverage would be very unnecessary.

The gradual loss of power over the muscles of the toes and ankles has, among our own children, been accelerated by the practice of wearing boots. Even in this matter, however, earlier inheritance is exemplified; because when boots first

[* This is proved by the adult Gorilla, which, though a very powerful animal, is unable to walk freely on its hind legs—it helps itself with its arms. In power of walking the adult Gorilla is a morphological equivalent of a twelve months'-old human infant.]

came into use this early loss of power could not immediately have been the result. Such loss would have been gradual, and would become, as in fact it does now, more pronounced the older the individual. It may be reasonably assumed, therefore, that at one time, even in adults, there was greater flexibility of these muscles than there is now in our own children; and, if such were the case, our own children can only have obtained this loss of power by earlier inheritance.

In savages the toes are said to be much more perfectly articulated than in civilised man; and this would bear out the argument. It would also shew that the loss of power has been accelerated by boots, though correlation of growth may also have played a part.

Turning from the feet to the arms and hands, the remarkable facts recorded by Dr Robinson prove undoubtedly the descent of Man from arboreal quadrumana. Infants are able to perform a feat which, as he remarks, "would tax the strength of many an adult." This power has been gained, in my opinion, from adult monkey-ancestors, in accordance with the law of earlier inheritance: for it is presumable that when, far back in the phylogenetic series, monkey-like animals* first took to an arboreal life, their young would not have possessed such power as this. In course of generations, however, the young obtained at any rate some of this power by earlier inheritance. The same law would hold good in the case of human infants in relation to adult monkey-ancestors; but at the same time, though the babies of the phylogenetic series have acquired this strength from their adults by the law of earlier inheritance, yet the reason our children retain any portion of this strength is due to the habits of young monkeys. (See page 305).

With this strength of arm, however, there is a want of flexibility in the hands. In very early infancy the hands have a semi-clasped hook-like shape which ancestors might have developed from the habit of constantly grasping boughs—

[* Like the Lemuroidea, for instance.]

especially if they used the hands for that purpose and for no other. That such an idea is not unreasonable anyone may know by the difficulty experienced in unclasping the hands after having subjected them to severe muscular strain in a clasping position; and, further, Darwin tells us that certain species of monkeys, from habitually using their hands as hanging hooks, have developed hands in which the hook-like form is permanent—the fingers have partially grown together, or in some species the thumb is absent.*

### Some further Characters of Children.

I may in this connection notice some other characters of infants and children. When, after birth, infants are placed on the knee they have an instinctive dread of falling, and will cling on to the arm or anything with a very strong grip.† Later, when carried on the arm they will, apparently quite unnecessarily, support themselves by grasping, preferably, the mother's hair; they take a great delight in clutching their father's beard, and, in fact, anything of a furry nature. Several observers state that monkeys hang on to the mother's hair to be carried about; and this may also explain the pleasure which children take in being ridden pick-a-back. The delight a baby feels in getting its clothes off—the joy of babies and children at being tossed in the air or jumped about—their pleasure in coming downstairs head-first—the fear of even small babies for strangers‡—the fondness of children for noise—their liking

* Darwin, "Descent of Man," 2nd Ed., p. 51.

† This happens even when first washed—about an hour after birth. My wife has many times remarked to me that the baby could grip her hard enough to be painful—this would be at about ten days old.

‡ The power to recognise strangers is exhibited in babies very early indeed; and they are generally frightened at them. They express their fright by a scream, and by trying to turn away. It may be noted that the infant's scream of fright or of pain is very shrill and entirely different to the ordinary cry or yell when it requires food or wants to be nursed. Infants also possess another cry—a sort of cooing noise of pleasure; but this is not developed so early.

for sweet things—their capacity for fruit, even the most hard and unripe—their love of stealing, of hiding away in corners to eat—these are not the result of mere cussedness on their part, but are characteristics inherited from monkey-like parents—characteristics which would have been the natural accompaniment of life in the woods, where they would have to spring from tree to tree, to get what food they could and how they could, and to possess, advisedly, a wholesome fear of strangers.

Further, take the manner in which our infants are got off to sleep—by rocking them in the arms or in the cradle. This, it seems to me, is an inheritance of monkeyhood; and the fond mother, while scorning the very idea of her darling being in any way connected with a monkey, gives you fair excuse for coming to a contrary conclusion when she imitates the to-and-fro swaying of the branches, and rocks her baby to sleep in the cradle, singing the while—

> "Lull-a-by baby on the tree top
> When the wind blows the cradle shall rock."

Whether some lingering tradition of a former arboreal life inspired the idea of this ditty I cannot say; but, undoubtedly, it fairly describes the kind of rest a monkey would have among the swaying branches. And the swaying of the branches would have become as important and absolutely necessary for the sound sleep of a monkey, as the motion of the vessel becomes to the repose of sailors—they make complaint of their inability to sleep soundly on land after a long voyage.

There are numerous other actions and habits peculiar to children which we call natural, simply because we are so accustomed to see children perform them, though why they should do so is not a question very often put. If, however, we consider that infants and children are the morphological representation of monkey-like ancestors and of savage Man, and if we think that some of the habits of the earlier stage would persist into the later stage partly by inheritance, partly by imitation, and partly by the same cause being potent, we can fathom the reason for nearly all the actions and habits of infants and children, and even for some of the strange ways of older persons (the fear of women for snakes). We shall thus see that the popular voice which applies the term "young monkey" to children is much nearer the truth than most people are inclined to admit; and if again we ask why these various habits arose in these ancestors it can easily be answered that they were the necessary results of environment, in the same way that the habits of adults at the present day are moulded by the exigencies of their surroundings.

Some of the habits of children seem to point not so much to monkeys as even to a lower grade in the scale. There can be no doubt that such characters are not spontaneous but have been inherited. For instance, the fondness of children for bones is curious. A child, I believe, seldom refuses a bone, even after the very fullest meal; and if it be allowed to run out of doors to gnaw it, its delight is increased tenfold. More remarkable still however is the fact that a sick child will greedily gnaw a bone when it refuses all other food—yet this is but an illustration of the law that atavic characters are more developed in a feeble state of the body.

It is well known that animals have a considerable distaste to eating or drinking after one another. Domestic animals, horses, sheep, and cattle, unless driven by hunger, will exhibit this tendency—in fact, horses are extremely particular about not drinking water touched by another horse. Children shew the same trait of character—they are extremely particular about not eating or drinking one after another. This cannot arise from any habit of cleanliness, as in their elders; for in the matter of want of cleanly habits children approximate closely to lower animals. It seems to me however that Natural Selection strengthened this character in the lower animals—that those who were particular not to eat or drink after others thereby escaped contracting diseases. Inheritance has preserved this trait in our children.

It is a matter of common knowledge that children almost habitually kneel up to go to sleep, and so bring all their limbs beneath them in a quadrupedal fashion. Dr Robinson has noticed this in the paper quoted. All my children have slept in this fashion as soon as they could shift for themselves, until they were about three years of age.* I know, however, of cases of adults who habitually go to sleep in this quadrupedal fashion; although they usually turn in their sleep. Some fond parents, thinking their own reason superior to the child's instinct, have gone to great lengths to break the child of this, as they thought, unnatural habit: more probably their efforts did much injury to the child's nervous system.

## On Rudiments.

I may, perhaps, add a few notes on rudiments, although they have been elaborately treated by Darwin in his "Descent of Man."

The ear is rudimentary so far as the outside portions are concerned—which are but remnants of the large ears possessed by animals. Darwin has called attention to the "projecting point,†" which is common in man. It may be noted that the overhung ears of terriers afford us a very good idea of the process by which this point would come to be the only indication of a formerly upright fold—first, the drop-over owing to disuse—second, reduction in size for the same reason.

The power to move the ears which most animals possess in a very marked degree has been lost through disuse in the case of Man and the Anthropoid apes;‡ but the muscles are present, only in a rudimentary condition. Sometimes they are slightly efficient in Man. I have a striking instance of this in the

* When a baby is cross, nurses often quiet it by turning it on its stomach across their knees.

† "Descent of Man," 2nd Edition, p. 11.

‡ The external ears of many of the Anthropoid apes are smaller and more rudimentary than those of Man.

case of a member of my family circle, who possesses the power to move her ears in an unusual degree. More curious still, when she wishes to listen intently she instinctively moves her ears, so that she actually and literally "pricks up" her ears in order to catch a sound. I have noticed that the upper portion of the ear is moved from the lower, though the whole ear is elevated.* The upper posterior part of the ear is moved towards the head, and the anterior part of the helix is moved forwards as well as slightly projected. There was also a circular movement of the whole ear. [As Professor Harker informed me that it had been stated the human ear could not be moved without the scalp, we arranged an exhibition for him showing that the ears could be moved quite independently.]

The senses of hearing, sight, and smell are possessed by Man, especially civilised Man, in a very inferior condition, merely because it is not of vital necessity that these senses should be kept at the high level of efficiency maintained by the agency of Natural Selection in the case of wild animals. That animals use the sense of smell more than sight in recognition of anything is proved by the way in which a dog recognises his master, and an ewe her lamb. The dog recognising the master tends to shew that each individual of the human species possesses a scent peculiar to himself,† although we are not able to recognise more than a general odour.‡ It would appear, however, that children have the sense of smell more developed than their elders; and they make use of it like animals. They are very particular not to wear each others clothes, which they declare to stink; but one of my girls, if asked whether a certain one of the various night-shirts be hers or not, does not recognise it by sight or touch, but says: "Dib

* The top part of the ear is elevated between three and four mm.

† There are probably also racial peculiarities of smell—Chinese asserting that the smell of Europeans is most distasteful to them; the Europeans returning the compliment.

‡ Negroes and Indians, however, can recognise persons in the dark by their odour. (Darwin, "Descent of Man.")

it me and let me 'mell it." One sniff; and she either rejects it with scorn if it be the wrong one, or complacently admits that it is hers.

The furrow which exists between the nose and the upper lip, and the point projecting from the upper lip are much more marked in children than in older persons. These are really vestiges of a former condition; for, to my mind, they obviously indicate that certain ancestors, somewhere in the phylogenetic series, possessed a divided lip—commonly known as the hare-lip, from the animal shewing it—and that the two parts of this lip have grown together again to form the single lip as we possess it. This idea receives further confirmation from the fact that in two of my children there is a distinct scar down the middle of the furrow.*

The mammae in the male are rudimentary, but curiously enough they are more developed in young boys than in young girls. Also at birth boys possess more milk than girls—in one boy it lasted for more than a fortnight. The toes are certainly in a rudimentary condition, and all but the big toe are probably on the high road to disappearance. So far is the rudimentary condition sometimes carried that I know a case in which the little toes are mere lumps of gristle, without bone. For the little toe to be without any joint is not an uncommon occurrence.

### Man's Characteristics in regard to Heredity.

The evidence which Man furnishes in support of the law of earlier inheritance is not so clear as in the case of Ammonites; because it is not possible to obtain as with the latter a successive series of the various phases of development, extending over such a space of time as is represented by Lias and Oolite. It may, however, be advantageous to briefly sum up what Man shews in this connection. The flexibility of the

[* In Häckel's "Anthropogenie," Vol. II., 4th Edition, p. 670, fig. 329, the human embryo is represented with a slit lip—the slit divides the nostrils too.]

muscles of the feet and toes must have been acquired by ancestors, as the result of taking to an arboreal life. Such flexibility would become more perfect in the adults by constant practice, and would be transmitted to their descendants earlier and earlier, so that those descendants would be able to reach still higher degrees of perfection. The same would be the case with the subsequent loss of the ability, owing to the abandonment of an arboreal life and consequent use of the hind limbs as mere supports on a flat surface. The young of such animals would still retain the old tree-climbing abilities and propensities; and only in later life would they, by constant practice, be able to assume something like the erect attitude. The ability to assume the erect attitude and to walk on the feet would be inherited earlier and earlier, and would in course of time appear as a character of the infantile stage—as in the human baby.

It is the same with the loss of tail and the loss of hair. It is impossible to imagine that these characters arose as spontaneous or abnormal variations in the infants of certain quadrumana, and that these characters gave to these possessors such preponderating advantages that they ousted all their rivals in the struggle for existence. But if it be impossible to believe this, how is it possible to account for the disappearance of hair and loss of tail in the infant about the time of birth, except by the law of earlier inheritance?

A case analogous to the loss of body-hair is going on at the present day—namely baldness; and as this occurs during maturity—even in some cases while physical strength may be at its maximum—we may assume that the loss of body-hair occurred in the same way at the mature stage of life in our ancestors. Then it was transmitted by the law of earlier inheritance—gradually, at the same time, becoming no doubt a more perfect and extended process in the adults—until at the present day the human infant loses the greater portion of its hairy covering by the time it is three months old. The same arguments may be applied to the other characters which I have enumerated; but I think these suffice to illustrate the evidence of earlier inheritance which Man affords.

Of "the unequal action of earlier inheritance" and of the "elimination of dissimilar stages" I cannot give any satisfactory proof from Man's ontogeny;* but I shall refer to these later when I treat of Man's future. Of "the modification of earlier inheritance," however, the human infant furnishes excellent examples. Although able to support the weight of its body by the arms directly after birth, it is unable to do the same with its legs; yet this want of strength cannot have been shewn by its adult ancestors. My theory supposes that this want of strength is, to a certain extent, adaptive—that since the young of Man or of monkey has not had to get upon its legs in order to suck the mother, strength of leg is not an absolute necessity of existence, and it has therefore been temporarily lost by disuse. At the same time the material which would have been employed to supply this strength is more advantageously and economically used elsewhere. If it were an absolute necessity that the baby should walk, it would be able to do so directly it is born, like calves and lambs.†

It may be objected that if the loss of leg-power is an instance of "modification of earlier inheritance," why has not the strength of arm been lost also since the human infant does

* Embryology would furnish proofs. Among Ammonites the proofs are numerous, and the reader is referred to my Monograph, published by the Palæontographical Society, 1886-1892, *et seq.*

† Kittens, puppies, and young pigs are very awkward in their movements, and quite unable to escape from any foe; these facts may be regarded as instances of modification of earlier inheritance. There has been no necessity for them to be nimble, as their parents are able to protect them. These animals, too, suck the mother when she is lying down, so that they have not even any stimulus to urge them to exertion. It would probably be found as a universal law that the young of preying animals are ungainly; while the young of those preyed upon and who save themselves by flight are very nimble—like a foal to whom flight is a necessity of salvation—unless the mother has some means of carrying, protecting, or hiding her young. The same law applies to birds hatched in nests on trees, etc., and to birds (partridges, fowls, etc.) hatched on the ground. The former are helpless, unfeathered, and require to be fed, the latter are downy, able to run about, and to feed themselves. That the young of dogs, cats, etc., are unable to see for some days after birth is again an illustration of the law of modification. It arises from these animals having aboriginally been born in caves.

not use its arms to support itself while sucking the mother. I have previously remarked that the reason why the strength of arm is retained by infants must be sought in the habits of young monkeys. Now baby-monkeys have not to stand on their legs in order to suck their mothers, and so modification of earlier inheritance has deprived them of strength therein; but they have to use their arms in order to hold to their mother's hair, that she may have her arms free to get from branch to branch. The human infant, however, has not to do even this much; and modification of earlier inheritance will, in time, deprive it of the strength of arm now left. Such strength of arm has doubtless become greatly attenuated already—it can be a mere nothing compared to the strength of an adult monkey, it can be but a tithe or less of that possessed by baby monkeys. The reason, however, why modification has left some strength in the arms is simply that it is a slow process, and that it has not had so long to act as in the case of the legs. Modification of arm-strength can only have commenced after our ancestors abandoned an arboreal existence; modification of leg-strength is a well-marked feature among monkeys themselves.

The fact that the human infant is born without teeth must also be regarded as a modification of earlier inheritance. If the law of earlier inheritance acted thoroughly in every way, the human infant ought to be born with its teeth in full vigour; because it is impossible to conceive the adult monkey-like progenitors of Man as being toothless, any more than to imagine them unable to use their legs.

Modification of earlier inheritance plays a most important part among Ammonites; but it seems to have entirely escaped observation. Many excellent workers in Ammonite-genealogy have, to my thinking, been led astray by not making due allowance for this phenomenon; and I have myself been misled in the same way. A too strict adherence to the details of ontogeny has resulted in genealogies with too many branches and too many gaps—at least so it seems to me in the light of this law of modification.

## Concerning the Later Stages in the Evolution of Man.

I have said that the early stages of Man's life shews that he is descended from a quadrumanous, arboreal, tailed ancestor—in other words from a monkey. It then becomes important to consider if it be possible to define his parentage more closely than this.

Monkeys are divided into two groups—the *Platyrhini*, with nostrils more or less wide apart and separate, and the *Catarhini*, with nostrils close together, situated each side of a septum which protrudes below them.*

Man, as Darwin says, agrees in his dentition with the *Catarhini*; and he brings forward various arguments to support his conclusion that man is simply a development of one of the Catarhine apes.†

Among his arguments he mentions Man's nostrils. Now certainly the shape and structure of the nostrils of the adult European are like those of the Catarhine monkeys; but the nostrils of a baby are wide apart, and considerably unlike them. The baby's nostrils, it is true, are separated by a septum, but this septum is very broad, and not at all prominent; and the nose is obliquely truncate—in fact, the baby's nose stands between the noses of the Catarhine and Platyrhine monkeys in point of shape and structure.

The developmental changes which transform the infant's nose into the adult's nose during the individual's life may be stated to be an elevation of the bridge, an elongation of the cartilage, a certain lateral compression of the nostrils, and a certain attenuation of the septum. The stages of change may be supposed to have occurred in Man's phylogenetic history as adult characters.‡

[ * The *Catarhini* have 32 teeth, the *Platyrhini*, 36.]

[ † In the British Museum Man and the higher monkeys are placed together as *Catarhini*.]

[ ‡ An adult negro is a morphological equivalent of an European baby so far as the nose is concerned.]

These changes certainly would not evolve the nose of an adult European from a Catarhine monkey, because the nose of a Catarhine monkey is more developed (further removed from a Platyrhine) than that of an infant. To change the nose of a Catarhine monkey into the nose of a baby it would be necessary to suppose a reversion of development, followed by a renewal of the development which produces narrow-nosed adult from broad-nosed infant.

On the other hand, to suppose the *Catarhini* and Man both the descendants of a Platyrhine monkey—to consider Man, not as a descendant, but merely as a development homoplastic of the *Catarhini*, only requires one to imagine that under certain conditions a Platyrhine nose develops into a Catarhine nose; and that this is the order of developmental change is seen by the fact that the broad-nosed baby becomes the narrower-nosed man.

There is a curious piece of evidence which seems to support the contention that Man is a descendant of the Platyrhine monkeys. I have mentioned the furrow beneath the nose—so very conspicuous in young children; and I have said this furrow probably represents the divided lip grown together again. I was curious to know which of the monkeys shewed this furrow, and I asked a friend to inspect the specimens in the Zoological Gardens for me. The answer I received was:—

"In *Cebus fatuellus*, the Capuchin, the only Platyrhine monkey I could see, there is a distinct groove which passes from between the nostrils to the upper lip, increasing in intensity downwards. In none of the *Catarhini* that I saw, namely, *Macacus*, various species, *Cercopithecus*, and *Cynocephalus* is there any trace of a median groove—instead the nasal septum passes downwards towards the lip below the level of the nostrils. In "Sally," the Chimpanzee, there was, as in other *Catarhini*, no median groove." This absence of the furrowed lip in Catarhine monkeys is certainly very important.

[Since this paper was written, I have, by the kindness of Dr Günther, for which I return my best thanks, been able to handle specimens from the cases of the British Museum; and I have inspected the monkeys in the Zoological Gardens with the following results.

The divided lip which is in perfection in the Marsupalia and Rodentia, and in different degrees of retrogression in the Carnivora and the Lemuroidea * is unrepresented in the Catarhine monkeys—the lip being perceptibly plain; but it is represented in certain Platyrhine monkeys,† notably in *Cebus*, by a furrow. In the specimens in the Zoological Gardens the furrow was very noticeable. There is a great facial likeness between *Cebus* and a baby—a slight elevation of the space between the nostrils being almost all that is required to complete the resemblance; for in babies the nose is sometimes as broad across the nostrils as it is long, and there is practically no bridge.] That such an elevation is in the normal process of development may be seen from the changes in shape of nose during a human individual's life.‡

Further about *Cebus* is the shape of the ear—it is certainly the most like a human ear of any that I could see. Also in Darwin's figure of *Cebus vellerosus* the hair grows from the front to the back of the head—the same as in Man; and although I have shewn that presumably in the ancestry of Man the hair was lost from the head for a time, yet when it re-appeared—being a reversion—it would probably assume the direction it possessed before.

To my mind, *Cebus* is the nearest morphological equivalent to the ancestors of Man that has been found. It is beginning to be recognised in biology, although it has not yet had much effect on classification, that similar characteristics may be

[* In the dog and cat it is in a half-joined condition—in the Lemuroidea the two side pieces are separated and partly joined to a depressed septum.]

[† In many specimens details of the nose and lip had been obscured in stuffing.]

‡ The developmental changes necessary to convert the nose of Cebus into the nose of a baby are hardly more striking than the changes necessary to convert the obliquely truncate, broad nose of a baby into the elongate, narrow nose of an adult; and the latter we know to be possible, as they occur during life in ourselves.

homoplastic but not homogeneous. The fact that Man agrees with the Catarhines in his dentition is no proof that he is not descended from an independent stock, the members of which have died out; because decrease in number of teeth has been a developmental process started long before the Platyrhines, and this developmental process would continue in separate stocks, producing homoplastic results.* On the other hand, though it seems curious to place more stress on the furrow in the lip than on the teeth, this furrow once lost would not be evolved again except for some very special reason.† The possession of this relic by Man and its absence in the Catarhine monkeys points to the latter being, so far as this feature is concerned, more advanced than Man, and shews that Man and the Catarhine monkeys are independent homoplastic developments from a Platyrhine ancestor.‡

Looking at the various races of Man it may be seen that the flat nose with broad nostrils prevails much more than the elongate nose with narrow nostrils. Certainly the Fuegians—usually considered a very low type of mankind—have very elongate noses; but the broad nose of our infants differs entirely from that, nor can the Fuegians' nose have developed into the nose of our infants, except by supposing a complete reversal of the developmental change observable in ourselves in the course of life.

On the other hand, another very low race of men, the Bosjesman or Bushman of South Africa, have the broad, flat nose. The description of them by the Rev. J. G. Wood § I summarize as follows :—

* And is in continuance in the present day. The Carnivora too are examples of similar reduction in number of teeth.

[ † A furrow divides the nostrils and lip in the human embryo six weeks old. Haeckel "Anthropogenie," Vol. II., Ed. 4, p. 670, fig. 329. The nose and lip have a facies something between that of the Lemurs and Platyrhines.]

[ ‡ The furrow becomes obsolete in adult and senile man—more noticeable in the female, because of the absence of moustache. This shews that it is in a retrogressive condition. The absence of the furrow in senile man and in the *Catarhini* is thus shewn to be homoplastic but not homogenous.]

§ "Nat. Hist. Man." Vol. I., p. 265, *et seq.*

"Imperfect language, they can hardly understand one another; true physiognomy of small blue ape of Kaffaria; about five feet high; scanty tufts of hair, short bristly beard; sight as good as an European's with a telescope; wide flattened nostrils very sensitive; trusts as much to his nose as his eyes. Children (p. 273), skull projecting exceedingly behind; short, woolly hair growing so low down on forehead that they look as if they were afflicted with hydrocephalus."

I presume the hair is thinner in adults than in children from these remarks, and the beard to be a mere rudiment of that possessed by his quadrumanous ancestors.

As to the size of the animal from which Man came it seems most probable, from the short stature of the Bosjesman, as well as from the fact that the human foetus shews legs only about as long as the arms, that Man came from a small form of monkey. This is supported by another fact, that increase of stature is a developmental variation in Man under favourable conditions; and Darwin says that the social habits of Man would more likely arise from his ancestors being small and having of necessity to band together for protection from common foes. This very banding may have been the cause of the increase of intellect and improvement of speech, which gradually made a monkey into Man.

Now the various steps by which Man has been evolved—in fact the ancestry of Man as shewn by part of his own ontogeny —may be summed up as follows:—

1.—A quadrumanous animal with body and face covered with hair, which hair shewed an inclination to become thinner in later life: and with a tail of which he made no great use. Earlier inheritance of these features in time produced—

2.—A quadrumanous animal without a tail and without hair on the front of the body, while the rest of the hair became thinner with age. This animal was beginning to favour the erect position. The earlier inheritance of the above for many generations produced—

3.—An animal in which the erect position had become a settled mature character. The body generally without hair; but some on the head and forehead, and perhaps a little on the back.

These steps are only an expansion of Man's ontogeny; and I have shewn in discussing the changes in hairiness the reasons for supposing these steps. The further development of the last stage would seem to lead directly to the Bosjesman; and from such a stock it would be possible for the various races of Man to have branched off somewhat in this fashion.

1.—Races with woolly hair, slight beards, and monkey-like faces with broad noses. They are, perhaps, a derivation from and improvement of the Bosjesman.

2.—Races in which the hair became almost lost; and these seem to have further developed and split up into—

(*a*) Races which acquired by reversion, hair on the head, but little or no beard.

(*b*) Races similarly advanced, but in which the nose has considerably developed and has become very prominently elongate, or as I might say, of the catarhine type.

3.—Aryan race, which also acquired head-hair by reversion; and still later obtained much hair on the face. The nose tends to become elongate in adult age.

4.—Native Australians, which in the matter of hairiness seem to be still further advanced than the Aryans. "Their faces so heavily bearded that scarcely the nose is perceptible among the mass of hair which covers the cheeks nearly up to their eyes. Several of the elder men are very remarkable for the development of the hair, which covers the whole of the breast and arms with a thick coating of pile." *

As I have remarked this hairiness of the breast is exactly the last acquired feature in Europeans, and by earlier inheritance it will become more pronounced in time, provided, of course, that vitality is sufficient to maintain it.

* J. G. Wood, "Nat. Hist. Man," page 2, Vol. II.

Straighter faces with more prominent foreheads, and hairiness of face and chest are developmental features in adult life of the Aryan race. It follows that a broad-nosed, oblique face, and want of hair indicate men which are lower in the scale than the Aryans. Now the Fuegians are, as I have said, generally considered the lowest type of mankind; yet their prominent elongate noses as well as hair of the head indicate that they, are biologically, above the Bosjesman, and also that they are not ancestors of the Aryans. It is evident, on the other hand, that a form like the Bosjesman or at any rate an adult form of which the young Bosjesman may be considered the morphological representation would have been the parental form of the Aryan and of Man in general; for this form would shew in a less developed degree just those features which distinguish our infants from ourselves.

### Man's Future.

It may be interesting to note, very briefly, the direction in which development is tending, according to the changes observable in life, and according to the laws of Heredity laid down.

The changes necessary to transform a monkey something like *Cebus* into a human infant must have been somewhat as follows:—A reduction of prognathous face by decreasing the jaws in correlation with an increasing skull—the very feature of development being an increased use of brain and a decreased use of the jaws—the growth of a more and more distinct nose —increased use of the hands—decreased use of the feet as organs of prehension, but increased use of the legs as organs of locomotion—and consequent increase in length of the leg from the thigh to the ankle (hock) correlating with decrease in length from the ankle to the toes.*

Now it may be observed that for the infant to become the Man by actual developmental growth all these same changes are continued in the same manner, and become more

* And loss of tail; but this is practically completed.

accentuated—the reduction of the jaw and the increase of the skull being the most marked features. The prognathous face with receding forehead of the infant gradually elongates during life, and assumes a less and less prognathous character, owing to the great amount of growth in the upper portion of the face—the forehead especially. (Compare the figures in the Plate.)

In adult Man, age, say twenty, the face may be called almost upright—the nose is longer and narrower than in the infant, the toes are not separately articulated.* Soon after this time physical strength begins to decline, but the brain-power increases, and the increased brain-power demands increased skull, which grows more and more over the eyes.

Soon after twenty in some cases—I take extreme examples the better to illustrate the development—the hair, the teeth, and the sight begin to fail. As years progress they decline more and more, and in advanced age they fail altogether. Another feature of advanced age is the extreme beak-like elongation of the nose.†

* The feet certainly do not grow so large in proportion to the increased size of the man as they did formerly, while the legs are probably longer. The toes become more and more useless and less under control; with the exception of the big toe they are really rudimentary, and no doubt the tendency is to develop a one-toed foot.

[† By the law of earlier inheritance we are advancing to being a longer-nosed race; but why, is not clear. That it is an inherent property among the Primates may be inferred from the independent development of nose in such different stocks as adult Europeans, Jews, Fuegians, and *Semnopithecus nasicus* (the Nose-ape). Among ourselves the long nose which is an adult feature is correlated with other adult features—decline of physical strength and increase of brain-power—therefore the appearance of pronounced nose early in life among ourselves would probably be accompanied by one or both of these characters. Among the Jews—a race which may be considered to have longest maintained a high civilised standard, the nose is a very prominent feature; their intellectual activity and disinclination for manual labour are well known. Among the Fuegians and *Semnopithecus nasicus* the nose has not been acquired in conjunction with these features; and therefore among them "nosiness" would not have the same significance. Among ourselves, the poorer classes in London seem the most long-nosed on the average, and they are exposed to conditions which we call the most unnatural, and are least able to escape the effects thereof. Among us, men of all classes are, on the average, more "nosey" than women—a snub-nosed man being a rarity.]

Now by the laws of earlier inheritance, supposing these individuals to leave a long line of progeny continuing for many generations, these features of old age would become features of immaturity, and then of infancy. In this case the two toothless periods—now infancy and old age—would be brought closer together; and by the law of elimination of dissimilar stages (page 268), which works to obviate useless changes, the result can be appreciated.

Perhaps, however, it is of little advantage to speculate on the future of the present quick-developing classes. Nature shews the same law everywhere—the quickly-developing forms die out—the slowly-developing forms live on; they propagate again and again series after series which go through the same quick-development and die out in turn; while still the slowly-developing forms live on, and, in time, very, very gradually pass through the same changes as the quick-developing forms did—ultimately perhaps to reach a higher stage of development.

In time—a distant time truly, but none the less certain—the European, the quick-developing race, will disappear altogether.* The average physical strength of the race is diminishing. Life is certainly prolonged to a greater age, but only too frequently on the principle of the cracked cup often outlasting the sound one. Medical Science and Philanthropy, though admirable for the individual, absolutely necessary for a high degree of civilisation, and indispensable for the evolution of scientific thought are decidedly detrimental to the race. They keep alive and allow to multiply just those weakly members who would be so surely and summarily weeded out by that rough-and-ready process known as Natural Selection. In the distant future, when that over-population which they do so much to cherish, (*teste* India at the present day) precipitates a genuine struggle for existence, the races in which Natural Selection has been checked the most will assuredly go to the

* Great fertility may accompany very considerable retrogression, as Ammonites often shew—the almost sudden disappearance of an extremely prolific stock being a well-known feature. As a whole the Ammonites were far more prolific than the Nautili; yet the former are long ago extinct, the latter still survive.

wall. A race in which a high level of *physical* vitality is maintained by a constant struggle for existence, under arduous but healthy conditions—a race able to subsist on a sparing quantity of food from the same cause—a race unaffected by so-called civilization—and a race sufficiently prolific withal, is the one which is destined to occupy the place of the European. Strange as it may seem, the Chinese appear to be fitted for the work.

## Supplementary Note.

[As the whole of the foregoing paper is directly opposed to the theory of the non-heredity of what are called acquired characters, it is advisable that I should briefly notice some of the points of this theory as put forward by Weismann * and Wallace.†

In the first place Weismann confounds under the heading of "acquired characters" what I have separated as Abnormal variations (mutilations) and as developmental variations. This seems to me a considerable mistake; for there is a great difference between them. Mutilations may not be inherited—a view to which Ammonites lend support; but this is no evidence that developmental variations—reactions to the stimulus of environment—are not inherited. A mutilation could only be inherited by a great violation of the law, which may be stated as "like breeds like stage for stage," or "ontogeny repeats ontogeny" (p. 269); and it would therefore be an abnormal variation. For instance, the young are born with a tail, and this is amputated so many, say six, hours or days after birth.‡ If their young shewed no tail, ontogeny would not have repeated ontogeny, which is the normal rule; because these young ought to have a tail which ought to come off six hours or days after

* "Essays on Heredity" English Translation. Oxford, 1889.

† Wallace, Darwinism. It may be noted that the last chapter of this work (p. 461 *et seq*) really furnishes the strongest arguments in favour of the ideas of this paper, and against the Weismann theory. It is a strongly-written essay, shewing that the intellectual qualities of Man cannot have been due to the agency of Natural Selection. The author's explanation of their origin is very interesting as a relic of pre-Darwinian ideas. From a sentimental point of view it is ingenious; but as a scientific theory it is illogical and unconvincing.

‡ The tails of lambs are usually amputated about two months after birth; though some farmers do it a very few days after.

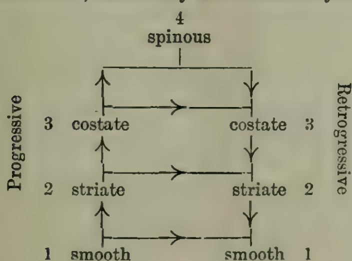
birth. Even if the amputation were performed directly after birth, there would be the pre-natal tailed stage to be repeated.

On the other hand, if, on account of lessened use, which involves a lessened blood-supply to the tail, and therefore less nutriment being received by it, the tail is 1 mm. shorter, the repetition of ontogeny by the offspring would repeat this 1 mm. shortness, and the continuance of the same causes would detract another 1 mm. This would be normal development.

The basis of Weismann's theory is that every change must come from a spontaneous variation of the germ; but I may say that to be recognised as spontaneous a variation must be appreciable in immaturity, because if not manifest till maturity, the variation might reasonably be claimed as the result of environment, and its spontaneity denied. Such is the evidence of Ammonites. They show that the different species arose from variations which did not appear till maturity, and that these variations gradually became embryonic by the law of earlier inheritance. By the Weismann theory, however, we must suppose an infinite number of spontaneous variations, each one in exactly the right direction, each one making the particular feature manifest a little earlier and earlier than before in order to achieve this result. I need scarcely remark on the intricateness of this theory.

I will examine some statements made against the inheritance of those acquired characters which, for the sake of distinction, I have called normal or developmental variations.* (p. 264).

* This term was first proposed in reference to the cyclical development of Ammonites, which may be illustrated by the following table :—




This development may be varied in any number of ways, as for instance, 1, 2 2, 1. 1 2 3 3 2 1. 1 2 3 4 3 2 3 4 3 2 1. or 1 2 3 4 3 then extinct. and so on.

"The children of accomplished pianists do not inherit the art of playing the piano: they have to learn it in the same laborious manner as that by which their parents acquired it; they do not inherit anything except that which their parents possessed when children, viz.: manual dexterity and a good ear." *

"Chinese women not born with distorted feet." †

These statements show that their authors are absolutely unacquainted with the law of earlier inheritance. Do they mean to say that only the characters with which the offspring is born are inherited, and that those which appear later in life are not inherited characters? Let me apply the same reasoning to other things and see where it leads.

The human infant is born without eyebrows, and without teeth—therefore eyebrows and teeth are not inherited characters. The offspring only inherit what their fathers had as infants; and they have to get their teeth in the same laborious manner as that by which their parents cut theirs.

The male infant is born without a beard; calves are born without horns; birds without feathers; plants first appear without flowers; and so on. Therefore all these features—beards, horns, etc.—cannot be transmitted by the parents.

Why, however, should the period of birth be taken as the time when transmitted characters are to be seen. Birth is not the beginning of life, but only an episode therein. One might with equal reason take the very first stage of life and say, "Man begins life as an unicellular organism, and since this does not shew sundry characters which might be named, these certain characters are not transmitted by the parent"—a *reductio ad absurdum*.

Looking, however, at the cases quoted above, we see that by the law of earlier inheritance all we have a right to expect is that ontogeny shall repeat ontogeny. Weismann admits that the child would inherit what its father had as a child.

* Dr August Weismann, "Essays on Heredity," English Trans.: p. 269; Oxford, 1889.

† Dr Russell Wallace, "Darwinism," p. 440.

But to suppose that it would when immature inherit its father's mature talent is as irrational as to expect it to exhibit the beard at that age.

On the other hand, here is a case of the inheritance of an acquired character. The wearing of boots has resulted in the crumpling of the smaller toes—particularly the little toe—in a curved manner, so that they grow somewhat over one another. This feature is now very common—most people shew it more or less; and it can only have been acquired since compression was applied. As this compressing begins very early in life—as soon as the child wears boots—it would not be surprising if—allowing for earlier inheritance—the infant were born with toes of this shape. In none of my children was this the case: their feet were always extremely broad across the toes, which were all perfectly straight. About six months after birth, however, a very distinct change began to be apparent—the curling up of the little toe became noticeable. One of my children went without shoes or boots for 18 months after birth; and though running about on his bare feet would tend to spread the toes, yet the force of heredity was too strong—they assumed the curled up position, though not quite to the same extent as if he had worn boots.

Having always learnt from Darwin's works that such characters were inherited, I had taken no exact record of this case, but on mentioning the fact to Professor Harker I learnt its importance. We could not then refer to this child, as he had just taken to boots; and although it might be safely asserted that boots would not have produced such an effect in the time if no such character had been inherited from the parent, yet the negative was open to sceptics. Fortunately, however, there was the baby, which had never worn boots: she was then seven months old. For some time after birth her toes were remarkably straight,* but at the age mentioned the curling

* I can be very positive on this point, having noticed it, not only in her, but in all my children; besides, most of the movements of toes, etc., detailed in the early part of this paper were obtained by continued watching of her feet, though the other children had also received much attention in the baby-stage.

under of the little toe* had become very noticeable, and I drew Professor Harker's attention to it.†

Even from Weismann's own works there is evidence of the inheritance of acquired characters. "When horses of normal size are introduced into the Falkland Islands, the next generation is smaller in consequence of poor nourishment and the damp climate; and after a few generations they have deteriorated to a marked extent." ‡ Weismann's attempt to reconcile this with his theory is nothing more than an admission that the change of environment has produced a change in the offspring—produced an effect on the body of the individual, and the effect reacted on the germ; but this must always be the manner in which acquired characters are transmitted: they must of necessity produce a change in the molecular constitution of the germ. According to Weismann, however, this ought never to be the case. "A small portion of the effective substance of the germ, the germ-plasm, remains unchanged during the development of the ovum into an organism, and this part of the germ-plasm serves as a foundation from which the germ-cells of the new organism are produced." § Therefore, as the germ of the new generation was present in the parents before they were imported into the Falkland Islands, and as, according to Weismann, this germ is totally unaffected by any external conditions of environment, there ought to have been no change in the offspring.

Short sight is certainly an acquired character. To my mind it is very doubtful if, in a normally good-sighted race, it has ever arisen as a spontaneous variation, totally unconnected with any habits of the individual or his parents. That the short sight now so prevalent cannot all have arisen as spontaneous variations is certain. Weismann admits it is hereditary

* The curling becomes fixed—the child has no power to straighten it.

† As both sexes in this country compress their toes, the effects would be more marked than if done only by one sex. (See page 276.)

‡ Weismann, Ibid, p. 99.

§ Weismann, Ibid. p. 266.

in some cases. Does he wish us to believe that there are two kinds of short sight—one which arose as a spontaneous variation and is hereditary, and the other acquired by the individual from study and not hereditary?

The degeneracy of slave-making ants * is explainable on the theory of the inherited effects of use and disuse, but not on the Weismann hypothesis. That Natural Selection should have preserved every spontaneous variation which shewed a less and less instinct to feed itself, and should have eliminated the more capable members until the different species had entirely lost the power of self-feeding, seems an incredible idea. What overpowering advantage, either in economy or any other way, could have accrued to the individuals unable to feed themselves so that they survived while their neighbours perished?

The further discussion of this subject I must leave for another time; but in conclusion I may say that the "change-induced-by-environment" theory does not exclude the action of Natural Selection. Such action must always have exercised a controlling and selective influence on the results which environment produced, just as, at a school, the boys in whom the conditions of environment—lessons—have produced the most effect are selected by the examiner for promotion to a higher class.]

* Lubbock "Ants, Bees and Wasps," p. 82, 10th Ed. 1891.

## EXPLANATION OF PLATE

### Fig. 1—4. Homo sapiens

Fig. 1.—Profile of the head of a female infant, three months old, to illustrate the peculiar features of babies' faces, namely, the large and projecting jaws, the short projected obliquely-truncate nose, the depressed bridge of the nose, the very low position of the ear, and the large development of the back of the head. The mouth is obscured by the large pouch-like cheeks. This drawing is the copy of a photograph ; and shews how the hair grows towards the forehead.

Fig. 2.—Profile of the head of an adult female—the mother of the infant depicted in fig. 1—reduced to about the same scale, to shew different relative proportionate development of the various features between infancy and maturity, namely reduction and recession of the jaws, elongation of the nose, elevation of the nose-bridge, projection of the forehead over the eyes—where the intellectual faculties are situated, the reduction in the size of the ear and its elevation in relation to the whole head, and the reduction of the back of the head. This drawing is a copy from a photograph, which, with the original of No. 1, was exhibited when this Paper was read.

Fig. 3.—Profile of a senile female to shew the further proportionate development of the features, namely the further recession of the jaw, the growth of the nose, its elongation and the elevation of the bridge. The ear has been dragged out of shape by the wearing of earings. Copy of a photograph.

(These three figures, the exact size of the photographs, from which, in fact, they were traced, were purposely taken, as nearly as possible, of the same size, to shew the proportionate development of features during the ontogeny of senile female Man. Fig. 1 may be regarded as the morphological representation of an ancient adult ancestor, while No. 3 may be considered the morphological prefiguration of the adult of the future, or of the infant of a still more distant time to come.)

Fig. 4.—Profile of the head of Miss Julia Pastrana, remarkable for the characters of reversion displayed. She was a Spanish dancer, and when she died her stuffed skin was exhibited. Copy of a wood-cut (originally a photograph) in Haeckel, "Anthropogenie," p. 363, Ed. IV.

### Fig. 5.—Cercopithecus nasicus

Fig. 5.—Profile of the head of the Nose-Ape, shewing as regards the nose a much higher development than is obtained even by senile Man. The figs. 1—3 illustrate that during life Man makes very considerable progress in the direction of nose-development shewn by this fig. 4. From a wood-cut in Haeckel, "Anthropogenie," *loc : cit.*

### Fig. 6.—Cebus capucinus

Fig. 6.—Head of a species of the genus frequently alluded to in the text. Copied from Darwin, "Descent of Man," Pt. II., Chap. XVIII., p. 549, fig. 74.

### Fig. 7.—Cebus vellerosus

Fig. 7.—Profile of the head of this Platyrhine monkey, shewing the projection of the jaws, and the growth of the hair *towards* the forehead—to compare with fig. 1. The different position of the ear and the more lateral position of the nostril should, however, be noted. Copy of a wood-cut in Darwin, *loc : cit.*

Fig. 1.

Fig 2.

Fig. 3.

Fig. 6.

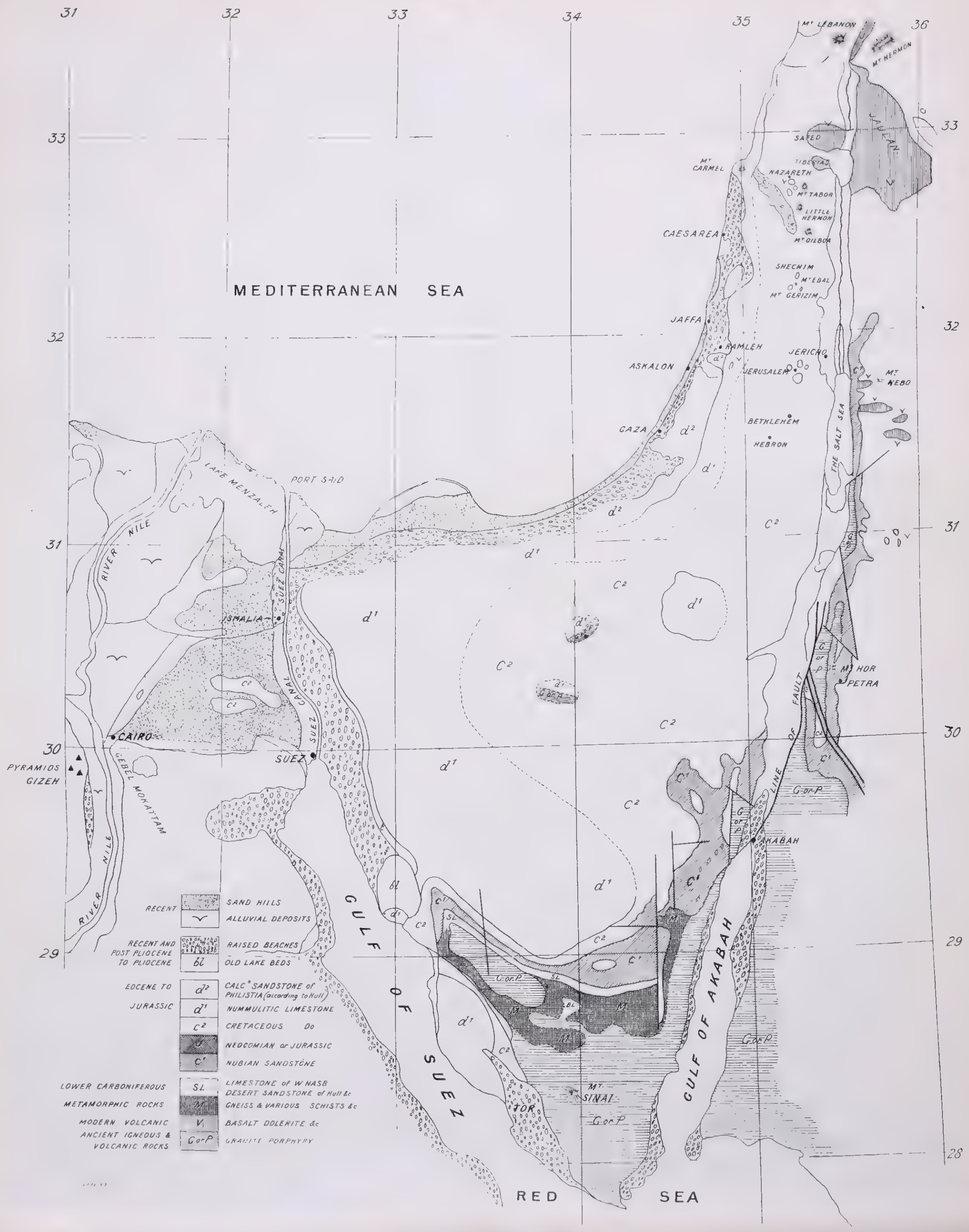
Fig. 7.

Fig. 5.

Fig. 4.

P. Buckman, del. et lith.

Mintern Bros. imp.


MEDITERRANEAN SEA
RED SEA
GULF OF SUEZ
GULF OF AKABAH
MT LEBANON
MT HERMON
JAULAN
SAFED
TIBERIAS
MT CARMEL
NAZARETH
MT TABOR
LITTLE HERMON
MT GILBOA
CAESAREA
SHECHIM
MT EBAL
MT GERIZIM
JAFFA
RAMLEH
JERICHO
ASKALON
JERUSALEM
MT NEBO
BETHLEHEM
HEBRON
THE SALT SEA
GAZA
PORT SAID
LAKE MENZALEH
RIVER NILE
SUEZ CANAL
ISMALIA
MT HOR
PETRA
LINE OF FAULT
CAIRO
SUEZ
PYRAMIDS GIZEH
GEBEL MOKATTAM
AKABAH
MT SINAI
TOR
RECENT
SAND HILLS
ALLUVIAL DEPOSITS
RECENT AND POST PLIOCENE TO PLIOCENE
RAISED BEACHES
OLD LAKE BEDS
EOCENE TO JURASSIC
CALC° SANDSTONE of PHILISTIA (according to Hull)
NUMMULITIC LIMESTONE
CRETACEOUS Do
NEOCOMIAN or JURASSIC
NUBIAN SANDSTONE
LOWER CARBONIFEROUS
LIMESTONE of W NASB
DESERT SANDSTONE of Hull &c
METAMORPHIC ROCKS
GNEISS & VARIOUS SCHISTS &c
MODERN VOLCANIC
BASALT DOLERITE &c
ANCIENT IGNEOUS & VOLCANIC ROCKS
GRANITE PORPHYRY

*Read at the Meeting of the Cotteswold Club, March* 22, 1892, *by* J. H. Taunton, *M. Inst. C.E. F.G.S.*

Before proceeding to the Syrian Coast and Palestine, I must take you for a little while to Egypt, in the neighbourhood of Cairo, with reference to the nummulitic and underlying cretaceous limestones at the Mokattan Quarries there, or at the old Pyramids and their plateau at Gizeh, in either of which you will see good sections of the Nummulitic Limestone, and have evidence of the variations of level that have taken place at the opening of the Tertiary period which witnessed the development of the present distribution of land and sea, and the upheaval of most of the mountain chains of the globe, and subsequently in a less degree in the pleistocene age of similar movements that will assist us when we get to the study of Syrian Geology, for as the sketch map* shows, the Geology of Egypt (as its history) is linked with that of the Holy Land. With this distinction, however, as noted by Sir John Dawson, that while the hills of Palestine are so largely comprised of cretaceous limestone, and the later eocene limestones (nummulitic) are represented there only by small patches. In Egypt, on the contrary, a grand development of the Eocene and less of the cretaceous limestones is found. He says:—"I am of opinion that there was an original difference, thicker deposits having taken place in the cretaceous period in Syria than in Egypt, and precisely the reverse in the Eocene age. Much of the physical difference between the two countries depends on this circumstance."

* The sketch map referred to was an enlargement of Dr Hull's Geological Map of Palestine, &c., published by the Palestine Exploration Society, from which the accompanying map is a reduced copy.

The evidences of the changes of level both at the Mokattan Hill and at Gizeh is afforded in the former locality by terraces 500 ft. and 200 ft. above sea level. Former sea beaches with pleistocene shells, borings of lithodomous mollusks, oysters adherent to the old sea cliff and other recent shells in its crevices.

At Gizeh plateau there are not only numerous oyster shells but a very marked old sea beach with large stones. These facts (which are confirmed by M. Lartet, Dr Fraas, Dr Schweinfurth, Sir John Dawson, and other eminent geologists) prove that in the Pleistocene age all this part of Africa was submerged to a depth of more than 200 feet, and this for a long time, while the higher terrace shows a submergence to the extent of at least 500 feet.

We now proceed to Alexandria Harbour and get on board a Turkish steamer, the "Romania," at 11 a.m., on the 16th April, 1891, proceeding to Jaffa. This harbour is silting up and kept open only by constant dredging, but outside we are soon in 50 and 100 fathoms water, which increases in depth to upwards of 600 fathoms not many miles off Jaffa. The depth of the Mediterranean between Alexandria and Crete is very great, for a considerable extent it ranges from 1600 to 1800 fathoms. The vessel was fairly comfortable, with a respectable-looking old Turkish Captain, who sat at the head of the table at lunch and dinner, drank his wine, looked smiling and agreeable, and spoke the best English he could. On the fore part of the deck were numerous parties of pilgrims from almost every country in Europe: Greece, Italy, Germany, Russia, France, &c., proceeding on pilgrimages to Jerusalem at the approaching Easter, kept some three or four weeks later than ours. Greek and Latin, Arminian and Coptic Church Christians were there, Jews from all parts going to keep their Passover at Jerusalem. I have no doubt Mohammedans also from many countries, for next to that of Mecca and Medina the pilgrimage to Jerusalem is most esteemed by Mohammedan devotees. These pilgrims were of varied classes, ages and sex, men and women, families with young children, mothers with their husbands and babes. They placed carpets or mats on the deck on which different families congregated, took their meals and slept, the men smoking a good deal.

On approaching Jaffa what first strikes the eye is the bright line of sand along the Philistian and Samarian coasts. The sands there, according to the ordnance survey, attain a height in some places of 200 feet, or even more. They are enormous accumulations of fine sand, advancing inland, driven by westerly winds. The ruins of ancient Gaza and Askelon are now covered by them. Possibly the sand has been largely drifted from Arabia and Africa directly, or under cyclonic action, as may be readily understood by anyone who has experienced a sand storm in Egypt or Palestine, which I had the misfortune of doing on two occasions, first in the neighbourhood of Cairo and afterwards at Jerusalem. To form an idea of the distance which sand is carried, *even over the sea,* I may mention the experience of a friend who was proceeding by Royal Mail Steamer from London to Brazil, on engineering business. He says that off Cape de Verde, about 200 miles more or less from the African Coast, the deck of the ship and the rigging were covered one morning with a layer of fine red sand, which the officers of the ship considered had been blown from the African desert, carried along in the upper air, the phenomena does not appear to have been one of uncommon occurrence when passing that locality. They expressed gratification at getting *clear of the desert.* Dr Hull observes that the soft calcareous sandstone, which, according to his section, is shewn to line the shore, and form the sea bed along the coast of Western Palestine, affords alone by its disintegration sufficient material for these advancing sand hills.

On nearing the shore the backgrounds of mountain and highlands of Philistia and Samaria come into view, and here before proceeding to describe the geological section it may be well to make a few remarks on the mountain range which extends about 70 miles, running nearly north and south almost midway between the Mediterranean coast on the west and the

River Jordan and Dead Sea on the east. This line of upheaval forms a saddleback or anticlinal. The stratification of cretaceous and nummulitic limestone of which the mountains are composed dipping in opposite directions, *i.e.* west towards the Mediterranean Sea and east towards the Jordan Valley. The mountain range of Judah has many points exceeding 3000 feet, and culminates at Yuttah, 3747 feet above the sea, being the reputed birthplace of John the Baptist. It has a somewhat less elevation in Samaria, although Mts. Gerizim and Ebal attain heights of 2800 and 3000 feet respectively. The range is broken by the Great Plain of Esdraelon. North of which and around Nazareth the country is irregularly mountainous, whilst further north are the lofty mountains of Upper Galilee, mainly of volcanic origin. Jeb Jermuk, in the neighbourhood of Safed, attaining an elevation of 4000 feet nearly. Further north on the Chain of Lebanon, Jeb Sannin is 8500 feet. Anti-Lebanon 8700 feet at Tal' at Mûsa, and snow-capped Hermon 9200 feet above the Mediterranean Sea. The Carmel Chain which trends to the N.W. broken by the Milheh and Daliyeh Streams attains at Esfia 1729 feet, ending at Cape Carmel, which shelters Haifa Harbour from the S.W. and W. These mountains are capped by nummulitic limestone. Major Corder speaks of having discovered a volcanic crater at Carmel, previously unknown. The Range of Gilboa and Little Hermon which block the Esdraelon Plain on the east attain each an elevation of about 1700 feet, and Mt. Tabor to the north of them of 1820 feet. As to the extent of Palestine proper (exclusive of the possessions in Moab, Syria, and Arabia, held in the days of *King David and Solomon*) the distance from Dan to Beersheba is but about 120 miles, and Palestine proper extending between these places and west of the Jordan to the sea, which is the portion of the country that has been accurately surveyed, occupies an area of about 6000 square miles, being in round numbers but one-tenth of the area of England and Wales.* The Mediterranean Coast forms the western boundary—

* The total kingdom of King Solomon would be in extent about the same as that of England and Wales, 58,281 sq. miles.

on the south is the Desert of Beersheba, forming part of the Plateau of the Tîh. On the north the mountain district south of Hermon, and the Highlands of Upper Galilee. It only remains to refer to the eastern boundary, which is the Valley of the River Jordan. This river, rising at the foot of Mt. Hermon, with tributaries from Banias (*Cœsarea Phillipi*) where the Jordan springs forth a full-grown stream, joining the Hasbany River, which geographically but not historically is the true head water. Some ten miles further south the River forms the Lake of Huleh, four and half miles in length by three and a half broad, in the neighbourhood of which other tributaries join. The Lake of Huleh is seven feet above the sea level, passing south the Jordan enters the Sea of Gennesareth or Galilee or Tiberias, which is twelve miles long and eight at its broadest measurement east and west. It is 682 feet below sea level, so that the River between Lake Huleh and this has fallen at the rate of 68 *feet per mile.* The fall proceeding south to the Dead Sea, which is 1292 feet below Mediterranean Sea level, and in direct line about 60 miles distance, being only at the rate of 10 *feet per mile.* It is to be remarked that the change of fall to a diminished inclination takes place below the locality of *volcanic agency,* as marked by the outburst at Safed and the great basaltic flows of the Jaulan.

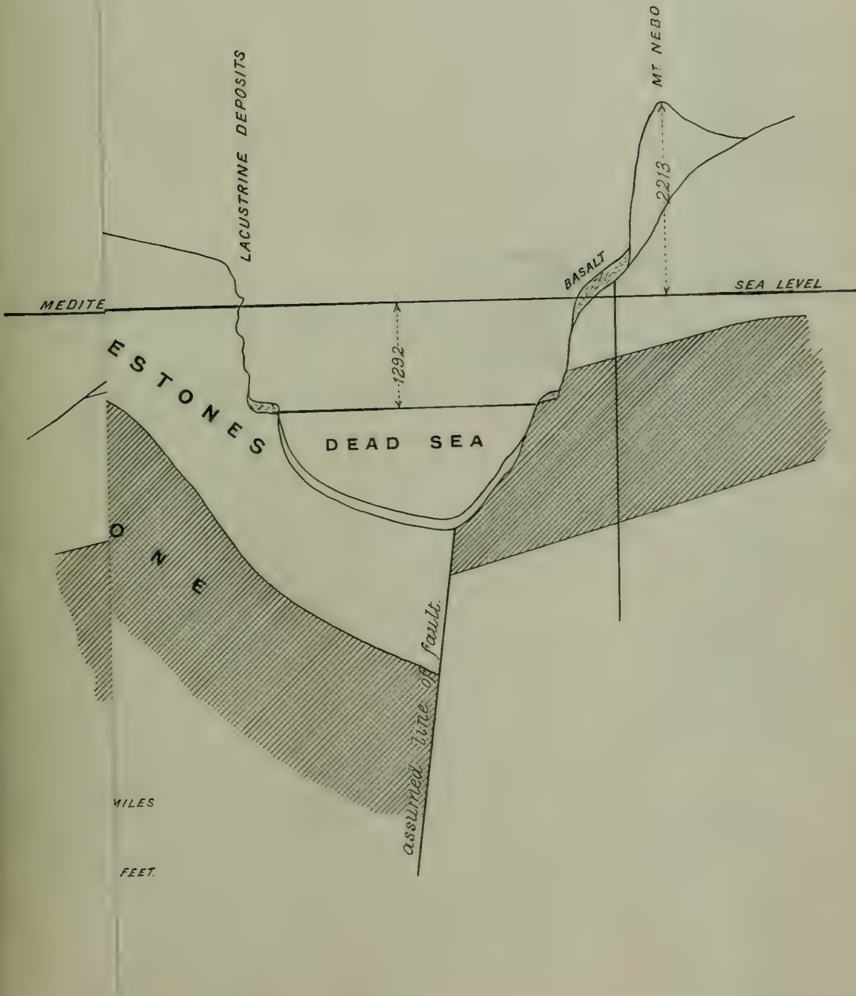
Proceeding southwards the length of the Dead Sea is approximately 46 miles, extreme width about 10 miles, maximum depth between 1200 feet and 1300 feet. The volume of water brought down by the Jordan and evaporated during the summer months in the Dead Sea makes a difference of five feet between the summer and winter surface of that sea over an area on the average of 360 square miles. The flow is greatest when the snows on Hermon begin to melt, about the time of Passover, when "Jordan overfloweth its banks all the time of harvest," for harvest in this deep valley is much earlier than even in the Sharon Plains.

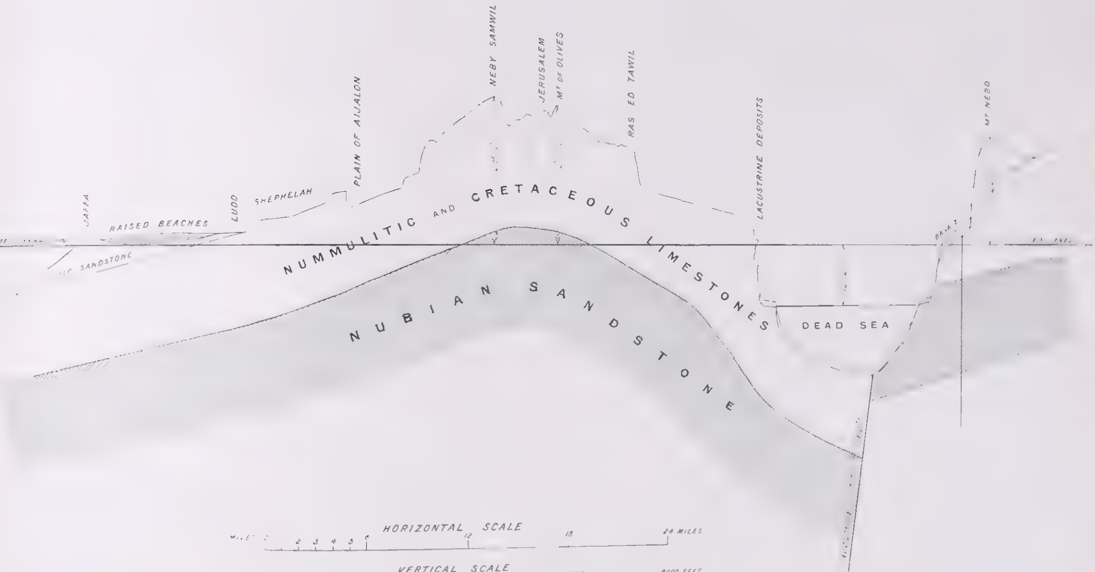
The distance from the south end of the Dead Sea (Jebel Usdum) to the Gulf of Akabah is 115 miles. The bottom of the Wady el Arabah being about 660 feet above the Red Sea at its summit, and 1952 above the Dead Sea.

As to the Watercourses in Palestine, the *Leontes* rising from the Anti-Lebanon Range, flows into the Mediterranean Sea 4 miles north of Tyre. There are 12 *perennial* streams, of which 8 flow into the Mediterranean and 4 to the Jordan. The principal affluents of the Jordan are the Jalûd and Fârah from the west, and the Jermuk and Jabbok from the east. Besides these two main streams the Calirrhöe and the Arnon from the east flow into the Dead Sea which also receives the drainage of Wady el Jeib from the south and of several Wadies from the west.

We come now to the Geological Section attached hereto, the levels on which are taken from the Ordnance Survey of Palestine, on a scale of 6 miles to the inch horizontal, and 2000 feet to the inch vertical. Commencing from the deep water of the Mediterranean Sea off Jaffa, we have, according to Dr Hull, the strata thereon called by him Calc Sandstone of Philistia, dipping to the west to form the sea-bed, resting thereon are the raised sea beaches, or maritime beds, as shewn on Sections given by Sir John W. Dawson and Mr Hudleston, admitted by all as Pleistocene Beds, and it becomes immaterial whether the so-called Calc Sandstone is of earlier origin and distinct, or should be treated with the overlying pleistocene formations or not. Dr Hull's authority is so great that I have prepared the section in accordance with his views where it cuts into the Mediterranean. He says:—

"At Jaffa the raised sea-bed stretches far inland from Jaffa, and may be traced along the Jerusalem road to beyond Ramleh, at Jaffa the shell sands rest on the more ancient sand stone, which forms the foundation of the city, and supplies the copious springs necessary for the extensive orange and lemon groves there; further inland about Ramleh, this fine gravel and sand gives place to beds of calcareous conglomerate formed of lime, stone pebbles of all sizes and well water worn. This is undoubtedly an ancient sea beach, which appears to rise to a level of considerably over two hundred feet, formed at a time when the waters of the sea extended over twelve miles inland beyond their present limits."


LACUSTRINE DEPOSITS
MT NEBO
2213
BASALT
SEA LEVEL
MEDITE
1292
ESTONES
DEAD SEA
ONE
assumed line of fault.
MILES
FEET.



JAFFA
RAISED BEACHES
SANDSTONE
LUDD
SHEPHELAH
PLAIN OF AIJALON
NEBY SAMWIL
JERUSALEM
MT OF OLIVES
RAS ED TAWIL
LACUSTRINE DEPOSITS
MT NEBO
NUMMULITIC AND CRETACEOUS LIMESTONES
NUBIAN SANDSTONE
DEAD SEA
HORIZONTAL SCALE
2 3 4 5 6 12 18 24 MILES
VERTICAL SCALE
FEET 0 2000 4000 6000 8000 FEET

A natural breakwater of calcareous sandstone at Jaffa projects outwards into the Mediterranean from the ancient walls at the south end of the town, outside this all large ships are obliged to anchor, the landing from which is effected in shore boats, which frequently have to breast a heavy surf, the rock under *the lens is seen to consist of comminuted shells, pieccs of coral and other marine forms,* apparently of recent formation, raised when the whole sea-bed was being elevated.* A similar formation appears to be still in process of consolidation, along the shore farther north as I noticed at Haifa, (near Acre), it is quarried just under the sands at the margin of low-water, the shells of which it is composed are those which strew the shore in immense numbers, and are chiefly those of *pectanculus glycineris.* The evidence of these raised beaches is incontestable, they have been recognised by Drs Hedenborg and Lartet, who attribute their position when at or near sea-level to the recent slow elevation of the sea-bed which may be still in progress.

*Mons Lartet says:* Page 227, "Essais sur la Geologie de Palestine," We have seen that on the Mediterranean Coasts of Egypt maritime deposits are found filled with actual shells. It is the same on the coasts of Phenicia, and the Plain of Sharon presents the aspect of a raised beach. The hills of reddish sands that prevail at Jaffa where gardens are planted as well as orange groves are covered with numerous shells, *Pectunculus violacescens murex brandaris Columbella rustica Purpura hemastoma*—identical with those we meet with on the coast, and this formation extends far in the interior, into the environs of Ramleh. Beyrout is built on a coarse limestone, filled with shells, *Capulus Cerithium Trochus, &c.,* which assume in some places a pisolithic structure as those at Alexandria, &c.

* * * * * * * *

Such are the maritime deposits of the coasts that appear more recent than the Tertiary deposits—older than of the historic period, and we believe should be classed as Quaternary.

Sir John W. Dawson in his popular work on "Egypt and Syria," describes the rocks on which Jaffa stands as extending under the whole maritime plains as a soft sandstone, traversed with vermicular-cylindrical holes, perhaps the work of marine worms, &c.

* Owing to the kindness of Prof. S. Hayter Lewis, F.S.A., I am able to show a piece of this rock, broken off by himself, and the sides polished, the top being purposely left rough to show the formation.

It is sometimes coarse and pebbly, containing shells now living in the neighbouring seas; the cementing material of the stone being carbonate of lime. It is sufficiently hard for building purposes. In some places on the road to Ramleh it is seen to pass into a conglomerate or pebbly rock, composed of rounded fragments from the hills. On the authority of Dr Paulus, of Jerusalem, he gives a boring made near Jaffa, which passed through 174 feet of the sandstone, with clay containing marine shells especially a species of cardium, below. The maritime plains which are undulating may be taken at 25 miles wide near the frontier of Egypt, constituting the plain of Philistia, towards Jaffa, near which diminishing to 12 to 15 miles wide thence they constitute the Plain of Sharon and run to a point at Carmel.

The Plain of Esdraelon which lies between the range of Carmel and the hills of Lower Galilee is included by Hudleston among the maritime plains. It has been the great battlefield of Palestine, where warriors of almost every nation of the old world under Heaven have pitched their tents from the days of Barak to *Napoleon*,* and which may again become the scene of great military events, as being the lowest valley of approach from the Mediterranean to the Jordan Valley, with a good harbour at its north end. Its average height is 250 feet above the former (sea) with a summit about 35 feet higher near Jezreel, where the watersheds of the Jalud and Kishon are parted. Its summit is lower by 375 feet than that in the Valley of Arabah, so that were it practicable to bring the waters of the Mediterranean into the Jordan Valley there would be an intervening anticlinal with a base of 115 miles and summit of 375 feet to get over before reaching the Red Sea—which of itself sufficiently shows the impracticability of the once talked of Jordan Valley Canal scheme. This plain, as that of Sharon, is rich and fertile, I was much struck by the great depth of soil

* On 10th May, 1799, Napoleon, who had taken Jaffa on the 6th March, having marched along the coast, assaulted St. Jean d'Acre (Accra). The British Ships lying in the roads of Carmel. He was defeated by Sir Sidney Smith, and the siege raised on 20th May.

observable at the sections of the streams and rivers that we crossed, in particular the River Kishon showed banks certainly 10 to 15 feet thick of rich black soil, and as the same thing was noticeable near Tiberias both localities being in the neighbourhood of volcanic outbursts it is probable that such richness is derived in a great degree from the decay of Basalt.

Esdraelon Plain has a fine harbour at its Mediterranean end, the Bay of Acre sheltered from the south and west by Mount Carmel. There was a French Steamer there which had brought some hundreds of Pilgrims from France whilst I was at Haifa. It is *a little town* on the south side of the Bay, where a colony of some 500 Germans have established themselves. A railway is projected from this Port to Damascus. The Haifa route promises to become the high road to the centre of Palestine.

From the plains, taking the line of the section, we pass to the lower hills, "*The Shephelah*,"* about 500 to 1000 feet above sea level, a tolerably fertile district, as in the plain of Ajalon, where, according to Scripture History, Joshua having effected a rapid flank march from Gilgal, near Jericho, made his furious attack on the five Canaanitish Kings who had combined against him and destroyed them.

The Shephelah, according to Conder, consists of a white softish limestone with bands of brown quartz. Its escarpment faces the west. *The Mountains* rising to between 2000 and 3000 feet above the sea consist of harder limestone (shown in Hull's section as nummulitic) capped in parts with chalk. They are intersected by numerous ravines, marked by great meteoric denudation.

Carriages passing from Jaffa to Jerusalem (about 37 miles) usually stop at Ramleh, Bab-Elwad, and Kolonieh. The plain of Sharon is passed before reaching Ramleh, and the Shephelah between that place and Bab-Elwad, which is probably 17 or 20 miles from Jaffa. After passing Bab-Elwad the ascent to the

* The Shephelah or Lowlands was the great battle ground of the Israelites with the Philistines and invaders from Egypt, Assyria, &c. The biblical division of Plain Shephelah and Mountain being distinctly marked in this locality.

hills commences with ascents and descents that appear to have no ending. The description given by Dr Fraas is so graphic that it deserves quotation: "Chalk marls, hard white limestone, "and beds of dolomite alternate with each other and form "great steps on the mountain sides, such as I have nowhere "else seen in equal beauty. The edges of the beds, three to "ten feet thick, stand out like artificial walls, enclosing the "hills. Olive trees and shrubbery overhang these natural "ramparts, while the softer layers form slopes covered with "green herbage, which is still richer in the moist hollows." The ascent to these hills is usually through narrow valleys on the sides of which here and there are beds filled with characteristic cretaceous fossils. In the section, see page 328, I have followed Sir J. W. Dawson and Mr Hudleston in showing no line of demarcation between the cretaceous and nummulitic series.* The summit before reaching Jerusalem is somewhat under 3000 feet. To the south it obtains, near Hebron, 3300 feet. The nummulitic limestone is well defined at the top of Mount Gerizim, which I visited after leaving Jerusalem, where I stayed for nine days. At the junction of the upper beds of the cretaceous with the lower beds of the nummulitic limestone there is a large aggregation of flint in the rock, which is particularly marked at Gerizim.* Sections of both rocks are found at Carmel, near where the range terminates at the sea and the road approaching the convent and lighthouse there. The section shows the dip of the strata towards the east in the direction of the Dead Sea on one side and towards the Mediterranean on the west of the anticlinal under Jerusalem.

I produce specimens of stones from the cretaceous formations on which Jerusalem stands, their local names being:—

1. Gaklüle (soft stone)
2. Nahre (means fireproof, will not calcinate—this is under Golgotha.)

* Mr Hudleston remarks: "that these two formations being so closely "connected by physical if not by biological ties, it is exceedingly difficult to "separate them."

3. Meleke—the Royal stone, found in the Haram and in the great quarries.
4. Misse (Jehudi=hard.)
5. Misse (Helu=soft sweet.)
6. Misse (Achmar=red pink.)

I had not the opportunity of seeing the Nubian sandstone, *in sitû*, owing to the extreme heat, which prevented my going to the Dead Sea, as I only saw it at a distance, I have extracted from M. Lartet's book some of his remarks thereon.

## NUBIAN SANDSTONE

Lartet "Essai sur la Geologia de Palestine," p. 127.

The sandstone first appears near Wady Ghuweir, where it has a red colour, with a weak dip towards the south. Between Wady Ghuweir and Wady Munshallah is seen whitish sandstone overlying reddish shales, of which we are about to speak. These sandstones follow uninterruptedly from there to the Wady Zerka Main, with a continually increasing thickness that attains more than 330 feet. The Wadies Hamara, *Meredjeb Hanr el Hamma*, have all their openings cut in these rocks, which in the Wady el Hamma present the following succession in passing from bottom to top:—

1st. Red Sandstone.
2nd. Greenish do.
3rd. Red Sandstone and Greenish Shales.

Zerka Main appears to run in a small Fault in the midst of these sandstones.

From the Wady to the Plain of Zara these (beds) loose their horizontality and dip towards the south. The cliff presents at this point the following succession of arenaceous deposits.

At the base white sandstones to which succeed alternations of sandstones and mottled shales of red and green, separated in little layers by very thin beds of clay. Then come red sands, after that white sandstones, covered by the débris of Basalt, which has descended from the flow of which the hill is capped.

The sandstones are then covered by incrustation deposits, forming the Plain of Zara, where gush out the hot incrusting springs.

They are seen again to the south of this plain and constitute the cliffs from this point to the Wady Mojib, there resuming their former horizontality. They appear covered in many places with saline incrustations and palm-trees are frequent wherever the sandstones are smoothed (or levelled.)

The Wady Mojib runs in a narrow gorge, deep and tortuous, in the midst of rocks to which atmospheric denudation has given odd and picturesque forms, the sandstones here have most varied colours, yellow, red, and black, (from bitumen no doubt). This Wady is one of the lowest valleys in the district, and the River (Arnon) runs in the midst of sandstone rocks, from the heights of Schihan, 2629 feet above the Red Sea, (in its valley near which place according to M. Lartet's map are large deposits from thermal and mineral sources as well as Gypsum).

From Wady Mojib towards the Lisanthe Nubian sandstone dips slightly towards the south, and disappears on approaching that peninsula. Further south again it rises and forms the foot of the Eastern Escarpments to the Southern Ghor. Here are beds met within it that are nearly black, which owe their colour to an excess of manganese that they contain. In the environs of Petra the Nubian sandstone attains its greatest development where it occupies the summit of Mount Hor, having been uplifted 5332 feet above the Dead Sea there.

Mr Hudleston says:—"I will now mention some of the "characteristics of the Nubian sandstone. Firstly: it is the "seat of considerable mineral wealth, especially near its junc- "tions with the older rocks. It is largely developed in the land "of Midian, where Burton speaks of the western wall of "Neyd Plateau as consisting of a sandstone remarkable for the "beauty of its brick red precipices and castellations. The "copper mines of Wady Nasb, and the turquoise mines of "Sarabit el Khadim and other localities are associated with "this formation. The turquoises of the Wady Maghera occur "in two beds, the rock being a soft coarse-grained quartzose "sandstone of a light yellow colour. The best stones are "found in the solid sandstone a short distance from the joints "where they usually occur in the centre of small red marly and "ochreous nodules. The Arabs were working the turquoise "mines of Sarâbit el Khadim quite lately, and, according to Mr "Holland, have destroyed by blasting many of the hieroglyphic "inscriptions sculptured upon the blocks of sandstone."

M. Lartet has classed this formation as cretaceous, but subsequently to his investigation there has been found in Nasb Valley undoubted evidence in the lower beds (called by Hull *desert sandstone*) of carboniferous fauna. The few fossils found by Bauerman were so dubious, one authority referring them to the carboniferous whilst another said they belonged to the new red, but Captain Wilson procured a block of limestone from the valley section from which one fossil *Orthis Michelini* was found well known in the carboniferous limestone. This was confirmed by Mr Davidson. Mr Hull also confirms its carboniferous character at this horizon. The base of the Nubian sandstone is not visible in the eastern cliffs of the Dead Sea, nor I believe where it is associated with limestone as in the Lebanon ranges. Mr Hudleston remarks: "no named fossils "have ever as far as I know been found in the Nubian sand-"stone of Eastern Palestine, though certain vegetable impress-"ions have been observed. But there is a note in M. Lartet's "earlier work which, seeing what has been found in Wady "Nasb, becomes of considerable interest. He noticed traces of "corals (*polypiers*) in the sandstone near the junction of "the Wady Haimen with the Wady Akaban, similar to some "collected from Sinai and from the vicinity of Nasb."

Mr Hudleston in his "Further Notes on the Geology of Palestine," admits the accuracy of Hull's Desert Sandstone with its associated limestone, found by that Geologist, not only at Wady Nasb but also on the banks of the Hessi, south of Kerak, as being carboniferous. He says Hull's party have traced the lower or carboniferous series much further than previous explorers, since they show an important carboniferous zone in the flanks of Mount Hor, and right into the Mountains of Moab.

He adds—Professor Hull has gone the length of constituting this into a separate formation, under the title of Desert Sandstone, along with the overlying limestone it forms a strip on the borders of the crystaline rocks, and is about 400 feet in average thickness.

Such are the observations of the eminent geologists I have quoted in reference to this wonderful formation, Nubian Sandstone, thousands of feet thick in many places, as at Mount Hor, and very unfossilliferous with the Wady Nasb Limestone and Desert Sandstone of Hull sometimes traceable at its base in either case resting on the old crystaline or metamorphic rocks, the surfaces of which are observed to be level below the sandstones as shewn in Mr Bauerman's section, with nothing intervening above between the Nubian Sandstone and the base of the cretaceous limestone, such is the case south of Mount Hermon, there, however, Neocomian or Jurassic Fossils are freely met with, and Mr Hudleston's map shows a locality in this mountain or its flanks of one of such formations.

I was prevented by indisposition from proceeding northwards to Damascus, according to my programme, but one of my party obtained from the Arabs at the side of this mountain the fossils produced, which Mr Etheridge has kindly named, viz., Rhynchonellidæ Substrahidra and Quadriplicata, &c., being Jurassic and the Ammonites Luynesi, &c., Spines of Cidaris Glandaria-Cretaceous.

I rode some 100 miles to Tiberias, which is a scattered old place in a volcanic district, and stayed some days at the Latin Convent there. To the north of it rise the basaltic hills of Safed, to the east the volcanic plateau of the Jaulan, to the west the *Horns of Hattin*,* (where the Crusaders made their last

* Kurn Hattin 1178 feet high above the sea, from which streams of lava (Basaltic) have flowed to Tiberias.

stand, under King Guy, of Lusignan.) The strand of the lake is interesting, covered with fine gravel formed of small pebbles of limestone basalt and rolled flint, polished by the incessant movement of the waters, and mixed with innumerable dead shells produced, belonging to the Genera Neritina Melania Melanopsis Cyrena and Unio. In 1834 there was much trembling of the earth in this locality, and upwards of 20 tons of Bitumen were ejected near the south end of the Dead Sea.

In 1837 one of the greatest earthquakes took place that has ever been experienced in Syria. The trembling of the earth occurred from one end to the other of the Jordan Valley, following the direction of the mountains which bordered it. and that of the great axis of dislocation of the basin. This earthquake was felt over a zone 184 leagues long, and 32 leagues wide. Six thousand persons perished in this catastrophe. The town of Tiberias was entirely destroyed, and in the environs new hot springs burst forth, and deep fissures were produced in the rocks. After this earthquake the Arabs saw floating on the Dead Sea a mass of asphalte as an island or like a house. They drew from it about 3000 dollars in selling it at the bazaar of Jerusalem at 100 francs the quintal (about 2 cwt.)*

There is a mineral spring about a mile below Tiberias or a little more, with a very high temperature, 143° Fahrt., so hot that where it is emitted I could not put my hand in it to take out this little pebble, which has as you will see a volcanic appearance, also a bath used on alternate days by Arab men and women, of course the water must become cooled greatly there before anyone could safely get in it, even an Arab. The bath is of the dirtiest character. The analysis of this spring taken from the United States official reports (Lynch Expedition) is as follows:—

* See p. 274 Lartet "Essai sur la Geologie de Palestine."

## WATER OF EMMAUS

| | Grains per Gall. |
|---|---|
| Sodium Chloride ... ... ... | 1200·5 |
| Potassium Chloride ... ... | 11·2 |
| Calcium Chloride ... ... ... | 620·9 |
| Magnesium Chloride ... ... | 142·1 |
| Calcium Sulphate ... ... | 50·4 |
| Sodium Sulphate ... ... | 43·4 |
| Magnesium Sulphate ... ... | 11·2 |
| Calcium Carbonate ... ... | 25·2 |
| Magnesium Carbonate ... ... | 6·3 |
| Alkaline and Earthy Sulphides; Free 3 D. 2 S. Bromine, Organic matter | Not estimated |
| | 2110·2 |

Sea water contains 1444 grains of common salt (*Chl. Sodium*) to the gallon, or say one lb. of salt in 5 galls.

Hudleston remarks the total saline residue is about equal to that of the Mediterranean, but exists in very different proportions. It is about double that of the Old Sulphur Well at Harrogate.

The hills on the shores of the Sea of Tiberias are much covered with basaltic débris, over and around Tiberias the rocks are very bold, showing in places an admixture of cretaceous limestone and basalt, where the hill side is grass land, as on the road to Nazareth I observed a considerable depth of rich loamy soil, arising doubtless from the decay of the basalt.*

No doubt the main features in the dynamic geology of Palestine are the raised beaches adjoining the Mediterranean Sea on the west, and the great fault that runs down the Ghor or Jordan Valley on the east, the course of which is inferential

* Between the Sea of Tiberias and the base of Hermon at Bâniâs the traveller marches for two entire days over sheets of basaltic lava.

from the neighbourhood of Safed to the south end of the Dead Sea, but determined and shewn on Mr Armstrong's map through the Wady Arabah with the geological details of Professor Hull marked thereon. The Valley of the Jordan and basin of the Dead Sea is one of the most remarkable on the earth's surface; "as observed by Murchison it is the key of the Geology of the whole district." It will be noted that the height of the summit at Jerusalem above the sea is about the same as the depth to the bottom of the hollow of the Dead Sea below it in both cases about 2600 feet.

The fault so far as it can be illustrated is upwards of 3000 feet as indicated on the section.* That it arose at the close of the Eocene Period may be concluded from the section which shows the upheaval of the cretaceous and nummulitic limestones of Western Palestine, both marine formations then converted into land areas. Then it was that the fracture of the formations became developed by the contraction of their constituent materials in this great fault which brings into contact as shewn the limestones with the Nubian sandstone. The period of upheaval is also arrived at as stated from the fact of no Miocene of a marine character being found in Palestine. It is probable that at this period of change and disturbance the mountains in Western Arabia in the Sinaitic peninsula and in Moab arose, and the main confirmation of the country as existing at the present day was established. It would seem from the numerous terraces which may be traced on the sides of the Ghor and the cliffs and escarpments adjoining the Dead Sea that a very extensive lake existed in the valley of the Jordan, the waters in which were maintained by a heavier rainfall than at present exists, which rainfall is quite insufficient to account for the great denudation apparent in the wadies and ravines that has been previously referred to.

* The maximum displacement is at the south end of the Ghor opposite Mount Hor.

I have remarked at the commencement of this paper that the opening of the Tertiary period witnessed the upheaval of most of the mountain chains of the globe, and here I need only again refer to the level surfaces which according to Bauerman's sections the older crystaline rocks and metamorphic-schists exhibit where the Nudian Sandstone rests on them (notwithstanding that they are both much pierced by dykes) indicating a gradual upheaval noticed by Mr Hudleston, who says: "It is of course well known to those who have paid any attention previously to the subject that the great physical break which fell upon these regions took place towards the close of the Eocone period. After that all was changed, and a marine area became a continental one."

## THE DEAD SEA

The superficial area of this sea may be taken at about 360 square miles or 10,036 millions of square feet. Mons. Lartet says that the estimated flow of the River Jordan into it may be stated approximatively at certain seasons of the year at 6,500,000 tonnes (French) during the day, which would be equivalent to 229,534,510 cubic feet. The evaporation to account for such a volume of water would be ·0228 of a foot or somewhat over a quarter of an inch, or 6·9 millimetres. This is exclusive of the numerous other affluents that flow direct into it, the total of which he assumes may equal but cannot surpass that of the Jordan. His figures, are I think, large, but he refers to the calculations of Professor Zech, of Stuttgart, whose calculations show a necessary evaporation of 13 millimetres in depth from the surface of the Dead Sea to account for the maximum flow of the Jordan, and I presume the whole of the affluents into the sea. This agrees materially with my previous figures. Taking therefore $\frac{1}{2}\frac{3}{5}$ of an inch or a little over ½-inch as the water to be accounted for without admitting the hypothesis of the Arabians that there is a subterranean outlet. We will consider the facts:—

1st.—That the occasional variations before referred to in the surface level of the Dead Sea is an argument against such an hypothesis, and shows a physical capability and tendency for retaining the affluent waters.

2nd.—The saliferous gypseous and other deposits now known to be forming *in the bed of the sea* is another.

3rd.—The uprise of the numerous mineral volcanic springs to high levels hundreds of feet above the surface of the sea is another.

4th.—The evaporation required to account for the whole affluent waters does not exceed what may be expected, having regard to their location in the latitude, say 31·30″ in the deepest hole in the earth's surface (*i.e.* nearly 1300 feet below the Red Sea), wherein the air having traversed large tracts of tropical waterless and desert land is deprived of its moisture and rapidly imbibes that from a large expanse of exposed surface. In England, lat. say 51′ 30″, after long summer drought we find an evaporation of one-tenth of an inch per diem, a little above sea level. In India, at the large reservoir at Ambàjhari, (containing 1500 million gallons) that supplies Nagpur, about lat. 21° 9″, situated 519 miles N.E. of Bombay, the evaporation stated by Mr Binney between October, 1872, and June, 1873, (clear of the monsoon months, viz., June, July, August, September, and early part of October) was ·0289 feet, somewhat over one-third of an inch per diem. This reservoir being situated from 975 to 1015 feet *above* sea level.

In the proceedings of the American Geological Association there is important information on the subject of evaporation from the large Salt Lakes in that country. Mr George Karl Gilbert, the Geologist in charge of the report on Lake Bonneville, having an area nearly 20,000 square miles, says that he has estimated that 80 inches are usually removed by evaporation from this Salt Lake annually, and Mr Thomas Russell has computed from annual means of temperature vapourtention and wind velocity that in the lowlands of the great Salt Lake basin the annual rate of evaporation from water surfaces ranges from 60 inches at the north to 150 inches at the south. The total area is 210,000 square miles. The boundary of the great basin is Columbia on the north, Colorado (of the west) on the east, and the basins of Sacramento River on the west.

About five miles from the south end of the Sea of Galilee the Yermuk affluent joins, from the east, the Jordan, below this point the waters of the river cease to be bright. Its bed is cut through the salt marls (deposited formerly by the Dead Sea) in its downward course, these somewhat resemble in appearance the Loes of the River Rhine. From this neighbourhood and the salific properties of the Terraces on the sides of the old lake basin the waters of the Jordan may be expected to have derived some saltness, although not sensible to the taste this is found to be the case on analysis. At seven miles above the Dead Sea M. Lartet found ·873 grains saline residue in a *litre* of the Jordan water, $1\frac{3}{4}$ *pint*. In consequence of the density of the Dead Sea waters 1162 at the surface and 1256 near the bottom, whilst that of the ocean is represented by 1027, the human body does not sink in them even under complete immobility.

The water at first does not appear different from that of the ocean, but if the hand is put in it a pronounced oily impression is felt, and after prolonged contact pustules arise in the skin, which are persistent while remaining on the lake. The water is rich in chlorides and bromides, and it is no doubt from the abundance of these salts that is to be attributed the complete absence of animal life, such as generally exists in sheets of salt water, as at Lakes Balkash, Urimiah, Van, &c., in Asia Minor.

Dr Hull says "no fact in physical history has been more clearly established than that the waters of the Jordan Valley Lake originally had a level somewhat higher than that of the Mediterranean, and considerably over 1300 feet above its present surface. At such a time this great inland lake would have had a length of about 200 miles, with however no connexion with the Red Sea or Mediterranean Sea being separated from the former by an anticlinal in the Wady el Arabah, 660 feet above its water level, and from the latter by an anticlinal upwards of 300 feet in the Plain of Esdraelon, the lowest enclosing bank west of the Jordan, as before described." Dr Hull gives an account of Terraces up to 630 feet above water level, and Mr George Armstrong has given me an interesting account of his ascent up the cliff (near Engedi) and has been good enough to lend me the specimens produced, (which Mr Etheridge has very kindly named) that he then collected on the Terraces.

It will be at once evident that the water level in this mighty reservoir without an outlet would be dependent as much on evaporation as on the amount of inflow. In post-glacial times the latter would be in excess and the former at its minimum, as the inflow diminished and evaporation increased, with warmer atmospheric conditions there would be a tendency to reduce the water level, but this would be a slow process in such a reservoir, and would occupy a long lapse of time before desiccation to the extent of 1300 feet of depth was effected. As Mr Hudleston observes a succession of Dead Seas were all dried up in the Jordan Valley before the days of Abraham.

In regard to the period of the volcanic outbursts that have been mentioned, Professor Hull says "Recollecting the manner in which both in Moab and the Jaulan the basalt streams flow along depressions, hollowed out of cretaceous and eocene limestones, it is clear that the basaltic eruptions are of later date than the depressions themselves, and we shall probably not be in error if we assume that the earlier manifestations of volcanic action began during the epoch of the Pliocene. I have already referred to the evidence from hot springs and recent earthquake in the neighbourhood of Tiberias, that vulcanicity is not yet effete in these regions. This is equally if not more decidedly marked in the Zerka Main Ravine, towards the N.E. end of the Dead Sea, wherein the steaming sources of the Calirrhöe Flow having a temperature of 142° Fahrt., much the same as those at Emmaus, near Tiberias, before referred to. Major Conder gives a graphic account of his ride down this ravine, a depth of some 1700 feet, and describes the outbreak of basalt that almost blocks it as resembling the high spoil heaps of an English coal mine.*

* See Hath and Moab, by C. R. Conder, R.E., p, 149.