THE

PROCEEDINGS

OF THE

Cotteswold Naturalists' FIELD CLUB

FOR 1868.

President.
SIR W. V. GUISE, BART., F.L.S., F.G.S.

Vice-President.
T. B. LL. BAKER, ESQ., F.S.S.

Secretary.
W. H. PAINE, M.D., F.G.S.

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FIELD CLUB.

VOLUME V.

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1872.

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Address to the Cotteswold Naturalists' Field Club. Read by the President, Sir W. V. Guise, Bart., F.L.S., F.G.S., *at Gloucester, April* 19*th,* 1869.

Gentlemen,—

The records of our Club during the past season, though rich, as usual, in all that makes such associations delightful—pleasant rambles, friendly intercourse, and instructive discussions—are yet deficient in that particular to which I have always attached the greatest importance, viz: in the publication of papers of scientific value. It is this, more than any other condition, which marks the zeal and intelligence of members, and affords a standard by which to measure our progress and practical utility. Doubtless the elaboration of scientific papers is not the only, or perhaps the principal, end and object of our Association. In an educational point of view such societies as ours are most valuable from the impetus they give to inquiry amongst those who, without such stimulants to knowledge, would perhaps care little to extend their scrutiny into the realms of natural science,—so rich in pleasure and intellectual advancement to those who, with loving hearts and observing eyes, are led to search into the laws and history of organic life, past or present, upon the surface of our planet.

The Cotteswold Club has always aimed at a high standard of scientific eminence; and by the labours of its distinguished associates—amongst whom the names of Wright, Buckman, Lycett, Jones, and Etheridge, are conspicuous—it has secured a position amongst scientific bodies second to that of no similar body of Naturalists in the United Kingdom. Let it be our care that this reputation shall be maintained and extended,—in

earnest whereof I may refer with satisfaction to the elaborate and important paper with which we are about to commence this session—by our colleague, Mr. Lucy, on the "Gravels of the Valleys of the Severn, Avon, and Evenlode"—a paper which I will venture to predict will form a starting point and basis for all future generalisation on the quaternary Gravels, so careful, so elaborate and so extensive are the observations upon which it is founded.

The following were the appointed dates and places of meeting of the Club for the past season:

Wednesday, May 27th, Nailsworth and Avening.
Tuesday, June 23rd, Sharpness.
Wednesday, July 22nd, Wotton-under-Edge.
Wednesday, Aug. 12th, Bredon.

It will be observed that we departed last year from our custom, to which I have always attached much importance, of holding one of our meetings outside the boundary of our county; but the experience of former years had forced upon us the conclusion, that members were indisposed to support these distant excursions. They were therefore of necessity abandoned. This year, however, we have received an invitation so hospitable and attractive that already a large number of names have been sent in reply to the notice which I caused to be circulated a few weeks since. This invitation comes from Mr. Maw, of Benthall Edge, and is so comprehensive in its terms, and so unbounded in its offers of hospitality, that it cannot be doubted that a very large body of our members will come together in the beginning of June, to partake of the hospitality of Mr. Maw, and, under his able guidance, to explore the highly interesting district by which his residence is surrounded.

I now pass to the records of our proceedings at the different meetings of the Club held during the last year.

The Annual Meeting took place at the Bell Hotel, Gloucester, on Wednesday, 25th March, when the President's Address was read. Dr. Paine, the Secretary, being—to the regret of all—unavoidably absent, through illness, his place was temporarily

filled by Mr. Lucy. The officers for the ensuing year were chosen, when you again did me the honour to testify your confidence in me by again electing me your President; and Dr. Paine was again chosen Secretary.

After the conclusion of the official business, some of the party, under the guidance of Mr. Lysons, proceeded to visit a spot in the parish of Lassington, where there are evidences of the presence of Roman Remains,—some *Tesseræ* having been brought to the surface, and the outline of buildings being discernible. This may afford subject for investigation at some future time. The party, about thirty in number, sat down to dinner at the Bell Hotel.

After dinner the President read a paper by Professor Buckman, on the "Rat-tailed Radish," (*Raphanus caudatus,*) recently introduced from Java, which Professor Buckman gave reasons for believing to be only a long-podded variety of our Garden Radish. Tastes differ in respect of its excellence as an article of food; but the Professor has no doubts at all upon the subject, pronouncing it "*simply nasty.*"

Some notes by Mr. John Jones were read on the origin of the word "Crupets," or "Crippetts," the name of a farmhouse, in the parish of Shurdington. This Mr. Jones endeavoured to shew is the modernised name of the family of "De Crupet," "Croupe," or "Crupes," to whom the place formerly belonged. This family Mr. Jones identifies with a Belgian or Walloon house of the same name, "De Crupet," who were formerly Lords of the Commune of Crupet, near the town and in the province of Namur. Their arms, six Mascles, Gules, and a label Azure, are to be seen on a knightly effigy in Whittington Church, in this county.

Mr. Lucy exhibited two Fossils, believed to be eggs of the "*Teleosaurus,*" given to him by Mr. Joshua Brown, residing near Cirencester. Mr. Lucy mentioned his having recently made an excursion in the Cotteswolds, round Stow and Burford, and called attention to the gradual thinning out of the beds in a northerly direction. On the authority of Mr. Hull's Memoirs, to illustrate Map 44 Geological Survey, he stated, that while at

Cleeve Cloud the Inferior Oolite attains an elevation of 1130 feet, the Cornbrash south of Burford is not much more than one-half that height. This, however, is in some degree due to the greatly diminished thickness of the underlying strata in the latter locality.

At Shipton Downs, near Burford, the

Inferior Oolite is only	20 feet
Upper Lias	20 ,,
Middle Lias . . .	24 ,,
	64 feet

And at Ascot there is even a greater diminution :—

Inferior Oolite . . .	10 feet
Upper Lias	6 ,,
Middle Lias	10 ,,
	26 feet

This law of "thinning out" does not, however, apply to the Great Oolite, which has a greater thickness than at Minchinhampton.

Mr. Lucy exhibited some good specimens of Fossils from the Forest Marble of Shipton Downs, and others from the Stonesfield Slate of Stonesfield. He gave a description of a section of these last-named beds, pointing out that the fissile band from which the Slates are derived is about four feet thick, and occurs at a depth of 60 feet below the surface. He briefly explained the variable character of this formation, and suggested that the Club should meet for the examination of the Upper Cotteswold district, with a view to correlate the same with the well-known sections in the southern portion of the county.

The First Field Meeting of the season took place on Wednesday, 27th May, at Nailsworth. The programme for the day embraced a visit to Minchinhampton and Avening. At the station at Nailsworth, the attention of the party was directed by Mr. Witchell to an extensive land slip, caused by the Fullers Earth beds slipping over the unctuous clays of the Upper Lias, to which action, perpetually going on, Mr. Witchell attributes the gradual widening out of many of the valleys and combes

of the Cotteswolds. At Nailsworth a visit was paid to the grounds of Mrs. Smith and Mr. Tabram. In the garden of the former a section was exhibited of the Supra-Liassic Sands; and under a hedgerow the "Leopard's-bane" *(Doronicum pardalianches)* was growing in great abundance, said to be wild, but probably introduced. In the grounds of Mr. Tabram the point of interest was a small ancient Chapel—date, apparently 15th century—still retaining many traces of its former structure, such as the original doorway, portions of the east window, and a piscina in a good state of preservation. Here, also, was a very curious ancient bell, supposed to have been a "Curfew," and said to have been found at Ozleworth. Passing up the hill towards the Common, the Geologists paused to examine the Scar Hill section of Inferior Oolite, and to compare it with the typical section of the same beds at Leckhampton, where they are found 60 feet in thickness; while at Scar Hill they have thinned out to about 3 feet. Though this section is not very fossiliferous, it was interesting to notice the hard bed of compact Oolite here, about 18 inches thick, bored in every direction by small vertical tubes of Marine Annelids. Leaving Scar Hill, the party proceeded over Minchinhampton Common to Old Lodge, where luncheon was served. By the way Mr. Playne drew attention to the long barrows so plentifully strewn over the plateau, and to the lines of earthworks which protect the ground on its most exposed face—pointing to the occupation of the position, at some remote period, by rude tribes, of whom these scattered mounds are now the sole records. These barrows might be opened at a small cost, and as the investigation would doubtless throw light upon their origin, it is to be hoped that the Cotteswold Club will devote some portion of their funds to the purpose. At Minchinhampton Church, Mr. Playne exhibited some carefully drawn diagrams of a number of very curious early stone coffin-lids, discovered in the course of repairs and restorations executed in the church in 1842. It is most desirable that these memorials should not be lost; and it is proposed to have them engraved for the Transactions of the Club. The south transept, with its fine stone roof and rose window, was much admired, as were the

interesting and well-preserved effigies of Sir John Delamere and his wife, who rebuilt the transept in 1382. The clerk of the parish, a really intelligent man, had much to say about the church and the celebrities of the place, both lay and clerical, concerning whom he had collected, with great industry, a store of manuscript records. From Minchinhampton the party proceeded to Avening, halting by the way at a spot known as "Woful Dane Bottom," to see a rude monolith, which has apparently, at some time, formed portion of a cromlech. Another stone of the circle still remains included in the foundation of a neighbouring wall. Report says that the superstitious poor were at one time in the habit of passing ricketty babies, by moonlight, through an aperture in the stone; which, if true, would seem to connect it traditionally with some religious purpose. At any rate, it had nothing to do with the Danes, who did not inter their dead after that fashion.

The Church at Avening displays architectural characters of remarkable interest, shewing the transition, by additions, from the simplest style of Norman to the "Early English" and "Decorated." The arches of the nave and tower, with the vaulting-ribs and shafts, and the stone roof, are perfectly preserved, and the later additions and alterations are clearly traceable. This church would well repay careful and detailed examination by a competent antiquary. Attention was directed to a broken stone in the Chancel, on which is inscribed a circle intersected by a cross, with a portion of an inscription, apparently in Norman letters: it is very peculiar, and merits attention.

On the return to Nailsworth a halt was made to examine a gravel pit, in a wood, near Longford Mills, where an angular sub-aerial drift, 8 feet thick, is seen overlying the rolled gravels of the valley.

The party dined at the George Inn, Nailsworth. After dinner, Mr. Maw, F.G.S., of Benthall Edge, exhibited a series of beautifully executed diagrams, in illustration of a paper lately read by him before the Geological Society of London, on "The Disposition of Iron in Variegated Strata," in which he shewed how, by the action of chemical affinities, the metallic oxides

are withdrawn from the paler portions, and re-aggregated, in a concrete form, along lines of mineral segregation, or around central nuclei. The tendency of iron to gather round, or to disperse from, central nuclei, being amply shewn by the diagrams.

Captain FISHER read a paper on the battle of Ethandun, in which the Danes were overthrown by Alfred, the site of which battle he proposed to shift from Edington, in Wiltshire, to Hampton, in Gloucestershire—a transfer not likely to be accepted by the Wiltshire antiquaries. Captain FISHER founded his theory upon passages from the Saxon Chronicle, and from the Saxon historian Asser, which seemed to support the supposition that Hampton might have been the site of the conflict; that here the Danes sustained a dreadful disaster—and, therefore, that "Woful Dane's Bottom" is by no means a misnomer.

The reading of this paper caused a lively discussion, in which Mr. WITCHELL, Mr. CUNNINGTON, of Devizes, and others, took part.

Mr. WITCHELL thought that "Woful Dane" was certainly the scene of a battle, but that it was not Alfred, but Canute and Edmund Ironside who were engaged in it; and that the battle of *Assandune*, so fatal to the Saxons, was fought at Aston Down, which is only half-a-mile from the stone at "Woful Dane."

The time being limited, barely permitted Mr. PLAYNE to draw the attention of the Club to some very interesting osseous remains from the gravels of the neighbourhood, including the jaw of a beaver *(Castor Europæus,)* the horns and jaws of a red deer, of large size, and a jaw, attributed either to the Irish elk *(Megaceros hibernicus,)* or to its ally, *Strongyloceros.* The relic of the beaver is of interest, being only the second instance of its discovery, in a fossil state, in this part of England—though found in the Peat beds of Cambridgeshire and the Eastern Counties—a surprising fact, when it is recollected that this animal inhabited Wales so late as the time of GIRALDUS CAMBRENSIS, and must therefore have been plentiful in England at no very remote period.

Circumstances having rendered it necessary to postpone the meeting at Sharpness, the Second Field Meeting of the Club took place on Tuesday, June 23rd, at Wotton-under-Edge.

Your President not having been present with the Club on this occasion, I am indebted to your Secretary, and to Mr. Niblett, for the following particulars:—

The members met at the Swan Hotel, Wotton, and, under the guidance of Mr. Vincent Perkins, visited the different points of interest in the neighbourhoood. The Geology is particularly interesting, exhibiting an unbroken succession of beds—from the Lower Lias to the Great Oolite, inclusive. Between Symond's Hall Down—more than 800 feet above the sea-level—and the town of Wotton, may be traced, in descending order, Great Oolite, Fullers Earth, Inferior Oolite, (Upper and Lower zones,) and all the beds of the Upper, Middle, and Lower Lias.

The first halt was made at the Dick Hill Quarries, and the sections on the slope of Dick Hill. The Cephalopoda beds, overlying the Supra-Liassic Sands, are here well exposed. The characteristic Ammonites, Belemnites, and other testacea, were found in abundance.

The next section was in the Freestone Quarry, immediately above the Cephalopoda beds. The beds were compared with those in other localities, and their gradual thinning out in this locality noted and commented upon.

Leaving these sections, the party proceeded through Westridge Wood, to examine the ancient Earthwork at Becketsbury, which is now rather difficult to follow out, the whole side of the hill having been thickly planted. It appears to have been square, with double intrenchments, and is said to have enclosed many acres of ground.

After a luncheon, provided by the kind forethought of Mr. C. P. Pritchett, of Coombe House, a start was made for Nibley Knoll, now crowned by the Tyndale monument; and here, in a quarry under the hillside, the Cephalopoda beds were again found well exposed. Several other very good sections of these beds were noticed during the return of the party to Wotton-under-Edge.

The day was fortunately very clear, and thus permitted the enjoyment of one of the most extensive prospects in Gloucestershire. Far away, on the extreme left, might be seen the high land near Bath, with the racecourse on Lansdowne Hill; then the estuary of the Severn, Portishead Point, and a portion of the Bristol Channel. Following the line of the Severn, came Aust Cliff, the New Passage, and the mouth of the River Wye, and, further to the right, the whole of the Severn valley, nearly as far as Gloucester. Then, beyond the Severn, the Forest of Dean, and the long line of hills stretching away into Monmouthshire and Brecon. Immediately below, to the right, nestles the pretty village of North Nibley, with an interesting church, dedicated to St. Martin, and formerly belonging to the Abbey of Tewkesbury. Just beyond is Nibley Green, the scene of the famous fight between William, Lord Berkeley, and Thomas, Lord Lisle. The dispute originated in a law-suit between James, fifth Lord Berkeley, and Richd. Beauchamp, Earl of Warwick, who, in right of his wife, seized Nibley and several other manors belonging to the Lords of Berkeley. During the continuance of the suit, Thomas Talbot, Viscount Lisle, one of the claimants, sent a challenge to William, sixth Lord Berkeley, desiring him to fix time and place that they might decide their title by the sword. The Lord of Berkeley was prompt in his reply, which ran thus: "Fail not to-morrow to be at Nibley Green, at eight or nyne of the clock, and I will not fail, with God's might and grace, to meet thee there, ready to answer thee in all things. So keep thy day, and the truth shall be shewed by the mercy of God." Accordingly "the morrow" being the 20th March, 1470, they met on Nibley Green, when the first to fall was the bold challenger, Viscount Lisle himself, who was shot in the mouth by an arrow from the bow of a Forest of Dean archer; and about 150 of his followers were likewise slain. The dispute itself was not, however, terminated till long afterwards, when the Courts settled it in a much more peaceable fashion; and the Manor of Nibley returned to the possession of the Lords of Berkeley, its rightful owners.

From Nibley Knoll the party visited the Church, for the following notice of which I am indebted to our colleague, Mr. NIBLETT:—

"The Church is large and lofty, and consists of a chancel, nave, and north and south aisles, with a tower at the west end, a separate baptistery on the north side, and a south porch. It is difficult to assign a date to the building generally, because so much has been done in restorations, that it is a puzzle how to discriminate old from new work, without long and careful study, and without calling in aid the able assistance of the vicar, who, in the course of 40 years, has done so much work in restoration. The county histories speak of a disastrous fire that destroyed the town in the reign of John (1199 to 1216). The vicar says, that during the progress of building and excavation he has never stumbled upon the slightest trace of Norman work. He thinks that the former church may have been of wood, as may still be seen in a few churches in England, also abroad, as at Honfleur, and elsewhere. The oldest portions may not be earlier than the latter half of the thirteenth century, contemporaneous with the tomb of DE WOTTON, the vicar, buried in the very centre of the chancel,—the most honourable spot in the church,—which we may conjecture was rebuilt by his exertions. These older parts—similar to work in the chancel of St. Mary-de-Lode, Gloucester, at Slimbridge, &c.—may be termed "Transition First Pointed," or of the date of the latter half of the thirteenth century. The capitals of the columns in the nave deserve especial notice for their under-cutting. The tower would appear to be of later date, judging from the "ball-flower" ornament round the arch; it may be of the time of EDWARD II,—early in the fourteenth century,—or early Second Pointed style. The remaining portions would be "Perpendicular"—work of the fifteenth century, and early in that century.

"On a flat stone in the chancel—round the edge of which the impress remains of an inscription in uncial letters of Lombardic character—these rhyming lines occur:—

"'NATUS IN HAC VILLA COGNOMINE DICTUS AB ILLA
QUI RECTOR FUIT HIC APTUM NOMENQUE SIBI SIC
R. DE WOTTONA JACET HIC CUI CELICA DONA
IMPETRAT IPSA PIA PULCHERRIMA VIRGO MARIA.'

"All the brasses are gone, but there may be readily traced the outline of a floriated cross, in the centre of which was the VIRGIN MARY, and at the foot a figure of R. DE WOTTONA himself, kneeling, with a scroll inscribed—

"'ES MIHI VIRGO PIA DUX ET LUX SANCTA MARIA.'

"On a raised altar-shaped tomb of Purbeck marble, in the north aisle, are the effigies, on a brass plate, of THOMAS, fourth LORD BERKELEY, who

died 1416, and that of MARGARET, his wife. The inscriptions, shields, and other accessories, are missing, also the sword, dagger, and spurs of the Lord; but otherwise the brasses are in a fine state of preservation, having been placed in an elevated position—out of harm's way. They are a fine study of costume."

The Third Meeting of the Club took place on Wednesday, 22nd June. The rendezvous was at Gloucester, from whence the members proceeded by steamboat, on the canal, to Sharpness. The programme included an examination of the "Forest Bed" in the "Royal Drough" and the Silurian outcrop at Purton Passage. The day was one of the hottest of the late unusually hot summer; tempered, nevertheless, by a pleasant breeze, which rendered the water transit very agreeable. At Shepherd's Patch Bridge, about four-and-a-half miles from Sharpness, the party quitted the boat and pursued the line of the canal for about a mile, following the course of the "Royal Drough," one of the main arteries for the drainage of the adjoining district. Mr. CLEGRAM, who acted as guide, drew attention to the trunks of trees projecting here and there in the bed of the drain, and indicating the level of the "Forest Bed," which, at the depth of 16 feet, presents itself as a bed of Peat, 6 feet in thickness, containing oak, hazle, beech, and water flags. From it was taken a piece of oak timber, bearing on its surface evident marks of fire. This was shown to the Club. When excavating at Shepherd's Patch Bridge, at a depth of 16 feet, after passing through deposits of sand and mud, tracks were found of sheep and cattle impressed in clay, as sharp and well defined as if the impressions had been made quite recently. The present distance of this point from the river is more than a mile, but regard being had to the rapid silting up of the river along the low lands bordering the estuary—of which evidences abound—it is certain that no very remote antiquity can be assigned to these evidences of human occupation.

Following the "Royal Drough" to its outlet into the Severn, the excursionists pursued the river bank to Purton. About 100 yards to the eastward of the outlet of the "Drough" occurs a patch of Oolitic gravel, resting upon Lias, and containing

Quartz pebbles—derived, apparently, from the "Northern Drift." This is a singular detached outlier, not easily to be accounted for. At Purton a somewhat prolonged halt took place. At this point, on the prolongation of the Malvern up-thrust, a patch of Lower Silurian is brought to the surface, thus marking the line of disturbance; which, passing under Tortworth and the Bristol Coalfield, governs the position of the beds throughout that area.

Arrived at the beautiful grounds of Sharpness, the property of Lord FITZHARDINGE, the Club found a capital dinner, *al fresco*, awaiting them, of which the wasps were disposed to dispute the right of the members to partake. The party was here joined by their associate, Mr. JOHN BELLOWS, accompanied by the distinguished *savant*, Professor MAX MULLER.

Mr. GEORGE F. PLAYNE, read a paper on "The Physical Geology of the District Drained by the River Frome," an area twelve miles in extent, from north to south, by eight miles from east to west. This paper was illustrated by a map of the district, shewing the course of the river and its tributaries, and marking the "Faults" which, at certain points, govern the course of the streams, while cross-sections, shewing variations of level, completed all that was necessary to the perfect illustration of the district under review. Mr. PLAYNE's paper embraced a multitude of observations and measurements very carefully and conscientiously elaborated. The views held by the writer were, in the main, those of Col. GREENWOOD—that Rain and Rivers have been the principal agents in excavating and moulding the present contours of our hill and valley systems.

The Fourth and last Meeting of the Club for the season was held at Bredon, on Wednesday, 12th of August. This, which was a joint meeting with the Malvern Field Club, resulted in a small muster, as has usually been the case at this locality.

The party went in carriages to Ashton-under-Hill, from whence they ascended Bredon at its western extremity, and passing round the northern edge of the hill, rejoined their conveyances at Westmancote. On the verge of the most northerly point of the escarpment, near to Bredon Tower, and close adjoining to the top of the Roman Camp on the

summit of the hill, is a mass of rock, popularly known by the name of the "Bambury Stone." Here Mr. LEES, Vice-President of the Malvern Club, was requested to supply some information on the subject, and proceeded to say that the interest of this monument is both antiquarian and geological. He described it as "a large and rugged honeycombed mass of Oolitic rock of a roundish figure, with interstices filled to a considerable extent with stalactitic incrustations; being, in fact, broken up Oolite reconstructed, and a relic of an old line of coast. This coast-line had been rendered cavernous by wave-action; and even so late as 1712 the existence of a large cave, near the "Bambury Stone," had been recorded by Dr. DERHAM, in his Physico-Theology. The name, though corrupted, proved it to have been one of those *Ambre* stones consecrated by the Druids to Celtic superstition. In Cornwall, many similar stones bear the name of *Ambre*. The late Mr. JABEZ ALLIES, a Worcestershire antiquary, had no doubt that this was truly a Druidical *Ambre* stone; and Mr. LUKIS, of Guernsey, no mean authority on such matters, was of the same opinion."

The "Bambury Stone" is of a very remarkable conglomeratic character, being composed of large angular masses of Oolite, compacted in a calcareous paste. With the exception of one or two smaller masses of the same rock close to the Bambury Stone, it is not again met with until it is found in two isolated outliers of like character and composition, called the "King" and "Queen," which occupy a similar position on the southern slope of the hill above Westmancote. These conglomerates—so different in character from any other rock either there or elsewhere in the district, and occupying as they do a position on the denuded escarpment of the plateau—seem to admit of but one interpretation, namely, that they owe their origin to shore-ice during the Glacial epoch, to the grinding action of which substance the hollowing out of the valley itself is probably mainly due. The "Bambury Stone" and the "King" and "Queen" are thus but the remains of a far larger extension of the same deposit, which has in its turn yielded to denuding influences, and left only these relics to shew what once has been.

Mr. Lees, in the course of some observations on the "King" and "Queen," threw out a suggestion that these singular rocks may, in times past, have served as a place of assembly for chiefs and people; and in proof of the conspicuous estimation in which they were held, stated that the Manorial Court of Hardwick had long been held there, and that it was only of late years that it had been removed, for convenience sake, to an inn at Bredon.

With the minutes of the Bredon meeting terminate the records of the Cotteswold Club for the past season.

We assemble again in 1869 with undiminished numbers, and, I hope, with unabated zeal and enthusiasm for the ennobling pursuits in which we are all united. The book of Nature is so ample, her stores are so vast, her bounty so unlimited, that none need despair of being able in his own sphere, and by his own diligent labour, of contributing something to the ever accumulating stores of scientific knowledge, which, in an accelerating ratio, are heaping up for future races of men such power and wisdom as would almost seem to pass man's understanding. Yet, looking at the scientific triumphs of the last half-century, it seems scarcely presumptuous to expect that even the steam-ship, the electric telegraph, and spectrum analysis, will be outdone in the future, and that these are but the forerunners of still grander discoveries, by which the mind of man will assert its pre-eminence—its god-like supremacy—over the power of nature.


1
2

On some Glass Flasks from Dorsetshire. *By* James Buckman, F.L.S., F.G.S., &c.

In the parish of Thornford, just over the Yeo, which separates it from Bradford Abbas, a proprietor, in digging a potato garden, came upon a row of Flasks placed end to end. They consisted of three quarts and two pints. They were globular in shape, and composed of rough, dark green glass, (see Fig. 1,) upon each of which was an impressed stamp, raised in the form of a label,—the stamp evidently being that of a crest.

Having sent drawings to Mr. Albert Way, I have been favoured by him with the following ideas upon the matter:—

"The Glass Flasks are curious. I have seen a few such objects marked with some heraldic insignia and initials. Whether they contained Sack, or Rhenish, I cannot pretend to say; or when the fashion came in of placing some personal decorations on such wine bottles—*the prototypes no doubt of decanters.*

"The form is, I imagine, Dutch or North German, but I fancy was probably followed in our glass works, and is not obsolete in these days. I should imagine yours to be about 1700, perhaps earlier. The flying falcon recalls the crest of the Paulets, but the coronet is that of a Baron.

"There is a glass bottle (amongst others) in the Museum of the Royal Irish Academy, with a raised stamp,—

J. Swift, Dean,

1727

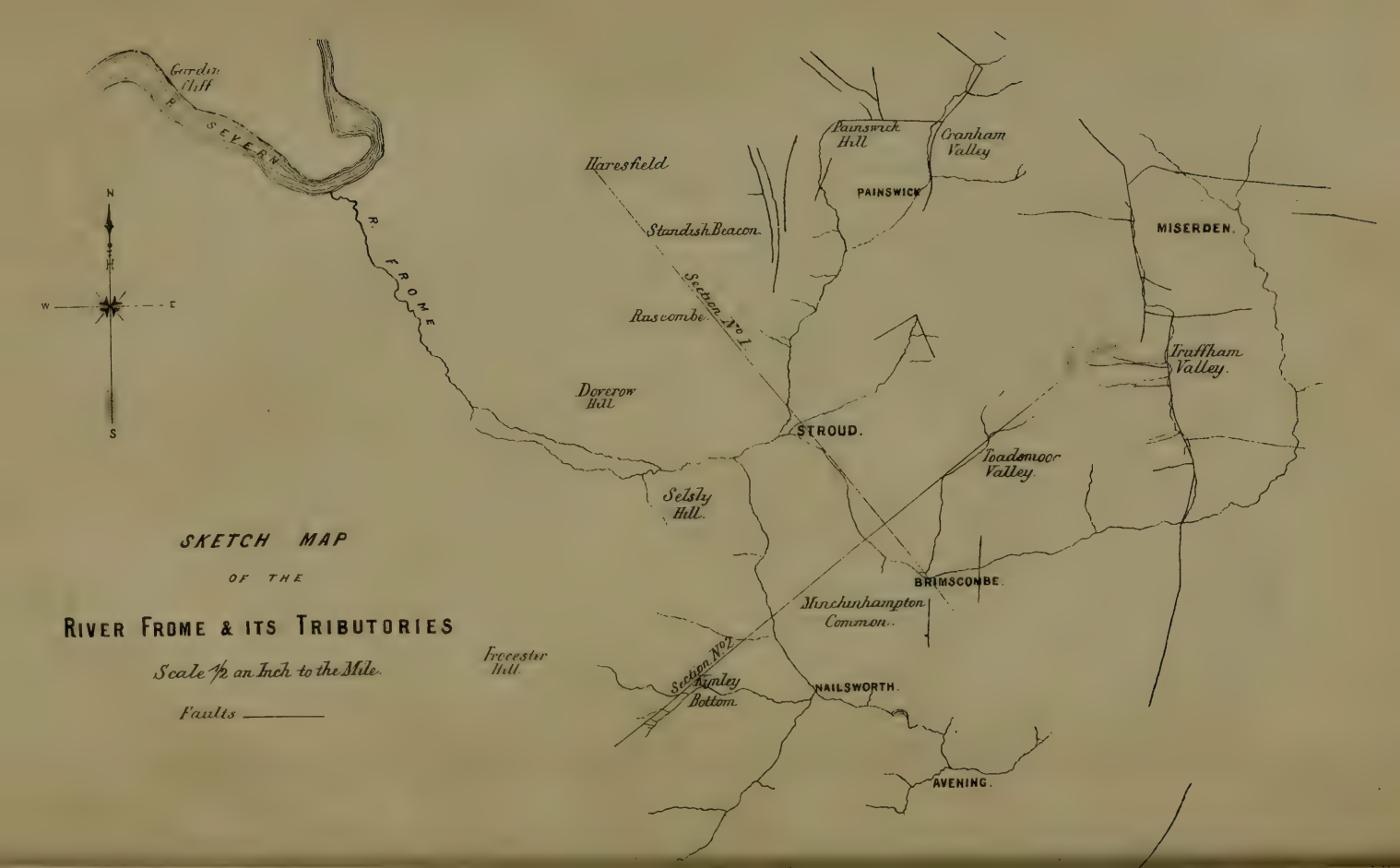
probably referable to the time of his popularity, as many others bear his name. I have seen, however, several bottles with heraldic stamps, certainly referring to the noble family for

which they were made; and I regard the circumstance as of interest, shewing the first idea of decorating this class of social appliances."

Now, as regards the raised stamps on the five bottles, it may interest to remark, that though all agree in every essential particular, yet the bottles show that they were stamped from at least two distinct dies.

I have not had an opportunity to decide as to this crest, but I fancy the PAULETS were much connected with the county. The fragment Fig. 2 is a stamp of a like kind, which was found at Clifton Maybank, now a hamlet of Bradford Abbas. This crest is of the HARVEY family, who held Clifton, and also Wyke. There are monuments to the HARVEYS in Bradford Church,—one to Sir THOS. HARVEY, on which is the same crest.

Whether these were the prototypes of decanters or no I cannot say, but at all events they are not inelegant in shape; and it seems quite evident that the crests were impressed upon them not only as a decoration, but to establish a kind of ownership.


SKETCH MAP
OF THE
RIVER FROME & ITS TRIBUTORIES
Scale ½ an Inch to the Mile.
Faults
N
S
E
W
Gordin Cliff
R. SEVERN
R. FROME
Haresfield
Standish Beacon
Section No 1
Rascombe
Dorerow Hill
Selsly Hill
Freestar Hill
Section No 2
Kimley Bottom
Painswick Hill
Cranham Valley
PAINSWICK
STROUD.
Toadsmoor Valley
BRIMSCOMBE.
Minchinhampton Common
NAILSWORTH.
AVENING.
MISERDEN.
Traffham Valley

On the Physical Geography of the District Drained by the River Frome and its Tributaries. By G. F. Playne.

Read at Sharpness, July 22nd, 1868.

That portion of the Cotteswold Hills which is drained by the River Frome and its tributary streams is remarkable for the narrow winding valleys which traverse the district in almost every direction. The probable means by which these deep valleys have been made is an interesting problem, which has frequently formed a topic of discussion on those occasions when the Field Meetings of the Club have been held in this district; and the subject has been brought prominently forward by the able and forcible paper of Mr. Witchell, "On the Denudation of the Cotteswolds."

Having lived all my life in these valleys, and for many years past taken an interest in the Geology of the district, this subject has often engaged my attention; and four years ago I endeavoured to ascertain the relative levels of the various Geological horizons in different parts of the district, in order to ascertain whether, in the elevation of the strata, irregularities had occurred which would in any way account for the formation of the valleys. Through the imperfection of the Aneroid barometer then used, the measurements of heights proved unreliable, and I abandoned the inquiry, and had to content myself with the belief, then so commonly held, that the sea had, in some mysterious way, scooped out these valleys, either by marine currents before the land emerged above its waves, or

that, during the elevation of the hills, the tides, running up narrow fissures, had produced the present configuration of this portion of the Cotteswold range.

The power of subaërial agents—of "Rain and Rivers"—had not then been fully recognized, though their claims had been forcibly brought forward by Colonel GREENWOOD in 1857, and latterly by J. B. JUKES, Esq., in writing on the formation of river valleys in the south of Ireland. From a most intimate acquaintance with the Geology of the district, and from acute observation and reasoning, Mr. WITCHELL has brought the arguments in favour of subaërial denudation to bear, in a powerful focus, on our Cotteswold Hills; and I, for one, have to thank him for thus, as I believe, clearing up many of the difficulties which presented themselves when the mode of the formation of these valleys was attempted to be explained.

There is always some danger of running from one extreme to the other; and in calling in the aid of our new ally—subaërial action—to account for the existing form of the earth's surface, we may easily slight our old friends, marine and volcanic agents. I trust, therefore, it may not be without interest if I bring forward some of the results of an examination of the stratification and general features of the district around Stroud—a district which illustrates in a very striking manner the changes which have been wrought in its physical features since the primary deposition of the strata of which it is composed.

On reference to the sketch map of the River Frome and its Tributaries, it will be seen that they carry off the rainfall of an area twelve miles in extent from north to south, and eight miles from east to west,—no inconsiderable portion of the Cotteswold range.

The peculiarities in the Physical Geography of this district appear to be due—

First. To the diversities of composition, and to irregularities in the amount of the original deposition of the strata.

Secondly. To inequalities of elevation or depression.

Thirdly. To the removal of a large portion of these irregularly deposited and irregularly elevated strata.

First. The diversities of composition of the strata composing these hills is very great. The argillaceous beds of the Lower Lias, Marlstone, and Upper Lias, form an impervious floor, on which have been built up the friable or slightly consolidated Sands, the rocky beds of the Inferior Oolite, again succeeded by the nearly impervious Fullers Earth, capped by the rocky beds of the Great Oolite and Forest Marble.

The variations in the amount of the deposits are well known over the extended area of the whole range of the Cotteswolds,—the Sands being estimated at 100 feet or more in thickness at their western edge, as at Cam Down, and at 15 feet or so beyond Stow; the Inferior Oolite estimated at 264 feet at Leckhampton, and at 25 feet at Bath; the Fullers Earth 200 feet near Bath, and as an inconsiderable band of Clay east of Cheltenham. All these thinnings out of strata are clearly perceived in their passage across the area under consideration, and exercise some importance in forming in their aggregation the relative heights of the hills in various parts of the district.

I ascribed the Physical Geography of this district to be due, in the second place, to inequalities of elevation or depression of the strata. In order to ascertain what inequalities exist, I have, by the aid of the Geological map, and by taking a large number of measurements with a delicately constructed Aneroid barometer, prepared several sections of this district, but on the present occasion will only mention two of them. In these sections I have endeavoured to lay down the position of the junction of the Sands with the Upper Lias, because of its important bearing on the water system of the district, and because this horizon is generally readily determined, being well marked on the hill sides by the outburst of springs; and at present I will confine my remarks to this junction line.

The first section is on a line extending from Haresfield, over Standish Beacon, and in the direction of the general dip of the strata of the Cotteswold range—namely, to the S.S.E. Just under the Beacon a fine spring of beautifully clear water (which probably supplied the Roman camp) indicates the position of this junction line, and here it is at an elevation of 500 feet

above the sea. At Ruscombe, a mile and three quarters off, this spring level is at 411 feet; at Farmhill a more sudden fall brings it to 300 feet; and near Brimscombe it occurs at 240 feet, thus showing a fall of 260 feet in six miles, or at an angle of 2½ degrees in the S.S.E. direction.

My second section is at right angles to the first. It cuts the line of the first section about a mile below Brimscombe, and extends from above Kynley Bottom, in the Shortwood Valley, to near Bisley. From this section it is seen that the strata dip from the south and from the north, and must form, underneath Minchinhampton Common, a synclinal axis. At Kynley Bottom the junction of the Lias and Sands occurs at an elevation of 300 feet above the sea. In the Nailsworth Valley this horizon is at 250 feet on the S.W. side of the valley, and at only 230 feet on the N.E. side, showing that some amount of disturbance has occurred in the line of this valley. Where the section crosses the Brimscombe Valley this horizon stands at 230 feet. In the Toadsmore Valley the actual junction is not to be met with, but the upper bed of the Sands stands at an elevation which indicates that the strata rise towards the N.E.; and on extending the line of this section to Miserden Park the Upper Lias is found at an elevation of 478 feet above the sea-level.

From these sections it appears that a depressed central area exists in this district, bounded on the N., W., and S. by the inclined beds just mentioned, only in the direction of the *general* dip of the Cotteswold Hills, namely, to the S.S.E., do the beds slope *from* this central area. The deep-seated forces which elevated the Cotteswold range acted *generally* so as to produce this dip of the strata to the S.S.E.; and in looking for the cause of nonconformity in this instance, whereby the strata of the hills lying immediately to the S. of the River Frome have a slight inclination to the N. E., it has occurred to me that this has probably been brought about by that elevating force which has produced in the Severn-side cliffs, near Gatcombe, an anticlinal arrangement of the strata, and which has brought Silurian strata to the existing surface near Berkeley. This upthrust appears to have extended underneath the Cotteswolds,

and to have influenced the elevation of Cam Down, Uley Bury, &c., as shewn by the Horizontal Section No. 1, Sheet 14 of the Geological Survey. It probably also extends to Frocester Hill, and Buckholt Wood, where I find the junction of the Lias and Sands occurs at an elevation of 600 feet, whereas at Ruscombe it is at 411 feet, and at Doverow, which stands in advance of a line drawn between these two points, this junction is at 325 feet *only*. It is true that the beds of Inferior Oolite which cap Doverow Hill stand at such an angle as to shew that they have slipped down from a higher position than that which they now occupy; but if we add even 50 feet to allow for this, their position will still indicate that the portion of the escarpment which once existed, over what is now the Stonehouse Valley, possessed a less elevation than the strata lying to the north and to the south of this spot. This depression in the line of the escarpment may be the cause that the present outflow of the rainfall of this district takes place at this point, and to the N.N.E., a direction exactly opposite to the general dip of the strata; but this direction of the outflow may also have been imparted to a very ancient River Frome, existing before these Secondary Rocks had assumed their present decided dip to the east, and this ancient river may have maintained its course in this direction through all the subsequent changes of level which have taken place of the strata lying beneath and around it. In passing, I would observe that nearly all the streams which cross the vale lying between the Cotteswold Hills and the River Severn, and from the Chelt to the Bristol Avon, flow in this N.N.W. direction.

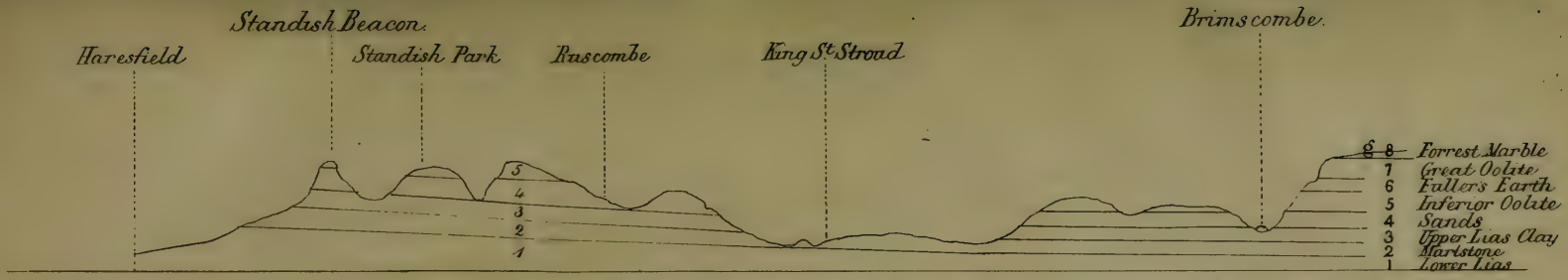
It has been mentioned that the strata, as shewn by the second section, have a synclinal axis,—this arrangement of the beds would, according to the views of Mr. Hull, in his paper "On the Physical Geography of the Cotteswold Hills," * produce a line of strength, and lead to the preservation of the overlying

* In the Quarterly Journal of the Geological Society, for Nov., 1855.

For bringing to my notice this and several other articles and publications bearing on the subject of this paper, I am indebted to the kindness of W. C. Lucy, Esq.

strata,—this result we have in the *table-land*, composed of nearly horizontal strata, of which the well known Minchinhampton Common forms part. At the same time this arangement of the strata would lead to the formation of an anticlinal axis on either hand, producing lines of weakness, in which lines, by the subsequent action of the denuding agencies, valleys would be formed. It is possible that the positions and directions of the deep valleys of Brimscombe, and of Nailsworth, have been determined by such anticlinal axes.

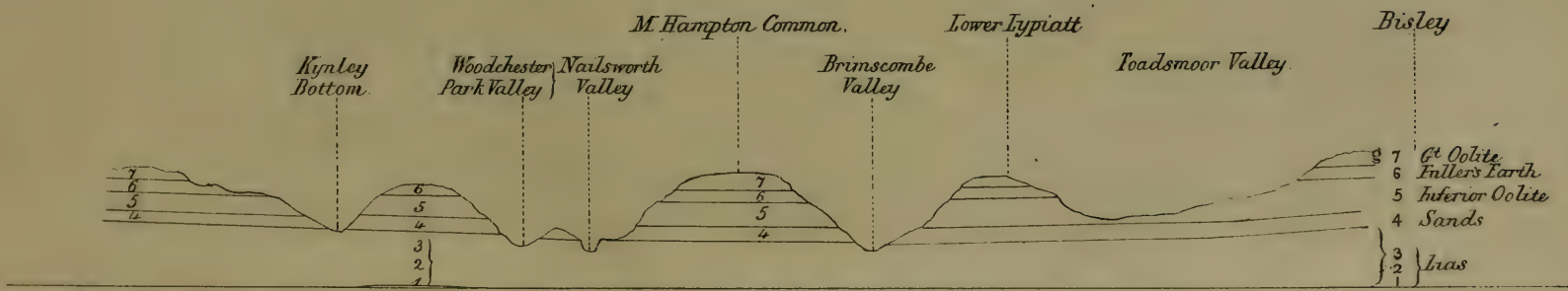
Whilst considering the irregularities which have occurred in the elevation of these hills, I would call attention to the FAULTS which are found in this district. As indicated by the Geological Map, they are—those grouped around Painswick Hill; those in the Cranham Valley; in the Truffham Valley; and two or three minor ones. As mentioned by Mr. HULL, in his Memoir on Sheet 44 of the Geological Survey, the neighbourhood of Painswick Hill has undergone an unusual amount of disturbance; and the way in which the Inferior Oolite has been shouldered off the dome-like elevation of that hill is clearly seen in the quarries worked on its flanks,—as, for instance, in one adjoining the road leading from Painswick to Upton St. Leonards. As regards the influence which Faults have in the formation of valleys, it may be remarked, that when they are confined to such highly pervious strata as the rock beds of the Great and Inferior Oolites, it is not to be expected that they should have conduced to the formation of valleys; but when they have extended to the argillaceous beds underlying these rocks, they must readily have received, retained, and given direction to the outflow of the drainage waters from the beds lying above and around them. And it is noteworthy, that in the Cranham Valley, where—as described by Mr. HULL—the Fault is so decided that, "at Sutton Mill, the Upper Lias is exposed to view on the left bank down to the brook, while on the opposite side the Marlstone forms a bank 30 to 40 feet in height," the stream runs chiefly in the line of the Faulting. Before this valley was scooped out to its present depth, and when by this Fault the Sands must have been placed in juxtaposition with



No. 1

SECTION IN A S. S. E. DIRECTION FROM STANDISH BEACON.

Horizontal Scale 1 Inch = 1 Mile. Vertical Scale 1 Inch = 1000 ft



No. 2.

SECTION AT A RIGHT ANGLE WITH THE ABOVE.

the Upper Lias, and the Inferior Oolite with the Sands, pervious beds resting against impervious, it is easy to perceive how this arrangement must have affected the drainage, and have given direction to the stream. On reference to the Geological Map, (Sheets 34 and 44,) it will be seen in how marked a manner the streams in the Truffham Valleys follow the lines of Faulting. In this locality the Fullers Earth Clays, greatly broken by Faults, provide the retentive beds which have formed barriers and conductors to the waters. The Fault on the line of which the lower part of the Truffham Valley has been formed, is intersected by the Sapperton Valley, which receives and carries westward the waters of the Truffham streamlet. The Fault extends southwards, across an elevated tract, and on its line a streamless valley commences, the drainage of which is into the Bristol Avon.

In the third place, the present configuration of this district has been brought about by the removal of a large portion of these irregularly deposited and irregularly elevated strata.

In order to form a just idea of the amount of denudation which has taken place, it is needful to take, in imagination, a bird's-eye-view of the district, and to realize the fact, that all the strata we now see composing the hills were once conterminous; they must have been deposited in continuous beds, but are now cut by valleys, which, commencing on the higher grounds in slight depressions, rapidly deepen, and in a very short distance attain a depth of more than 400 feet. These valleys are to be seen converging at one or two points, and finally opening out into the vale of the Severn through the western escarpment, with on one side the bold headland of Selsly Hill, rising to the height of 525 feet above the stream; and on the other side, Randwick Hill, of an equal altitude. Between these two points the beds of the Inferior Oolite, a mile and a half in lateral extent, have been removed, with the exception of a little patch capping Doverow Hill.

In like manner the beds of Great Oolite have disappeared between Bown Hill and Minchinhampton Common, a distance of more than a mile and a half. The whole amount of rocks,

clays, and sands which have been abstracted from the beds ranging down from the Forest Marble to the Lower Lias, is very great.

As regards the part the SEA has acted in bringing about the present configuration of this district, I would remark, that there is no proof that any portion of its area was raised above the surface of the ancient Liassic and Oolitic oceans, during the deposition of these strata, though such may have been the case; but there are many indications that the depth of the waters varied greatly from time to time,—the organism preserved in these deposits prove this; and one remarkable stratum deserves notice, as indicating the shallowness of the waters at one period. Over the greater part of this area the bed immediately underlying the Ragstones is found,—as Dr. LYCETT describes it,—"literally covered and grooved with impressions and remains "of animal life, valves of oysters clustering and adherent, a "labyrinth of grooves and tracks of Annellida and Mollusca, "crossing each other in all directions."* And again, at a little higher horizon, in the Ragstones, a vast oyster bed, (of *Gryphœa Buckmani*,) extending from Leckhampton to Rodborough, points to a like conclusion. It is not unlikely that the marine currents, in such a shallow sea, may have wrought upon the surface of the sedimentary deposits forming its bed, and so have produced channels; but if such occurred in the directions of the present valleys, all traces of such marine action have long since been removed.

There is little doubt that the general tendency of the action of the sea, on a coast line, is to plane off all strata that rise above its waves, but the more or less rapid elevation of the land, the varying dip of the emerging strata, the direction of the marine currents and other causes, combine to prevent this result. As regards the Cotteswold range—supposing the rate of elevation to have proceeded uniformly,—if the power of the waves was just sufficient to remove *Clay beds* as rapidly as they were raised above its surface, directly *Rock beds* presented themselves and,

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* The Cotteswold Hills. By JOHN LYCETT, Esq., 1857, pp. 62, 63.

by their superior hardness, resisted the wash of the breakers, the land would gain upon the sea. Mr. Hull attributes the preservation of Churchdown Hill to the resistance which the Marlstone beds have made to the denuding agencies; and it is noteworthy to what an extent the compact layers of the Ragstone form the capping of the escarpments of our hills, and appear to have been the means of arresting the spoliation of the beds beneath them.

The moment any portion of the strata had risen above the surface of the sea—even before they attained a position above the flood tide,—at each ebb of the waters, subaërial denudation would commence. Of the subaërial agents, the rainfall, accumulating in streamlets, would act in the direction of the dip of the strata, and speedily *cut channels in those directions.* To this I would refer as the cause of the tributary streams of this district flowing *in the direction of the dip of the strata.* The five principal streams which flow into the Brimscombe valley do so from the north, and of the four which join their waters to the Nailsworth stream, two flow towards the north, and two to the north-east, but all have their direction in accordance with the dip of the strata over which they run.

Into the mode of operation by which such great results have been accomplished, as are now generally ascribed to the power of "Rain and Rivers," I have no intention of entering, but will make one remark on the subject:—When we look across one of our valleys, a mile or more wide, and see a stream at the bottom, a few yards only in width, it is difficult to realize what relation that river has to such an excavation; and yet, though that river may at no period of its history have possessed twice its present volume of water, or have changed the direction of its bed to any great extent, it has, in all likelihood, been the *chief agent* in the formation of that valley. The stream must be regarded as a cutting instrument, and as a carrier—chiselling out its bed deeper and deeper into the strata, and all the while carrying off the spoils brought into it by rain, frosts, &c. This subject is well illustrated at the heads of our valleys, where, in many cases, it is seen how the surface drainage of a large

area is received and conveyed away by an insignificant streamlet, or when the surface strata are composed of porous beds, by mere occasional storm made currents running in a depression in the surface, but in either case carrying off much spoil of solid matter from the land.

To denudation by subaërial agents, carried on during the uncounted ages which elapsed whilst the Tertiary Strata were accumulating, I would refer as the *principal* cause of the formation of these valleys, but believe that when, during the Glacial Period, a change occurred in the relative levels of sea and land, the marine currents running up these narrow valleys, would act with great force, especially *by their surface waves*, wearing down the sides, and thereby widening the valleys. During these changes of level the surface of the waters must have acted on a constantly new horizon, for a while rising higher and higher, and then gradually sinking, thus bringing the force of the surface waves to act on every part of these hill-sides. It is easy to conceive how they would operate to produce cliffs when acting on rocky strata, and uneven slopes when wasting clay beds, also how by wearing away the loosely consolidated sands, and thus undermining the Inferior Oolite, they would produce those extensive landslips which form so marked a feature of this district. It is remarkable how conspicuous are the sands in these valleys, as delineated on the Geological Map, and how seldom they are to be seen in the field, being almost everywhere overlaid by materials derived from higher strata, and are only again brought to view by artificial cuttings, by water-worn lanes, and, occasionally, by running streams.

If it is conceded that this district was *totally submerged* during the Glacial Period, it will be interesting to inquire what would be the effect of marine currents flowing over such submerged hills and valleys. It is well known that the bed of the North Sea, of the present day, contains a great number of valley-like depressions. Dr. Lycett has kindly furnished me with information on this subject, and on the present action of the currents as they effect the bed of the sea off Scarborough. Of the sub-marine depressions, Dr. Lycett writes:—

"Upon the whole I perceive, from the Admiralty Chart of the "North Sea, that the largest and deepest valleys are off the coast "of Norway. In one place is a drop of from 60 fathoms in three "miles to a large valley with a mean level of 200 fathoms. The "Dogger Bank, a vast dome-shaped mass, almost an island, with "all its bordering valleys, is a very conspicuous object. It seems "to me that the general direction of the sea valleys off this coast "is from west to east, or at right angles to the flow of the tide, "which is from north to south. The opinion of intelligent "mariners is—that the bed of the North Sea strongly resembles "the surface of the land over England, in its general features; "and that in storms the sea exerts a great wearing influence to "the depth of 100 fathoms, or even more. One of the most "striking proofs of this is brought home to us in the wintry crop "of Liassic boulder stones strewed upon the coast, more especially "upon the Tertiary coast of Holderness, 40 miles in length, "Upper, Middle, and Lower Lias, and Kimmeridge Clay blocks "occur with all their characteristic fossils; and it is a notable "fact, indicative of their different origin, that the Lower Lias "fossils thus obtained are much better preserved than those "obtained from the cliffs and scars to the northward of Whitby. "There can be no doubt, therefore, of the denuding action that "is going on upon the submarine Liassic beds. The Holderness "Ammonites are very remarkable, often weighing one hundred "weight, encased in blocks of large size: thus every Spring the "fossil dealers at Bridlington have a new stock of Liassic and "other fossils upon sale."

Whilst this information is very interesting, as shewing the power of the sea to carry on the work of denudation, yet it is probable that such marine forces must act rather to remove strata from the higher parts of the bed of the ocean, than from those parts situate at greater depths; and thus the tendency of this denudation must be to produce a level surface. In passing, it is well to mention that the present configuration of the bed of the North Sea is regarded by subaërialists as due *to the submersion* of hills and valleys, which in former ages existed, as such, above the level of the ocean.

It has been very properly objected by Mr. Witchell, that if the sea has had a share in the formation of our valleys, it ought to have left traces of its former presence. That such have not been met with, I would suggest that all traces of this occupation of these valleys by the sea, as would be afforded by its depositing shells or sands, have been lost by the *subsequent* action of subaërial agents. At the close of the Glacial Period, and whilst the sea and land assumed their present relative levels, the surface of the land, largely denuded of vegetation, must have been in that condition on which subaërial agents of denudation must have acted with great effect to remove all such marine deposits.

The action of Ice during the Glacial Period must have largely assisted in abrading the hill-sides of this area.

The result of these various agencies has been the production of a district singularly varied in its external features, and this from causes so well described by Hugh Miller, in his early work, "The Old Red Sandstone," that I will quote from it here. He writes* :—

"In all the sedimentary formations, the peculiarities of scenery "depend on three circumstances—on the Plutonic agencies, the "denuding agencies, and the manner and proportions in which "the harder and softer beds of the deposits on which these "operated alternate with one another. There is an union of the "active and the passive in the formation of landscape; that "which disturbs and grinds down, and that which, according to "its texture and composition, affects, if I may so speak, a peculiar "style of being ground down and disturbed; and it is in the "passive circumstances that the peculiarities chiefly originate. "Hence it is that the scenery of the Chalk differs from the scenery "of the Oolite, and both from that of the Coal Measures."

These effects are well illustrated on the hill-sides of this district. Where these consist of the Upper Lias, steep banks have been produced; the more yielding Sands, where not covered up by fallen Rock-beds, have formed more gentle slopes, usually

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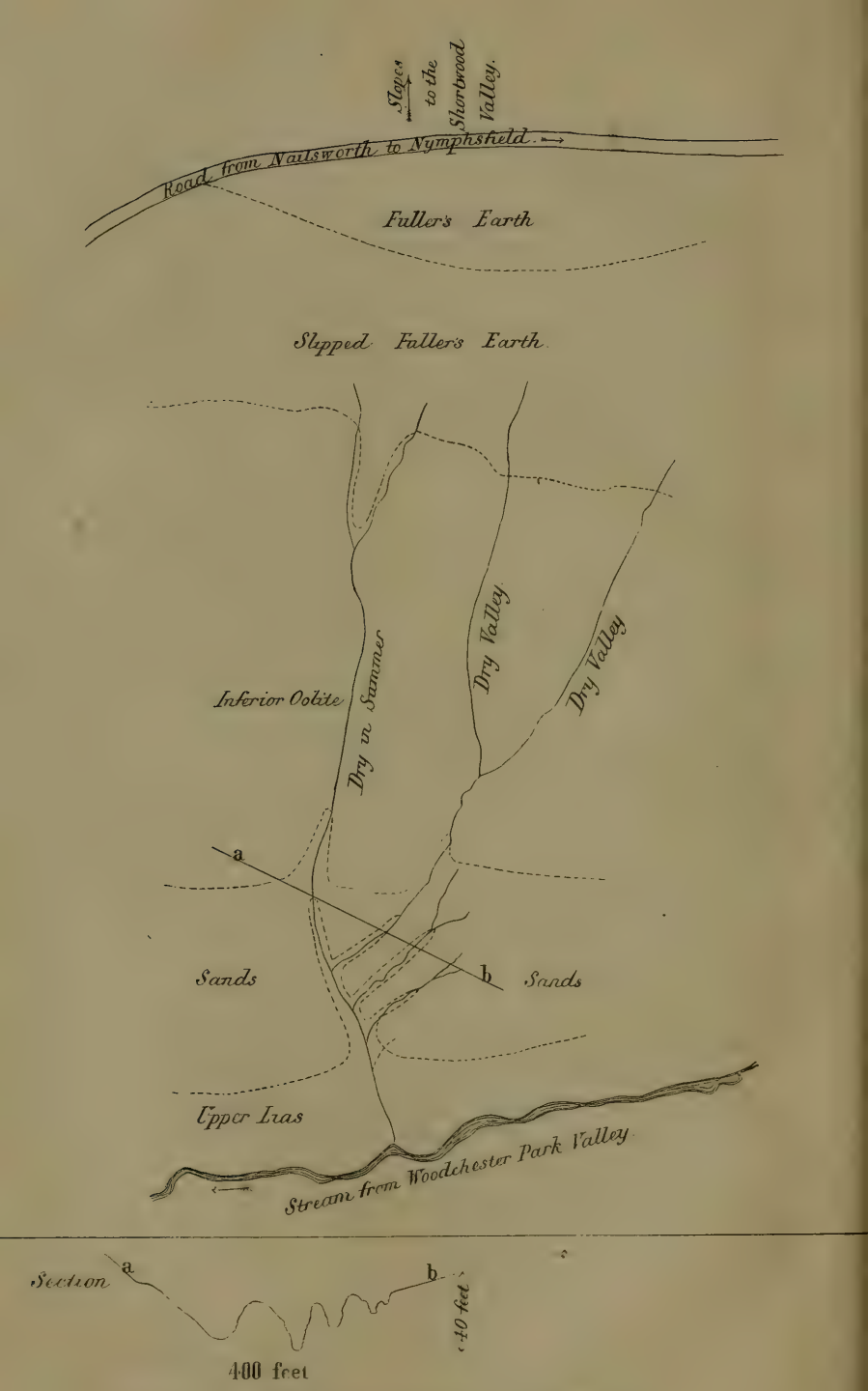
* At page 246, sixth edition.



SKETCH MAP OF THE FERNIE HILLS.

occupied by grass-fields, and frequently by orchards. The Inferior Oolite beds commonly present such an inclined face as to forbid the operations of the plough; and formerly this zone of these hill-sides was occupied by beech woods, except where the rock had been covered up by Clay slipped from the beds of the Fullers Earth. That argillaceous deposit usually exists as a nearly level band of arable land, and is succeeded by an abrupt cliff-like bank of Great Oolite. The forms of the present surfaces have directly resulted from the nature of the strata on which the denuding forces have acted.

A study of the Physical Geography of this district would embrace a variety of interesting topics, as, for instance, the manner in which the volume of waters of the streams are affected by the nature of the strata over which they pass, suffering loss of volume in some places, and in others, as where the streams first cut the sands, receiving great accessions, examples of which occur at Chalford, Longfords, &c. This, and other topics, must be passed by, but there are one or two Physical features to which I will call attention.

The line of my second section crosses at the Fernie Hills,* near Woodchester Park, a combe on the hill-side, a sketch-plan of which is here given. It would occupy far too much time to describe this spot in detail—suffice it to say that here can be seen

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* This locality well deserves this name, which it has borne for upwards of sixty years. Thirteen species of ferns are found on these hills, and seven other species in their immediate neighbourhood. Formerly, when high trees grew here, not only were the ferns remarkable by the number of their species, but by the abundance of plants of some species with which the banks were clothed. *Blechnum Boreale* especially attracted attention, with its deep green barren fronds spreading on all sides, and the graceful forms of its fertile fronds rising from the crowns of the plants. Occasionally, but rarely, *half-fructified* fronds occurred; and these, it was interesting to observe, inclined in a position intermediate to the wholly barren and the wholly fertile fronds.

The botanical changes which have occurred on this spot since the felling of the high-wood, have afforded much of interest. The surfaces of many parts of these steep banks having been denuded of *all* vegetation in the processes of felling and removing the timber, the Mosses had full scope for their office of renewing vegetation. On the clay banks appeared patches of the beautiful *Dicranum bryoides*, with its delicate yew-like branchlets; on the sandy banks the minute

a system of minature valleys in course of formation by streamlets cutting their way through the sands—above these, the dry valleys of the Inferior Oolite—and, yet higher, the streamlets borne forward by masses of Fullers Earth Clays slipped forward from their normal position. In fact, in this limited area, the subject of Subaërial Denudation may be studied with great advantage.

Another topic to which I would call attention, and enter on more in detail are the Alluviums which are found occupying the bottom of the valleys in many parts of this district.

The line of my second section, in crossing the Nailsworth Valley, cuts a small tract of these alluvial deposits, which extend up and down the valley. Wherever they are opened they are found to consist of beds of Gravel and Peat, resting on the Lias. They vary constantly in thickness and in length. The Gravels appear either to have been deposited in patches, or the beds, originally larger, have been denuded. The beds of Peat likewise vary greatly in thickness, but are more persistent in width. Both Gravel and Peat contain organic remains: those found in the latter are in a fine state of preservation. Near Lightpill, a splendid stag's horn, measuring 2 feet 5 inches from base to tip, and 9 inches in circumference above the ring, was found in the Peat. Above Nailsworth, portions of large deer jaws and antlers have been met with. In the construction

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Earth-mosses, accompanied by numberless young plants of various species, which, after a while, proved to be *Brynum hornum, Polytrichum commune*, &c., &c. The decaying "stools" of the felled trees were mantled with the vivid green foliage of the Cypress-leaved Feather-moss, and more than twenty other species of the genus *Hypnum* ultimately flourished here.

It is in such temporarily unoccupied soil that we must expect to find species of plants, hitherto unknown in the locality, to make their appearance: and here, before the ground was much occupied by the ordinary vegetation of the neighbourhood, I found a single specimen of *Lycopodium Clavatum*. This, the Stag's-horn Club-moss, has flourished on these hills to the present time, and in some years spore-bearing spikes have been produced. As far as I have yet ascertained *Lycopodium Clavatum* has not been found elsewhere on the Cotteswolds. Mr. Edwin Lees, Vice-President of the Worcestershire and Malvern Naturalists Clubs, informs me that, though it has been found in a very few instances on Hartlebury Common and Bromsgrove Lickey, it has never been met with on the Malvern Hills.

N°1 Horn of the large variety of Rein-deer; from Dunkirk.
N°2 " of Red-deer " Lightpill.
N°3 " " " " Dunkirk.

of the Stonehouse and Nailsworth Railway these beds were extensively opened close to Nailsworth, but scarcely any organisms were found, except a few fresh-water shells, and portions of trees and of water-plants. At Dunkirk Mills, one mile below Nailsworth, these beds have produced a remarkable assemblage of organisms. In digging for foundations of a building, and in deepening the channel of the stream, in the year 1854, these alluvial deposits were well exposed, and I had the opportunity of thoroughly examining them.

Underneath the surface soil, was a bed, 4 feet in depth, of yellow-brown Clay, which, at the time, Mr. Lycett concurred with me in considering to consist largely of redistributed Fullers Earth Clays. Below this was a bed, 6 to 9 inches in thickness, of white Clay, with Oolitic Gravel, on the upper surface of which lay the skull of a small deer, with the antlers attached. It was, however, in such a decaying state that only the occipital bone has been preserved. Underneath this a bed of Peat, 4 to 5 feet in depth, was charged with the remains of trees and plants. The trunk of a birch tree, with branches attached, lay in an inclined position in the direction of the stream; portions of trunks of ash, beech, and a wood resembling Scotch fir, and several cones of that tree *(Pinus sylvestris)*; also a red-coloured wood, either alder, or withy, and remains of stems of equisetacea; numerous hazle nuts, a few whole, but the greater number with holes eaten into them.

The mammalian remains found in this bed of Peat were yet more interesting. They consisted of a well-preserved jaw and horn of red deer, another larger jaw, and a number of broken antlers and ribs of deer, a tooth of an ox, of a horse, the jaw of a pig, a boar's tusk, and the jaw of a beaver.

At the time when this assemblage of osseous remains were met with, I had an opportunity of submitting the greater number of them to Professor Owen's examination. Professor Owen most kindly took much interest in them, especially in the larger jaw of deer, which at first he believed to have been the jaw of an Irish elk, *(Megaceros Hibernicus,)* or of some deer nearly as large; for on comparing it with the skull of the large

elk in the Hunterian museum, it was found to be nearly as large as the jaw in that splendid skeleton. He was also much interested in the shaft of a massive horn, of which the upper portion and one of the two brow antlers were wanting. He had great difficulty in determining what species it belonged to, but considered that it must have been a species of reindeer, the great length of shaft before branching occurred forbidding it to have been the horn of a red deer. Professor Owen thought this large horn, and the larger jaw above-mentioned, may have belonged to the same animal.

The beaver jaw he at once pronounced to be "the left ramus of the lower jaw of the European beaver," (*Castor Europeus*,) and added, "he had not cut this (the posterior) tooth long." This jaw was found in the Peat, and is well preserved. It presents a beautiful example of the dentition of a rodent: the molar teeth, with their transversal plications, maintaining a fine triturating surface; the incisor, with its chisel-shaped edge preserved by enamel being deposited only on its anterior surface, and the whole constantly replaced by growths at its base, and pushed forward as fast as the cutting portion is worn away by contact with hard bodies and by the opposing incisor.

These Peat beds also contained, of land shells, two or three species of *Helix*, and of fresh-water shells, a *Cyclas* and *Lymnœus Pereger*.

The bed of Peat in which these remains were found was 4 to 5 feet in depth; but 50 yards lower down the valley it had thinned out to an inconsiderable bed, composed of Peat *and Clay*, 1 foot in depth only, and in it were to be seen several stumps of trees, 1 foot in diameter, rooted to the spots on which they had grown, but with their trunks broken off and lying along on a level with their stumps, the wood still tolerably sound, and in its texture, and reddish tint of colour, resembling alder.

It is not difficult to picture out in thought the scene which this valley must have presented at the time when these Peaty deposits were accruing:—The streams, unimpeded by art, in many places flowing in a rapid current, and falling in a sounding

cascade over some temporary barrier; in another part, where the bottom of the valley was choked by the fallen trunks of trees, and by the abundant water plants a morass was formed, through which the stream pursued its onward course with difficulty, a colony of beavers had established themselves under the shelter of the overhanging branches of birches and alders. Amongst the forest trees on the steep hill-sides roamed at least three species of deer, and the other animals whose remains have been found imbedded in these alluvial deposits.

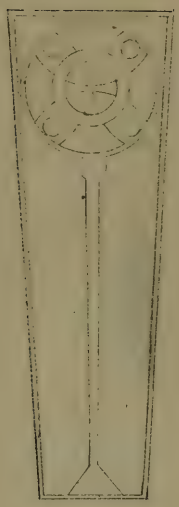
At the time these beds were thus so well exposed to examination, I considered that they were due not only to the obstruction offered to the waters of the stream by a luxuriant vegetation, both during its growth and its decay, but that the stream had been subjected to obstruction from slipped masses of Fullers Earth Clays. Such a landslip has occurred half a mile below Dunkirk Mills, and probably aided materially in the formation of the beds just described.

In the "Handbook of the Cotteswold Hills," published in 1857, Mr. Lycett mentioned that I held this view; and a further examination of our valleys confirms me in it.

On the line of my second section, where it cuts the Toadsmore Valley, may be seen at the present time a mass of Fullers Earth, which has slipped from its normal position, 200 feet above, over the Inferior Oolite, and has so filled the valley that even now its upper surface stands 40 feet above the former bed of the stream, and it is evident that the alluviums which now occupy the bottom of the valley to the distance of three-quarters of a mile above this landslip, owe their deposition to the fact that this intruding mass of Fullers Earth Clay at first dammed back the waters of the stream to that extent.

In conclusion, had this area of the Cotteswold Hills remained a nearly level tract, it would have formed a fine agricultural district, with probably a sparse population; but in its present configuration of hills and valleys, it is occupied by a very large population. In the sheltering valley-heads, supplied with abundant springs of excellent water, stand the older towns and villages—in their earliest state the homesteads of the cultivators

of the lands around them. Bisley, Minchinhampton, Painswick, Nymphsfield, &c., are so situated. The exposure on the hill-sides of the various qualities of stone suited to varied economic purposes, has given occupation to generation after generation of quarrymen and masons—as at Painswick, Quarras, Avening, &c. The streams, with their rapid currents so readily converted into millfalls,—the ponds of water being easily retained by the aid of the impervious Liassic strata composing the bottoms of the narrow valleys,—attracted hither successive immigrations of Flemmings, who, driven from their native land by religious persecutions, and from other causes, brought to this country their industries. In these and many other particulars this district presents a striking illustration of the manner in which the earth has been prepared for the service of man.



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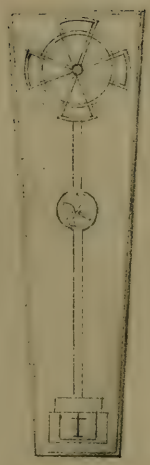

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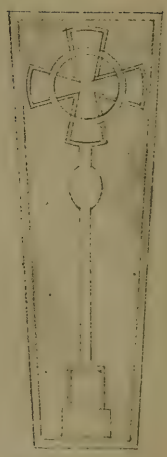

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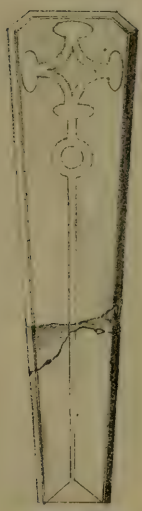

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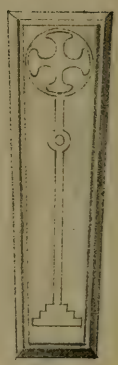

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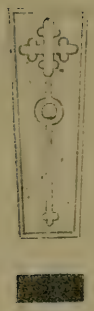

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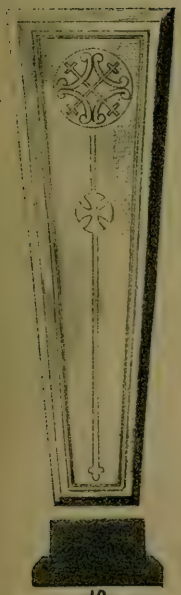

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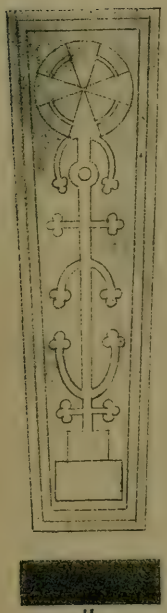

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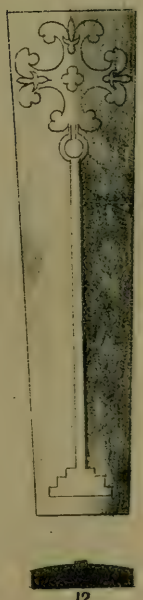

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Scale ½ inch to a foot.

On the Incised Grave-stones and Stone Coffins of Minchinhampton Church. By G. F. Playne.

Read at Gloucester, April 7, 1869.

On the occasion of our Field Meeting in May last year, the Parish Church of Minchinhampton was visited, and I had there the pleasure of exhibiting to the Club plans of some Incised Grave-stones, or Coffin-lids, found at that Church, and which our President considered of sufficient interest to be engraved for the records of the Club. I have now briefly to bring before you an account of these Incised Slabs, and also of some Stone Coffins, with such particulars of the buildings of which they have formed part, as are needful to illustrate their history.

From the Doomsday Survey we learn that in the reign of Edward the Confessor, Goda, the Countess, held Hamptone, and that in the reign of King William the Conqueror the church of the nuns of Caen, in Normandy, held it. This foreign convent continued to hold it until the suppression of alien monasteries in the reign of King Henry the Fifth, when it passed into the possession of the nunnery of Syon, in Middlesex. No evidence remains to show whether a church stood here in Saxon times, but a portion of a Norman church existed quite recently,—for until the restoration of this Parish Church, in 1842, there remained a range of piers and arches of Norman work, on the north side of the nave; and in the wall over these arches were found two small Norman windows, walled up, the apertures of which were only 6 inches in width. Of Early

English work there remained the wall below the east window, and the north wall of the chancel, in which were found, walled up, two windows of this style. All the other parts of the old church were of fourteenth century work, with the exception of a few alterations in the Debased style of architecture.

At the restoration, which took place in 1842, only the tower and the north and south transepts were retained, the old nave and chancel were broken down, and in those portions of the walls which had been built in the fourteenth century, were found a number of Incised Stone Slabs, which had been employed *as building material* in various parts of these walls. Some of these slabs had been built into the foundations of the walls of the south aisle, and one (No. 5) had been used as a kind of sillstone to the east window of the chancel. By this means they had been preserved for some 500 years, and handed down, in this somewhat singular manner, in a remarkably fine state of preservation,—the incisions on some of them being almost as sharply defined as when they were first made. Nearly twenty of these slabs, and a yet larger number of fragments, were found. They are formed of the softer beds of the Great Oolite Weather-stones of the district. With the exception of No. 12, which is slightly coped, and its cross cut in relief, the designs with which these slabs are enriched are *merely incised* on the flat upper surfaces of the stones. The crosses are of a beautifully simple character, with the exception of the one numbered 11, which has attached to its shaft several branching ornaments or scrolls. Nine of the twelve slabs engraved—namely, Nos. 1, 2, 3, 4, 6, 7, 9, 11, and 12, possess various forms of the "Calvary," on which the foot of the cross rests. No slabs were met with bearing any symbol denoting the occupation of the person for whom the memorial was placed; and only one was found bearing any inscription, and that was merely a fragment.

These ancient Grave-stones, as forming portions of the materials of the old church, were appropriated by the contractors engaged in the restoration, and were by them scattered here and there throughout the neighbourhood. As adjuncts to

rockeries and ferneries, or lying in neglected corners of pleasure grounds, they have since suffered greatly by exposure; and more has been done during the last quarter of a century to efface these memorials of an early age, than had been accomplished during the previous 500 years.

On comparing the slabs found at Minchinhampton with the engravings in a work by the Rev. Edward L. Cutts,—"A Manual for the Study of the Sepulchral Slabs and Crosses of the Middle Ages,"—and with those in the kindred work by the Rev. Charles Boutell,—"Christian Monuments in England and Wales,"—they appear to coincide with those assigned by the authors of these two works to the twelfth and thirteenth centuries. It is confessedly difficult to assign anything like an exact date to these incised Coffin-lids or Grave-stones. On this subject Mr. Cutts writes,—"While in all other parts of "ecclesiastical architecture during the thirteenth, fourteenth, and "fifteenth centuries, we find three strongly marked styles,—the "Early English, Decorated, and Perpendicular,—we do not find "any corresponding broad distinctions of style in these Grave-"stones. Ornamental work peculiar to these styles frequently "occurs upon them; but almost as frequently there is so little of "peculiar character in the design, that it requires considerable "familiarity with the subject to be able to assign, within a "hundred years, the probable date of a slab within this period." As already mentioned, the walls into which the Minchinhampton Slabs had been built were all of fourteenth century work.

It may appear strange that the old builders should have shown so little respect for these memorials of the departed, as to use these slabs for building material; but it is very possible that at the time of the erection of this fourteenth century work, the church was enlarged, and it was needful to remove these memorial slabs from the positions they occupied, and once removed, it is not surprising that they should have been appropriated to the buildings under course of erection. This treatment of ancient Grave-stones was possibly not uncommon, for instances of their being thus used have been met with elsewhere. The Journal of the Archæological Institute (Vol.

iv, 1847) contains a description of a fine series of such Gravestones, discovered in the year 1841, at the Parish Church of Bakewell, Derbyshire, where, on the demolition of a large part of the old church, prior to extensive restoration, upwards of fifty incised slabs were met with amongst the materials of the old walls.

Incised Stone Slabs appear to have been used not only for coverings to Stone Coffins, but as memorial stones, placed on the surface of the ground over graves made in the soil beneath. If they had only been used for the former purpose, no doubt Stone Coffins would more frequently still accompany such slabs. I believe that—besides the three to be mentioned presently—only one Stone Coffin has been met with at Minchinhampton: this was found in the churchyard, near the S.W. angle of the nave; when found in 1842, it was without a lid attached to it.

Though not immediately connected with my subject, I may here mention that on excavating the ground at the west end of the church, in 1843, for the purpose of forming a new approach to the western door, there were found eight or ten graves of a very early character. The rock had been excavated to a depth only just sufficient to receive the corpse, undressed stones of 2 or 3 inches in thickness were fixed on edge all round this excavation, and on these rested, as a covering, a rough undressed flat stone. A grave of similar construction was also met with under the large west door of the old church. No coffins had been used in these graves, most of which contained skeletons of adults.

The church of Minchinhampton contains examples of sepulture in Stone Coffins of a later age than that of the slabs already mentioned. They are coeval with those portions of the church built in the fourteenth century. One of these Stone Coffins occupied a recess in the north wall of the north transept; on its lid was a cross, not incised, but cut in relief.* This coffin

* The central portion of this lid, and the slab (No. 5,) are now in the possession of Mr. Fenning Parke, of Minchinhampton. I am indebted to Mr. Parke for information on several subjects connected with this parish; for during his 50 years' residence there, as master of the Endowed School, Mr.

was destroyed in 1842. I am informed that, with a skeleton of an adult which it contained, were found traces of habiliments, and "clouted shoes."

In recesses in the south wall of the south transept are two Stone Coffins, under elaborately ornamented ogee canopies. The exposed sides of these coffins are relieved by quartrefoils, and on their lids are recumbent figures of a knight and of a lady. These tombs are so evidently part of the original design of this transept that the whole building must be regarded as a memorial of the personages represented by these effigies. This building has scarcely received the attention, which from its great architectural interest, it deserves. Internally, it is 30 feet in length, 16 feet in width, and 40 feet in height. Its eastern side has seven buttresses, the spaces between which contain six two-light windows. One-half of the western side opens by an arch into the south aisle of the nave of the church; the other half has four buttresses, and three windows of similar

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Parke has taken an intelligent interest in all that relates to the antiquities of the parish, and has also preserved a record of local events as they have occurred. To him it is mainly due that the very interesting early churchwardens' accounts, commencing in the year 1555, have been made public. Having found them amongst the parochial records in a neglected state, Mr. Parke carefully collected and arranged them, and subsequently brought them to the notice of John Bruce, Esq., Treasurer to the Society of Antiquaries, by whom a very interesting paper on the subject, accompanied with numerous extracts from these accounts, was communicated to the Society of Antiquaries, and published in their Archæoligia, vol. xxxv. These accounts afford many illustrations of the manners and customs of former inhabitants of our Cotteswold Hills, as, for instance, the following items of medical practice in the seventeenth century:—

"(1663.) Payd; for 1 yeard of rebbond for Jonathan Harris his child, that have the kings evill 5d."

"(1664.) Payd; for beare for Hiller boy, being sick of the pox 10d."

"(1676.) Payd: Mr. Edward Barnard, for setting broken bones for the yeare 1£"

It would scarcely meet the views of country squires of the present day to find in their churchwarden's account such entries as the following:—

"(1577.) Payed: for foxes hedes xvjd. . . . . for a foxe hedd xijd."

"(1582.) Payments: for iij foxe-heads iijs."

"(1603.) Paid: for foxe heades and grayes heads vs."

"(1634.) Payed: for the destroying of noysum foule and varmints 14s."

dimensions to those on the eastern side. The whole space over the tombs on the south side is occupied by a fine window, the geometric tracery of the upper portion of which consists of a rose, or wheel, with eight radiating arms, which, dividing, inclose sixteen equalateral compartments. This window has lost something of its true character, having been "improved" in 1842. Previously, a transom extended quite across it on the line of the springing of the arch, and the four mullions of the lower division of the window ran up into this transom; thus indicating, I believe, the late character of this fourteenth century work, and its near approach to the Perpendicular style. The side buttresses, already mentioned, stand but three feet apart, and from these, at 18 feet above the floor line, spring stone arches, which support a roof formed of slabs of stone. It would add greatly to the interest of this building if this stone roof were again brought to view externally. From some cause it was found needful to cover it in with a roof of ordinary stone tiling, and the probable time when this was done may be gathered from the early churchwarden's accounts belonging to this parish, in which, under date, 1578, occur the following entries. "Payed for . . . xxx dayes work to the tylor for "tylynge Ansleyes chapell, xxs. . . ." "To the mason . . for "the water tablinge of Anslowes chapele and the bynche of the "porch xvjs. iiijd." The name *Ansloes Chapel*, by which this south transept is thus spoken of, and by which it is yet known to some of the old inhabitants of the parish, is derived from the circumstance that a chantry was established at Minchinhampton by a person named Ansloe; the foundation deed of which Fosbrooke states, may be seen in the roll of patents of the 12 Edward III. Sir Robert Atkyns, probably misled by this name, ascribes the erection of this south transept to "one "Ainsloe, whose statue," he writes, "lies there cross-legged, "with a sword and shield, and his wife at his feet." Rudder follows Atkyns in this statement, but Bigland says:—"In the "reign of Richard II., 1382, Sir John de la Mere, and Maud, "his wife, rebuilt the south transept. Under the great window "are two arcades, with the recumbent effigies of the founders, as

"a croisader, and a lady in the dress of that age. Upon the "shield, is an eagle displayed, part of the arms of De la Mere. "At this period they held a manse, and 60 acres of land in this "parish."

A reference to the Inquisitionum Post Mortem, shows that in the 5 Richard II. (1381,) Robertus de la Mere died, seized of lands, &c., in Wilts, Herts, Devon, Hereford, Oxon, and of lands, &c., "at Munechenehampton, in Gloucestershire." In 6 Henry IV. (1404,) "Matilda uxor Roberti de la Mere, Chivaler," died, seized of these lands. The arms of the De la Meres (who came originally from the neighbourhood of Caen, in Normandy,) are, as given in Edmonson's Heraldry, very various, but amongst others occur "three eagles," and "a lion passant." A pavement of encaustic tiles was found, in 1842, underneath the stone pavement of this transept, the alternate tiles of which bore a lion passant, and an eagle displayed.

From these facts it appears that our earlier county historians are incorrect in assigning the foundation of this memorial chapel to Ansloe, and that Bigland's statement may be received as correct, with this exception, that it was a Sir "Robert," and not "John," de la Mere, who, with his wife Matilda, built this transept, and whose stone coffins and effigies occupy the niches underneath its large window.

Address to the Cotteswold Naturalists' Field Club by the President Sir W. V. Guise, Bart., F.L.S., F.G.S., *read February 23rd,* 1870.

In presenting to the Cotteswold Naturalists' Field Club my Report for the year 1869, I have to congratulate the members on the continued prosperity and activity of the Club. Our fasciculus of Transactions for the past season will shortly be in the hands of members, and will be received with the greatest satisfaction; comprising as it does two communications of unusual interest and importance, viz.:—the carefully elaborate paper of Mr. Lucy on the Drifts of the Severn, Avon, and Evenlode Valleys, a work upon which he has been occupied nearly four years, and which combines a larger amount of information on the question of local Gravels, Drifts, and Erratics, than has ever been systematically accumulated heretofore; and a paper by Dr. Wright on the Correlation of the Inferior Lias or Hettangian beds of the Côte d'Or (France,) with those of Gloucestershire and the adjoining districts. It will readily be understood that considerable expense has necessarily been incurred in the Map and Sections to Mr. Lucy's paper; but I felt that I was only acting in accordance with your wishes in sanctioning the necessary outlay upon a work on which the author has expended so much time and labour, and which is calculated to reflect so much credit on the Cotteswold Club.

In respect of our Field Meetings during the past season, I am glad to report that they have been, on all occasions, well attended, and have proved very agreeable gatherings. Especially must I refer in terms of admiration and gratitude to the delightful week spent by the Club with Mr. George Maw, at

Benthall Hall, in Shropshire; a week which will never be forgotten by those who had the good fortune to be participators in that delightful visit.

You will be glad to hear that our excursions in those Shropshire fields, so new to many of us, will not be wholly without result. I am able to inform the Club that our friend and associate Mr. Charles Moore has been successful in detecting in the Carboniferous Limestones and Shales of "Steeraway" and "The Hatch," a Fauna in many respects new and peculiar. His labours are not yet completed, but as soon as possible it is his intention to communicate to the Club a report on the subject. To this we may look forward as an important contribution to our Transactions for the present season.

THE ANNUAL MEETING OF THE CLUB

was held at the Spread Eagle Hotel, Gloucester, on Wednesday, the 7th of April, when your President delivered the Anniversary Address; after which the usual election of officers for the ensuing year took place, when you did me the honour to testify your continued confidence in me by again placing me in the distinguished position of President of the Cotteswold Field Club. Dr. Wright and Mr. Lucy were chosen Vice-Presidents, and Dr. Paine was re-elected Secretary. A communication was read from Professor Buckman on the Oolites and Oolitic Sands of Dorsetshire, in which, after stating that his observations confirm the conclusions of Drs. Wright and Holl, that the Oolitic Freestones of Dorset are the equivalent of the Inferior Oolite of Gloucestershire; he adds that the *Parkinsoni* and *Humphresianus* zones are both present, though in Dorsetshire both of these Ammonites are frequently found side by side, and occupying a wider range than the zones in which they most frequently occur.

The learned Professor gave it as his opinion that the "Sands" at Bradford-Abbas, and about Sherborne and Yeovil, with their alternate layers of imbedded and nodular *Calcareous Sandstones*, are the representatives of the Freestone beds of Cleeve Hill, and that the wall of Siliceous Freestone below

the true Pisolite of Crickley Hill, is the equivalent of part of the Dorsetshire Sands, while the grand Somersetshire section of *Ham Hill* building-stone, is the equivalent of the Supraliassic Sands of Gloucestershire.

These views were discussed and commented upon by Dr. Wright and Mr. Etheridge, both of whom differed from the learned Professor as to his correlations and deductions.

A second notice by Professor Buckman bore reference to some curious old green glass bottles, with an heraldic stamp, probably the armorial bearings of the family for which they were made.

After dinner the Club adjourned to the Tolsey to hear the long and able paper by our Colleague and Vice-President, Mr. Lucy, on the Gravels of the Severn, Avon, and Evenlode Valleys, which forms so important a portion of the published "Transactions of the Club" for the present year. A work of which it is not too much to say that it will rank with the most masterly efforts which have hitherto been made to unravel the intricate problem of the successive agencies to which are due the accumulations of Erratics, Boulders, Drift, and Gravel scattered over the wide area, drained by the rivers above mentioned. There is no portion of British Geology more difficult of elucidation than the latest changes which have taken place in the physical history of Great Britain, during the Pre-Glacial, Glacial, and Post-Glacial periods. Mr. Lucy has had many industrious and able predecessors in this field of research, of whom it will suffice to name the late Hugh Strickland, Dr. Buckland, Sir Roderick Murchison, the Rev. W. S. Symonds; Messrs. Hull, Maw, Jones, Witchell, &c.; but it has remained for our friend and colleague Mr. Lucy to amass the largest amount of carefully gathered facts over a wide area that has ever yet been accumulated; and it is only through the accumulation of such facts that truth can be arrived at, and sound conclusions drawn respecting the forces which have gone to fashion the present configuration of hill and valley which we see around us. With a view to the more exact understanding of his observed facts, Mr. Lucy has had constructed a very elaborate and beautiful Map of the district,

geologically coloured, on a scale of three inches to the mile; upon this is laid down the various superficial Gravel accumulations, their ages being differentiated by coloured dottings, which thus are made to express the distinctive character of the drift, whether quartzose or oolitic, local or derived from distant regions through the agency of water or ice. Besides this, the map expresses in numbers the height of almost every elevated point within the area referred to, so that argument deducible from elevation is at once settled. The heights have been determined by aneroid and trigonometrical measurements. The questions of the formation of gravel, the derivation of the pebbles of which the gravels are composed, the origin of boulders, &c., are all discussed in Mr. Lucy's papers. Numerous sections of the gravels constructed from the most important localities are given, shewing their manner of accumulation, superposition, and arrangement done to scale; and shewing the variable thickness of the deposits at different localities over the area treated of.

The argument of the paper is based upon these sections which in themselves pourtray a marked history as respects arrangement and accumulation. They are all carefully described in Mr. Lucy's memoir, their fossil contents are noticed, and the peculiarities, and source of the gravels comprised in them are carefully described; rocks that have travelled from the North and North-West of England and Wales, from Derbyshire, Lancashire, Shropshire, and other remote localities are detected and approximately traced to their sources. The line of junction of the "Northern Drift" gravels with the local Oolitic debris in the Severn Valley, and higher levels, have been laid down and their modes of accumulation explained. The terraces of river-gravels, forming low table-lands, rising from 40 to 100 feet above the present Severn, limiting, as it would appear, the vertical distribution of Mammalian remains in this valley, are carefully noted and described. Finally, the gravels known as "Northern Drift" are traced to the height of 750 feet on the Cotteswolds, thus incontestably proving the submergence of this area some 800 feet during the Post-Pliocene Epoch.

This paper was received with marked approval by a crowded and appreciative audience, and there can be no doubt that its publication will add much to our knowledge of the "Quaternary" Geology of the British Islands.

The first Field Meeting of the Club for the season was appointed for

MINCHINHAMPTON COMMON.

Your President being detained by militia duties, was not able to join till late in the afternoon. He is therefore indebted to the notes of others for the detail of the events of the day. A chief object of investigation was the age of the extensive earthworks on the Common, attributed by old county historians to the Danes, but to which others have assigned a much earlier date, referring them to præ-Roman times. The Members assembled at the Brimscombe railway station, and under the guidance of Messrs. Witchell and Playne proceeded along the old lane to the Hyde, examining *en route* the Supra-Liassic Sands, which are well exposed, and show a thickness of about 50 feet. At Hyde House occurs a deposit of sub-angular gravel, derived apparently from the Great Oolite and Forest Marble above. It occurs at an altitude of 460 feet above the sea level, and according to Mr. Lucy owes its origin to the action of snow and ice during the Glacial or Sub-Glacial Epoch, while Mr. Witchell contends for rain and atmospheric agencies at a period anterior to the excavation of valleys to their present depth. On arriving at the higher ground above Hyde, the members found an excellent luncheon awaiting them, provided by the kind forethought of Mr. Playne. On the flat table-land is a Roman barrow, much broken up, from which was disinterred in 1845 a fine fibula, the spring of which was quite perfect. This, which is now in the possession of Mrs. Farrar, was kindly entrusted to Mr. Playne for exhibition to the Club. A Great Oolite quarry was next visited, in which the conglomerate was well shown, and the variation in the lithological character of the different beds was very remarkable. Arrived at that part of the common near Amberley, the members proceeded to examine the excavations made in the mounds

near the Old Lodge, under the direction of Mr. Cunnington, of Devizes, and Mr. G. F. Playne. Everyone passing over the hill in this direction must have noticed the earthworks, here of considerable size, and continuous with those crossing the common towards Hampton; and also that there are a large number of mounds more or less elevated, some nearly circular, others of more elongated form; and that, scattered everywhere over the surface, there are numerous small depressions or pits, with a heap of earth thrown up on one side of them. What these mounds were, and what purpose was served by these curious pit-like depressions, were the questions upon which the club hoped to be able to throw some light, aided by excavations which had been made the previous day. These earthworks have attracted the attention of most local historians, and have been variously interpreted in the histories of Gloucestershire. Rudder speaks of them as "fortifications and rampires thrown up at the time when the Danes ravaged this part of the country." Fosbrooke seems to take it for granted they were Danish; and Atkins passes them over without notice. Bigland says of these earthworks that they are composed of the rubble stone of the country coated with turf, and extend from Littleworth to Woeful Dane's Bottom. He mentions the theory that they were of Saxon origin, and throws out a hint that they may have been British. These historians seem to have noticed the earthworks, and trenches only, and to have overlooked the mounds and pit-like depressions so numerous on the common, and which may perhaps furnish the best historical clue. It must at once strike the most careless observer that the earthworks themselves could scarcely have been intended for purposes of defence, as they are nowhere sufficiently formidable to have opposed any serious obstacle to the advance of a hostile force, even in the rudest times. Many of the larger mounds on Hampton Common present all the appearance of "long barrows," but when opened, they have as yet yielded little to their explorers. But the curious pit-like depressions, so numerous all over the common, tell their story with more exactness. In all of these that were examined, were found bones of animals,

some partly charred, with the rough stones used for crushing grain, and fragments of pottery of a very rude and primitive type. It appears certain that these depressions were used as rude cooking-places—dwelling-places they scarcely can have been. They are very shallow, excavated to a depth not exceeding two or three feet, having the sides built up of loose stones, and the floor formed of earth trodden hard. On a former visit of the Club, many years ago, to Hampton Common, General Younghusband,—since dead,—stated that in India some of the native tribes are in the habit of forming cooking-pits after the self-same fashion at the present day, by excavating a hole and throwing up the earth in a heap on one side.

After dinner which had been served in a tent, the President and Members adjourned to the neighbouring inn, where, around a good fire, they discussed the question of the mounds and entrenchments by the light afforded by their recent excavations. Mr. Cunnington, so well known to antiquaries, by the reputation he has acquired in examining the tumuli of Wiltshire, gave it as his opinion that he much doubted whether the earthworks were raised for defence; and as regarded the pit-like excavations, he thought they were not British, but probably belonged to more recent times. They were however the work of a rude people, who from the few things found, he judged only occupied them for a short time; no metal was found. Two pieces of the pottery found were not made upon a wheel, whilst some others fairly worked, might be rather late Roman. Very few remains of animal bones were discovered. There was a little slag. Without giving a positive opinion, he thought they were of a date shortly subsequent to the departure of the Romans. But after all it would seem that from the scantiness of the evidence, the actual date and attribution of these mounds and earthworks remains still a matter of considerable doubt and uncertainty.

The next Meeting of the Club—one to be in its annals,

"For ever marked with white,"

took place on the invitation of Mr. George Maw, F.G.S., at

BENTHALL HALL, IN SHROPSHIRE.

The programme, drawn up by Mr. Maw, comprised visits to Wenlock, Buildwas, and Haughmond Abbeys; to the Wrekin, and the buried city of Uriconium; to the Rhynchosaurus Quarries, at Grinshill; to the Breidden Hills, and Shrewsbury—a splendid programme, which, favoured with fine weather and Mr. Maw's admirable organisation, was carried out "*au pied de la lettre,*" to the singular delight and enjoyment of all concerned.

On Monday, 27th June—The party, twenty-five in number, arrived at the Ironbridge Station, on the Severn Valley line, where they were met by Mr. Maw, and conveyed to his hospitable residence, at Benthall Hall; where Mrs. Maw had made every preparation for the comfort and accomodation of so large a party.

On Tuesday, 8th—After an early breakfast and a stroll through the gardens at Benthall, (where Mr. Maw has under cultivation a most interesting collection of European and North African plants, a great proportion of which are the result of his own travels, for the express purpose of procuring them) the party proceeded to Benthall Edge, an elevated ridge of Wenlock Limestone and Shale; where, at a height of 600 feet above the sea—500 above the Severn Valley—a magnificent panorama is displayed; bounded in front by the giant mass of the Wrekin, while in other directions the eye ranges over a wide expanse, in which the Longmynd, the Lawley, Caer Caradoc, and the Clee Hills form conspicuous features. Descending the escarpment by the Vineyard and Wyke, the party made their way to Tickwood, the residence of the Rev. W. H. Wayne, junr.; to whom they were afterwards indebted for two very interesting papers on the Abbeys of Wenlock and Buildwas. From Tickwood, a sylvan walk, of singular beauty, led them by Farley Dingle to Bradley Quarry, remarkable for the presence there exhibited of Bitumen in large quantities in the upper beds of the Wenlock Limestone. Mr. Maw, with great show of probability, attributes the presence of this mineral to

infiltration from Carboniferous beds, since denuded. The course of the party was now directed to Wenlock Abbey, where a long halt was made; and a paper was read by Mr. WAYNE, giving all the information now to be gathered respecting this fine old monastic foundation, the plan of which is still clearly traceable, though the wreck and ruin of 300 years have left but scanty remnants of what was once amongst the noblest of those religious edifices, which, formerly scattered broadcast over the land, having done their work, have been very properly disestablished and disendowed. The style is, for the most part, Early English with some late Norman, of which the Chapter House, with its beautiful intersecting arcades, is the principal example. Here, surrounded by these old monastic associations, and by those of a not less pleasing nature, which spring from genial company and good fellowship, the party, numbering in its ranks many ladies, partook of a luxurious luncheon, provided for them by the kind forethought of Mrs. MAW.

From Wenlock the party went by train to Buildwas: the name, according to Mr. WAYNE, derived from "Bield," a shelter and "Was," water; indicative of its character and position, and so far very appropriate. It is a small cruciform Norman Church, very homogeneous in character, smaller than Wenlock, but much more perfect. In the course of some late excavations an underground passage has been discovered, which has only been partially explored, leading in the direction of the Severn, and apparently a means of shelter and escape in case of danger. Perhaps this was the very "*bield*" from which the Abbey derived its name. Near Buildwas are the Strethill Drifts—a stratified mass of Gravel and Boulder Clay, 210 feet thick, resting against the old Silurian coast-line. A full detail of this section is given in Mr. MAW's exhaustive papers on the Gravels of this district, in Volume XX of the "Quarterly Journal of the Geological Society."

Wednesday, 9th.—The sun was shining brightly as the party, under the guidance of Mr. MAW, descended the hill to IRON-

BRIDGE, on their way to visit the QUARRIES at STEERAWAY and The HATCH, the WREKIN and URICONIUM. At Ironbridge a short halt was made, to see the process of manufacture at the encaustic tile works of Messrs. MAW, where this branch of industry, now so largely employed for decorative purposes, is carried to the highest degree of perfection. Taking the train they proceeded to Lawley Bank Station, where they were joined by the President, Secretary, and seven or eight Members of the "Severn Valley Field Club," in company with whom they directed their course to the Steeraway Quarries, in the Carboniferous Limestone. This formation is here seen thinning rapidly out; the entire series from the "Yellow" beds to the Coal Measures being compressed into a thickness of some fifty feet. The beds abound in huge *Producti* and Corals: of the latter some splendid specimens were obtained. A toilsome scramble up hill, and through brushwood brought the party to the quarries at "The Hatch," where the Carboniferous Limestone is exhibited in a still thinner section, with the Coal Measures resting upon it. This was evidently the limit, in this direction, of the old Carboniferous Limestone Sea: from hence, in a north-easterly direction, it is wholly absent over a space of some 70 square miles, and the Coal Measures rest either upon "Old Red" or "Silurian" beds.

From "The Hatch" the course lay along the Erkal Ridge to Lawrence's Quarry, at the foot of the Wrekin, where trap dykes are seen traversing "altered rock," "Caradoc" or "Upper Llandovery." Considerable discussion took place, and the different theories of infiltration and injection were urged by their respective advocates; but, looking to the fact that the line of the dyke does not disturb the stratification which it divides, the opinion that the intrusive rock was due to injection along a line of fissure met with general acceptance. From this point commenced the ascent of the Wrekin, up the steep, almost precipitous, shoulder of which the party struggled resolutely, to find, as a reward for their toil, that Mrs. MAW, the active and beneficent dispenser of so many good things, had prepared a sumptuous luncheon for their refreshment; and

there, strewn upon the grassy slope, with a glorious prospect around and beneath, the sun tempered by a pleasant breeze, and all nature glowing with life and warmth, a delightful half-hour was spent; after which, with recruited energies, the party started for the final ascent to the summit of the mountain. Only those who have stood on similar isolated altitudes, under conditions equally favourable, can form an idea of the magnificent panorama which such an elevation commands. At their feet lay the fertile plain of Cheshire, diversified with

> "Woods and corn-fields, and the abodes of men
> Scattered at intervals" :—

bounded by the hills of Grinshill, the Breidden, Long Mountain, the Longmynd, Caer Caradoc, and the hills about Church Stretton; the long ridge of Wenlock Edge, extending 16 miles in length, with the parallel escarpment of Aymestry Limestone, on which Burton stands. In the blue distance might be distinguished the Arran Hills in Wales, those of Radnor Forest and the Black Mountain on the borders of Hereford and Radnor, and even the remote Cader Idris is within the range of vision, though the haze concealed it on the present occasion. The height, taken by aneroid, was made to be 1320 feet. The Wrekin is a great centre of igneous action, similar to that of the Malverns, and, like that, has been the means of bringing up the Coal, and rendering that important mineral available for the use of man. The line of disturbance is traceable from Lilleshall to the hills of Radnor Forest. Standing on the Bladder-stone, (explained as originally Balder-stone, in honour of Balder, the Scandinavian deity) the highest point of the hill, Mr. Cooper, the Secretary of the "Severn Valley Field Club," pointed out the Geological features of the surrounding district, the Long Mountain of "Upper Silurian," capped with "Old Red," the "Lingula Flags" of the Stiperstones, the so-called "Bottom Rock," or "Cambrians" of the Longmynd, the Breidden Hills of "Lower Llandovery," with interbedded Trap, the Trap of Caer Caradoc, and the "Wenlock beds," and "Aymestry Limestones" of Wenlock Edge, and View Edge. A humerous

poem, on the Wrekin, was read, amidst much laughter, by the Rev. Mr. Cobbold, and a short paper by Mr. Dickenson, President of the "Severn Valley Field Club."

It was time now to proceed to meet the carriages which were to convey the party to Uriconium. Passing over the fine-grained Red Syenite of Primrose Hill, a rapid descent brought them to Longwood, where the carriages were in waiting, and in due course they were deposited at Uriconium, a British Pompeii, buried for 1,400 years in the ruins of its own conflagration, for by fire it undoubtedly perished, and that so utterly and completely, that with the exception of a grim fragment of wall, out of which the tooth of time has bitten huge mouthfuls, no external vestige remains to mark the site of a city which once boasted a circumference of three miles, and *Thermæ*, a *Forum*, a *Basilica*, and all the public buildings of an important Roman town. A few ditches, becoming rapidly overgrown—the foundation-walls of chambers—a few *tesseræ*, and the tiles of a *Hypocaust* laid bare within these few years, attest at the same time the endeavours to excavate on the site of the buried city, and the disappointing nature of the result. Nothing can be more barren, tame, and uninteresting than the present appearance of the remains, which in all charity should again be covered up and restored to that repose from which it seems almost a sacrilege to have brought them into daylight.

Thursday, 10*th June*.—The programme of this day embraced an examination of the *débris* of the Clive Copper Mines in the Keuper Sandstone—the Keuper escarpment of Clive Hill, and the Grinshill Quarries in the "Waterstones" of the Keuper. The train conveyed the party to Shrewsbury, and carriages thence to Clive Hill. Here the "Bunter" or "Bromsberrow" beds are seen faulted against the "Waterstones." Veins of Copper in the form of carbonate are found along the line of fault, and have been worked at Clive Hill, though the workings are now abandoned. Along the line of the lode very beautiful examples are found, illustrating the disposition of Iron, in variegated strata, which formed the subject of an able paper

by Mr. Maw, published in the "Quarterly Journal of the Geological Society" for November, 1868. The Lode of copper has its sides commonly bounded by oxide of iron, in connection with which, curiously marked bands of the same mineral variegate the surface of the yellow sandstone with singular regularity. It seems due to galvanic action, causing the iron contained in the Keuper to arrange itself in these parallel bands. Some very beautifully illustrative examples were here obtained. The next point of interest was the well-known Grinshill Quarries, famous not only for the excellence of their building-stones which are unsurpassed for beauty of colour, for texture, and endurance; but to Geologists of special interest, as having yielded in greater abundance than any other locality, the bones, and supposed footprints, of the *Rhynchosaurus*, a curious beaked Saurian of peculiar character, having an apparent connection with the *Chelonians* or Turtles, and restricted to the Keuper. The quarries exhibit a magnificent section of the "Waterstones," some 80 feet in thickness, capped by Lower Keuper Marls, and resting upon the red "Bunter" beds. These beds occur in successive rolls as far as Prees, where they are succeeded by the "Rhœtic" and the "Lower Lias," up to the "Marlstone" of the "Middle Lias." From this point (at Prees) the Lias would not again be met with for forty or fifty miles; yet, it must once have been continuous over the whole of the intermediate area, and have extended some 1,500 feet above the present level of the Grinshill series. What an idea does this convey of the gigantic scale upon which denudation has been carried on! And how does the mind of man recoil when it endeavours to grasp the idea of *time*, in connection with events of such magnitude and duration! The Geologists found ample matter of interest in some slabs preserved by the quarrymen on which, upon the ripple-marked surface of the ancient Keuper beach were stamped the tracks attributed to the *Rhynchosaurus*, while the casts of the rain or hail-drops stereotyped for ever in the rock, bore witness to the fact that in those long distant epochs the rain fell, and the winds blew, and the atmospheric conditions

were pretty much the same as at present. Only one of the slabs exhibited any portion of the bony skeleton of the little Saurian, but this was of much importance, as it showed one of the vertebræ with its spinous processes, and there was reason to think that in the hands of a careful operator more of the skeleton might be developed. This precious morsel may possibly help to lift the veil of mystery which still hangs over much of the physical history of the reptile. It fell into the hands of Mr. Maw, who will not fail to elicit from the relic all the information it is capable of yielding, respecting the nature of the creature of which it once formed a part. The botanists of the party had their share of gratification in finding *Teesdalia nudicaulis* in considerable abundance.

After luncheon, provided by Mr. Maw, at the Elephant-and-Castle, the party was conveyed in carriages to Haughmond Abbey. Another of those *recent Fossils* which remain to excite the interest of the antiquarian, and to set him speculating upon a condition of things which some among us would wish to see restored—as well attempt to revive the *Rhynchosaur!* A short time only was spent at Haughmond, evidently derived from *Haut Mont.* There are some interesting bits about it, especially the Chapter House of "decorated Norman," the three arches of which are very fine, but like most of its congeners it has been used as a quarry, and the entire church, with large portions of the other parts of the building have thus disappeared. By the side of the road, eastward from the Abbey, is a quarry in the "Cambrian" rock, on which grow *Sedum telephium*, and *Sedum Forsterianum*, the latter a very local plant.

Friday, 11th June.—This day was set apart for a visit to the Breidden Hills, and an examination of their structural and other peculiarities. The rail conveyed members to Shrewsbury, and thence to the Middletown Station, at the foot of the Breiddens. A few yards west of the station is a deep cutting which exhibits extensive Drift deposits, consisting of "Boulder Clay," capped by Gravels. In an article from the pen of Mr. Maw, in the *Geological Magazine* for June, 1867, this section is

thus described:—"Cutting west of Station, 310 to 530 feet above the sea; thickness 120 feet, consisting of 65 feet of tough Clay, overlain by 45 feet of Gravel and Pebble beds, intermixed with Clay and Boulders."

At Middletown the ascent of the Breiddens was commenced. These hills consist of interbedded Felspathic Trap in beds of the "Lower Llandeilo" period, precisely as at Cader Idris. Immediately at the base of the hill called Moel-y-Golfa, the Felspathic rock exhibits a most remarkable conglomeratic character most difficult to account for, the Felspathic masses being charged with rounded pebbles identical in character and composition with the matrix. No foreign matter of any kind is intermixed. The pebbles have evidently been rolled and re-deposited in a soft bed of the same constituent materials without the intermixture of any extraneous substance. That these are due to mechanical force is certain, but how acting, it is most difficult to explain.

At the Meeting of the British Association at Exeter in August last, a paper was read by Mr. Maw on the Trappean Conglomerates of Midletown Hill, of which the following condensed account is extracted from the Report of the Transactions of the Meeting:—

"This was a description of the contemporaneous traps of Lower Silurian age in the ridge known as Middletown Hill, running parallel with the Breiddens, on the borders of Shropshire and Montgomeryshire. Especial reference was made to the great beds of Bouldered Trap, consisting of boulders of compact felstone, imbedded in a softer matrix of Felspathic Tuff. The nodules occupy about half the mass of the conglomerate, and are unaccompanied by pebbles of any other rock. They vary from the size of a walnut to rounded masses of more than a hundred weight. Sir Roderick Murchison's description of these beds was referred to, and the author took exception to the term "Concretionary Trap," employed in the "Silurian System," as he considered that the rounded outline of the boulders was unquestionably due to mechanical causes. The interbedded Traps, bounded on either side by Lower Llandeilo Flags, are of a collective thickness of about 780 feet, including Bouldered Felstone, alternating with a whitish-green Felspathic Breccia. The line of separation between the Breccia-bed and Boulder Trap is remarkably sudden, and no gradation of character occurs between them. The Breccia is worked for hard felspar, used for

pottery purposes, and contains small nests of Steatite. The bouldered condition of the Felstone-bed was considered due to its partial breaking up on being erupted under water, the soft matrix of Felspathic Tuff being the portion more intimately divided, and the compact boulders fragments that had resisted disintegration. The sudden alternation in Middletown Hill of eruptive beds of very dissimilar character was noticed; they seem to have been emitted in immediate succession, as, although overlain and underlain by sedimentary deposits, there is no evidence of interstratification of sedimentary beds. The author, in conclusion, pointed out the close geographical association with these bedded Traps of the much later porphyritic greenstone of the Breidden Hills, which, it was suggested, might have been emitted from the same point of eruption: and the local association of the intrusive greenstone with the Lower Silurian interbedded Felstones was noticed as being very general in North Wales."

A sharp scramble up the precipitous shoulder revealed a fine prospect over Welshpool and the Denbighshire hills beyond. In passing from Moel-y-Golfa to the Breidden, an intermediate valley was crossed, eroded in the Lower Llandeilo Shales. Then commenced the ascent of the Breidden proper, on the summit of which stands the obelisk erected to the memory of Admiral Lord Rodney, known as the Rodney Pillar. Its height is slightly under 1300 feet above the sea, and commands a noble prospect. In front is seen Llanymynych, the southern extremity of the great Carboniferous Limestone range which runs through North Wales to Oswestry, west of which are seen the Denbighshire hills by Welshpool and Montgomery to the Long Mountain and the Shropshire Silurians. But a short halt was made to admire the beauty of the prospect, as time was limited, and the discovery of *Potentilla Rupestris*, the exact habitat of which nobody quite knew, had yet to be effected. So, under the leadership of Mr. Maw, away went the botanists of the party, "thoro' bush thoro' briar," in quest of the coveted species for which the Breidden Hill is the only known locality in Great Britain. Long and tedious was the scramble, and doubts of success were beginning to damp the ardour of pursuit, when a shout from Mr. Maw proclaimed the welcome "*Eureka!*" Immediately below the eastern extremity of the Breidden, on the bare precipitous slope of the eruptive trap rock *Potentilla*

rupestris, the Queen of the Breiddens, in tall branchy panicles of snow-white bloom, grows in profusion. No fear of its being exterminated, as it is protected by the scarped precipices, on which it delights to dwell. This was the crowning success of the day, after which it was necessary to turn in the direction of the Middletown Station, where the train was due at 4.12. By the way a visit was paid to a Baryta mine, now no longer worked, on the Middletown Hill. This mineral is found associated with Carbonate of Lime and Lead, in veins, occupying fissures in the Felspathic Trap. Some good specimens were here obtained from the refuse heaps.

The party returned by rail to Shrewsbury, where, having two hours to spare, the Museum was first visited, and afterwards the quarries, on the further bank of the Severn. The chief objects of interest in the Museum are the relics from Uriconium and the remains of the *Rhynchosaurus* from Grinshill. The collection from the former locality served only to show more forcibly the insignificance in an antiquarian point of view of the result of the investigations carried out on that site; the objects collected are unimportant in number and in value, and bear no proportion to the former extent and importance of the place. In these respects they will bear no comparison with those found at Cirencester, and preserved in the Museum there; nor to those from the villa discovered on the estate of Lord Eldon, at Chedworth, so nobly cared for and preserved at his expense.

The *Rhynchosaurus*' remains are mainly referrible to portions of the skull and jaws, in which the prominent eye-orbits and the beaked and edentulous character of the jaws are well shown: but it would seem that if sufficient zeal had been displayed, it should have been possible by this time to construct the entire skeleton of the reptile, of which several important parts are still wanting. There remained after leaving the Museum but scanty time for a visit to "the Quarries," which proved full of interest. The beds consist of about 50 feet of stratified sand and gravel, the lower portion sandy, and containing Marine Shells; the upper, of gravel with granite

boulders and scratched blocks. A huge boulder of granite, weighing at least a ton, was seen on the floor of the quarry, derived as was stated by the quarryman, from the gravel in the upper part of the quarry, which would seem to be the equivalent of the Upper Boulder Clay of Strethill. The following Shells were extracted from the sandy layers :— *Caprina islandica, Cardium edule, Tellina solidula, Turritella communis, Nassa reticulata,* and *Purpura lapillus.* These beds are full of interest, and would well repay Geologists for their investigation.

Saturday the 12*th*, terminated the programme so admirably arranged by Mr. Maw, and under his guidance carried to a successful conclusion, with a degree of comfort, exactitude, and punctuality, which added much to the enjoyment of the party. It will be long ere the Cotteswold Club shall cease to recall to mind the pleasure of the four days spent under Mr. Maw's hospitable roof—the kind solicitude of their hostess, or the splendid hospitality which watched over every want, provided against every contingency, and not content with preparing creature comforts and transporting them great distances, so that the tired wayfarers found refreshment just when and where they most needed it; but, with a rare munificence supplied means of transport, which for so large a party could neither be easily provided nor limited in extent.

I annex the lines read on the summit of the Wrekin, by the Rev. Mr. Cobbold, to which reference has been made.

LINES ON THE WREKIN.

(Supposed to have been written by a Nephew of John Forster, *the Essayist.)*

You and your glass might spend a week in
Viewing the prospect from the Wrekin;
Mortal in Britain ne'er set eyes on
Such an extended wide horizon;
Indeed, the prospect from this mount is,
Over no less than nineteen Counties!

From Worcester, which King Charles encamp'd on,
To Stafford, Warwick, and Northampton;
O'er Shropshire, Oxford, and to Brecon,
The crow near seventy miles would reckon,
Exact, till sixty-eight from Wrekin,
In a straight line to Brecon-beacon.
Next Gloucester, Monmouth, 'mong the rest are
Radnor, Montgomery, and Leicester;
And Hereford we number with
Denbighshire, Flint, and Merioneth.
The sated eye may roam at leisure
Over the dull flat plains of Cheshire;
Derbyshire and Lancashire are visible,
No more are in my list admissible.
Notice yon batter'd skull-shap'd rock,
The British fortress Caradoc.
Those pointed summits bare of trees
Are the two barren Shropshire Clees.
Not neck of swan or maiden whiter is
Than yon cleft height of Cader Idris,
Sixty miles distant—barring two—
That peak presents itself to view.
Above the rest behold that dim 'un,
It is the lofty Welsh Plinlimmon:
And even Snowdon could be seen
Where there not other hills between.
And Ireland—oh, sad perplexity!
Is hidden by the earth's convexity.
There's Banbury famous for its cakes,
Which some big Banbury baker bakes;
And Malvern, where for each disorder
That folks are heir to, doctors order
Wet naps in sheets, and large potations
Of water cold—and scanty rations.
But stay my Muse, 'tis useless seeking
To tell the prospect from the Wrekin;
The house and park of Squire Moseley,
Wellington, Shrewsbury, Newport, Broseley.
But stay, I'm off again, so be it,
That you 'ere long may go and see it.

The third Field Meeting of the Club took place on Tuesday 20th July, and was well attended. The members assembled at the

FROCESTER STATION,

from whence they walked up the hill, passing on the way the Old Barn at Frocester Court, and pausing to examine the well-known fossiliferous beds at the base of the Inferior Oolite. From the summit of the hill, the party proceeded under the guidance of Mr. J. W. Hallewell, through Woodchester Park to Nailsworth. At the Quarry, near the Park Farm, Mr. Witchell drew attention to the thinning out of the shelly weatherstones of Hampton Common, which are here represented by a bed only 3 or 4 feet thick, and thin out altogether between Frocester Hill and Nymphsfield. From a fissure in this quarry Mr. Lucy extracted a number of small Quartz Pebbles. They were discovered in a red looking earth, which filled up the fissure. This was regarded as important, furnishing apparent evidence of the submergence of this part of the Cotteswolds during the Glacial Epoch.

From hence the party crossed the valley and at the tower in the park, admirably chosen for the beauty of its situation, they found a handsome luncheon which the kind forethought of Mr. Hallewell had prepared for their refreshment.

Their next visit was to a landslip which had taken place during the previous winter. These slips are perpetually occurring on the flanks of the Cotteswolds, and serve to show how these combes and valleys have been widened and are still widening. In this instance about twenty perches of ground had slipped, carrying along trees, bushes, &c., and with them an apple-tree, which was seen still standing erect on the ground it stood upon, with its fence still enclosing it.

The next halt was at Ferny Hill, near the bottom of the park where similar slips have occurred; by means of which, in conjunction with the streamlets running down the slope and excavating deep fissures, a combe is now in course of formation. These features of the valley were pointed out on the spot by Mr. G. F. Playne, who had prepared a small map of the Combe, copies of which were distributed among the party.

It was intended to have gone over the Monastery, but time would not permit, and the party returned to Stroud, and dined

at the Corn Hall. After dinner, Mr. PLAYNE gave an account of his researches on Hampton Common and Rodborough Hill, on the site of the supposed pit-dwellings which are visible there in such numbers. He produced a quantity of rude pottery, two flints, and several stones, and pebbles of foreign origin, which he had found in the pits, and which he regarded as evidence of human occupation.

Upon this occasion several visitors were present, including the Secretary, and several members of the Bristol Naturalists' Club.

The last Field Meeting of the season took place on Tuesday, 31st August, at

WOTTON-UNDER-EDGE.

The members assembled at the Charfield Station where a break and four horses were in waiting, and though the lanes were of the narrowest and the hills of the steepest the cattle and the coachman were quite up to the mark, and a pleasanter mode of travelling could not have been devised. The first point of interest in the programme was Kingswood Abbey, of which only the gatehouse remains, date fifteenth century. In a room over the entrance arch, a paper was read by Mr. PRITCHETT on the history of the Abbey, originally founded, as appears by DUGDALE, in 1139, for Cistercian Monks from Tintern. After many vicissitudes, moving to Haselden first, and then to Tetbury, they returned in 1170 to Mireford in Kingswood, at a distance of a mile-and-a-half from their first place of settlement. Both establishments appear to have been maintained, and a road communicating between them known as the "Trench Road" or "Trench Lane," is still traceable. Nothing now remains of the buildings at Mirewood; a chapel which now stands on the site being apparently that formerly attached to the dwelling-house of the Thynnes, now entirely obliterated.

After leaving Kingswood the party separated, some going up the Wortley Hill by a deep ferny lane to some quarries on the summit, while the rest proceeded in the break to Ozleworth, a lovely drive by Alderley and Newark. The church at

Ozleworth is of singular interest from its peculiar architectural characters—"Norman" and "Transition" of a most unusual, if not unique type. The chancel-arch, and the north porch both present features of rare occurrence. Nothing is more remarkable than the fact of the early establishment of churches by the Normans in the remote Cotteswold valleys, pointing to the comparative wealth and density of population in those times; but it is difficult to account for the elaborate beauty of the work at Ozleworth. The walking party here joined their fellows, and the whole proceeded to discuss a capital luncheon which Mr. Pritchett had kindly provided; after which they went on to Wotton-under-Edge, where dinner was served at the White Lion.

After dinner Dr. Wright gave a most interesting *resumé* of a paper, which will appear in the published Transactions of our Club, "On the Correlation of the Jurassic Rocks of the Côte d'Or (France), with formations of the same age in the Counties of Gloucester and Wilts." The Doctor, who had been turning to good account a short vacation during the summer, had visited the district in question where he had the advantage of being the guest of Monsieur Jules Martin, at Dijon, a former correspondent, and author of an important Monograph on the Infra-Lias of the Department of the Côte d'Or. As much misapprehension exists as to the true age, position, and character of the beds described under the name "Infra-Lias," the Doctor desired to make an attentive study of the fossils collected therefrom by Monsieur Martin, many of which he had figured and described for the purpose of ascertaining to what stage of our Liassic series they appertained.

Monsieur Martin received him most kindly, and gave him every facility for studying the same; and it was the result of this examination which he now proposed to communicate to the Club. Dr. Wright read a letter from M. Martin in which that *savant* gave a detailed account of the different formations developed in the Côte d'Or, with the leading Fossils contained in each stage, for the more perfect identification of the formations commencing with the *Avicula-contorta-beds* which are very

well developed at *Marcigny-sous-Thil*, and at *Montigny-sur-Armançon*, which greatly resemble the beds of the same age at Westbury, and contain a similar assemblage of Fossils, some of which were especially noted, but fuller details are contained in his Memoirs.

The *Lower Lias formation* exhibited nearly all the stages with which we are acquainted in Gloucestershire, in which the Doctor enumerated the "Infra Lias," as in fact a great development of the zone of *Ammonites angulatus*, containing in the Côte d'Or a larger variety of Fossils than had been met with in any of the localities in England hitherto explored.

The Doctor traced the other stages one by one, and compared them in passing with those of our own region, showing the identity existing between the Faunas of both countries.

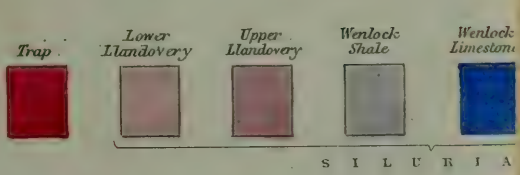
The *Upper Lias* and its super-imposed "Sands" is well developed in France, and the Sections exposed in the Côte d'Or were compared with those at Frocester Hill, and other typical localities.

The Doctor glanced at the succession of beds through the Inferior Oolite, and the stages known by Continental Geologists as the *Bathonien, Oxfordien, Corallien, Kimmeridgien,* and *Portlandien;* the two latter of which he added, were not easily to be correlated with ours.

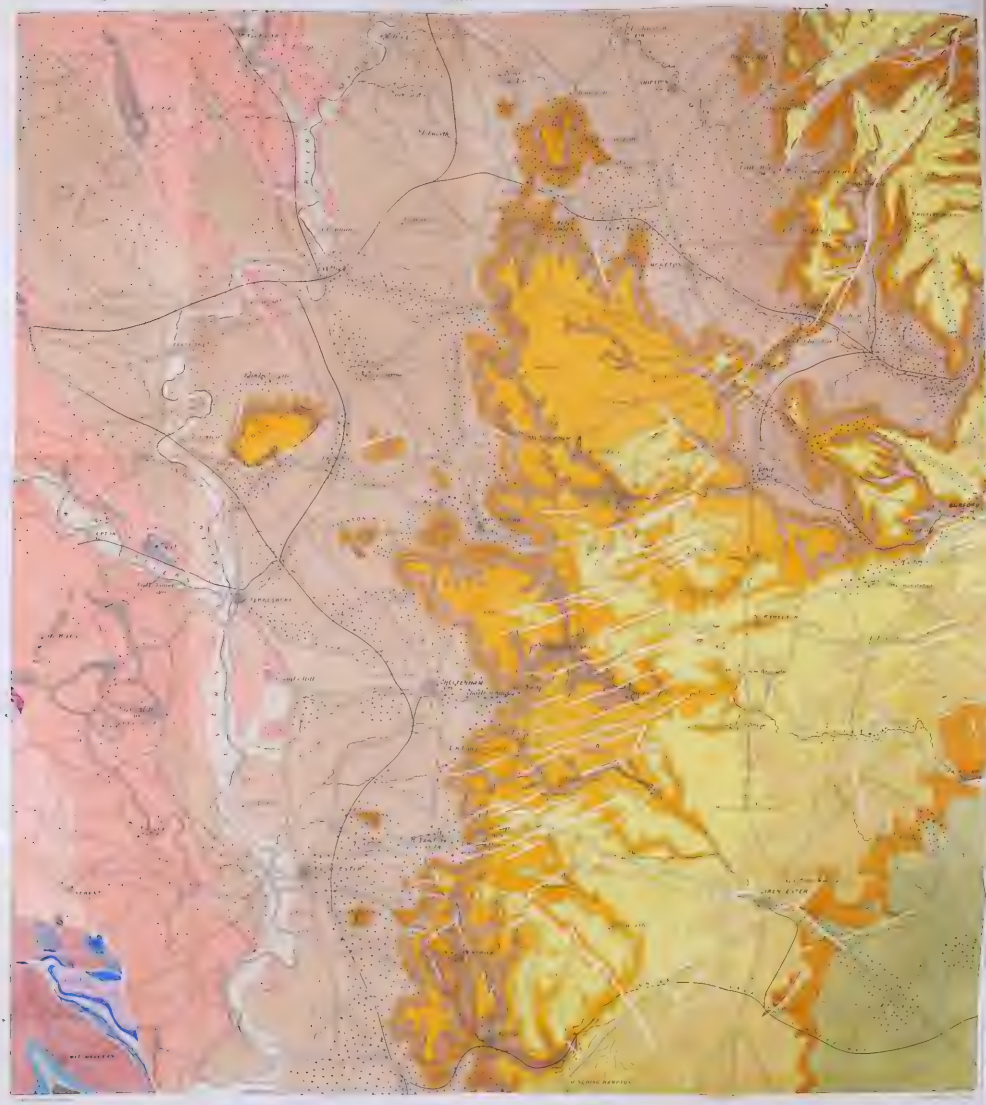
The result of the comparisons thus briefly summarised will be found thoroughly exhibited in the learned paper which forms no unimportant portion of our published Transactions for the present year, after the perusal of which we shall be better able to form a correct estimate of the value of our Colleague's visit to M. Martin's collection.

This was the last meeting of the Club for the season—a season which will be long remembered as amongst the most agreeable and instructive which the Club has ever known. Let us hope that it will be the forerunner of many such, and be a stimulus to every individual amongst us to maintain and extend the credit and influence of the Cotteswold Club.

Drawn by James B. Jordan.



Map illustrating M^r W C Lucy's Paper upon the Gravels of the Severn, Avon, and Evenlode, and their extension over the Cotteswold Hills



The Gravels of the Severn, Avon, and Evenlode, and their extension over the Cotteswold Hills. By W. C. Lucy, F.G.S., F.A.S.L. *Read at Gloucester, April* 7, 1869.

The attention of Geologists has during the last few years been much directed to the study of the superficial gravel formations and deposits of the Pliocene and Post Pliocene period.

In France, the Valley of the Somme, in which so many flint implements have been found, has been rendered classic by the able writings of Mr. Prestwich, Mr. John Evans, Sir C. Lyell, M. Boucher de Perthes, Mr. Tylor, and others.

The Thames Valley and the gravels in the neighbourhood of Bedford, Salisbury, and particularly the East Coast, by S. V. Wood, Junr., and the Rev. J. Rome, have been carefully described and correlated. The first account that I have found on the Severn and Avon gravel deposits was written by a member of this Club, the late lamented Mr. H. E. Strickland, in 1834; and subsequently papers have appeared in different publications by Sir Roderick Murchison, Professor Buckman, Mr. E. Hull, and Mr. G. Maw.

With the exception of two very good but incidental notices by Messrs. Jones and Witchell, the only paper published by the Club is that in 1861, by the Rev. W. S. Symonds, on the Drifts of the Severn, Avon, Wye and Usk, and it was mainly in consequence of the following remark of his that I was induced to study the subject,—"We have much to investigate before we can hope to obtain a clear insight into the history of the Drifts of Gloucestershire and Worcestershire;" and also of the appeal made by our President in his address in 1863, and again in 1865, to the members of the Club to examine these Gravels.

My attention was at first confined to the Gravels of our immediate neighbourhood, and originally the map illustrating my researches was only one fourth of its present size; but after visiting the Moreton and Stow Districts and reading the very valuable paper in the *Reliquiæ Diluvianæ*, by Dr. Buckland, descriptive of that region, I became convinced that to render the subject at all intelligible, it would be necessary to increase the area, and my great difficulty has since been to know where to stop.

The object I have endeavoured steadily to keep in view is, first to give you, in as concise a form as possible, the Geological position and physical characters of the various beds of drift Gravel, in the hope that the members will be led to investigate them, and that ere long they may be as well known as any of our *Oolite* sections in the Cotteswolds. Secondly, to explain what appears to me to be their origin and age. Should it be found that I have done my work fairly, there ought to be little difference of opinion upon the first; but the second is one upon which unanimity can hardly be expected.

It has always appeared to me, that in writing a paper upon a complicated and difficult subject like the present, it is very desirable, even at the risk of taxing the patience of those who are thoroughly conversant with it, to place before the not so well informed, what may be regarded as the generally received opinion of some of the best authorities. Even amongst those who are non-geologists, there is a wide and general interest felt in the subject, as it is in the drift deposits that we find the first records of man and his works upon the globe; and any information therefore which tends to lead us to reconsider our views, with regard to his chronology, cannot fail to be of the highest importance.

Upon an examination of a geological table we shall find at the very top the words, Recent, Post Pliocene, and Newer Pliocene, and it is in the two latter that the drifts which form the subject of this paper, and which include the Glacial Epoch, mainly occur.

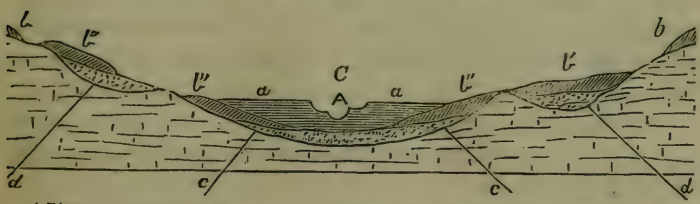
Mr. Page adopting the views of Mr. T. F. Jamieson, arranges the Glacial period into three stages,—the *first*, when the

pre-glacial land, somewhat higher than the existing continents, began to receive the ice sheet; the *second*, during which the ice-bound land subsided to the extent of 1800 or 2000 feet; and the *third*, during which the land was re-elevated step by step, and the ice gradually disappeared.

After speaking of the difficulty in reading aright the phenomena of the Glacial Epoch—the second stage having obliterated so much of the first, and the third so much of both—he adds, "this much, however, is certain, that the Pre-Glacial or Pliocene land surfaces, wherever they are found, contain fossils; that the first stage of the Ice Epoch is characterized by boulders, little removed from their parent rocks, by finely glacialized rock-surfaces, and by the true boulder clay or *till* of Scottish Geologists, and is always un-fossiliferous; that the second stage is characterized by re-assorted clays, by more rounded and widely-dispersed boulders, and is also un-fossiliferous; while the third stage has more moraines, ridges of sand and gravel, terraces with occasional shells, and finally, in the lower levels, the silty clay or brick clay, containing boreal shells, star fishes, bones of seals, whales, northern ducks, and other kindred remains."

By way of illustration, and to enable you the better to follow me, I have reproduced Mr. PRESTWICH's section of the Valley of the Somme in France; and my explanations will be mainly based upon his admirable paper, read before the Royal Society.*

Theoretical Section across the Valley of the Somme.



A River. *a* Recent alluvium. *b b' b''* Loess on different levels and of different ages. *c* Low level Gravels. *d* High level Gravels. *C* The Valley excavated.

* I have, however, where necessary, drawn largely from the works of Sir C. LYELL, Professor RAMSAY, and other competent authorities.

A, represents the present river Somme; *a*, recent alluvium; *b*, *b′*, *b″*, Loess on different levels, and of different ages; *c*, low level Gravel; *d*, high level Gravel. Now it is supposed that the upper bed of Gravel marked *d* was, at one time, the level of the water course; that shortly prior to that time, in Pliocene or early Post-Pliocene period, the cold was so severe as to be called the Glacial epoch, and that the greater part of England was submerged. The high-level Gravel marks a period of a gradual increase in temperature, and consequently denudation proceeded more rapidly. It is rarely more than 20 feet thick, and has an average of about 12 feet. The low level *c* varies from 10 to 30 feet above present water level, and it is mainly in this deposit that the remains of flint implements, which are admitted to be the work of human agency, have been found, associated with the remains of extinct mammalia.

I would particularly call your attention to the Loess, or brick earth (*b*, *b′*, *b″*.) This is thought to be the result of river floods, commencing at the period of the highest valley Gravels, and continued down to the end of that of the lowest valley Gravel; that the higher beds (*b*) were formed at the time the higher level gravels were being accumulated in the bed of the old river; the bed (*b′*) after the valley (*d*) was left dry, whilst the lower beds (*b″*) result from inundation of the river after the excavation of the valley (*C*), and when the higher levels were beyond the reach of floods.

Careful examinations have been made along the French coast, and a remarkable resemblance is found in the Estuarine deposits—more particularly the low level ones—to those on our own coasts. Probably the English Channel was much narrower than at present, and there is reason to think that at the period of the higher Gravels, or slightly antecedent to that time, the two coasts were joined; in other words, that there was then no English Channel.*

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* As I hope to be able to visit the Drift deposits of the east coast of England, I purpose to give a supplemental paper to show how far the Severn, Avon, and Evenlode drifts can be correlated with them, and also with the ideal section just given.

Very few of the high level Gravels contain organic remains, and the general fauna of these Estuarine deposits shews a large percentage of those now living. There is one remarkable shell, the *Cyrena (Corbicella) fluminalis*, which is now not met with in European rivers or lakes, but is found in the Nile deposits, and parts of Asia.

Sir CHARLES LYELL says:—"It may be contended that when *Cyrena (Corbicella) fluminalis* abounded in the Thames, the Hippopotamus may have been suited to the same climate, just as the same mollusk and the living hippopotamus co-exist in the Nile. We may doubtless imagine that during the countless centuries which may have passed away since the Glacial epoch, there have been oscillations of temperature, in the course of which certain members of a more Southern fauna migrated northwards, and then retreated again when a succession of less genial seasons prevailed; while other migrations in an opposite direction took place whenever there was a change from a warmer to a colder climate."*

Formation of Gravel.—"In all rivers," says Mr. PRESTWICH, "subject to floods and carrying down much sediment, (as for example the Severn in its lower course,) three forms of sediment will be deposited.

1st.—Coarse gravel and shingle in the more direct channels through which the waters flow with the greatest velocity.

2nd.—Sand and fine gravel in those portions of the more direct channel, where the velocity of the stream is checked from any cause; and

3rd.—Fine silt and sediment in those parts where the flood-waters out of the direct channel remain for a time in a state of comparative repose; such places are the lee-side of the hills, lateral valleys and plains, and any local depressions or hollows. None or little would accumulate in the main channel, as the scour of the retiring waters would there prevent its deposition.

1.—That certain beds of gravel at various levels follow the

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* "Antiquity of Man," p. 130.

course of the present valleys, and have a direction of transport coincident with that of the present rivers.

2.—That these beds contain in places, land and fresh-water shells in a perfect and uninjured condition; and also the remains, sometimes entire, of land animals of various ages.

3.—That the extent and situation of some of the beds of gravel so much above the existing valleys and river channels, combined with their organic remains, point to a former condition of things when such lands constituted the lowest ground over which the waters passed.

4.—That the size and quantity of the *débris* afford evidence of great transporting power, whilst the presence of fine silt, with land shells, covering all the different gravel beds, and running up the Coombes, and capping the summit of some adjacent hills to far above the level of the highest of these beds, point to floods of extraordinary magnitude."

And now, before proceeding to the more direct subject matter of my paper, permit me to acknowledge most fully the very great assistance I have received from Mr. Etheridge, in constructing the map, making the vertical sections, and naming the rock specimens and fossils, and to whom I am further indebted for many valuable suggestions; also to my friends our President, Sir W. Guise, Bart., the Rev. W. S. Symonds, Dr. Wright, Messrs. Tomes, Kirshaw, Playne, Witchell, Bellows, my old companion and instructor, Mr. John Jones, and Mr. Boyd Dawkins, who classified the Mammalian remains. I have further to thank Mr. Jordan, of Jermyn Street, for his admirable execution of the map.

With the late Mr. Strickland I regard the term "Drift" to denote all those superficial accumulations of transported materials, which are so circumstanced that they cannot have been produced by the tranquil causes which are in daily operation in the district, and which I propose to divide as follows:—

First,—I adopt the general name of Northern drift, which, although sufficiently comprehensive, I acknowledge is far from being definite or satisfactory. It is composed of Quartzose pebbles, long since shown by Sir R. Murchison to be derived

from the conglomerate beds of the New Red Sandstone, Red Silicious Sand, Lickey Quartz, Millstone Grit, Coal Measures, Igneous Rocks, Coarse Granite from Cumberland or Scotland, Silurian Slabs with fossils, Old Red, Flint, Chalk, &c., &c., &c.

This I subdivide into five parts:—

a.—That which occurs at an elevation of about 750 feet on the Cotteswolds, and extends down to where the cretaceous flints first appear, and is chiefly composed of rather sub-angular and rounded quartzose Pebbles.

b.—That which extends from the point where the cretaceous flints are met with, to the highest beds containing mammalian remains; in this division every above-mentioned description of drift is found.

c.—The highest mammalian drift which is variable in character, but does not differ essentially from the last.

d.—A terrace at an altitude of about 40 to 50 feet above the *present* rivers.

e.—The lowest mammalian drift from 15 to 25 feet above the present level of the rivers.

Second,—The Oolitic Gravel forming most of the beds east of the Severn lying near, and flanking the Cotteswold range; this may be divided into upper and lower Mammalian Oolitic detritus, and also some beds of Oolitic *débris* occurring at a higher elevation on the flanks of the hills.

Third,—The small sub-angular Oolitic Gravel which is found at a height of 500 to 700 feet, and is composed of the *débris* or weathering of the freestone of the inferior Oolite, and considered by Mr. Hull in his memoir to be raised sea-beaches.*

Beginning where the lowest level of the gravels that I have undertaken to describe, and which occurs at Gloucester; and then taking the left half of the map, which includes the hills to the west of the Severn, the valley through which that river, the Avon, and the Arrow flow on their way to the sea; and also the greater part of the western escarpment of the Cotteswold

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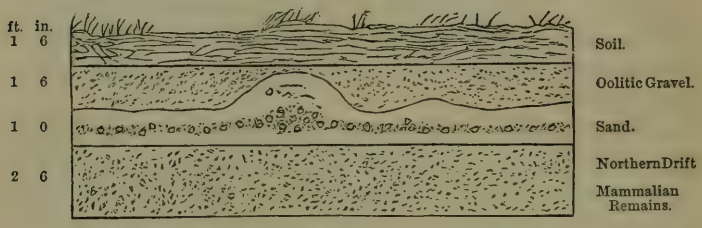
* "Mem. Geol. Survey Great Britain; Geology of the Country around Cheltenham," 8vo. By E. Hull, Esq., B.A. and F.G.S.

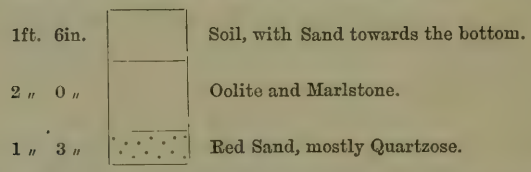
hills, which latter forms the great watershed or area, from which our small rivulets (shown in the map with blue lines) take their rise in the Coombes, and work their way through the Valleys, often by a tortuous route, until they join the Rivers.

At Gloucester the two descriptions of gravel (*i.e.* the Oolitic and N.D.) meet, and consequently to the West it is nearly all N.D. and to the east the detritus of the Oolite and Lias.

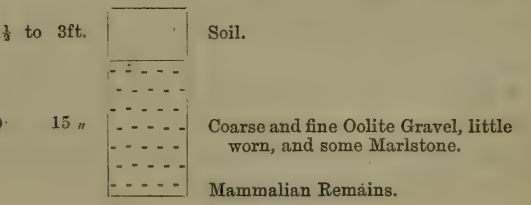
The pit at Kingsholm consists of—



It will be seen that the Oolite overlies the N.D., and the sand of the latter extends further eastward to the end of Barton Street, near the railway bridge, crossing the road to Upton St. Leonards, where the following section is well shewn—



The Gravel and Sand are met with in places on the same side of Gloucester, but at the Railway Station the Gravel is all Oolite and Lias. There is a large developement of Oolite Gravel at Barnwood, about $1\frac{3}{4}$ miles from Gloucester, which consists of—



The last time I visited it I found a small seam of the Red Quartzose Sand which I had never noticed before.

About half-a-mile further on at an increased elevation of about 40 feet, is a pit belonging to Mr. Rea, containing—

1ft. 0in.	Soil.
7 " 0 "	Oolite, Marlstone, and Lias Gravel, with Gryphites, Belemnites, and Corals.
	Mammalian Remains.

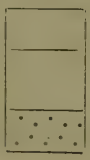
The surface ground round and at these Pits is quite flat, which is a characteristic I shall have to notice more fully in describing the probable origin of the Gravels.

Leaving Gloucester on the way to Highnam, some little distance from the Over Gate, (west of the Severn,) is a field by the side of the road in which there is a pit just where the Alluvium ends—containing

2ft. 8in.	Soil, with N.D. Pebbles.
0 " 9 "	Fine Quartzose Sand.
0 " 4 "	Pebble band of N.D.
4 " 0 "	Fine Quartzose Sand.

There is no trace of Oolite, and the Sand does not differ from that met with at a considerable altitude, or when found in its normal condition in the beds of the New Red Sandstone.

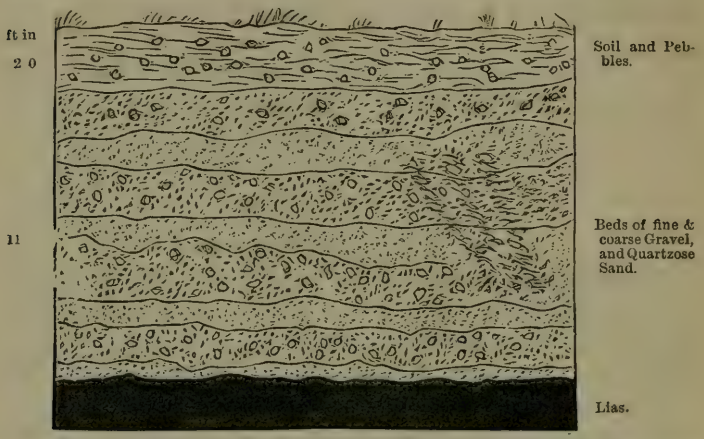
At Hempsted, I had the good fortune to arrive just in time to see the following excellent section in a large vault being made in the Churchyard—



2ft. 0in.	Soil and Pebbles.
2 " 0 "	N.D. with some rolled Lias, Gryphites, Pebbles, (thicker towards the bottom) with Syenite, Flint, and Chalk.
6 " 0 "	Fine Quartzose Sand.

The land here is quite level.

A short distance beyond Highnam Church, near the Court, is a pit with



There are N.D. Pebbles of considerable size but little worn, Syenite, Chalk Flints, rare, but some large, and rolled Gryphites, Belemnites, and Cardinias, &c., &c., from the Lias beds upon which the Gravel rests. There is a little Oolite, much water-worn, and its position seems to indicate having been brought there by a strong current.

At the Pinetum on Sandy Hill, a short distance from the Keeper's house, close to the footpath leading to Bulley, is a pit fully 7 feet deep. It is mostly Red Quartzose Sand, some of it very fine; there are, however, in it a few thin seams of small Quartz and N.D. Pebbles, but no trace of Oolite.

From the number of holes in the hill, the Sand appears to have been worked to a considerable extent, and the hill, which is situated on a fault of the New Red, has a very steep escarpment towards May Hill, resembling some of the Cotteswold Coombes. The high ground from there to Lassington is fairly strewn over with N.D., but on descending into the Valley it is very sparingly seen, not extending beyond Tibberton, or at farthest, Taynton.

From Lassington to Newent, and also on the road to Dymock,

it is met with, increasing in thickness on the high ground at Collen Park, and is traceable on to Upleadon.

Limbury Hill has on its summit, flat table land of about 10 acres in extent, in which gravel is worked, which shews the following section—

ft.	in.	
2	0	Northern Drift
0	8	Dark Red Quartzose Sand.
0		N.D. Syenite, Lickey Quartz, Granite, Carboniferous Limestone, one piece of Rolled Chalk, Flint, and small slabs of Silurian Rock, containing the following Fossils :—

Heliolites	Wenlock Limestone.
Halysites catenularius	" "
Cyathophyllum	" "
Favosites alveolaris	" "
Petrina bina	Caradoc
Chonetes lata	Upper Ludlow.
Orthis elegantula	" "
Atrypa reticularis	Wenlock Limestone.
Phacops caudatus	" "
Rhynchonella Wilsoni	" "

This section also rests upon the New Red Sandstone.

Catsbury has some N.D. Gravel scattered over the surface, but no sub-angular pieces of Silurian Rocks.

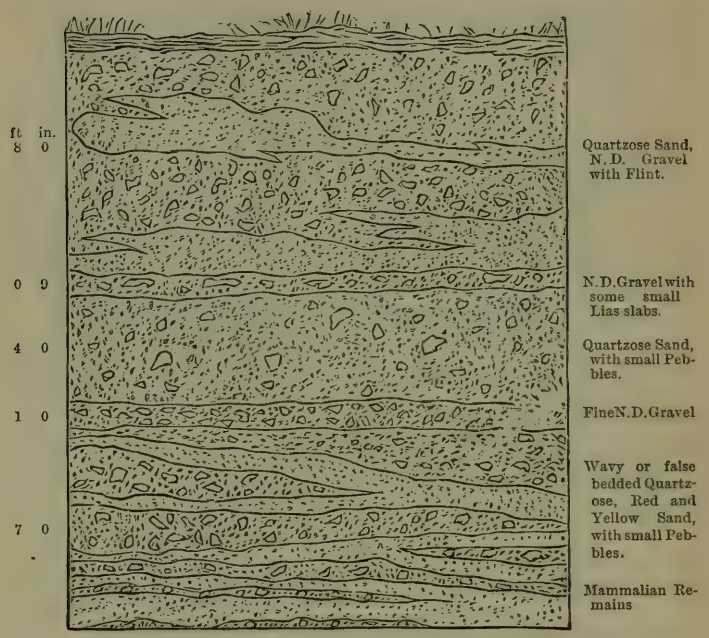
At Maisemore the N.D. is very irregular, increases in thickness towards the summit, and is in places composed mostly of Quartzose Sand; on the road to Woolridge, at Spring Hill, there is a pit about 9 feet deep of nearly all fine Red Quartzose Sand with some layers of small N.D. Pebbles.

At Woolridge I found one slab of Silurian Rock, with *Atrypa reticularis* and *Orthis elegantula* in it.

The table land of Foscombe and Corse is composed of Lias, with hardly, however, any N.D.; and there is a little N.D. at

Birth Hill; but upon Gadbury Camp it attains a considerable thickness, and from there to Eldersfield and round Pendock it occurs abundantly.

At Pull Court at an elevation of 180 feet, is a mass of Quartzose Sand, with seams of Pebbles, of which this is a



section; and I traced the same beds to the top of the hill, which is about 20 feet higher.

On to Upton-on-Severn, immediately above the Alluvium of the river, at a rise of about 12 feet (say 63 above the sea) is a section at the Workhouse of 4 feet of coarse N.D. Gravel with Sand; in which there is a good deal of White Quartz, and some coarse Porphyritic Granite, similar to that which I have seen in Shropshire, and which appears to have been derived from Cumberland or Scotland.

Close to the Railway Station at Upton, during the construction of the line, I am informed by the Rev. W. S. Symonds that

two molar teeth of *Elephas primigenius*, *Turritellæ*, portion of worn *Cardium* and fragments of *Cyprina Islandica* were found, some of which are now in the Worcester Museum. Near the Workhouse a *Purpura lapillus* was picked up by Mr. Sewell, (formerly of Upton,) and given by him to Lord Ducie.

At Tunnel Hill, which is about 100 feet above the sea level, N.D. Gravel is met with, and there appear to be in this locality three distinct zones of Gravel, namely—Pull Court, Tunnel Hill, and the slightly rising ground above the Severn, with Mammalian remains in the first and last.

At Tewkesbury, in a cellar excavated at a house in the High Street, I saw, about 4 feet below the surface, 4 feet of N.D., with some rolled Lias Gryphites resting on New Red.

This Gravel is found round Tewkesbury (particularly at Northway) in considerable abundance, and thins out at Ashchurch Station, where it meets the Oolitic detritus.

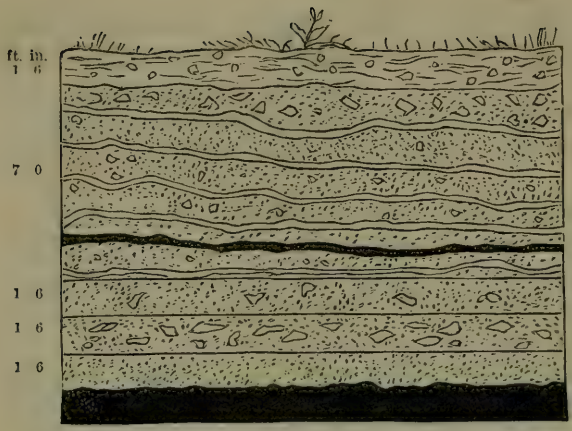
Following the course of the Avon the N.D. Gravel occurs in a field opposite the fourth milestone on the road from Tewkesbury to Eckington, and when worked nearer to the river it was evidently much thicker, as it now thins out towards Bredon.

The following is a section—

ft.	in.	
2	4	Soil with N.D.
1	3	Coarse N.D.
0	6	Fine Quartzose Sand.
3	0	Fine N.D. Gravel, with Flints resting on Lias.

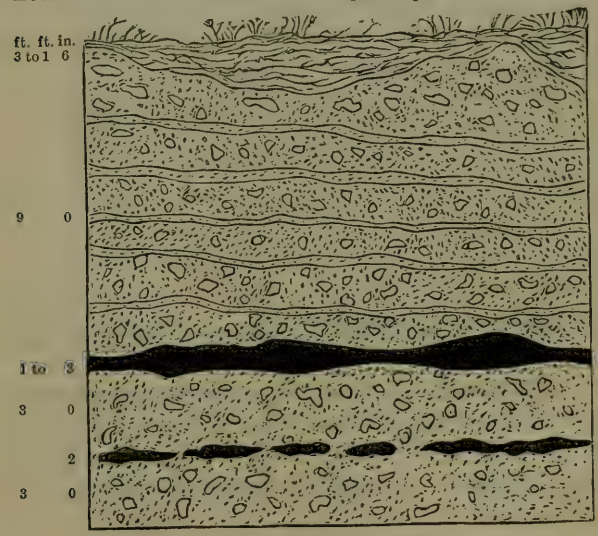
I obtained here *Galerites subrotunda*, (Mantell,) from the chalk which was given me by one of the workmen.

At Bredon's Norton, in a field near the Church, called Gravel Hole, and which approaches nearer the hill, the N.D. and Oolite join. This pit is at an elevation of 160 feet, and is the highest point on Bredon at which I have met with Quartzose N.D. Sand.



On ascending the hill, in a field belonging to Miss Martin, is a small pit with 6 feet of very coarse sub-angular Oolitic and Marlstone Gravel resting upon six inches of Red Quartzose Sand.

At Beckford, in a field from which the ballast was taken for the Evesham Railway, was a large gravel pit, when I visited it in 1865, and I then made the following section; but the sides are now levelled down and there is hardly a trace left.



Seven feet unworked.

In the Gravel, which is mainly Oolitic, with some N.D., there are beds of fine Quartzose Sand. Remains of *Elephas primigenius*, *Rhinoceros tichorinus*, *Bos bison*, *Sus ferus* and *Cervus tarandus* have here been found.

The President of the Cotteswold Club, in his address for 1865, mentioned that he found there a portion of a Shell which Mr. Gwynn Jefferys identified as *Lucina borealis*.

Returning to the river Avon, at Eckington, near the Church is a small pit with N.D. Gravel, which extends over the fields to near Wollershill (Col. Flood's); and at Defford, on the other side of the river, at an elevation of about 20 feet above the railway, is a section of N.D., with fine Quartzose Sand, Chalk Flints, and rolled Lower Lias Gryphites.

Both at Eckington and Defford Mr. Strickland mentions that bones and fresh-water shells have been found.

On the high ground from Defford to Pershore N.D. is met with, and just before entering the latter place, in a field adjoining the turnpike road, I found 6 feet of N.D., with large masses of Lias limestones, very little worn.

One of the workmen told me when the pit was opened higher up in the field, the Gravel was 12 feet deep.

From Pershore to Cropthorne the N.D. is found in considerable abundance, and close to the latter place, about 20 feet above the Avon, is a pit of 6 feet of the same Gravel, with occasional beds of Red Quartzose Sand, and the Gravel is interspersed in the surface soil, which is about 18 inches deep.

Here I found Millstone Grit, Mountain Limestone, with Actinocrinus, Syenite (not Malvern) one block 20lbs, Quartzite, and White Quartz; also fragments of some Lower Lias Gryphites, small Oysters, Chalk, and some Chalk Flints of considerable size.

The whole rests upon a perfectly even surface of Lower Lias, and its upper part presents a plain which extends across the river to the Great Western Railway, near which is a large ballast pit exhibiting in places a considerable thickness of N.D.

At Cropthorne Mr. Strickland found the remains of the following animals :*

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* See page 96, Memoirs.

Hippopotamus ...	A few bones and teeth, probably belonging to the same individual.
Bos Urus	Numerous remains of several individuals.
Cervus	A few bones and fragments of horns.
Canis	A radius.
Ursus	A metatarsal bone;

and the following list of terrestrial and Freshwater Mollusca:—

TERRESTRIAL.

1.	*Helix virgata*	V.R.
2.	*H. Pulchella*	R.
3.	*Pupa marginata*	R.
4.	*P. pygmœa (? vertigo)*	V.R.
5.	*Succinea amphibia*	R.

AQUATIC.

6.	*Limnœa palustris*	V.R.
7.	*L. fossaria (? truncatula)*	R.
8.	*L. peregra*...	R.
9.	*L. auricularia*	V.R.
10.	*Planorbis nautileus*	V.R.
11.	*Planorbis vortex*	R.
12.	*P. complanatus*...	R.
13.	*P. lateralis, (Strickland)*	C.
14.	*Ancylus lacustris*	V.R.
15.	*A. fluviatilis*	V.R.
16.	*Valvata Fontinalis*	C.
17.	*Paludina tentaculata*	C.
18.	*P. minuta, (Strickland)*	R.
19.	*Cyclas Henslowiana (? Pisid)*	C.
20.	*C. amnica*	C.
21.	*C. cornea*	C.
22.	*Anodon anatinus*	C.
23.	*Unio ovalis (? littoralis,) (Fleming)*...	C.

Note.—V.R. denotes very rare. R. rare. C. common.

In addition to the above Shells, the valves of a *Cypris** also occur.

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* This is now referred to *Candona reptans*, BAIRD.—ED.

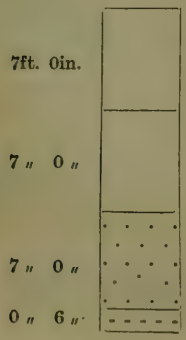
Gravel of like character is met with at intervals near the banks of the Avon to the extent shown on the map, (at the top of Welford Hill it is 40 feet thick) and good sections occur on the banks of the Arrow, at Broomford, and near the river, close to the Workhouse at Alcester.

Berry's Coppice, near Donnington, is at an elevation of 160 feet above the river Arrow at Broom, 273 feet above sea level, and presents the following section:—

It may clearly be traced from Pershore to Inkberrow, through Throckmorton, and at the last-named place I picked up a piece of coarse Granite, similar to that which I found at Upton, and in Shropshire; also a small block of Millstone Grit, the latter shewing evident marks of glacial striation.

Along the Ridgeway the N.D. is in considerable quantity, and at Cook's Pit there is a bed of Red Quartzose Sand, 40 feet thick, with Pebbles near the surface, and some Charcoal.

At New Inn Brickyard, a quarter of a mile from the Inn, there is a section showing:



H

Completing the western, or upper portion of the map, it will be seen by the dotted red marks, that from Evesham to Broadway, the N.D. extends to the Cotteswolds, and that at the foot of the same the Oolitic Gravel is in places of considerable extent and thickness.

An excellent section, 9 feet deep, is shewn at Stanway, in a field opposite the 11th milestone from Tewkesbury. The Gravel is sub-angular with many bits of rolled Marlstone, and in which were obtained the following fossils:—*Pholodomya Heraulti, Modiola plicata, M. Sowerbyi, Belemnites elongatus, Lima proboscidea,* and rolled *Gryphites.*

The pit, which is a short distance from the hill, is situated near the mouth of a Coombe, and from the character of the ground, which is nearly level, the gravel is evidently of considerable thickness, covering a large area.

From Stanway to Hayles Abbey, Oolitic detritus is met with, and extends up to Winchcombe, where at an elevation of 300 feet, on table land, at the back of the town, is a Gravel pit of 8 feet of sub-angular Oolite, with some Lias Gryphites. Gravel of like character, I am informed, occurs under part of the town.

At Alderton the Quartzose Sand is met with, being 8 feet thick, overlain by 9 inches of small Oolite Gravel, and 1ft. 6in. of soil. This Sand extends to Little Washbourn, on to Beckford, (but there it is mixed with Oolite), into Kemerton, thence to the N.D. at Bredon, to which it belongs.

The same description of Sand is at Bishop's Cleeve; at and round Cheltenham it is of great thickness, and Dr. Wright informs me that at Hopwood's nursery gardens, when a boring was made for the railway, it was found to be 40 feet deep.

In Ryworth field, Charlton Kings, about 1½ miles from Cheltenham, at a height of 264 feet there occurs 32 feet of Quartzose Sand with fine Oolite and Marlstone Gravel in seams, more sandy towards the bottom, where it rests on rather coarser gravel, covering up the Lias Clay.

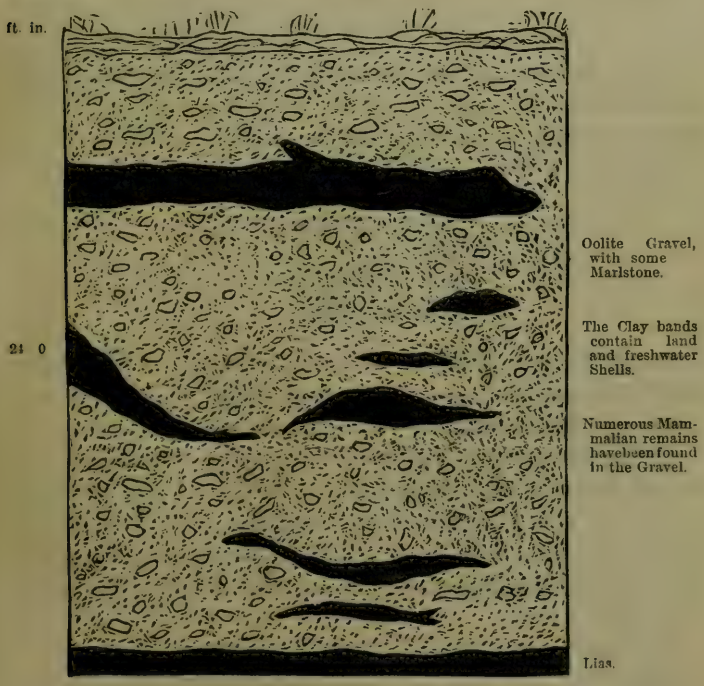
Proceeding along the road which leads to Andoversford, near the fourth milestone from Cheltenham, where the valley becomes

quite narrow, is a large bed of sub-angular Oolitic Gravel, (with some Marlstone,) at least 10 feet thick.

At Leckhampton this Gravel is largely developed, also a peculiar small sub-angular Gravel which I intend to describe separately, as it is met with elsewhere, and which, as I have mentioned before, is considered by Mr. HULL, in his "Memoirs of the Cotteswolds" to be the remains of a raised sea beach—an opinion from which I dissent.

At Witcombe, Oolitic gravel is found; also at the foot of the range continuing to Stroud, being in many places of considerable thickness.

At Gannicox's pit, which is near to Stroud and on the road to Cainscross, the upper part running up to the Great Western Railway, there is a very large quantity of Oolitic detritus, mixed with some Marlstone and Lias.



The depth is about 24 feet, and consists of a mass of Gravel, (near the surface it is fine Sand) with several thin Clay bands, varying from 4 to 6 inches in thickness, not always persistent, being folded or twisted in a peculiar manner, indicating lateral pressure.

It is in these lenticular clay bands that so many Land and Freshwater shells have been found, and the following list is from the interesting paper by Messrs. Jones and Witchell:

Ancylus fluviatilis
Limnæus auricularius
,, *pereger*
,, *truncatulus*
Helix Nemoralis
Zua lubrica
Pupa muscorum
Zonites excavatus

Many Mammalian remains have also been discovered, but, unfortunately, few were preserved, and I am indebted to Mr. Boyd Dawkins for naming some which were kindly lent to me by Mr. Witchell and Mr. Biddell. They are—

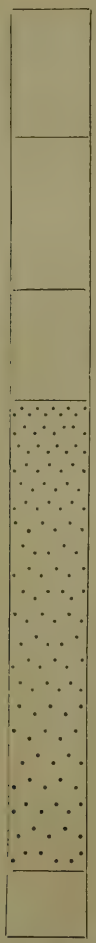
Elephas Primigenius
Bos
Rhinocerus tichorhinus
Cervus tarandus

It will be now necessary to examine the upper, or eastern half of the map, beginning near to Stratford-on-Avon, and following the course of the Stour into the Shipston Valley.

At Stratford, which is about 180 feet above the sea, there is a good deal of N.D. on either side of the Avon, and at Shottery, about one mile from the town, some fine remains of *Elephas primigenius* have been found, which originally formed part of Mr. Wheeler's collection, but are now in the Museum at Shakespere's house.

Near to Stratford, at The Ox-stalls, 130 feet above sea-level, on the Warwick road, is some coarse N.D. Gravel 3 feet

thick, and at Welcombe, at an elevation of 200 feet, is the following section:



3ft. to 4ft. 1in.	Loam on an eroded surface.
4 "	Light Reddish Brown Clay.
2 " 6 "	Laminated Reddish and Grey Brown Clay.
13 "	Fine Yellowish Laminated Quartzose Sand, coarse towards the bottom, and containing small Brown and Black Pebbles.
1 "	N.D. with Lias Gryphites.

Near there, and at a further elevation of 40 feet, is a pit of Gravel with a good deal of White Quartz and some Granite, but little Flint.

When at Black Hill, near to Snitterfield, in Mr. Hutchins' brickyard, height, 300 feet, I was accompanied by Mr. Lloyd,

with Mr. R. F. Tomes, who had previously made the following section, which we verified.

2ft. 6in.	Surface Soil, with Pebbles.
6 " 6 "	Light Red Loam.
0 " 8 "	Thin seam of Carbonaceous Matter.
2 " 6 "	Light Red Sandy Loam.
1 " 0	Quartzose Reddish Sand.
8 " 0 "	Reddish Loam, Laminated Green and Dark.
4 " 0	Reddish Brown Clay.
6 " 6 "	Quartzose Sand.
13 " 0	Fine, Light Brown Quartzose Sand, Quartz Pebbles, Lias Gryphites, and pieces of Lower Lias Bone Bed.

We found *Cardinias*, *Pentacrinites*, Oolite, Slate, and Chert. The Gravel is small at the bottom, with large blocks of Blue Lias Clay. Beds dip 5°, and there is a fault in the pit. The two beds, 8 and 4 feet thick respectively, I consider to be Boulder Clay.

Here, as at Welcombe, and near the New Inn on the Ridgeway, the Quartzose Sand is intermediate between a bed of Clay and Gravel, the latter being the lower.

On either side of the river Stour the N.D. is largely developed, extending to Shipston where it attains an elevation of 212 feet, and at Alderminster, about half-way between Stratford and Shipston, Mammalian Remains occur.

Two and a half miles distant from Shipston, at Wilmington, at a height of 272 feet, is a pit of 8 feet of gravel, covered with 1½ foot of soil, in which there are Quartzose Pebbles, Millstone Grit, Flints, Chalk, with a little Oolite and Marlstone, some of the Gravel is small (much water-worn) and in it are seams of Red Quartzose Sand.

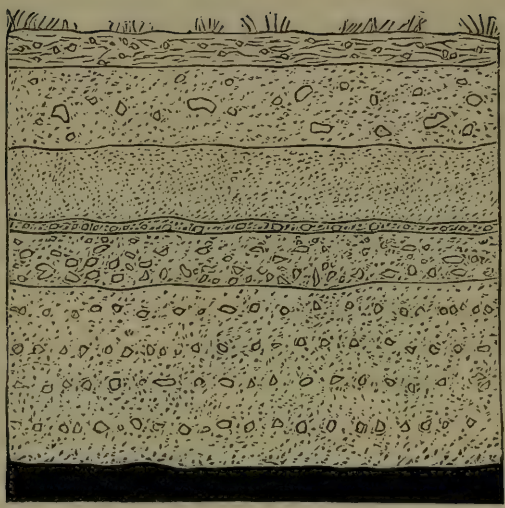
At Honington Hill, 362 feet above the sea, the Gravel is close to the surface, for the first 3 feet it is very coarse, resting upon 7 feet of finer description, some of it much reduced by attrition, in which, however, large pebbles are interspersed, *i.e.* N.D. with Flints. The surface is table-land, but the Gravel is thickest just where the ground begins to slope.

Ascending the hill towards the village of Brailes, I found a few scattered N.D. Pebbles at an elevation of 422 feet, but after leaving the main road could discover no further trace of them until reaching the summit, 607 feet high, where just beyond the clump of trees, where the ground is flat, and composed of Stonesfield slate, I again met with them.

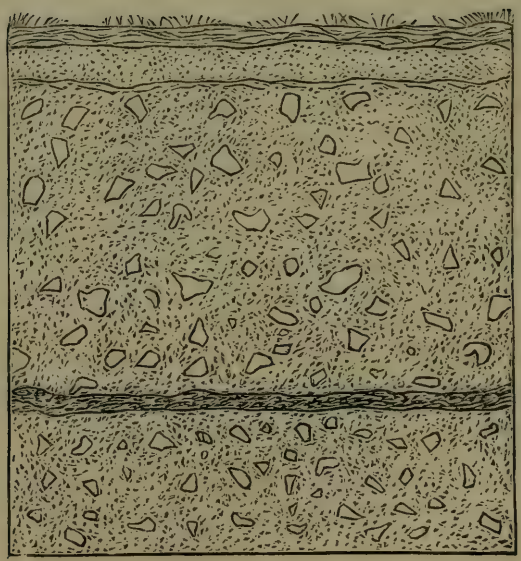
From Cherrington to Little Woolford, at a point where the road branches out to Weston Park Farm, is a large, angular, irregular-shaped boulder of Millstone Grit, weighing, as far as I could judge, 2 cwt.

In Little Woolford fields, near Pepperwell buildings, are two important sections of Gravel, in the same ground.

(1)


ft. in
1 0
3 0
2 6
0 2
2 6
10 0
Soil, with Pebbles.
Arenaceous Marl, with few Pebbles.
Very fine Sand resting upon a thin Pebble bed of N.D.
Fine Sand, with Pebbles increasing in number towards the bottom.
Fine Sand, with a few layers of small Pebbles.
Lias.

(2)


ft. in.
1 6
12 0
5 0
Fine Sand.
N.D. with many pieces of white Chalk, some of considerable size & well rounded.
Red Chalk, white Lias, large angular Flints; some of quite fresh fracture.
N D. with Flint, Gravel, and Lias Fossils.

The first and lower is 374 feet above the sea, contains some arenaceous marl, some thin layers of Clay, many Flints, (some quite fresh in fracture), Millstone Grit, granular white Quartz, Quartzose Pebbles, and hard Chalk; and the second, and higher pit is of very large size, differs greatly in character, although forming a sequence, and rests upon the upper beds of the lower pit, containing many pieces of lower hard White Chalk, also some Red, (both, perhaps, from Lincolnshire), large angular cretaceous Flints in great abundance, (many of quite fresh fracture), Granite from Cumberland or Scotland, fine grained Trap, with glassy felspar, Millstone Grit, from the Coal measures, White Quartz and Quartzose Pebbles, Mountain Limestone, some new Red Sandstone, White Lias, (very deceptive, resembling Chalk,) Gryphæa cymbia, and incurva, Amm: angulatus, semicostatus, Rhynchonellæ, and Belemnites, with one small fragment of Oolite.*

Gravel of like character is found in great abundance in the surrounding locality, extending to Long Compton; but after leaving that village, and ascending the hill by road, I failed to find any.

Returning to the Mickleton Tunnel, a good section of which will be found in Mr. Gavey's paper in the Quarterly Journal of the Geological Society for 1853—as the sides of the cutting and spoil are now much covered with grass I think it better to give an extract from his paper:—

"The surface of the ground at the summit of the tunnel is 490 feet above the sea, it is on a level with the Marlstone of the hills on the east and west, and is composed of loamy silicious

* It was, doubtless, from this pit that Dr. Buckland, in his paper on "Valleys of Denudation and Beds of Diluvial Gravel in Warwickshire, Oxon, and Middlesex," mentions having "found Pebbles of a hard red species of Chalk, which occurs not unfrequently in the Wolds of Yorkshire and Lincolnshire, but is never met with in the Chalk of the south or south-east of England. The nearest possible point, therefore, to which these Pebbles of Red Chalk can be referred, is the neighbourhood of Spilsby, in Lincolnshire. With these Pebbles of a Red Chalk, are others of a hard and compact White Chalk, such as accompanies the Red Chalk in the two last-mentioned counties, and which occurs also at Ridlington, in Rutlandshire."

Gravel, Sand, and Red clays, to a depth of 76 feet, disposed in layers, resting immediately upon the upper beds of the Lower Lias Shale. The following is the order of the beds downwards, viz.:

	ft.	in.		ft.	in.
Vegetable soil, about					9
Loamy Sand and Pebbles	5	0	to	15	0
Fine Loamys and, passing into coarse ...	5	6	"	20	0
Gravel and Clay	5	0	"	30	0
Red Clay, with boulders of Marlstone ...	2	0	"	6	0
Loose shingly Gravel	1	0	"	16	0
Red Clay, with boulders of Marlstone ...	2	0	"	15	0
Lower Lias shale, more than				80	0

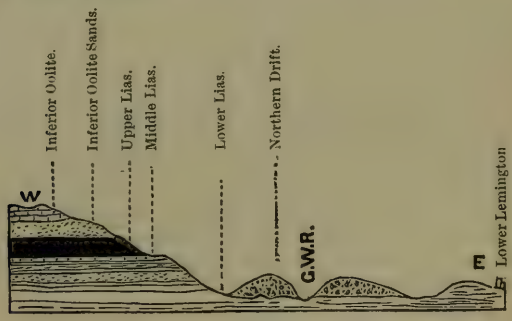
"The Sands and Gravel are limited to about 170 yards on either side of the tunnel, and have an anti-clinal arrangement, the beds dipping irregularly north and south, in one instance the Gravel dips 15° to the west.

"In the Sand and Gravel beds there were found but very few Shells, which were principally *Gryphæa* and a few *Belemnites*, but in the lowest Gravel bed the Fossils were more numerous, consisting mostly of *Belemnites*, *Gryphæa*, *Serpulæ*, and all having the appearance of being much water-worn.

"The beds of Red Clay are non-fossiliferous, but contain large detached blocks of Marlstone, of a bluish colour and of uneven fracture, and with the edges considerably rounded by attrition.

"At the south of the tunnel, in the Red Clay, large Marlstone boulders were embedded, very much rounded by attrition, similar to those above mentioned; they were from one cwt. to three tons weight each."

The following vertical section of Aston Magna was made by Mr. R. Etheridge, F.G.S., who accompanied me when I examined this district.



Mr. Gavey says of Aston Magna:—"The cutting in question lies north and south, which gives a transverse section of the hill. From the north end to the centre of the cutting, the upper bed consists of a thick accumulation of Gravel, Sand, and Clay, derived from the inferior Oolite. This is not disposed in layers, but forms an unstratified deposit, capping the summit of the hill, and containing large blocks of the same formation, lying in various positions. From the centre of the cutting this deposit becomes mixed with a large quantity of small Chalk-Flints, which are common in the neighbourhood. It may therefore be inferred that this accumulation of Oolitic Gravel, etc., consisted of the debris of the Cotteswold Hills during their denudation, but which had not long been subjected to the action of water, for the Gravel and blocks of Oolite bear no appearance of having been rolled, and differ very much in this respect from the large deposits of rolled Oolitic Gravel near the village of Paxford, about two miles distant from this point, neither had the few fossils (chiefly Terebratulæ) which I found, any appearance of being water-worn. In the centre of the cutting and lying immediately under the above-mentioned Oolitic Gravel, etc., is a thick deposit of very large Chalk Flints, many of them weighing one and two cwt. each; they are not water-worn and retain their original white coating uninjured. These are intermixed with blocks of hard Chalk, Greensand, and Clay, together with a quantity of silicious Sand and pebbles."

With the exception of too much Oolite being given, and not sufficient Chalk Flints, I accept Mr. Gavey's description as accurate.

I saw some enormous blocks of Flint, not at all water-worn, one, with a piece of chalk adhering to the hollow, with dendritic manganese, but a good deal of the Flint in the Gravel is broken up and reduced to a moderate size.

On the surface of the northern part of the cutting the Gravel is nearly all Oolitic, but the south is mainly composed of Flints, with some N.D., the latter being found however throughout the mass.

It is difficult to estimate correctly this large accumulation of

various Gravels, forming a remarkable mound, and having a valley on either side.

I was informed by my friend, Mr. Robert Tomes, who was with me, that he had several times visited the cutting, while the railway was being made, and that he had seen many large blocks of Chalk, bearing marks of glacial striation.

Mr. Gavey observes "A cutting about 250 yards north of Aston cutting is composed entirely of the upper beds of the Lower Lias Shale with a covering of Sand and Clay containing a few erratic boulders of Marlstone, but there is not the least appearance of Oolitic Gravel, or Flints.

"The Shale is very arenaceous and resembles that of the cuttings at Mickleton, but is not nearly so fossiliferous.

"In a cutting on the south side of this hill near the village of Dorn, the first 360 yards are composed of the upper beds of the Lower Lias Shale, containing Fossils quite distinct from those of the Aston cutting; also Ironstone similar to that found at Mickleton North Cutting. The rest of this cutting from Dorn to Moreton is composed of Silicious Sand and Pebbles, and a sub-stratum of Loamy Clay, mixed with small Flints.

"So that the Aston cutting differs materially from the cuttings north and south of it."

At Berrington, near Campden, is a pit close to the Railway Bridge, consisting of 3 to 4 feet of Oolitic Gravel, containing with other Upper Lias Fossils, *Amm: bifrons*, etc., and it is capped with Clay soil. On the surface of the land are large angular Pebbles of N.D. I found one of Millstone Grit, and a Coal Measure Sandstone, with *Stigmaria ficoides.*

To the west, before reaching Pudlicote Mill, at Goose Hill, 527 feet high, I saw some Flints, Jasper, etc., and at Compton Scorpion, fine grained Greenstone and Mountain Limestone, with encrinital stems, at an elevation of 607 feet.

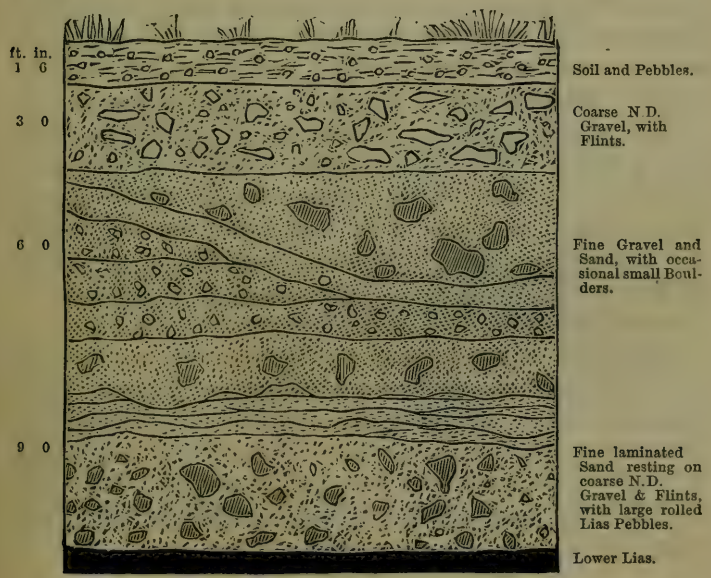
Ebrington Hill is a plateau, about 750 feet high, which is completely covered with grass, rendering investigation very difficult, and although I could find no trace of N.D., as it is met with on the outlier of Meon, it may be, and probably is, there.

Returning to Campden *via* Longlands, White Quartz and Jasper are abundant, with some Slate and Flint, and the field descending to the Railway Station is literally strewed with the N.D. Pebbles. Passing the promontory of Aston Magna, at the cross roads of Batsford, at an elevation of 612 feet, the N.D. which is thinly scattered over the surface, contains a large proportion of Chalk Flints.

It will therefore be seen that the heights at which the N.D. is met with at Ebrington Hill on the one side, and Batsford on the other, are the same within 5 feet by Aneroid measurement, and that the plateau of the Marlstone seems in this district to be the highest level on which Gravel is found.

The great increase in the quantity of Chalk Flints at Batsford, as compared with that at Mickleton Tunnel, is worthy of notice.

At Blackdown the section now shows a depth of nearly 20 feet, but Mr. Fletcher, upon whose property it is, informs me that there is Gravel 5 feet lower than was being worked when I was there.



There are some large Millstone Grit and Lias boulders, Gneiss, fine Quartz, Brownstone from the Old Red Sandstone, Pebbles, and cretaceous Flints, and the ground is a roundish hill, or tump, about 400 feet above the sea-level, a deep valley intervening between Blackdown and Goose Hill.

Near the pit, from which it had been removed, I observed a piece of Hornblende Greenstone, 2ft. 3in. long, 9 inches thick, and 15 inches wide.

At Stretton-on-Foss, is a pit, at an elevation of about 380 feet, containing 2 feet of Gravel and soil, then 8 feet of Quartzose Sand, which rest upon 3 feet of the same Quartzose Sand mixed with coarse N.D. Gravel, but the whole does not cover more than 70 acres, and is very irregular in thickness.

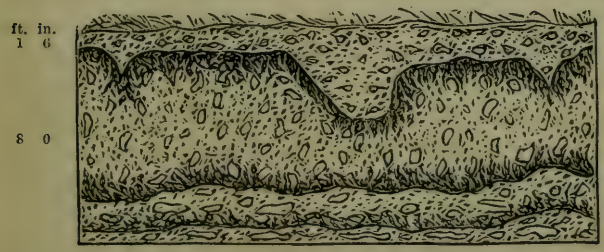
At Lower Lemington, near the church, is a pit, much resembling Blackdown, only the Gravel is finer and more mixed with soil. A large boulder of very indurated carboniferous limestone, 20 in. long, 12 in. thick, and 15 in. broad, was just taken out when I was there. Height about 360 feet.

From Ebrington to Brailes, and including the district as far as Moreton-in-the-Marsh, the country is a series of small hills rising to about 400 feet above sea-level, intersected by numerous valleys. The character of the drift is extremely variable. At Paxford, I saw exposed in a field which was being drained, fully 4 feet of Boulder Clay, containing some Flints, Quartzose Pebbles, Lias, Greenstone, Millstone Grit, and Syenite from Charnwood; whilst on the other side of the road with hardly any difference in level, being only slightly lower, is at least 12 feet of sub-angular Oolite Gravel, capped with one foot of surface soil, in which are N.D. Pebbles.

In this district, there is a great quantity of Flints, some very small, having a chipped appearance, and occurring irregularly in places; from their abundance they form quite a coating on the surface of the land; and a stranger ignorant of the locality would be under the impression that he was in a cretaceous country. The large Flints are deeper in the soil, and when dug up, shew a white chalky covering.

Alternations of Oolite, Flints and N.D. Gravel prevail to a great extent round Ditchford, and even where there are Oolite Gravel pits, the surface soil has generally in it N.D. When draining on the Compton Scorpion side of Stretton-on-Foss, Mr. FLETCHER cut through a large mass of drifted comminuted Chalk, of the depth of 10 feet, with very little Flint, but it did not extend far. Near to Barton-on-the-Heath is a pit of 7 feet of Quartzose Sand, and about half-a-mile from there on the old road leading to Moreton, there is another pit of 12 feet of Gravel, and some Quartzose Sand, with very large Flints, like those at Aston Magna, and pieces of hard Chalk of considerable size, Greenstone, Millstone Grit, White Quartz, Permian, Lias, and some Gryphites.

In a perfectly flat field called "The Poor Lots," about half-a-mile out of Moreton, on the road leading to the "Four-shire Stone," there is a very large pit shewing 1ft. 6in. of sandy soil, with N.D. Pebbles, and 8 feet of drift, of which at least one-third is composed of *large* Flints, and as will be seen in the section, many of the Pebbles are vertical,* shewing lateral pressure—one which I measured was 8 inches in length.



* Mr. BOYD DAWKINS, in an article (in the *Quarterly Journal* of May, 1867) "On Age of the Lower Brick Earths of the Thames Valley," in describing a section at Uphall Pit, south side, No. 5, says, "There is one point deserving attention in this bed; the long axes of the Pebbles are in the main vertical, instead of occupying the horizontal position of those which have been deposited by water." He also states, "is proved beyond all doubt to be of glacial origin —to have been carried down by the ice and deposited, on its melting, upon the eroded top of fluviatile deposits below."

There is mixed up in the pit a considerable quantity of a ferruginous, tenacious, clayey soil, which when dry forms a loam, and although the Gravel rests on Lower Lias, there is no trace in it of that formation; the Pebbles are very large, not many of Quartz, and the Gravel extends for a considerable distance, becoming, however, much thinner as you approach "The Four-shire Stone," near which, in a field by the side of the road I found Stigmaria, amygdaloidal Greenstone, Chalcedony, Agate, metamorphosed Slate, and saccharoid Millstone Grit, but not much Quartz. Height 415 feet.

At Daylesford, about 15 feet below the Ordnance "Bench mark" at the church, there is a pit 12 feet deep, consisting of rather more than half Flints, and the remainder N.D., with no Oolite Gravel, and the same Gravel occurs in considerable quantities at Addlestrop, in Sir John Reed's Park, and the N.D. extends to Stow-on-the-Wold, diminishing in thickness as the latter place is approached.

On the way to Oakham Farm above Little Compton, at an elevation of 555 feet N.D. occurs, and also at the junction of the road near the 76th milestone, south of Long Compton, looking towards that village, at an elevation of 730 feet; and on the high ground leading to Whichford, at a height of 731 feet; at the junction of the road leading to Chapel-house at 721 feet; near the Workhouse at Chipping Norton at 716 feet. These places, and at Stow-on-the-Wold are the highest points at which I have met with N.D. on the Cotteswold range.

From Chipping Norton, after leaving the road to the railway junction, on the way to Bruern Abbey, about quarter-of-a-mile below Churchhill Heath Farm, is a pit 10 feet deep, containing large N.D. Pebbles, a few Flints, a little White Chalk, one piece, probably Red (Chalk,) some large White Quartz, a little Oolite and Marlstone, the Sand very Quartzose.

After crossing the railway and passing Bruern Abbey, at a distance of three-quarters of a mile, at a point called Bruern Wood (in the Geological Surveys Sheet, 44) where boulders of Millstone Grit are said to occur, there is a great quantity of Gravel thickly scattered over the surface of the fields adjoining

the wood; it is mainly of White Quartz, with few Flints, and some Oolite. Many of the Pebbles were 3lbs. in weight, but could hardly be called boulders, and a man who had lived in the neighbourhood for some years, told me that he had never seen any larger than those now on the surface of the ground.

Leaving Chipping Norton, and taking the high road to Shipton Station, N.D. Pebbles are very sparsely strewed; occasionally a bit of Flint may be found, but on descending the hill, near the Station, the Gravel becomes abundant.

To complete the Valley work it will be necessary here to proceed rather more than a mile along the railway to Ascott, where, near the Mill, there is a cutting on the line, 20 to 25 feet above the Evenlode, (at an elevation of 286 feet at level of rails,) and which is composed of N.D., with much sand. In the same field which the railway severs, a great deal of Gravel was obtained for ballasting, and Mr. Taunton, a Member of our Club, who was the engineer, informed me that many large boulders were found in the cutting, which, at his suggestion, the contractor broke up and used in the construction of the bridge, which here crosses the railway. On examination I found them to be Lower Lias. Numerous Mammalian remains were discovered in the Gravel, but were given away for the most part to persons who have since left the neighbourhood, and therefore I have not been able to make a record of them.

Mr. Hull, who is generally accurate, has committed an error in his Memoirs of Sheet 44, by stating that the Mammalian remains were found in the local Oolitic detritus, instead of which, they occured in the N.D. Gravel.

Above Ascott is the high ground of Wychwood Forest, rising to an elevation of about 270 feet greater than the Ascott cutting, and in which N.D. is found. The forest here is a series of Coombes which seem to have been formed by Meteoric abrasion.

The Church at Leafield, from its position, is quite a landmark for some miles round, and is of great assistance to those who are studying the physical aspect of the country, especially when they are near Stow.

From Shipton to Burford the N.D. is met with on Shipton Downs in considerable quantity, attaining an elevation of 614 feet. At Burford and round Taynton it is well scattered over the surface, and is to be seen along the ridge of high ground as far as Stow-on-the-Wold.

Near Bourton-on-the-Water, in a field adjoining the lane leading into the Stow road is a pit containing fully 7 feet of sub-angular Oolitic Gravel, in which the remains of an Elephant were lately found, but of which I could only obtain a portion of a tusk. The ground presents here, as elsewhere, the appearance of a gentle rise with a plateau on the top, and the Gravel evidently extends for some distance.

Continuing along the lane after crossing the Stow road there is another pit of Oolitic Gravel, with some Marlstone. It is sub-angular, and 8 feet thick.

On the high ground above Bourton is N.D., but from thence to Northleach it was only after a diligent search that I was enabled to pick up some scattered pieces, and they were mostly square, or slightly rounded, Millstone Grit; and the same was the case from Burford to Northleach. I may here remark that in the Windrush Valley there is very little N.D. Gravel, and after leaving the main road to Great Barrington, and returning into it again at Windrush I found only one Pebble.

From Northleach, on the way to Cheltenham, a short distance beyond Hampnett, is N.D. but very sparsely scattered.

Taking Cirencester as the next starting point, at Siddington, on the way from there to Minety Station, is a pit of 6 feet of sub-angular Oolite, and at Wire Pool toll-bar, along the lane leading out of the main-road to Somerford, there is another pit of 5 feet of Oolite, and there is evidently a great quantity of Gravel of like character in this locality.

The first Chalk Flint I saw in this district was in a field after passing Cave Wood House, before joining the cross-roads leading to Minety Station.

On the road which branches off to the Station, a short distance from the seventh milestone from Cirencester, and just before

reaching the toll-bar, there are pits on either side of the road, entirely composed of Flints, some of which are much worn.

The ground from Cirencester to Minety and round that district is very flat. At Row Hill, in the parish of Leigh, 2½ miles before reaching Cricklade, is a pit composed of—

1ft. 0in.		Soil.
3 " 0 "		Flint mixed with Soil.
1 " 0 "		Fine Flint Gravel, resting on Oxford Clay.

I found here some small, much worn and partly rounded pieces of Stone, which on examination proved to be Millstone Grit, Micaceous Old Red, Quartz, Chert from Mountain Limestone, Jasper, etc., and I was informed that bones were sometimes found in the gravel as large as a man's thigh.

At Latton the Oolite Gravel is small, and is much used for garden walks, but at Down Ampney it is coarser.

At Maisey Hampton is a considerable quantity of Oolitic Gravel, in which occur large masses of crystallised Carbonate of Lime, from the Inferior Oolite, bored by *Lithodomi;* and around there, on the surface of the land, are the N.D. pebbles, which extend to Bibury.

1. It will I think be seen from the description I have given of the Gravels, and following the order in which I commenced —That on the Western side of the Severn the Gravel is Quartz, Millstone Grit, Coal Measures, Coarse Granite, Syenites, Flints, Greenstone, Gneiss, Chalk, etc.,* with the exception of a little Oolite at Highnam.

* As you approach May Hill and Malvern it is hardly met with. It occurs at the Green, near the former, a considerable valley intervening, at an elevation of 260 feet; and at Haffield, near the latter, at a height of 247 feet. There is a remarkable correspondence in the altitudes. At Glynch Mill, near Eastnor, the Gravel is 252 feet above the sea; at the Imperial Hotel, Malvern, 275, in both of which Mammalian remains have been found. There is, however, a great deal of sub-angular gravel and *débris*, the result, I believe, of meteoric abrasion found at the foot of the Malverns, and running up their flanks to a considerable elevation, which is a different character of gravel to that found near the Imperial Hotel.

2. That the same Gravel crosses the Severn, and meets the Oolitic Gravel, in a line not always continuous, extending from Saul Lodge, near Frampton-on-Severn, a little to the S.W. of the Map, to Gloucester (see section of pit at Kingsholm, the N.D. and Quartzose Sand being the lower) and on to the Gravel Hole pit, near Bredon's Norton; and this line seems to me to indicate the lowest level of the country at the time when the two Gravels met, *i.e.*, the Oolitic Gravels and those of the N.D.; and N.D. Pebbles are sometimes scattered in places over the surface of the soil, even where the Oolitic Gravel is underneath.

3. That Red Quartzose Sand, which is very abundant, breaks the line, and skirting Chosen Hill, runs up to and beyond Cheltenham, attaining near there a much higher elevation, (being at Ryeworth 262 feet above the sea,) thence as far as Alderton and the side of Bredon Hill, and it is rarely absent wherever the N.D. is met with.

4. That as the Cotteswolds are approached the Oolitic Gravel increases much in thickness, especially on their flanks.

5. That in the Vales of Shipston, Moreton, and Evenlode, the Gravel is in greater quantity, mostly of the same Quartzose character, much coarser, with more Flints and Chalk; but the nearer the Cotteswold Range is approached, the more Oolitic the Gravel becomes.

6. That at an elevation of 15 to 40 feet above the existing rivers, Gravel is found in considerable abundance, rising gently from the Alluvium, forming table-lands, and flats, and terraces, rarely, however, exceeding 8 to 10 feet in thickness, in which Mammalian remains, marine, land, and freshwater Shells occur.

7. That at an increased altitude of about 40 feet other terraces of Gravel are met with, presenting the same character as the last.

8. That at a further elevation of about 80 feet there is another similar terrace, being the highest point at which Mammalian remains have been found.

9. That above the Gravel where the last Mammalian remains

are first met with, the drift which occurs at from 350 to 420 feet above the sea-level is of great extent, and very varied in character; but perhaps the greatest thickness of drift is at, and near, the Mickleton Tunnel, the summit of which is at an elevation of about 490 feet.

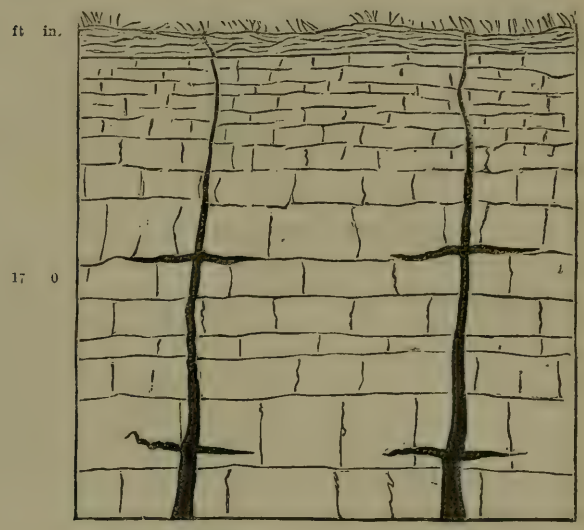
10. That at Batsford, and Compton Scorpion, on either side of the valley near Ebrington, there appears to be a clearly defined line of Gravel running up to the Marlstone terrace, and reaching an altitude of 605 to 612 feet.

11. That the highest ground where the N.D. Pebbles are found, is at an elevation about 700 to 750 feet—at Stow; near the 76th milestone from London south of Long Compton, and looking towards that village; near to Chipping Norton; and on the road leading to Whichford.

From the presence of N.D. Gravel in the neighbourhood of Stow, above Long Compton, Whichford, and Chipping Norton, I was anxious to ascertain how far it extended over the entire Cotteswold range. The *red* marks on the map shew it at Northleach, Bibury, the neighbourhood of Cirencester, and a more diligent search would doubtless diminish the part left *white*, as we know that it is traced to the S.W., just beyond the point the map takes in; and I am indebted to Mr. G. Playne, of Nailsworth, who has enabled me to continue it considerably further to the S. for some Quartz Pebbles, which were found at a height of about 700 feet, in the clayey partings in a great Oolite quarry at Woodchester Park Farm, near Nympsfield, which the section on the next page represents.

The following sketch of the quarry was made for me by Mr. Playne. The quarryman from whom Mr. Playne obtained the Pebbles informed him "in only one parting were they found, and they were stuck all over the Clay, that is to say, when the stone was removed from one side of the seam of Clay, the Pebbles appeared scattered over the vertical side of the seam exposed to view." When I visited the quarry with Mr. Playne, we failed to find any, but the partings, or openings, reminded me much of the cylindrical perforations in Calcareous Strata, referred to, and explained so ably by Mr. Prestwich, as being

owing to the action of carbonic acid, held in water, gradually percolating, eroding, and forming openings or fissures.*



When Mr. Playne mentioned the finding of the Quartz Pebbles to the late Mr. John Morton, author of "Morton on

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* I have since visited the Quarry with the Cotteswold Club, and subsequently with Mr. Etheridge, and on both occasions found several Quartz Pebbles, and not confined to one opening in the clayey partings. These fissures or openings seem to be general in Oolitic quarries, and it is singular that near Cirencester the openings or joints, like those at Woodchester, strike north and south. I am indebted to Professor Church, of the Cirencester College, for the following analyses of the clay taken out of the quarries referred to :—

I.—Clay from fissures in Oolite, Stroud Road, near Royal Agricultural College, Dark Purplish Brown. Sectile, *Saponaceous.*

Organic Matter and Water of Combination	11·43	per cent.
Silica	53·95	"
Alumina and Oxide of Iron	31·88	"
Carbonate of Lime...	1·95	"
Carbonate of Magnesia...	·75	"
	99·96	

With traces of Chlorine, Sulphuric Acid, and Alkalies, and some Manganese.

Soils," the latter told him of having found a bed of Quartzose Sand between Buckholt Gate and Frocester Hill, in sufficient quantity to be carted away to improve the soil of the beds in the garden at Woodchester Park.

The height where the Sand was discovered, Mr. PLAYNE estimated at 750 feet.

I think, therefore, it is evident that there are remains of this drift over a considerable portion of the hills up to 750 feet, and it is clear that it could only have been deposited when the Cotteswolds were submerged.

Although the Pebbles are very sparsely scattered, and I noted carefully that where there was scarcely any soil they were rarely found, still what are now left can hardly be considered a measure of the quantity of drift which prevailed at the time of their deposition, and it appears to me evident that the flat table-land of the Cotteswolds is mainly attributable to the denuding power of forces that brought the Pebbles there, most of which were swept away at the time, and which planed off the surface of the ground.

It is an interesting question, but one extremely difficult to determine, what was the thickness of the formation that capped the Inferior Oolite of the western escarpment of the Oolitic range, and how far the Chalk extended westward, immediately prior to the setting in of the Glacial epoch.

We must remember that we are contemplating a period when the physical geography of England was far different to what it is now, and there is but little doubt that in forming an opinion of the then condition of the country, we must consider

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II.—Clay first received from Woodchester, September, 1869. Drier, more Fissured, less sectile, less soapy than No. 1.

Organic Matter and Water of Combination	5·65		per cent.
Silica	70·50		"
Alumina	10·38	19·11	"
Oxide of Iron	8·73		
Carbonate of Lime...	2·67		"
Carbonate of Magnesia...	1·11		"
	92·04		

the probability of how far the Oolite extended to the westward, and fortunately we have some evidence left to guide us, as it occurs on the outliers of Robins Wood Hill;* Oxenton, Bredon, and extending to Meon, clearly proving that the Valley now intervening between those outliers, and the main hills, was once conterminous.

The only point at present where I have met with Oolitic Gravel west of the Severn, is at Highnam, and there it has more the appearance of having been carried in by an eddy, probably from somewhere near; but still there is, I think, every reason to believe that at the period when the N.D. Pebbles were left on the Cotteswolds, the Oolite covered over the New Red, extending probably to May Hill and Malvern, which hills had not then assumed their present rounded appearance, their flanks coming further eastward. Professor Ramsay (143)† seems to be of opinion that the Valley of the Severn existed before the Glacial epoch, because Boulder and Boulder Drift are found as far as Tewkesbury, and therefore before the Glacial epoch this part of the Severn ran very much in the same course as it does at present.

"Then," he says, "the country sank beneath the sea, and Plinlimmon itself (where the river rises) was buried in part, or possibly altogether, beneath the waters. When the country again emerged, the old system of river drainage in that area was resumed, and the Severn, following in the main its old course, cut a channel for itself through the boulder Clay, that partially blocked up the original valley through which it ran. But when *that* original valley was formed through which the older Severn ran, no man can yet say, although England, having probably been above the sea during greater part, or perhaps the whole of the undoubted part of the Miocene epoch, it is likely that some of our great contours were then first begun; or if not begun, carried on and very seriously modified."

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* Chosen is capped with the *Communis* zone of the Upper Lias, the Oolite being denuded.

† "Physical Geology and Geography of Great Britain."

From the circumstance that no large Boulders or Boulder Clay * have been found on the high ground of the Cotteswold Hills, and that the former are only met with in the Valleys, increasing in size and number as you proceed northward in the Severn's course, it would appear to follow from Professor RAMSAY, that the denudation of the Cotteswolds took place prior to the Glacial Epoch: but such, I think, was not the case, and I am inclined to refer the time to an early part of the Glacial period.†

The presence of fragments of Millstone Grit, Quartzose Pebbles, and the apparent absence of Cretaceous Flints from the height at which Gravel is first met with, down to about 100 feet, seem to indicate the transportation of the former, when the Chalk was not in a position in this part of the country to admit of being denuded, and brought to the higher plateaus of the Cotteswolds.

Afterwards the ground seems to have sunk further beneath the sea, and, as Mr. PAGE remarks, it was then, and during the period of its subsidence, that the high boulders were carried by floating ice far from their parent rocks, marking in a special manner the second period of the Glacial epoch, and this period in the district we have under our consideration, would, I think, embrace the country from the coming in of the Cretaceous Flints down to nearly the time of the High Level Gravel.

In visiting the Shipston and Evenlode Valleys, I was much impressed with the distinct evidence of the action of ice in all its varied forms of berg, land, and sheet; of the vast mantle of frozen snow and ice which, as it appeared to me, must once have lined the tops and sides of the hills, carrying down with it, when the summer thaws set in, the materials upon which it rested; and it was in consequence of my observations there, that I have

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* Unless the clay found in the partings of the Oolite quarries on the Cotteswold, more particularly at Woodchester, where the Quartz Pebbles occur, belongs to the latter.

† The extent of the denudation of the Cotteswolds was so great as to lead so acute an observer as Dr. BUCKLAND to attribute it to a vast diluvial wave caused by the Noachian Deluge.

quoted so largely from Mr. GAVEY's paper on the Mickleton tunnel and Aston Magna,* wherein he shows how much the character of the Gravel deposit varies within so limited an area, and which is now recognised as one of the characteristics of ice.

And now we arrive at that time when the water-shed was considerable, the hills being probably 600 to 700 feet above the sea; and according to Mr. PRESTWICH, the river action peculiar to each Valley commenced with the High Level Gravels, while the mass of *débris*, and the large blocks present in the beds, indicate the action of a large volume of water and ice transport.

The climate began to ameliorate as the Low Level Gravels were approached, and I incline to the belief that most of the terraces occurring in the same, are the result of fresh-water action, re-distributing and depositing the old *débris*, in the same way as we now see the alluvium formed in our Severn meadows, which, to those who have not studied what is taking place, would appear incredible.†

And now, probably, a further depression occurred, which brought the sea far into the Valleys, and by tidal action, planed off the surface of the Lias, as there is no agent which will give an uninterrupted level except the sea. I am led to

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* This paper was written many years ago, and before the ice theory was recognised.

† Mr. JOHN JONES, in his very valuable paper in our Procedings "On the Geology of the Sharpness Point District," gives the following letter from Mr. CLEGRAM, showing the great change in the deposition of sand by the action of the Severn:

"The sub-contractor of the canal between the Cambridge Arm and Purton, tells me that he retains a distinct recollection of the excavation for the foundation of the bridge walls and platform at the Shepherd's Patch, which is now a mile and a quarter distant from the Severn, and that at a depth of from 15 to 16 feet below the present surface of the meadows, which are called the 'New Grounds,' they came to the old river mud, upon which were the footmarks of sheep and cattle, as distinct and sharply defined as though they had been made the day before, extending over a considerable area. These marks were filled up with pure, clean sand and mud, sometimes in separate deposits, sometimes mingled together. The mud excavated and exposed to the action of the air, dried and divided into laminæ about the eighth of an inch in thickness, showing the quiet tidal process." The work referred to was executed thirty-nine years ago.

believe that such was the case, because in my examinations I have almost invariably seen that the Lower river Gravels rest upon an even surface; then it was that the Marine Shells which have been found were deposited, an upheaval of the land subsequently took place, and river action again began its work on the Upper Gravels, forming the Lower Mammalian Drift.

In correlating the Gravels of the Severn with those of other rivers in the kingdom, it is necessary to bear in mind that there is every reason to believe the same large amount of tidal action, which is now so marked in the Severn estuary, formerly existed, and which may account for some of the differences that appear in these Gravels compared with the Thames and some other rivers. The tide at Chepstow sometimes rises 48 feet; at the London Docks the average range is about 22, Liverpool 15, Portsmouth and Plymouth 12, Bristol 33.

The small sub-angular Oolitic Gravel which Mr. Hull considers to be the remains of raised sea beaches, occurs in parts of the Cotteswold range, always presenting the same character.

It is met with at Standish, following the Coombe to Stocken, opposite the Horsepools, at Cooper's Hill, Crickley, and Leckhampton; and it is generally found at the foot of the Inferior Oolite, or resting upon the Upper Lias Sands, (sometimes, as at Leckhampton and Nailsworth, on coarse sub-angular Oolite,) in all cases running up to a point where the Coombe is at a considerable angle. It is composed of the Freestone of the Inferior Oolite, without any Fossils or even recent Shells, and my impression is certainly opposed to the opinion that it is a raised sea-beach; I believe it to be attributable to frozen snow or land ice, which, when the thaw set in, would slip down, carrying with it the *detritus* of the Freestone, and is of the age when the climate had become comparatively mild. The elevation varies from 500 to 700 feet, but at Longford, near Nailsworth, it is only 300; and, indeed, similar Gravel of yellower colour is found in the holes or hollows on Cleeve Hill, at an elevation of at least 900 feet.

To suppose that the several beds are raised sea-beaches, we must account for the absence of marine Shells, and admit that

very little change has taken place in our climate since the surface of the country was raised some 700 feet.

It is quite clear that no Gravel, of the soft perishable kind derived from that part of the Cotteswold Hills, could have endured the variable changes arising from ice, frost, and snow, without being converted into Sand; or indeed, could have resisted the action of sea-water without being reduced to a fine mud.

Boulders. Although they occur so abundantly in the upper part of the Severn in Shropshire, they are rarely met with now in the district we have under consideration. The nearest point to Gloucester at which I have seen any is Limbury, where small angular pieces of Silurian rock occur. At Haffield, flanking the eastern end of the Malvern range, in some Gravel associated with Boulder Clay, are some large angular masses of Silurian rocks; and also on Holly-bush Common, near Little Malvern, where the contour of the ground clearly indicates an old moraine, and where I found striated and polished rocks from many formations—Gneiss, Granite, Quartz, Greenstone, —and further to the S.E., at an increased elevation, in a lane leading into the Gloucester road, at the Hollybush Pass, part of the original surface of the rocks, forming the mass of the Malvern range on the East, is seen surrounded by a large accumulation of sub-angular Gravel, composed entirely of decomposed Trap. The exposed surface of this rock exhibited a face of 2 feet by 20 inches, upon which we found no less than nine grooves or striations, all in one direction (55 S.S.E.) Two or three pieces of equally well striated rock were collected in the same *débris.** At the corner of a street in Upton-on-Severn is a piece of fine grained Quartzite, of considerable size and very hard, and an old inhabitant told the Rev. W. S. Symonds he had seen similar blocks, which have since been broken up. At Lower Lemington is a large striated boulder of carboniferous Limestone; and by the side of the road, in the village of Great

* From observations I have subsequently made during a short stay at Malvern, I think it not improbable that there is evidence to be met with there pointing to an older glacial action than that which forms the subject of this paper.

Woolford, there is an angular block of Greenstone, weighing at least 4 cwt.; and near to Blackdown, is another of Greenstone, which was dug out of a field in draining; and moderately sized pieces of the same kind of rock are also found in many of the Gravel pits. At Cropthorne and Pershore I saw some, and along the Ridgeway they also occur, but not of large size; near to Weston Park I found a large boulder of Millstone Grit.*

Having frequently, in my investigations, heard of boulders which are not now to be found, I believe they have, within the last few years, been extensively used for road making. Even in the Vale of Moreton, where Mr. Hull mentions in his Memoirs they "are by no means rarely scattered over," many have disappeared.

Should my view be correct that the same additional tidal action formerly prevailed, which now exists in the Severn, as compared with other rivers in England, it is not improbable that the Boulders and Boulder Clay, so extensive in other parts of the kingdom, may have been mostly removed from the neighbourhood of Gloucester, (where the effect of the tide must have been great, and the extent of denudation large, as is shown by the great width of the valley,) during the submergence that brought the marine Shells, which are found in the Gravels of the Severn, and in the subsequent upheaval of the land.

Whence Pebbles forming Gravel are derived. So varied are they that Dr. Buckland, quoting from the Rev. W. B. Conybeare, says, "That it would not be difficult in the Valley

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* Mr. Robert Tomes informes me that near Dorsington, at Uddewell, was a large block of Sussex Marble, containing Paludina and other characteristic Purbeck Shells, which, when taken up and broken for road material, made by measurement, eight tons. This stone was close to a fine spring, forming a well, supplying the village. The tradition held by the villagers is that the devil kicked it from the top of Meon Hill, at Bidford Church, but falling half way, it became embedded by the side of the spring. It is supposed to be a Roman well—Dorsington is derived from the Latin, Dorsum, a back or ridge, and so signifying a village thus situated.

As Purbeck Marble was at one time extensively used for churches I am disposed to think this was not a boulder, and yet it seems improbable it should have been left in such a position.

of Shipston-on-Stour, to form almost a complete Geological series of English rocks from among the rounded fragments which often occur in boulders of very considerable size." He makes a similar remark of the country west of Market Harborough.

The source, however, of many of the rounded Brown Quartzite Pebbles, appears to be from the Conglomerate beds of the New Red, and the White Quartz is from the Lickey and the Wrekin. The carboniferous Limestone is probably from Derbyshire, also the Coal-measure Sandstones. Some of the Syenite from Charnwood, and the coarse Granite resembles that found in Cumberland and Scotland.

The great quantity of Quartzose Sand, occurring at nearly all elevations, is clearly derived from the New Red, and on reference to the maps of the Geological Survey of England, it will be seen how much that formation, even now, surrounds and forms part of the district we have under investigation, and how enormously it must have been denuded.

My impression is that the N.D. Pebbles, which are now found on the upper part of the Cotteswolds, are probably of the same age as those which cap in such abundance the higher ground of the Lickey.*

The evidence of Water Action. There are no boulders on the high grounds of the Cotteswolds where the N.D. Drift Pebbles are first found, and as I have before remarked, in fields where there is hardly any Soil there are few, if any, Pebbles, indicating a considerable amount of water action; and in a conversation I had with Mr. Thomas Brown, of Barton, Cirencester, one of the oldest Geologists of our hills, he told me he had observed the same characteristic in his own neighbourhood.

After the upheaval of the land which left the higher plateau of the Cotteswolds dry, and down to the level I have indicated of the coming in of the Flints, some great transporting agent seems to have prevailed, bringing with it, from a considerable

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* When at the latter, a few days since, I found *Cornulites serpularius* from the Wenlock beds.

distance, large boulders. Mr. MAW mentions in his admirable paper in the *Quarterly Journal of the Geological Society*, May, 1864, "On the drift Deposits of the valley of the Severn in the neighbourhood of Coalbrook Dale and Bridgnorth," that erratic N.D. blocks occur more abundantly at altitudes of 400 to 800 feet in the Shrewsbury district than in the Valleys, which is also the case south-west of Bridgnorth, in the direction of Wolverhampton, and at Burton, 3½ miles west of Much Wenlock, blocks of Grey Granite are most abundant, extending 700 to 800 feet above the sea.

At Mickleton Tunnel, in the neigbourhood of Moreton-in-the-Marsh, the varied character of the Gravel—in a short distance, large patches of White Chalk and Flints of considerable size being met with—seem to indicate the presence of icebergs in that locality, as well as land-ice. It is not however improbable that the masses of cretaceous Flint may have been brought and dropped on the slopes of the hills, and afterwards carried down into the valleys by the land-ice.

There is less evidence left of direct powerful water action above the Alluvium than is generally supposed. The Sands which are interspersed with the Gravels and occur so largely, still preserve the same character as when met with in the New Red, from which they are clearly derived. The Fossils found in the Gravels are either derived from, or near the beds upon which they repose. My friend Mr. ROBERT TOMES informs me that he found the Corals in the Gravel at Leamington were from Fenny Compton; those at Welford from the *Hippopodium* bed, probably of Honeybourne, and at Fladbury they were from the ridge of Lias at Chadbury; and Mr. GAVEY mentions how the cuttings north and south of Aston Magna differ materially from each other. These facts appear to me to be incompatible with the theory of a strong fluviatile action occurring at the deposition of the Gravel, or even subsequently.

There is also no accumulation of the fine silt which is now being deposited by the Severn and the other rivers we have under consideration, although, as I have before stated, it is probable that some of the Boulder Clay may have been removed

when the subsidence of the land took place and tidal action was a work in our valleys, at the period of the low level or terrace gravels.

The Submerged Forest Beds. These beds, which are met with in the estuaries of most of our rivers that empty themselves into the sea, occur in the Bristol Channel, and have been well described by Mr. Godwin Austin in the *Quarterly Journal of the Geological Society of London,* for November, 1865, on the "Submerged Forest Beds of Porlock Bay," and I have ascertained they extend from below the entrance of the Gloucester and Berkeley Canal at Sharpness, up to Gloucester.

On either side of the Royal Drough, at a depth of about 16 feet, is a bed of Peat 6 feet thick, containing Oak, Hazle, Beech, Waterflags, and some large trunks of trees; and my friend Mr. Clegram informs me that a large piece of Oak was taken out, having on its surface evident marks of fire.

I have now in my possession part of the skull of a *Bos primigenius,* with very fine horns attached, which was dragged out of the peat-bed between the Royal Drough and Purton, some years ago. After heavy tides in this part of the river, trees often come to the surface, and Mr. Clegram, in making recent borings for the contemplated new entrance of the canal at Holy Hazle Pill, found peat and trees some distance from the shore.

A few miles higher up the Severn at Epney and Framilode, not far from the river bank, the following is a general section, in descending order:—9 feet of Alluvium, 3 feet of Clay, 12 feet of Peat, 3 feet of strong Blue Clay, and 3 feet of N.D. Gravel and Sand, resting on Lower Lias.

In the meadows at a distance of half-a-mile from the river where draining has been done, Mr. Hawkins who resides in the neighbourhood, and is a very close and accurate observer, informed me that there is, first: 1 foot of Vegetable Mould, then 2 feet of Clay and 10 feet of Peat reposing on Lower Lias. The Peat occurs at Whitminster, and also at Hardwicke, gradually becoming less as we approach Gloucester.

The Rev. P. B. Brodie has given in the first vol. of the

Transactions of the Cotteswold Club, page 245, the following section from borings made by the Gloucester and Chepstow Railway Company, at Over Bridge, Gloucester, which he obtained from Mr. EDWARDS, one of the engineers:—

Soil	1ft.	0in.
Sand and Red Clay	10 "	8 "
Light Blue Clay	13 "	9 "
Peat	2 "	0 "
Red Sandy Clay	4 "	0 "
Brown Sand	1 "	10 "
Rough Gravel	7 "	8 "
Sand and Gravel	2 "	0 "
Fine Gravel	5 "	10 "
Hard Blue Marl	2 "	3 "
	51 "	0 "

Mr. JONES was, I believe, the first to call attention to the Submerged Forests, at the Royal Drough, in his valuable paper on the "Sharpness Point District," published in the third vol. of the Transactions of the Club, and I am indebted to him for the following note:—"As Submerged Forests are generally made known to us by the exposure of their trunks and contents by the action of the sea, may we not infer that their submergence must have been of a more sudden character than that exhibited in most geological operations. For example, we see that such fruits as Hazle nuts and the like, reeds, grasses, iris leaves, &c., were not washed away or decomposed during the submerging operation, but when once exposed again, crumble and decay in very brief time. The fact of their occurring upon the shore, *i.e.* the lowest point of erosion indicates that the upheaval has been slower than the submergence."

Mr. GODWIN-AUSTIN observes in his paper that "The greatest depth at which Submerged land-surface has been ascertained is about 120 feet; a rise of such amount would place the *whole* of the Bristol Channel in the condition of dry land, and such probably it was at the time of the forest growths;" and Sir CHARLES LYELL states,* "There is good reason to believe that

* "Principles of Geology," vol. i., p. 545.

Note.—The position of the Forest-bed in the Humber is given in Messrs. Wood and Rome's paper, p. 182, of the "*Quarterly Journal of the Geological Society*," for May, 1868.

there was once a woodland tract uniting Somersetshire and Wales, through the middle of which the ancient Severn flowed;" and in estimating the age of the Peat deposits, he says at page 546, "If, therefore, all the littoral sunk forests of the South and West of England are referable to about the same geological period, the occasional presence in them of Mammoth will entitle them to be regarded as very ancient, or of a date intervening between the era of the lake-dwellings and that of the oldest epoch to which man has yet been traced."

Although the Forest Beds, at Holy Hazle Pill, are probably nearer the surface than those described lower down the Channel at Porlock, by Mr. Godwin-Austin, (and even they are to be seen at low-water,) there is, I think, every reason to believe they are a continuation of them, and are therefore of the same age, and the difference in level is attributable to their being more inland.

*Altitudes.**—To describe all the heights given would require a paper on the subject, and for the present, I shall merely observe, that by reference to the map, it will be seen the valleys of the Severn and Avon are almost level, with outliers rising out of them, and that a depression of 50 feet would cause the tide to flow far inland, and cover a large area with water. The height at the Bell Inn, Frampton-on-Severn, a little to the S.W. of the map, is 35 feet above the sea-level; at the Mariner's Chapel, at Gloucester, 39 feet; at Coomb Hill, at the Lock, at the entrance of the Severn, 30 feet; at Tewkesbury Church, 48 feet, but at the bridge over the river there, 38 feet; Upton-on-Severn Church, 51 feet; whilst on top of battlement of the Small bridge, 3·57 feet above the centre of the road it is 43 feet; and at the top of centre pier of Barbourne bridge, Worcester, 0·16 feet above the centre of the road, the height is 54 feet.

The bench-mark at Bristol Cathedral shows an elevation of 63 feet; at Gloucester Cathedral, 57 feet, and at Worcester Cathedral, 87 feet.

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* *See* Appendix. I am much indebted to Captain James, of the Trigonoical Survey, for many of the heights given therein.

The highest point of the Cotteswold Hills is at the race-course, at Cleeve, and is 1,093 feet; from there the ground falls on the S.W. continuously; but on the N.E. only for a short distance, when it again rises until it reaches, at Broadway tower, 1,030 feet. By reference to the map the rise from the Severn valley to the hills is well shown, beginning at Coombe Hill, where it is 30 feet above the sea; in the High Street, at Cheltenham, 194 feet; the west angle of the new church, at Charlton Kings, 264, feet; Dowdeswell tollgate, 350; Sandywell Park, 698 feet; the ground then falls to 548 feet at Andoversford and it afterwards gradually rises until at Pewsdown tollbar it attains a height of 824 feet, and falls from there to Northleach to 557 feet.

There is a very close correspondence in the height of the outlier of Bredon with some other points of the main hills of the Cotteswold, as will be noticed in the following table:—

Bredon	975ft.
Leckhampton	978 „
Near Birdlip	955 „
Painswick Beacon	929 „
Broadway Tower	1031 „

I am indebted to Mr. Boyd Dawkins for part of the following list of Mammalian remains:*

Elephas primigenius	Gravel, Malvern Hills. Jermyn St. Museum.
Hippopotamus Major... ..	Defford, Eckington.
Rhinoceros tichorhinus ...	
Elephas antiquus	
Cervus elephus	

* In a note to me he says, "There is one point in connection with the Severn Valley that you may care to know. From my tabulated list of post-glacial Mammalian remains I have inferred that during the post-glacial epoch the hills of Wales were covered with glaciers, as those of Scotland undoubtedly were. The latter country, indeed, was partially covered with a sheet of ice like that of Greenland. Glaciers in Wales being granted, the occurrence of post-glacial mammals in glacial gravels is what might be expected."

Hippopotamus major	Cropthorne-on-Avon.
Urus [*Bos*] *primigenius* ...	
Rhinoceros tichorhinus ...	"Wyre," near Pershore.
Ovibos moschatus	Oolitic Drift, Barnwood.
Rhinoceros tichorhinus ...	Oolitic Drift, Barnwood, and
Elephas primigenius	Oolitic and N.D., Gloucester.
Elephas primigenius	Oolitic Gravel, Gannicox
Bos primigenius	Pit, Stroud.
Rhinoceros tichorhinus ...	
Cervus tarandus	
Bos bison [*primigenius*?] ...	Gravel, Beckford, eastern
Cervus tarandus	side of Bredon Hill,
Elephas primigenius	Gloucestershire.
Sus ferus	
Rhinoceros tichorhinus ...	
Equus [*two teeth*]	Glacial Gravel, High Lugwardine, Herefordshire.

WORCESTER MUSEUM.

Elephas primigenius	Fladbury.
Equus	
Rhinoceros tichorhinus ...	
Cervus tarandus	
Bos bison	
Hippopotamus major	Little Comberton Gravel.
Equus	
Elephas primigenius	Eckington.
Hippopotamus major	
Cervus tarandus	
Cervus elephus	
Elephas primigenius	Bromwich Hill.
Rhinoceros tichorhinus ...	
Cervus elephus	Chadbury.
Rhinoceros tichorhinus ...	Gloucester.

Elephas primigenius	Stratford and Shottery, in the late R. B. WHEELER'S Collection, in the Stratford Museum.
Elephas	Luddington and Alveston, near Stratford-on-Avon; authority, — Mr. J. W. KIRSHAW.
Elephas	Ascott
Elephas	Drift Stour, near Alderminster, tusk and teeth, Mr. J. W. KIRSHAW.
Elephas	Tusk, from near Bourton-on-the-Water.
Elephas primigenius	Upton - on - Severn, two molar teeth, authority the Rev. W. S. SYMONDS.
Elephas primigenius ... ... *Rhinoceros*	Pull Court; authority Rev. W. S. SYMONDS.

These Mammalian remains occur at heights varying from 40 to 300 feet above the sea, and where they are met with in the Gravels of the Severn, Avon, Stour, and Evenlode, they occupy a different elevation as they may be nearer or more remote from the sea; and in correlating them, a careful examination, I believe, will shew that the position to be assigned in time is not altitude above the *sea*, but above that of the existing *rivers*.

The Gravels I have described clearly, I think, dispose of (at least to my mind) the view which is sometimes taken that most of the changes of our valleys have been brought about by alteration of sea level and not by that of land.

I mentioned at the commencement of the paper that to complete the subject it would still take me some months, as there are several points of considerable interest and importance which require to be dwelt upon more fully, and I am deeply sensible of how imperfect this communication is; but I was

anxious no longer to occupy ground which other Members, more competent than I am, were generously conceding to me.

The period we have been considering is one of the last of the many great changes which have taken place on this Globe of ours, and the British Islands * in particular. It bears upon it the same marks of the greatness and beneficence of the Creator as those which have preceded it throughout all time. In contemplating the Coal formation we recognize the wisdom of the arrangement which stored up the sun's heat for ages, to be afterwards given out for man's benefit; yet who would think that the Pebbles and Sand we have had under our consideration, more particularly the latter, have contributed, and in no small degree, to make the land fertile, and therefore to enable us to supply ourselves more readily with the great necessaries of life?

In my researches, when investigating the changes which have taken place in our hills and valleys, and when contemplating how varied must have been the physical aspect of the country at different times, often have the words of the Poet Laureate been present to my mind:

> There rolls the deep, where grew the tree,
> O earth what changes hast thou seen!
> There where the long street roars, hath been
> The *stillness* of the central sea.
>
> The hills are shadows, and they flow
> From form to form and nothing stands;
> They melt like mists, the solid lands,
> Like clouds they shape themselves and go.

Permit me to close these remarks with my humble testimony in favour of the study of the Natural and Physical Sciences, and to express a few thoughts which have occurred to me during the progress of these investigations. When I have reflected upon the mind which God has given us—when I have seen that the great discoveries which have been made in science have

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* See Maps 39, 40, and 41, illustrating successive Revolutions in Physical Geography during the Post-Pliocene Period, in Sir Charles Lyell's "Antiquity of Man."

tended to ameliorate the condition and increase the happiness of the human race, in what way, it has occurred to me, should our faculties be applied in obtaining further knowledge? I answer, by a more diligent study of His works, which when conducted in a reverential spirit, must, in the very nature of things, reveal more fully His power and great goodness, and lead us to a deeper sense of humility and thankfulness. What a vast field the student of nature has before him, and how great and wonderful those works are, we may gather from the words of the Psalmist, "O Lord, how manifold are thy works: in wisdom hast thou made them all; the earth is full of thy riches." And are we not also told that when by the creation of man, the great Maker of the Universe had completed His labors, "He saw every thing that He had made, and behold it was very good."

APPENDIX.

THE ALTITUDES AT SUNDRY PLACES,

From Ordnance Survey.

EXCEPT THOSE MARKED (*a*) WHICH ARE ANEROID.

Asterisks refer to places on the Map.

		Feet.
St. Mary's Church, Berkeley. Bolt in south end	1·9 ft. above surface	64·6
Slimbridge Church. Bolt in south face of tower	2·6 ft. ditto	49·1
Putlow Church. Bolt in west face of tower ..		36.6
St. Mary's Church, Hardwicke. Bolt in south face of tower,	1.7 ft. above surface	43·7
Haresfield Church. Bolt in west end of tower	1·1 ft. ditto	105·7
St. James's Church, Quedgley. Bolt in south-east side	2·1 ft. ditto	60·9
Pier Head, at junction of River Severn, with Gloucester and Berkeley Canal. Mark on top 19·05 ft. above bed of water in Canal, and 10·1 ft. above surface of water in Canal on the 8th of of January, 1849		36·7
Gloucester Gaol. Mark on face of stone at door	1·20 ft. above surface	36·8
Mariner's Chapel.	2·1 ft. ditto	39·8
* On corner of St. Michael's Church tower, Gloucester Cross	1·2 ft. ditto	66·1
Gloucester Lunatic Asylum. Mark on stone-work under iron railings in front	0·6 ft. ditto	89·
Mark on battlement of Over Bridge, 2·7 ft. below top of battlement		61·9
Bolt in Minsterworth Church tower	3·1 ft, ditto	34·3
Bolt in north-east corner of Newnham Church	4.4 ft. ditto	125·6
Westbury-on-Severn Church. Bolt in south-west corner, 2·5 ft. do.		36·
Awre Church. Bolt in tower	4·8 ft. ditto	71·
Worcester Cathedral. Bolt in stone under centre of window in north transept	4·4 ft. ditto	87·8
Great Malvern. Centre stone, 1·21 ft. below general surface		1394·6

		Feet.
Bolt in side of small door in north transept of Great Malvern Church	6·2 ft. above surface	431·7
Mark on flag-stone under gate of Lady Huntingdon's Chapel of Ease	0·5 ft. below centre of road	537·2
Mark on flagstone at door of Admiral Benbow Inn	0·2 ft. ditto	437·6
Mark on the fifth milestone from Upton-on-Severn and third from Great Malvern	0·3 ft. ditto	223·8
Bolt in south-west parapet of Stratford-on-Avon bridge, over the Avon	0·7 ft. above the surface	127·9
Clifford Chambers Church, bolt in buttress at north-west angle of tower	2·5 ft. above surface	136·1
Atherstone-upon-Stour Church, mark on south-west corner	2.2 ft. do.	141·4
Preston-upon-Stour Church, bolt in west side of tower	2·2 ft. ditto	205·2
Chipping Norton Church, bolt in south side of tower	3·9 ft. ditto	571.
Mark on south-west pier of gate, at north-west entrance to Union Workhouse, near Chipping Norton	0·7 ft. above surface	710·
Bolt in east corner of church tower of Cricklade Church	4.5 ft. ditto	298·1

	Above surface.	
* Bench mark on south-east entrance to Stow Church ...	1·1 ft.	768·8
* " on east end of Daylesford Church	2·1 "	395·5
* " on north end of the Cross-Hands Inn ...	1·5 "	744·3
* " on Four Shire Stone, at junction of roads ...	1·5 "	415·4
* " on north-east angle of Moreton Church ...	1·2 "	418·5
" on north-west angle of Bourton-on-the-Hill church tower	1·76 "	622·
* " on north-west angle of the Coach and Horses Inn	1·4 "	736·7
* " on third milestone from Moreton	1·1 "	806·4
* " on south-west angle of Broadway tower ...	1·2 "	1031·6
* " on gatepost west side of road...	1·7 "	897·6
* " on east angle of Stump's Cross toll-gate ...	1·2 "	811·9
* " on the fourth milestone from Stow	1·3 "	587·1

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* May Hill	966
* The Green (*a*)	260
* Limbury (*a*)	180
* Birth Hill (*a*)	180
* Gloucester Cross	66
* Robin's Wood Hill	652
* Painswick Camp	929
* Stroud Station	182
* Witcombe Reservoir (*a*)	276

	Feet.
* Birdlip	969
* Leckhampton	978
* Sandhurst Hill (*a*)	200
* Upton-on-Severn	51
* Pull Court Section (*a*)...	180
* Oxenton Hill	733
* Bredon Tower ... ... surface	975
* Cleeve (Cheltenham Race-course)	1093
* Mickleton Tunnel (*a*)	490
* Ebrington Hill (*a*)	750
Goose Hill (*a*)	527
* Blackdowns (*a*)	400
* Shipston-on-Stour	212
Wilmington (*a*)	372
* Brailes Hill (*a*)	607
* Little Woolford Heath (section *a*)	394
* " " " (*a*)	374
* Compton Scorpion (*a*)	612
* Batsford (*a*)	605

A List of Bench Marks, with their Altitudes, cut in the neighbourhoods of

GREAT ROLLRIGHT, SHIPTON AND UPTON.

	Feet.
Bench mark on corner of Long Compton toll-bar at Cross-roads, near King's Stones	727·2
* Bench mark on long stone at Druids' Temple, and on south side of road	737·4
Bench mark on rock, south side of road	712·9
" on stone 19 links north-east of road, and 133 links south of cross roads	677·4
Bench mark on north-west corner of New Cottage, east side of road, and about 76 chains south of Shipton Church	473·8
Bench mark on milestone at summit of bank 1·2 ft. above surface	614·9
" on cottage, at division of building, east side of road ...	605·5
" on Upton toll-gate, at junction of roads	489·1

List of Bench Marks along the roads to and in the Towns of Chipping Norton, Burford, Lechlade, Northleach, and Cheltenham.

CHIPPING NORTON TO BURFORD.

	Above surface.	Feet.
* Mark on corner of stables opposite the Chapel House Inn, at junction of roads	2·5 ft.	723·5

	Above surface.	Feet.
Mark on south-west pier of gate, at north-west entrance to Union Workhouse, near Chipping Norton	0·7 "	710·0
Mark on corner of the Three Tuns public-house, at north end of Chipping Norton	1·4 "	658·6
Mark on north-west corner of the Town-hall, Chipping Norton, ...	2·1 "	647·7
Bolt in south side of tower of Chipping Norton Church ...	3·9 "	571·
From mark on south-east corner of the Three Tuns Inn		658·6
Mark on north corner of cottage, west side of road	1·4 "	684·6
* Mark on the first milestone from Chipping Norton ...	1· "	691·
Mark on south-east corner of Seagrove Lodge	1·5 "	615·1
" the second milestone from Chipping Norton ...	1·1 "	655·9
" the third milestone from Chipping Norton ...	1· "	629·7
* " the fourth milestone from Chipping Norton ...	1·3 "	638·1
" the fifth milestone from Chipping Norton	1·1 "	519·
" east battlement of Railway bridge over cr. of arch	1·9 "	355·5
* " buttress at south-east angle of Shipton church ...	1·6 "	325·1
" north-west corner of new cottage, east side of road	1·5 "	473·7
* " milestone at summit of bank	1·2 "	614·9
" wooden post of gate, east side of road	1·2 "	571·4
" front of new cottage, west side of road	2· "	378·4
" south-west corner of the Carpenter's Arms ...	1·2 "	374·1
" south-west battlement of Burford bridge	1.3 "	339·5
" south end of Priory Lane, Burford	2·3 "	341·9
" south end of Sheep Street, Burford	2·3 "	371·2
" north-east angle of Mr. Smith's house, Burford ...	1·6 "	422·7
" out-house at Bird-in-Hand, Burford	2·8 "	436·9
* " west entrance to Burford church	3·1 "	335·6

BURFORD TO LECHLADE.

From mark on out-house, at Bird-in-Hand Inn ...		436.9
" north-east corner of Signet Farm House	2· "	343·8
" " angle of Braddle Grove Lodge	2·2 "	392·6
" " corner of Pompus Barn, west side of road	2·7 "	353·1
" " corner of cottage at Apsley House ...	2· "	304·8
" " angle of porch of Filkin's church ...	1·3 "	283·9
" stone pillar of gate at south-west junction of roads	2·3 "	271·8
" avenue-gate pier, west side of road	1·3 "	273·2
" south-west corner of cottage, at east side of road...	2· "	254·9
" corner of house at junction of Sherbon St. Lechlade	1·6 "	252·3
" north-west angle of Lechlade church	2·2 "	255·4
" north battlement of bridge over the river Isis ...	1·5 "	254·2

LECHLADE TO CIRENCESTER.

		Above surface.	Feet.
	From mark on west angle of Lechlade church ...		255.4
Mark on	north-west corner of cottage, west end of High St.	1·3 "	246·3
"	north-east corner of cottage, opposite the Woodman's Inn	1·1 "	239·8
"	south-west corner of barn at Warren's Croft ...	1·2 "	249·5
"	south front of Thorn Hill Cottage	1·1 "	255·2
"	wooden post of gate at stone wall, south side of road	1·7 "	272·9
"	south-east corner of foundation-stone of Fairford church...	1·1 "	294·6
"	" corner of Mr. Salmon's beer-shop ...	1·2 "	285·6
"	seventh milestone from Cirencester	0·9 "	330·2

BURFORD TO NORTHLEACH.

	From mark on out-house at Bird-in-Hand Inn ...		436·9
"	gate pier near junction of road	1·7 "	457·4
"	Upton toll-gate at junction of roads	2· "	489·1
"	the nineteenth milestone from Oxford	3·7 "	524·9
"	east corner of New Inn, Barrington...	3·7 "	535·6
"	top of the twenty-first milestone from Oxford ...	3·2 "	573·4
"	the twenty-second milestone from Oxford ...	3·2 "	596·6
"	stone wall at entrance to Sherborne Park	2·6 "	593·9
"	east angle of New Barn toll-house	1·4 "	611·3
"	top of the twenty-fifth milestone from Oxford ...	2·7 "	611·5
"	front of Mr. Shepherd's house, opposite the Prince of Wales' beer-shop	2·1 "	548·6
"	angle of school-house at junction of roads	2·4 "	536·4
"	angle of house at junction of King's Head Lane ...	2· "	533·6
"	front of house	2·3 "	536·5
"	front of Northleach prison, at cross roads	2· "	552·2
"	south-east angle Northleach Church	3·6 "	557·2

BURFORD TO OXFORD.

	From mark on out-house at Bird-in-Hand Inn ...		436·9
"	angle of Oxford House...	4· "	436·7
"	front of Coach and Horses Inn, at junction of roads	2·8 "	446·5
"	top of the fifth milestone from Witney	2·9 "	406·2
"	the fourth milestone from Witney	1·4 "	373·6
"	Minster toll-gate, near White Hart Inn	1·8 "	382·8
"	the second milestone from Witney	3·9 "	378·2

	Above surface.	Feet.
Mark on the first milestone from Witney	1·2 "	330·9
" entrance to Witney Union	1·1 "	314·9
" the last house at west end of Witney	2·1 "	264·9
" front of the Nag's Head, Witney	2·2 "	283·8
" east end of Corn Street, at market-place	1·2 "	277·8
" front of the New Inn, Witney	1·3 "	265.2
" west angle of house, at entrance to Wesleyan Chapel	1·2 "	264·7
" south face of east battlement of bridge over river...	1·7 "	273·5
" north-west angle Witney Church	2·9 "	278·7

STONELANDS TO BUCKLAND.

Mark on top of the fifth milestone from Witney ...		406·2
" top of stone in stile, at junction of fence and road	2·4 "	413·8
" top of old milestone at Stone Lands, two miles from Burford	0·6 "	385·8
" south-west angle of Barn Hill Farm	2·1 "	318·1
" angle of Methodist Chapel at junction of road, Norton bridge	2·7 "	301·6
" north-east angle of stable, near gate entrance to Marsh Hadden Farm	2·2 "	254·6
" the sixth milestone from Burford, and first from Bampton	1· "	252·8

NORTHLEACH TO CIRENCESTER.

From mark on front of Northleach prison, at cross roads		552·2
" stable near Seven Springs	1·6 "	604·7
" top of the ninth milestone from Cirencester ...	3·6 "	645·2
" " eighth milestone from Cirencester ...	3·5 "	595·8
" front of Foss Bridge toll-house	1·9 "	518·6
" the Hare and Hounds Inn, Foss Cross	2·2 "	550·1
" top of the fifth milestone from Cirencester	3·3 "	476·7
" the fourth milestone from ditto	1·3 "	547·4
" the top of the third milestone from ditto	3·6 "	504·3
" the second milestone from ditto	1·5 "	456·2
" the first milestone from ditto	1·5 "	420·1
" angle of Roman Catholic Chapel, ditto	1·9 "	363·8
" front of Public Office, Dyer Street, ditto	3·3 "	362.3
" south angle of St. John's church, ditto	2· "	367·8

NORTHLEACH TO ANDOVERSFORD.

		Above surface.	Feet.
	From mark on front of Northleach prison, at cross roads		525·2
Mark on	the twenty-seventh milestone from Oxford ...	3·4 "	666·9
"	the twenty-ninth milestone from Oxford	1·7 "	778·1
* "	the twenty-eighth milestone from Oxford	3·3 "	705·2
* "	Pewsdown toll-house at cross roads	0·6 "	824·2
"	gate-post near junction of fence	2·9 "	780·3
* "	the thirty-first milestone from Oxford	1·2 "	768·8
"	stone in base of wall near junction of fences ...	0·9 "	667·8
"	Shipton Solers Church	1·8 "	560·6
"	angle of Andoversford Inn	1·9 "	548·9

ANDOVERSFORD TO CHELTENHAM.

	From mark on angle of Andoversford Inn		548·9
"	stone of wall at entrance to Sandywell Park ...	2·2 "	698·8
* "	south face of north battlement of small bridge ...	1·7 "	416·3
"	front of Dowdeswell toll-gate	1·1 "	350·8
* "	front of New Inn, Charlton Kings	1· "	306·2
"	west angle of new church, near junction of road ...	1·7 "	264·6
"	angle of Hewlett Street, at London Road	0·7 "	211·
"	Bath House Furniture Rooms, south end of Bath road	0·6 "	198·8
* "	foundation stone of town clock in front of Public Offices	0·8 "	194·7
"	north-west corner of the Presbyterian Church ...	0·7 "	191·8
"	malt-house nearly opposite St. Mary's Cemetery ...	1·6 "	181·7
"	corner of the Gas House Offices, Cheltenham ...	1·5 "	173·3
"	corner of north transept of St. Peter's Church ...	3·2 "	167·
"	south parapet of railway bridge	1·7 "	173·8
"	corner of the Cross Hands Inn	1·7 "	136·6
	From mark on Bath House Furniture Rooms ...	"	198.8
"	buttress in north-west corner of tower of St. Luke's Church	2·1 "	204·2
"	pillar at entrance to Paragon Buildings, Bath Road	1·1 "	207·3
"	pilaster at junction of lane to Kavenza, ditto ...		234·1
"	corner of St. Phillips School House, ditto	2·4 "	245·2
"	pillar in front of Rose Bank, ditto	1·8 "	264·6
	From mark on Bath House Furniture Rooms ...		198·8
"	parapet of bridge over river Chelt, Bath Road ...	0·6 "	194·8

ANDOVERSFORD TO THE AIR BALLOON.

	Above surface.	Feet.
* From mark on angle of the Andoversford Inn ...		548-9
Mark on north-east angle of Mr. Matthews's house	1·8 "	565·6
" milestone at angle of house at cross roads		659·5
" milestone north side of road	1· "	801·2
" the eleventh milestone from Gloucester	0·9 "	921·1
" the tenth milestone from Gloucester...	0·6 "	865·2

ANDOVERSFORD TO STUMPS CROSS.

From mark on angle of the Andoversford Inn ...		548·9
" the seventh milestone from Cheltenham	1·4 "	581·7
" stone pier of gate, east side of road	1·3 "	647·1
" stone pier of gate, opposite entrance to Brookhampton Park	4·4 "	662·
" gate post, south-east side of road	2·1 "	657·2
" gate post at junction of roads	1·5 "	911·9

ON THE LINE FROM BASINGSTOKE TO COVENTRY.

Mark on base of third metal milepost from Chapel House and seventh from Shipston	2· ft. above surface	571·2
" front of the Red Lion Inn, Long Compton village	2·7 ft. ditto	376·
* Bolt in north side of tower of Long Compton Church	3·9 ft. ditto	349·
Mark on corner of the Dog Inn, at junction of roads, Long Compton	2·3 ft. ditto	356·9
" the fifth mile mark from Chapel-house and fifth from Shipston	2·1 ft. ditto	364·7
" angle of wall opposite southern lodge, at entrance to Weston Hall	1·2 ft. ditto	410·6
" the sixth mile mark from Chapel-house and fourth from Shipston	2·3 ft. ditto	372·4
" culvert 16 links off east side of road at junction of fences	3·3 ft. below centre of road	328·9
" the seventh mile mark from Chapel-house and third from Shipston	2·5 ft. above surface	305·4
" west parapet of bridge over stream at junction of roads	1·1 ft. below top of parapet	238·8
Bolt in north side of Burmington Church tower, 2·1 ft. above surface		267·2
Mark on east parapet of the bridge over the river Stour, 1·5 ft. below top of parapet		225·8
Bolt in buttress at south-west corner of Tidmington Church, 2·7 ft. above surface		232·7

		Feet.
Mark on east parapet of bridge over stream near the first milestone from Shipston	1·2 ft. below top of parapet	230·2
" west side of Wrigh House, opposite Furze Hill toll-house,	1·7 ft. above surface	237·
" north-east corner of girl's school-house at south end of Shipston-on-Stour	1· ft. ditto	218·3
* Bolt in west side of tower of Shipston-on-Stour Church,	1·8 ft. ditto	212·2
Mark on corner of the Thatch Tavern at north end of Shipston-on-Stour	2·6 ft. ditto	213·2
" west post of gate at Honington toll-house	2·6 ft. ditto	227·8
" east side of small bridge over stream at east side of road	0·6 ft. below centre of road	192·4
* Bolt in west side of Tredington Church tower	3·1 ft. above surface	216·1
Mark on coping stone of wing wall of small bridge over stream north-east side of road	1·9 ft. below centre of road	179·8

BRANCH LEVELLING.

Todenham Church, bolt in north side of spire	2·5 ft. above surface	398·7
Mark on south parapet of bridge over river Stour, 12 chains from Shipston-on-Stour Church	2 ft. below top of parapet	209·2
Barcheston Church, bolt in north side of tower	3·9 ft. ditto	247·4
Honington Church, bolt in south side of tower	4 ft. ditto	220·5

List of Altitudes of Bench Marks on the Line from Manchester to Gloucester, above mean level of the Sea.

Mark on face of the ninth milestone from Worcester, and first from Upton-on-Severn	0·7 ft. above centre of road	70·6
" top of battlement of small bridge at end of Upton-on-Severn	3·5 ft. ditto	43·4
* Bolt in south-west corner at south side of Upton-on-Severn Church	1·7 ft. above surface	51·1
Mark on stone in breast wall of Upton-on-Severn bridge	0·7 ft. above centre of road	49·9
" freestone block over small bridge	0·2 ft. ditto	39·
" stone in small plat at junction of roads	0·03 ft. below ditto	65·8
" top of the sixth milestone from Tewkesbury	2·5 ft. above ditto	62·
" stone over sewer at gate, to field 3 chains from Ryall cross roads	0·09 ft. ditto	56·1
" top of the fifth milestone from Tewkesbury	1·8 ft. ditto	70·1
" large stone in plat at junction of road to Naunton	level with centre of road	66·2

		Feet.
Mark on east battlement of Stratford bridge, between Gloucestershire and Worcestershire	3·1 ft. above ditto	48·6
" stone at side of pipe at north-west boundary of Brockbridge Common	2·6 ft. below ditto	53·7
" top of third milestone from Tewkesbury	4 ft. above ditto	112·8
" stone covering sewer at gate to field near cross roads	1·3 ft. below ditto	103·8
" top of the second milestone from Tewkesbury	2·4 ft. above ditto	114·9
" boundary stone of Tewkesbury borough, at Shuthonger Common	0·4 ft. ditto	74·7
" top of the first milestone from Tewkesbury	2·9 ft. ditto	117·7
" top of large pier in Tewkesbury bridge over river Avon	1·7 ft. below ditto	38·4
" flag at entrance to railway station Tewkesbury	0·1 ft. above ditto	49·7
" plinth of pillar in front of Tewkesbury market-house	1·1 ft. ditto	45·2
* Bolt in gable end of north transept of Tewkesbury Old Church	2·6 ft. above surface	48·8

TEWKESBURY TO GLOUCESTER.

Mark on battlement of bridge in Church Street at south end of Tewkesbury	4·1 ft. above centre of road	43·3
" flag over drain at footway to Tewkesbury and opposite lane to lodge	0·1 ft. ditto	56·
" kerb stone of footpath opposite T. Stokes' house near avenue to Southwick House	level with centre of road	85·6
" boundary stone at Tredington gate	0·8 ft. above centre of cross roads	71·7
" kerbstone of footpath opposite wicket to Mr. Wm. Hulcher's house Highfield	0·07 ft. below centre of road	69·8
" stone on top of wall opposite road to Walton	4·7 ft. above centre of road	81·2
" flag in front of the Swan Inn, Comb Hill	1·2 ft. ditto	80·1
" flag at wicket to Mr. Hill's house, Leigh farm	0·2 ft. below centre of road	55·6
" top of the fourth milestone from Gloucester	2·7 ft. above centre of road	39·7
" battlement of small bridge at Norton, over the river Chelt	3·3 ft. ditto	40·5
" top of the third milestone from Gloucester,	3 ft. ditto	66·4

		Feet.
Mark on edge of the stone cistern opposite lane to Wellfield Twigworth	0·03 ft. ditto	44·
" stone over sewer at gate to fields, nearly opposite entrance to Walsworth Hall	0·6 ft. ditto	38·7
" corner of Twigworth new church	4·1 ft. above surface	42·4
" face of the first milestone from Gloucester	1·2 ft. above centre of road	38·4
" stone on side of road opposite Mrs. E. Durrett's house Longford	0·3 ft. ditto	34·2

BRANCH LEVELLING.

Warehouse at Hanley Quay, mark on north-east corner	3·4 ft. centre of road	42·8
Upton-on-Severn Market-house, mark on plinth under pillar	1·4 ft. ditto	49·3
Mark on west parapet of bridge, west side of the Severn, north of Barley House Inn	1·1 ft. above surface	39·7
" Barley House Inn, at east side of the Severn, mark on gable	2.1 ft. above surface	40·8
" Earls Crome Church, mark on abutment at north-west corner	1·9 ft. ditto	56·2
" small bridge over stream, dividing Gloucestershire and Worcestershire, near Ripple Church	1·5 ft. above centre of road	43·8
Ripple Church, mark on stone in base course at north-east corner of tower	1·6 ft. above surface	59·5
Twining Church, mark on stone in west side of tower	2·7 ft. ditto	112·3
The Mythe Bridge, mark on face of stone abutment at west end of arch	0·4 ft. above centre of bridge	55·5
Centre of cross-roads at Oxeye Farm		43·
Bushley Church, mark on base course at Eastend, 0·7 ft. above surface		50·7
The Quay bridge, Tewkesbury, mark on stone abutment at west end	4·4 ft. below road on centre of bridge	41·2
New Church, Tewkesbury, mark on abutment on north side	3·2 ft. above surface	53·3
Mark on top of boundary stone on centre of bridge at end of Barton Street, Tewkesbury	1·3 ft. above centre of road	40·5
Walton bridge over the Tirle brook, mark on battlement	3·0 ft. ditto	41·5
Walton Cardiff Church, mark on stone abutment at west end	0·1 ft. above surface	38·2
Swilgate bridge, Tewkesbury, mark on battlement	3·0 ft. above centre of road	40·2

		Feet.
Mark on base of wooden rail on small bridge over pill at Lower Lode	0·3 ft. above crown of bridge	35·2
Tredington Bridge, mark on coping stone 0·07 ft. below centre of road		49·1
Tredington Church, mark on west side of tower 1·8 ft. above surface		68·7
Stoke Orchard Church, mark on south-west corner	1·1 ft. above surface	84·1
Mark on upper surface of keystone of small bridge at Stoke Orchard	0·07 ft. above centre of road	67·3
The wharf or basin of the Comb Hill Canal, mark on coping-stone on the north side 207 links west from north-east corner 3·3 ft. above water on the 3rd of September, 1844		30·6
Knightbridge, mark on kerbstone of footpath	0·1 ft. below centre of road	60·0
* Comb Hill Canal, mark on stone at side of swing bridge over canal		30·9
" " " stone at south end of swing bridge over canal		29·4
" " " stone at north end of swing bridge over canal		30·2
" " " stone in north side at entrance to canal from the Severn outside the outer lock		31·1
The Leigh Church, bolt in south side of tower	2 ft. above surface	51·
" School, mark on hinge-stone at door of stable	0·1 ft. ditto	51·
Norton Church, centre of hole bored for bolt in south side of tower	2·7 ft. ditto	98·5
Centre of Down-Hatherley cross roads		53·1
Down-Hatherley Church, mark on north side of tower	1·9 ft. ditto	69.4

List of Altitudes from Cirencester to Gloucester, via. *Birdlip Hill.*

	Above surface.	feet.
* Mark on buttress in south-west corner of St. John's Church, Cirencester	2· ft.	367·6
" corner of shop, at junction of Coxwell street, Cirencester	1·1 "	366·7
" east battlement of bridge over river, Gloucester street	1·7 "	366·2
" east battlement of bridge over river, north end of Cirencester street	1·7 "	371·3
" front of Stratton-gate toll-house	1·9 "	372·2
" corner of cottage at south side of road	0·9 "	411·7
" the first milestone from Cirencester	1·1 "	403·3
" front of dwelling-house at east side of road ...	1·3 "	423·7
" entrance to sheep-pound at junction of Ermine road, Stratton	1·8 "	426·9

	Above surface.	Feet.
Mark on the second milestone from Cirencester	1·4 "	550·5
" corner of outhouse at north-east side of road ...	2· "	610·8
" the third milestone from Cirencester	1·6 "	639·2
" horsing-block at junction of roads to Corwood house	1·6 "	600·9
" the fourth milestone from Cirencester	1·7 "	656·9
" pillar of gate at junction of occupation road ...	1·4 "	711·1
* " the fifth milestone from Cirencester	1·4 "	746·
" the north-east corner of the Five-mile-house inn ...	1·7 "	726·3
" the sixth milestone from Cirencester	0·6 "	821·4
" south-east corner of cottage at west side of road ...	2· "	838·4
" corner of dwelling-house at junction of road to Cheltenham Beech pike	1·4 "	843·7
" pilaster in wall at junction of fence, north-east side of road	1·8 "	867·9
" south front of cottage at east side of road	1·4 "	910·8
" north pier of gate at west side of road	1·7 "	848·3
" south-west gable of cottage at north-east side of road	3·6 "	858·4
" the eighth milestone from Cirencester	0·7 "	842·4
" end of wall at junction of road to Brimpsfield ...	2· "	830·
" front of Nettlecomb Police station	1.9 "	864·3
" corner of stables, adjoining the Golden Hart inn, Nettlecomb	2· "	823·5
" corner of cottage at south-west corner of road ...	1·5 "	892·5
" stone in wall, east end of garden, south-west side of road	0·9 "	955·9
— " corner of dwelling-house at south-east end of Birdlip village	2·8 "	934·2
" corner of Sydney Cottage at junction of roads to Cheltenham	2·1 "	946.7
" rock in wall, west side of road	1·6 "	857·5
" south-west angle of Montebello house	0·9 "	757·6
" top of old milestone, near junction of fence ...	2·3 "	572·8
" south-east angle of Hill cottage	1·6 "	503·3
" face of stone post near cottage	0·9 "	315·2
" north-east angle of cottage, side of road	1·4 "	267·1
• " north-east angle of workshop of White Horse Inn, at Horse-ferry bridge	2·7 "	221·8
" south-east angle of Horse-ferry Bridge toll-gate ...	1·9 "	221·4
" milestone, near post-office	2·4 "	171·4
" north-east angle of cottage at junction of roads ...	1·7 "	157·

	Above surface.	Feet.
Mark on top of milestone at junction of fence	1·8 "	135·5
* " angle of buttress at south-west angle of Hucclecote Church	2· "	114·5
* " base stone of gate-pier at entrance to villa ...	1·1 "	93·6
" north-east angle of coach-house near villa	1·9 "	84·7
" south-west angle of Northgate bar	1·1 "	70·9
" foundation-stone of iron letter-box, Wotton hill ...	0·4 "	78·4
" south-west of railway bridge, and south side of Northgate	1·7 "	50·4
Bolt in west side of south transept of Gloucester Cathedral	2·8 "	57·8

Level of Rails at several Stations, Great Western Railway.

	Western Railway, Datum.	Ordnance, Datum.	Trinity High Water mark, Datum.
The Bridge over the Wilts and Berks Canal, at Swindon	318·	337·75	325·25
Cirencester Station	349·75	369·5	357·
Stroud "	162·7	182·45	169·95
Cheltenham "	164·7	184·45	171·95
Gloucester "	4·0	59·75	47·25
Grange Court "	37·65	57·4	44·9
Hereford "	165·43	185·18	172·68

N.B.—Difference between Ordnance and Great Western Railway Data ... ... 19·75

Trinity High Water mark above Ordnance ... 12·5

MARINE SHELLS.

Sir R. MURCHISON, in his "Silurian System," p. 533, in describing the northern drift of the Vale of Worcester, gives the following list of species associated with the drift:—

Buccinum (Nassa) reticulatum
Dentalum entalis
Littorina littorea
Tellina solidula
Cardium tuberculatum
Cyprina Islandica
Turritella ungulina ? communis
—— *terebra*

With fragments of Venus, Astarte, Donax, and other genera, in too imperfect a state to be specifically recognized.

At Kempsey, near Worcester, were found:—

Turritella ungulina ? communis
Purpura lapillus
Anomia ephippium
Cypræa pediculus ?
Trochus cinerarius
Murex erinaceus
Bulla ampulla ? oliva
Ostrea edulis

The following complete list of Shells, &c. from the drift at Strethill, is from Mr. G. MAW's valuable paper on the "Severn Valley Drift," in the Quart. Journ. Geol. Soc., 1864:—

MOLLUSCA.

(Bivalves.)

1. *Anomia ephippium.* A single valve, very soft.
2. *Ostrea edulis.* Some very thick, others thinner and of younger growth.
3. *Pecten opercularis.* Mostly small fragments.
4. *Mytilus edulis.*
5. —— *modiolus.*

6. *Cardium echinatum.*
7. —— *edule.* Abundant; some small valves quite perfect.
8. *Cyprina Islandica.* Small fragments plentiful.
9. *Astarte borealis.*
10. *Venus exoleta.*
11. —— *lincta.* A very perfect valve.
12. —— *verrucosa.*
13. —— *gallina.*
14. *Tellina Balthica, var. solidula.* } Abundant; several valves perfect and fresh in appearance.
15. —— *calcaria.*
16. *Psammobia Ferroënsis.* Eight or nine fragments.
17. *Mactra solida.*
18. *Mya truncata.* A single hinge-fragment.
19. *Saxicava rugosa, var. arctica.*
20. *Pholas crispata.* Four fragments.
21. *Teredo Norvegica.* Part of a tube.

(Univalves.)

22. *Dentalium entale.* Four or five examples.
23. *Trochus magus.*
24. —— *umbilicatus.* } A single broken example of each.
25. —— *cinerarius, var.*
26. *Littorina littorea.* Two or three examples.
27. —— *rudis.* One example.
28. *Turritella terebra.* The most frequent species.
29. *Aporrhaïs pes-pelicani.* Three examples.
30. *Purpura lapillus.* Five or six tolerably perfect examples.
31. *Murex erinaceus.* Four or five good examples.
32. *Nassa reticulata.* One example.
33. *Buccinum undatum.* Two or three examples.
34. *Fusus antiquus.* Much broken; one specimen perforated by *Cliona celata.*
35. *Defrancia turricula.* Three examples.

CIRRIPEDES.

36. *Balanus Hameri.*
37. —— *porcatus.*
38. —— *sulcatus.*
39. —— *balanoides.*

ANNELID.

40. *Pomatoceros triquetra,* on *Ostrea edulis.*

SPONGE.

41. *Cliona celata,* in *Fusus antiquus.*

On the Correlation of the Jurassic Rocks, in the Department of the Côte-d'Or, France, with the Oolitic formations in the counties of Gloucester and Wilts, England. By THOMAS WRIGHT, M.D., F.R.S.E., F.G.S.

ON returning from Switzerland last summer, I determined to visit my former correspondent on Jurassic Geology, M. JULES MARTIN, F.G.S., of Dijon, author of several memoirs on that subject, for the purpose of paying my personal respects to him, and at the same time examining the fine collection of Fossils he had collected from all the different stages of the Terrains jurassiques, so well developed in the Department of the Côte-d'Or. M. MARTIN's admirable Monograph,* Paléontologie Stratigraphique de l'Infra-Lias du Département de la Côte-d'Or, had likewise long interested me, and I was very desirous of studying, from my own point of view, the Liassic Fossils so well described and figured in that work; more especially so, as it appeared to me, that the term Infra-Lias, as used by my friend, had given rise to much misapprehension on this side of the channel, in reference to the true position, character, and fauna of the beds he had described under that name. M. MARTIN received me in the kindest manner, and with great courtesy opened his numerous cabinets for my careful inspection, placing before me, for examination, all the type specimens he had figured and described in his works. The fossils are all neatly mounted on tablets, and most carefully described on the labels attached to each; the whole are disposed in glass cases, and stratigraphically arranged in stages as they lie naturally in the different super-imposed beds. The examination of such a collection is an easy and satisfactory one, and affords an observer acquainted with the subject the best means of

* Mémoires de la Société Géol. de France, 2e Série, tome vii, Mem. No. 1.

comparing opinions with facts, and deducing conclusions on the spot. It is the result of this examination, so interesting to all students of Jurassic Geology, that I now propose to lay before the members of the Cotteswold Club.

The Department of the Côte-d'Or comprehends the northern portion of the Duchy of Burgundy; it has the form of an irregular oval; is in length, from north to south, about sixty-five miles, and in breadth, from east to west, from twenty-five to fifty miles, with a superficial area of 3430 square miles. It is divided into four "arrondissemens communaux"—Dijon, Beaune, Châtillon, and Semur. Dijon is the ancient capital of Burgundy, and the chef-lieu of the Department of the Côte-d'Or. This region contains a very complete development of the different Jurassic formations which have formed the subject of many important memoirs made, from time to time, by some of the most eminent French geologists, and the result of their labors is seen in the accurate description of the different stages which are here exposed. As I was desirous of possessing the best teaching on this subject before bringing the matter before our members, since my return home, I addressed a letter to M. Jules Martin and begged of him to favor me with a Stratigraphical table of all the stages of the Jurassic rocks exposed in the Côte-d'Or, and to add to each zone a short list of the leading fossils contained therein, in order that I might be enabled to compare correctly the French series with our English beds. I was the more anxious to possess this information from M. Martin himself, as he has made the Geology of his Department the subject of extensive studies, and has carefully examined the Palæontology of all the beds. M. Martin kindly and promptly complied with my request, and I have very great pleasure in publishing his letter, and, at the same time, offering him our united thanks for this important communication:—

"Dijon, le 20 Août, 1869.

"Cher Monsieur,

Je m'empresse de déférer à votre désir en vous adressant ci-après le tableau sommaire de la constitution des étages

jurassiques et du Lias de la Côte-d'Or, en partant de l'étage Rhætien. Le voici :

Portlandien ...	Calcaires marneux et marno-compactes à *Trigonia Boloniensis* et *Pinna supra-jurensis*, Calcaires marno-compactes à *Amm. gigas.*
Kimméridien ...	Marnes et calcaires marno-compactes à *O. virgula.* Calcaires à Ptérocèren avec quelques *Ostrea virgula.*
Séquanien ...	Calcaires marno-compactes à *Astarte minima* Calcaires marneux à *Terebratula humeralis*, Calcaires durs ou blancs crayeux à *Nerinea Bruntrutana*, Calcaires blanchâtres à *O. solitaria* et *Hemicidaris diademata.*
Corallien ...	Oolithe corallienne à *Diceras* et calaire compacte. Calcaire fissile, sub-oolithique et calc. blanc à Polypiers, Calcaire grumeleux compacte, calcaire à chailles et marnes inferieures à *Glypticus hierogliphicus, Cidaris florigemma, etc.*
Oxfordien ...	Marnes superieures à grandes *Amm. plicatilis* et *Pholadomya parcicosta.* Calcaires pseudo-lithographiques à *Pholadomya ampla.* Marnes grises et calcaires gris cendré à Spongiaires. Marnes ferrugineuses oolithiques à *Am. cordatus, Am. perarmatus, Am. oculatus*, etc., Marnes Calloviennes et calc. marneux à *Ammon. athleta, Am. lunula, Duncani, Pholadomya lineata, Ph. decussata, Collyrites elliptica*, etc.
Bathonien ou Grande Oolithe	Dalle nacrée et calcaire marneux inf. à *Pernostrœa, Pentacrinus Buvignieri*, et nombreux Bryozoaires. Calcaires en plaquettes à Bryozoaires, *Ostrea costata, Terebratula coarctata* etc., Calcaires sub-oolithiques et marnes à *Terebratula, digona, obovata, ornithocephala et intermedia*, Calcaire gris sub-oolithique et marnes à *Terebratula cardium* et *T. hemispherica, Apiocrinus Parkinsoni, Hemicidaris Luciensis, Heteropora pustulosa*, etc. Calcaires compactes ruiniformes à *Acrosalenia Lamarckii.* Oolithe blanche miliare à *Purpura glabra* et *Purpura minax.* Calcaires marneux à *Ammonites bullatus, Am. arbustigerus* et *Phaladomya Vezelayi.* Calcaires marneux inférieurs à *Pholadomya bucardium.* Marnes à *Ostrea acuminata* et *Ammonites Parkinsoni.* Oolithe canabine à *Pholadomya. gibbosa* et quelques *Ostrea acuminata.*

Oolithe inférieure	Calcaires fissiles à Gervillies. Calcaires à Polypiers. Calcaire à entroques à *Pecten Bajocencis*, et *Cidaris Courtandina*, etc. Calcaire marbre inférieur à *Amm. Murchisonæ* et *Pecten personatus*. Feuillet grézeux à *Chondrites scoparius*.
Toarcien ou Lias superieur	Marnes jaunàtres à *Ammonites mucronatus*. Marnes brunes à *Turbo subduplicatus*. Marnes et calcaires marneux à *Ammonites complanatus*, Calcaire marn. et marnes schisteuses à *Am. serpentinus*.
Liasien ou Lias moyen	Marnes et calc. marneux à *Ostrea gigantea*. Marnes feuilletées et micacées. Marnes et calcaires argileux bleuâtres à *Am. Bechei* et *Davœi*.
Sinémurien ou Lias inférieur	Calaire marneux bleuâtre à *Am. oxynotus*, *Am. stellaris*, *Birchii*, etc. Marnes et calc. marneux à *Ammon. bisulcatus* Calc. marneux à *Am. Scipionianus* et *Am. rotiformis*.
Hettangien ou Infra-Lias	Calcaire marneux à *Am. angulatus* et *Am. liasicus*. Lumachelles à *Am. planorbis*, *tortilis* et *Burgundiæ* (*Am. laqueus*, Quenst.)
Rhætian ...	Grès et marnes à *Avicula contorta* et *Bone-bed*.

Marnes irisées ou granite.

Si quelque jour vous vous décidez à publier l'étude comparative, que vous vous proposez de faire, de ces terrains avec les votres, je lirai avec le plus vif intérèt le résultat de vos recherches à cet égard.

Veuillez agréer, cher Monsieur, l'expression de mes sentiments affectueux et dévoués.

J. MARTIN.

In making a comparison between the fauna of the Jurassic rocks of the Côte-d'Or and those of their correlative formations in England, I studied the beds in an ascending order, and I purpose following the same method in transcribing from my note-book the gist of these observations.

The Avicula contorta, or Rhætian, Series.

These *Arkoses* are composed of Sandstone and Marls, with *Avicula contorta* and the Bone-bed; the sections given in M. J. Martin's memoir, shewing the presence of these, agree very closely with the order of sequence of the same beds seen in Gloucestershire.

1. Marcigny-sous-Thil.—*Lumachelle du lias (assises peu développées.)*

Lithology.	Fauna.
Sandstone, with fucoids ...	Cerethium Semele, *d'Orb.* Cardium cloacinum, *Quenst.* Avicula Dunkeri, *Tqm.*
Arenaceous strata, formed of disaggregated Arkose	Non-fossiliferous.
Arkose, with large elements	Pecten Valoniensis, *Defr.* Avicula contorta, *Portl.* Mytilus minutus, *Goldf.* Ostrea marcignyana, *Mart.*
Whitish, micaceous, fine-grained Sandstone, traversed by veins colored by Oxide of Iron	Chemnitzia Oppeli, *Mart.* Turbo subcrenatus, *Mart.* Anatina præcursor, *Quenst.* A. Suessi, *Opp.* Myophoria inflata, *Emm.* M. multiradiata, *Emm.* Cardium Rhæticum, *Mérian.* C. cloacinum, *Quenst.* C. Philippianum, *Dunk.* Avicula contorta, *Portl.* Lima præcursor, *Quenst.* Pecten Valoniensis, *Defr.* With many other new sp. of Gasteropods and Conchifers.
Sandstone like the above resting upon Granite	Non-fossiliferous.

2. Montigny-sur-Armançon.—*Lumachelles. Banc de* 30 *à* 35 *centimètres.*

Lithology.	Fauna.
Granitoid Arkose	Without any known fossils.
Deep red fine-grained Sandstone, feebly aggregated and browned by the Oxide of Iron	Avicula contorta, *Portl.* Gervillia præcursor, *Quenst.* Lima præcursor, *Quenst.* Pinna semistriata, *Tqm.* Lima Bochardi, *Mart.* Ostrea Marcignyna, *Mart.* Anomya irregularis, *Tqm.*

Two sections are given from the S.E. and S.W. of Semur, and another from Pouillenay, which resemble the preceding in their lithological character and organic contents.

In a subsequent memoir* M. J. Martin has given more extended investigations on this zone, and has discovered the presence of the Bone-bed in several localities.

At Savigny-sous-Malain, in the Arrondissement of Dijon.—"Ce gisement que j'explorai dans toutes ces parties alors visibles ne me présenta d'abord aucune trace de fossiles. Cependant en fouillant à travers les décombres arrachés sur place pour la plantation des vines, et amoncelés à la limite de chaque parcelle de terrain, je découvris quelques écailles de poisson, puis une magnifique dent du *Sargodon tomicus*, Plien., et enfin, en retournant à la roche en place où j'opérai un petit découvert, plusieurs dents de *l'Acrodus minimus*, Ag., et de *l'Hybodus minor* du même auteur.

"Je me trouvais donc définitivement en possession de ce *Bone-bed* que j'avais si longtemps et si minutieusement cherché sans succès, et c'était à une simple donnée minéralogique que je le devais; tant il est vrai que, pour ces sortes d'investigations, le moindre indice, la plus vague indication, doivent être utilisés et mis à profit. Une fois sur la trace de cet intéressant dépôt, qui à Savigny semble occuper principalement la partie supérieure de la zone à *Avicula contorta*, je devais facilement arriver à en constater la presence sur d'autres points au même horizon géologique.

"Mémont.—Un gisement très riche sur la rive nord du ravin de Pissou est trouvé dans les bancs gréseux qui surmonte les arkoses à gros éléments. Les dents de *Saurichthys d'Hybodus, d'Acrodus*, de *Sphœrodus*, et de *Sargodon*, y sont en telle abondance qu'il est difficile, en cassant la roche de trouver un seul fragment qui n'en présente des traces. Le sommet de l'assise est surtout la partie la plus fossilifère; mais il est rare qu'elle ne le soit pas dans toute son épaisseur."†

Remilley-en-Montagne.—Les deux bancses de la zone à *Ammonites angulatus* sont argilo-calcaires, comme dans l'Auxois et qu'ils reposent sur une assise de lumachelle à *Ammonites*

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* De la Zone à *Avicula contorta* et du *Bone-bed* de la Côte d'Or. Mem. de l'Académie des Sciences et Belles Lettres de Dijon, tome XI: 1863.

† *Ibid* p. 5.

Burgundiæ dans laquelle abondent les cardinies et *l'Ostrea irregularis*, Munst. Cette lumachelle qui n'a guère que 15 à 20 centimètres d'épaisseur, s'appuie à son tour sur mince assise argilo-calcaire très compacte, sorte de lumachelle aussi, riche en espèces de la zone à *Avicula contorta* et en debris du *Bone-bed.* Ce n'est pas tout: non seulement il y à transition dans le caractère mineralogique, qui prend insensiblement l'aspect liasique; mais cette transition existe aussi dans la faune, car *l'Ostrea irregularis* apparaît fréquemment au sommet de l'assise dont il est question, à travers les espèces les plus caractéristiques de la zone à *Avicula contorta* et les dents de poisson du *Bone-bed*, tandis que ses derniers débris (*Saurichthys acuminatus, Sargodon tomicus, Sphœrodus minimus, Hybodus minor*, etc.,) ne sont pas rares dans les lumachelles à *Ammonites planorbis*, j'ai même trouvé une dent de *Saurichthys acuminatus*, jusque dans les calcaires de la zone à *Ammonites angulatus.*†

Montigny-sur-Armançon.—Les grès et arkoses de la zone à *Avicula contorta* y sont entièrement développés et très fossilifères. *L'Ostrea marcignyana* Mart., y pullule au point de former des bancs. Dans les grès à *Avicula contorta* nous avons pu recueillir également en abondance le *Pecten Valoniensis*, la *Lima præcursor*, le *Mytilus minutus*, *l'Avicula contorta* et autres espèces; puis le *Mytilus rugosus*, *Panopœa arkosiæ*, et un gros gasteropode canalifère, un *Fusus Montignyanus*, Mart.

The following species have been collected from the zone of the *Avicula contorta* in the Côte-d'Or.

Reptilia.

Termatosaurus Alberti, *Plien.*	Teeth, Saurian, not determined.
" Crocodilinus, *Quenst.*	Vertebræ, " "

Fishes.

Saurichthys acuminatus, *Agass.*	Ceratodus cloacinus, *Quenst.*
Hybodus minor, *Ag.*	Sargodon tomicus, *Plien.*
" sublœvis, *Ag.*	Sphœrodus minimus, *Plien.*
" cuspidatus? *Ag.*	Gyrolepis tenuistriatus, *Ag.*
" cloacinus, *Quenst.*	Dapedius, *Sp.*
Nemacanthus filifer, *Ag.*	Tetragonolepis, *Sp.*
Acrodus minimus, *Ag.*	Placodus gigas, *Ag.*

† *Ibid* p. 23.

Gasteropoda.

Chemnitzia Oppeli, *Mart.*
Acteonina elongata, *Moore.*
" oviformis, *Moore.*
Natica Opelli, *Moore.*
Turbo, *Sp.*
Cerithium semele, *d'Orb.*
" subundum, *Mart.*
Fusus Montignyanus, *N. Sp. Mart.*

Conchifera.

Panopœa depressa, *Mart.*
" Montignyana, *Mart.*
" rugosa, *Dunk.*
Leda Deffneri, *Opp.*
" Heberti, *Mar.*
" Schiavi, *Stop.*
Venus cloacina, *Quenst.*
Pullastra arenicola, *Strick.*
Venus depressa, *Moore.*
Corbula arkosiæ, *Nov. Sp.*
Cardita Austriaca, *Houer.*
" lucræ, *Stopp.*
Cyprina lens, *Stopp.*
" Marcignyana, *N. Sp.*
Cypricardia Suevica, *Opp.*
Pteromya Crowcombeia, *Moore.*
Myophoria inflata, *Emmr.*
" multiradiata, *Emmr.*
" Emmerichi, *Winkl.*
Myophoria ? isoceles, *Stopp.*
" Reziæ, *Stop.*
" arkosiæ, *N. Sp.*
Cardium Philippianum, *Dunk.*
Anatina præcursor, *Quenst.*
Saxicava Sinemuriensis, *Mart.*
Arca Sinemuriensis, *Mart.*
Pinna semistriata, *Tqm.*
Mytilus minutus, *Goldf.*
" rugosus, *Stopp.*
Lithophagus faba, *Winkl.*
Lima præcursor, *Quenst.*
" Bochardi, *Mart.*
" compressa, *Tqm.*
Avicula contorta, *Portl.*
Gervillia præcursor, *Quenst.*
Pecten Valoniensis, *Defr.*
" Hehlii, *d'Orb.*
Plicatula intusstriata, *Emmr.*
Ostrea Marcignyana, *Mart.*
" irregularis, *Münst.*
Anomia irregularis, *Tqm.*
" pellucida, *Tqm.*
" Renovii, *Stopp.*
Terebratula pyriformis, *Suess.*
Nucula Hausmanni, *Stopp.*
" Bocconis, *Stopp.*

Echinodermata.

Asteria lombricalis, *Schl.*
Ophiura, *Sp.*

Anthozoa.

Thecosmilia Martini, *From.*

Spongia.

Achilleum grande, *Winkl.*

Annelida.

Serpula strangulata, *Tqm.*
" Blaisyana, *N. Sp.*
Terebella Liasina, *Tqm.*

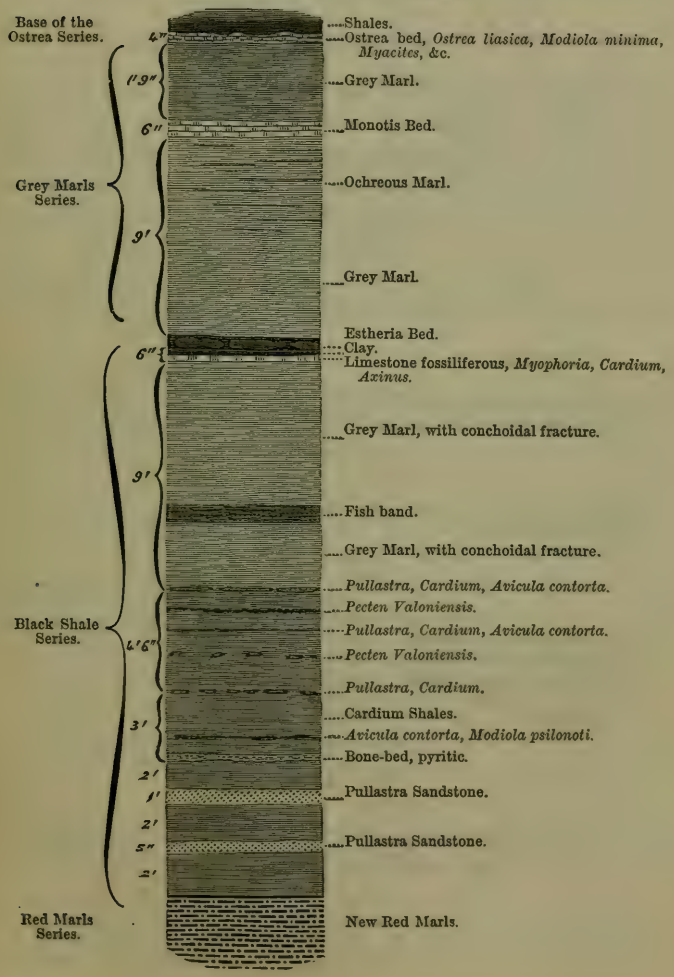
Plants.

Calamites arenaceus, *Broug.*
" *N. Sp.*

Ainsi quatre-vingt-dix espèces animales ou végétales ont été recueillies dans la zone à *Avicula contorta* de la Côte-d'Or.

Sur ce nombre cinquante-deux paraissent spéciales à cet horizon; six ont dejà été signalées dans le Trias et vingt-six continuent à se propager dans l'Infra-Lias proprement dit. Les autres sont douteuses.

Fig. I. General Section of Garden Cliff, near Westbury-on-Severn.



This general section of Garden Cliff was drawn by my friend R. Etheridge, Esq., F.R.S.E., for Professor Rupert Jones' Monograph on the Fossil Estheriæ, Palæontographical Society's volume for 1862; and I have to thank my friend the Rev. T. Wiltshire, F.G.S., Secretary to the Society, for the loan of the wood-cut, and Mr. Etheridge for his permission to use it.

The Avicula Contorta Beds in Gloucestershire.

In the Severn valley the *Avicula contorta* series has a similar development in several well known exposures, as at Coombe Hill, Wainlode Cliff, Garden Cliff, Aust Cliff, Penarth Cliff, on the banks of the Severn, and in several other localities in Somerset and Dorset. Garden Cliff, near Westbury-on-Severn, forms the best type of the whole. The following section, made by me many years ago, gives the details of the Lithology and Palæontology of this most beautiful river section.

Lithology.	Fauna.
Cream-coloured argillaceous fissile Limestone, *Monotis bed*	Monotis decussata, *Goldf.* Myacites musculoides, *Schl.* Cardium Rhæticum, *Mer.* Modiola minima, *Goldf.* Ostrea liassica, *Sow.*
Light grey nodular Limestone, *Estheria bed*	Estheria minuta, *Bronn.* Pecten Valoniensis, *Defr.*, and other shells.
Dark, chocolate-colored, friable, laminated Shales, containing many shelly seams; fossils very abundant	Pecten Valoniensis, *Defr.* Cardium Rhæticum, *Mer.* Axinus cloacina, *Opp.* Myacites musculoides, *Schl.* Lima præcursor, *Quenst.* Anatina Suessii, *Opp.* Avicula contorta, *Portl.* Gervillia præcursor, *Quenst.* Neoschizodus posterus, *Quenst.* Nearly all in the form of sharp moulds which had to be determined on the spot, with many species that were indeterminable.
Dark shaly Clay, containing many seams of compressed shells	Pullastra arenicola, *Strick.* Pecten Valoniensis, *Defr.*, very abundant.
Dark laminated shales ...	Avicula contorta, *Portl.* Cardium Rhæticum, *Mer.*, forming compressed layers of crushed shells.

The *Bone-bed*, a thin band of grayish calcareo-siliceous rock, with much sulphuret of iron, coprolites, bones, teeth and scales of fishes, and bones of Sauria; a true osseous breccia in parts	Acrodus minimus, *Ag.* Nemacanthus filifer, *Ag.* N. monolifer, *Ag.* Hybodus minor, *Ag.* H. pyramidalis, *Ag.* Gyrolepis Alberti, *Ag.* Saurichthys apicalis, *Ag.* Sargodon tomicus, *Plien.* Bones of Ichthyosaurus, Plesiosaurus; tooth of Ceratodus, with shells. Avicula contorta, *Port.* Axinus cloacina, *Opp.*, Pullastra arenicola, *Strick.*
Black Shales	Non-fossilliferous.
Pullastra bed, dark grey, micaceous, ripple-marked Sandstone	Avicula contorta, *Portl.* Cardium Rhæticum, *Mer.* Pullastra arenicola, *Strick.* Modiola minuta, *Goldf.*
Dark gritty Sandstone, containing fishes' teeth and pyrites	Pullastra arenicola, *Strick.* Avicula contorta, *Portl.* Saurichthys apicalis, *Ag.* Gyrolepis Alberti, *Ag.* Sargodon tomicus, *Plien.*
Black Shales, laminated...	No fossils.
Hard black Shale... ...	Bodies resembling Coprolites.
Grey Marls of the Keuper.	

The Côte-d'Or specimens of this stage consisted of coarse-grained Sandstones or Arkose, in which *Pecten Valoniensis* and *Cardium Rhæticum* were conspicuous. I observed several fragments of the Bone-bed recently found in the Department; its presence in this stage has likewise been indicated at Mont d'Or, west of Lyons, from whence M. Fournet * obtained a Saurian tooth. The whole facies of this bed much resembled the specimens from Garden Cliff, and other well known localities in England, and it was interesting and instructive to observe the great similarity subsisting between formations of the same age, accumulated so widely apart as the shores of the Triassic sea of the Côte-d'Or, and those in the centre of England.

The following section was made by my friend R. Etheridge, Esq., F.R.S.E., to illustrate his paper on the Rhætic beds of Garden Cliff, which appeared in the transactions of the Cotteswold Club, for 1864. It is, by his kind permission, re-produced here, as it gives all the details necessary for fully understanding this most instructive river section.

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* Fournet, Geologie Lyonnaise, p. 141 : 1861.

FIG. II. DETAILED SECTION OF THE AVICULA CONTORTA BEDS AT GARDEN CLIFF, NEAR WESTBURY-ON-SEVERN.

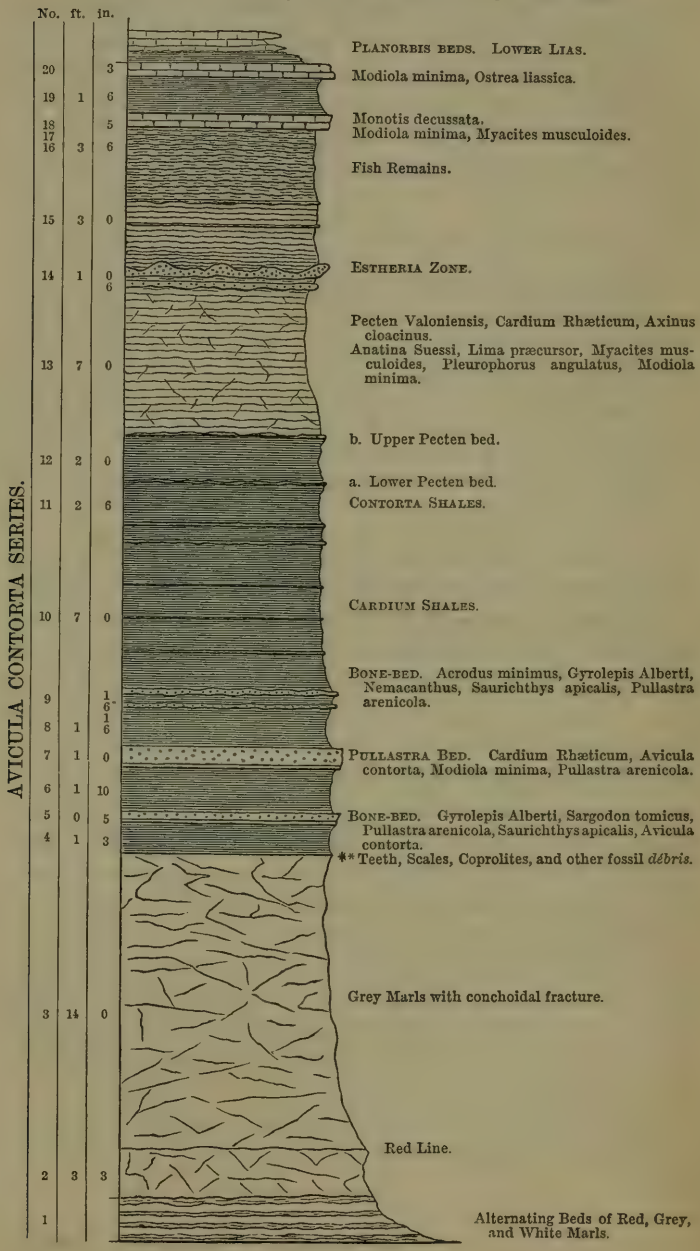
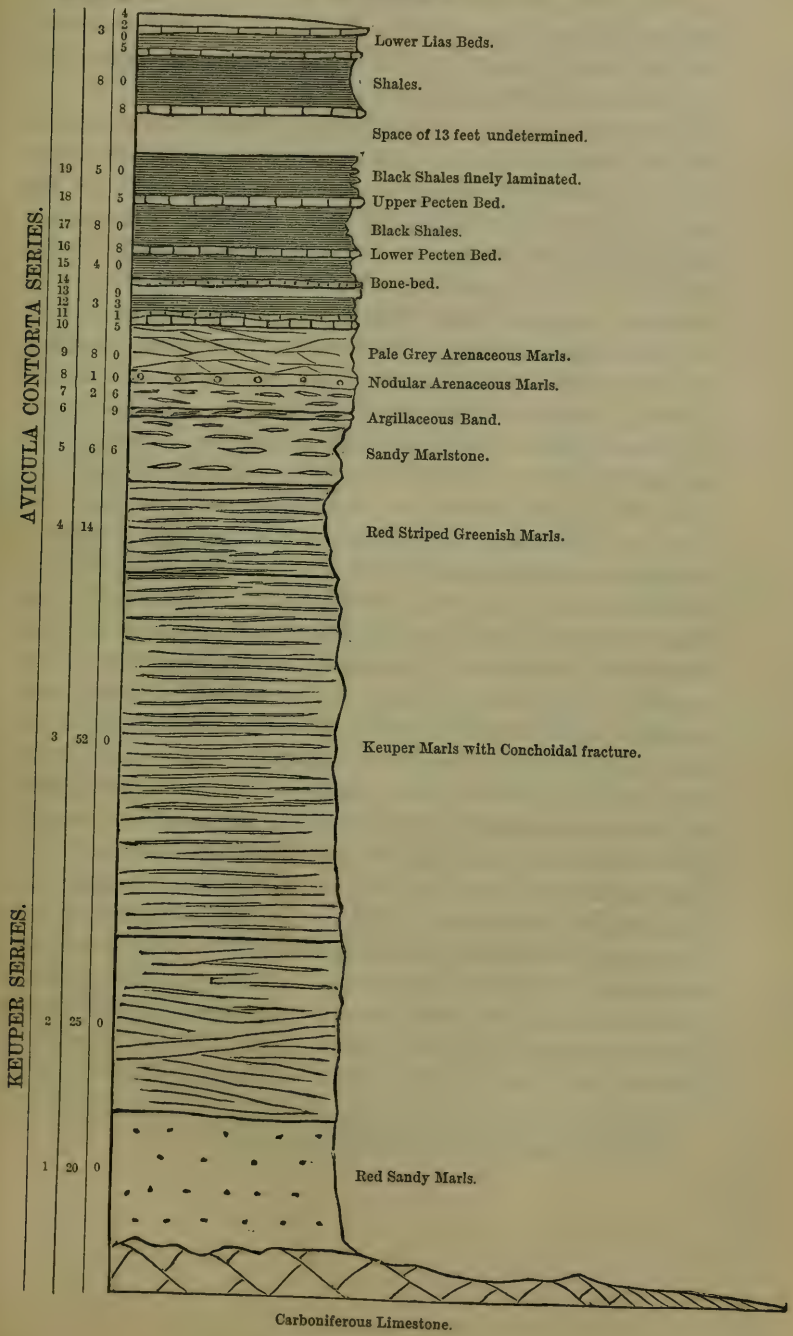


FIG. III. SECTION OF AUST CLIFF, ON THE SEVERN, NEAR AUST PASSAGE.



This section was measured by Mr. ETHERIDGE, and drawn by him to illustrate an address read by our esteemed President, Sir WILLIAM GUISE, Bart., F.L.S., at the Annual Meeting of the Club held at Elmore Court, 21st March, 1866.

AUST CLIFF.—If we proceed from Garden Cliff down the Severn, the next section of the *Avicula contorta* beds is met with at Aust Cliff, so long famous for its Bone-bed, and the large number of *Ceratodus* teeth which, from time to time, have been collected therefrom. My friend WILLIAM SANDERS, Esq., F.R.S., of Bristol, many years ago carefully measured this section, a matter of much difficulty from the mural character of the escarpment, and the result of his labors were published by Sir HENRY DE LA BECHE, in his valuable Memoir on the Geology of the south-west of England. * BUCKLAND and CONYBEARE having previously published a section of this cliff in their Memoir on the south-western coal district of England.†

In the upper part of the section are found about 3 feet of grey argillaceous Lias Limestone, containing *Ammonites angulatus*, Schloth., *Lima gigantea*, Sow., *Lima antiquata*, Sow., and *Modiola Hillana*, Sow., representing the lower beds of the Lima series. Below these are nine beds consisting of grey marls and argillaceous Limestones, representing the zone of *Ammonites planorbis*. The lowest Limestone bed of the series contains scales of fishes, elytra of insects, with Modiola and Terebratula; this rests upon 8 feet of grey, light-colored marls, with nodular Limestone, the equivalent of the white Lias series, or the beds numbered from fourteen to nineteen, inclusive, in the detailed section of Garden Cliff. The Cotham Marble caps the marly beds; this well-known singular band forming the base of the Ostrea series. The gap in the section is intended to represent a space of 13 feet which could not be satisfactorily examined. Below this space, 5 feet of thinly laminated black shales are exposed; and beneath a five-inch band of hard grey Limestone, containing scales of fish, *Pecten Valoniensis*, *Placunopsis alpina*, *Pleurophorus elongatus*, representing the

* Memoirs of the Geological Survey of Great Britain. Vol. i., p. 253: 1846.
† Geological Transactions, 2nd Series. Vol. i., p. 37.

upper Pecten bed of the Garden Cliff section, &c., this band rests upon another bed of black shales, 8 feet in thickness, containing seams of shells. Here are found *Avicula contorta, Cardium Rhæticum, Pullastra arenicola, Axinus, Anomia,* &c. The fossils are very numerous, but much compressed, and determined with difficulty. The Contorta shales rest upon a second, or lower, Pecten bed, consisting of a hard grey shelly Limestone, 8 inches thick, containing *Avicula contorta, Cardium Rhæticum, Pullastra, Axinus, Anomia,* &c., in fact, all the same shells that are found in the black shales above. Beneath the Limestone band is another bed of black shales, 4 feet thick, intersected by thin, inconstant, indurated bands, containing fishes' scales, &c. The shales rest upon the true Bone-bed, which is here a most remarkable band of dark grey, crystalline, calcareo-siliceous rock, containing nodules of marl, masses of dark coprolitic matter, bones of saurians, teeth of ceratodi and other fishes, in fine preservation. Its thickness varies from 2 to 8 inches; and it rests upon a thin band of dark shales, to which succeeds a yard of grey sandy marls, containing hard concretionary nodules; beneath are bands of hard sandy marl, resting upon 8 feet of pale grey arenaceous marls, having at their base a nodular band of similar marls, passing into a thick bed of sandy Marlstone, 6 feet 6 inches thick, and forming the base of the *Avicula contorta* series, which rests upon nodular greenish marls, thick bedded and red striped, fourteen feet thick, and next a thick mass of marls, having a conchoidal fracture, 52 feet thick; then follow the gypsiferous series, containing fibrous gypsum, in string-like lines, 25 feet 6 inches, having at the base 20 feet of red sandy marls,—the whole resting upon highly inclined strata of the lower portion of the carboniferous Limestone, which here forms the bed of the Severn.

The special character of this section consists in the great development of its Bone-bed, and the number of large teeth belonging to the genus *Ceratodus* that have been obtained here. Mr. Higgins, of Birkenhead, who has made the largest collection therefrom, reckons that he has found at Aust 140 different forms of teeth belonging to this singular genus.

I.—The Lias.

M. Martin divides the Lias into four stages—1st, *Hettangien* ou Infra-Lias. 2nd, *Sinémurien* ou Lias inférieur. 3rd, *Liasien* ou Lias moyen. 4th, *Toarcien* ou Lias superieur.

The Hettangien ou Infra-Lias	Calcaire marneux à *Ammonites angulatus*, et *Ammonites liasicus*. Lumachelles à *Ammonites planorbis*, *A. tortilis*, et *A. Burgundiæ*.

The Lumachelles, *zone à Ammonites Burgundiæ*, Mart., evidently represent the beds I have described as the zone of *Ammonites planorbis*, which rests upon the *Saurian* beds with *Ostrea liassica;* in the sections I have given in my memoir on "the *Avicula contorta* and Lower Lias of the south of England."* M. Martin's Ammonites are almost identical with forms of *A. planorbis* and *A. tortilis*, collected from beds of the same horizon in England, in the localities given in that memoir. Associated with the Ammonites are one or two species of *Hemipedina*, nearly allied to the small Urchins, collected from this zone near Pinhay Bay, Dorsetshire, and the Guinea Bed at Binton, Warwickshire. Corals, likewise, are found in the Lumachelles, nearly allied to the species of *Septastræa*, *Isastræa*, *Stylastræa*, and *Montlivaltia*, discovered in this and the next zone in England. The general facies of the fauna cannot be mistaken, for similar forms of the same genera appear for the first time in these basement beds of the Lias formation, many of them identical with, and when different from, nearly allied to the common type.

"Calcaire marneux à *Ammonites angulatus* et *Am. liasicus;* un des horizons paléontologiques les mieux caractérsés qu'il y ait dans le Département de la Côte-d'Or, et les plus riches en fossiles variés, est certainement la zone à *Ammonites Moreanus*. Limité à deux ou trois mètres de puissance au maximum, ce dépôt parait correspondre à une période d'animalization d'une admirable fécondité. C'est au sein de ses assises qu'a été recuillie la charmante faune que nous avons signalée, l'an dernier, et qui a de si intimes rapports avec la faune hettangienne, dont on doit la connaissance aux travaux de M. O. Terquem.†

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* *Quarterly Journal of the Geological Society.* Vol. xvi., p. 389: 1860.

† Paléontologie stratigr. de l'Infra-lias, p. 38: 1860.

From this zone M. Martin has collected a total of 176 species, of which 58 species are found in the underlying stages, 98 species are special to the zone, and 47 pass upwards into the overlying calcaire à Gryphites arquées, or *Am. Bucklandi* beds. Among the fauna enumerated are 1 *Ichthyosaurus*, 1 *Ichthyodorulite*, 10 sp. of *Cephalopoda*, 63 *Gasteropoda*, 77 *Conchifera*, 5 *Brachiopoda*, 4 *Echinodermata*, 10 *Anthozoa*, 3 *Annelida* and *débris* of *Crustacea*.

This zone is found in Gloucestershire with a limited fauna; in the Harbury cutting of the Great Western Railway, Warwickshire; and in the coast section near Lyme Regis, with a numerous fauna. It is found, likewise, in the north of Ireland, and in the remarkable Lias district near Portrush. The Ammonites that characterize this zone have been figured and described by M. d'Orbigny, under the names *Am. Moreanus*, *Am. catenatus*, and *Am. Charmassei*, which are all so many different varieties of *Am. angulatus*, Schloth.; the typical forms of these are collected from the English beds, together with a very rich fauna of small Gasteropoda and Conchifera, many of which are identical with those so beautifully figured by M. Martin, from the zone in the Côte-d'Or, and by MM. O. Terquem et Ed. Piette au Lias inférieur de l'est de la France from strata of the same age.

It is clear, therefore, from this analysis, that the *Hettangien ou Infra-Lias* of M. Martin consists of the two lowest stages of the true Lias, namely, the "*zone of Ammonites angulatus*" and the "*zone of Ammonites planorbis*," the latter resting upon the Grès et Marnes à *Avicula contorta* and Bone-bed; in all their essential phases these two stages being the true equivalents of the bed so well known by these names to the members of the Cotteswold Club.

II.—Sinémurien ou Lias Inférieur

Consists of—*a*. Calcaire marneux bleuâtre à *Am. oxynotus*, *Am. stellaris*, *Am. Birchii*, &c. *b*. Marnes et calcaire marneux à *Ammon. bisulcatus*, cal. marneux à *Am. Scipionianus*, et *Am. rotiformis*.

Following these beds in an ascending order, the marnes et calcaire marneux à *Am. bisulcatus* are clearly the true equivalent of the "*zone of Ammonites Bucklandi*," of which *Am. bisulcatus*, Brug.,=*Am. multicostata*, Sow., is the dominant species in France, and the form that appears to prevail in the Côte-d'Or. I saw several specimens of this species, which were identical with our own, from the same zone in Gloucestershire, Warwickshire, and Dorsetshire. The bed with *Am. Scipionianus*, d'Orb., likewise occurs in the vale of Gloucester, as I have a beautiful example of this Ammonite obtained near Bredon, from the deep cutting made in the formation of the Midland Railway.

The bed with *Am. rotiformis*, Sow., was exposed in excavating the Lower Lias Shales at Cold Pool, in the construction of the Cheltenham and Gloucester Railway; it is found likewise at Saltford, near Bristol, and at Lyme Regis, Dorsetshire. The bed with *Am. stellaris*, Sow., and *Am. Birchii*, Sow., occupies a higher position, and forms a portion of the *zone of Ammonites obtusus*, Sow.; most of the specimens of *Am. stellaris*, Sow., in M. Martin's collection are, in fact, true examples of *Am. obtusus*, Sow., and from the same localities were obtained *Am. Sauzeanus*, d'Orb., and *Am. Dudressieri*, d'Orb. *Am. Oxynotus*, Quenst., is grouped with these species, but in Gloucestershire this Ammonite occupies a higher position and characterizes a considerable zone, consisting of beds of dark clay, largely charged with the peroxide of iron; from these, many years ago, I collected a very large number of type specimens identical with the German forms. Swindon, near Cheltenham, and the excavations for the New Docks, Gloucester, may be mentioned as localities from whence they were largely obtained.

III.—"Liassien ou Lias Moyen"

Consists of the following sub-divisions:—

a Marnes et calcaire marneux à *Ostrea gigantea.*

b Marnes feuilletées et micacées.

c Marnes et calcaires argileuse bleuâtres à *Am. Davœi et Am. Bechei.*

This division, or the Lias Moyen, attains a considerable development at Semur (Côte-d'Or). The under beds consist of

marls, containing *Am. Jamesoni*, *Am. Ibex*, *Am. Davœi*, with the lower portion of the beds containing *Am. margaritatus*, whilst above the marls are brown crumbling Limestones, with *Am. margaritatus*, *Am. spinatus*, and numerous specimens of *Gryphæa cymbium*. We shall find this to be the same condition of things prevailing in the vicinity of Cheltenham; in the many exposures of the Middle Lias beds along the western escarpment of the Cotteswold Hills; and in the magnificent sections along the Yorkshire coast in the north, and Dorsetshire in the south. In Gloucestershire the Middle Lias admits of a sub-division into five zones of life: these are in ascending order—1st, *zone of Ammonites Jamesoni*; 2nd, *zone of Am. Ibex*; 3rd, *zone of Am. capricornus*; 4th, *zone of Am. margaritatus*; 5th, *zone of Am. spinatus*.

1.—*The zone of Am. Jamesoni* is known to me only in a few localities in Gloucestershire. One of these (an old pit sunk deep for brick earth in the environs of Cheltenham,) has furnished fragments of a large *Am. Jamesoni*, Sow., and many of the young forms of the same species, known as *Am. Bronnii*, Röm., with *Rhynchonella rimosa*, von Buch. *Am. Jamesoni*, Sow., is found in Robin Hood's Bay, on the coast of Yorkshire, where it is associated with *Gryphæa obliquata*, Sow.; *Pholadomya decorata*, Ag.; *Pinna folium*, and *Am. Taylori*, Sow. This zone is likewise well developed in the Island of Pabba, near Skye, in the Hebrides, if I may judge from the suite of fossils collected therefrom by my friend Arch. Geikie, Esq., F.R.S., Director of the Geological Survey of Scotland, who sent these specimens to me for determination. The original type *Ammonites Jamesoni*, Sow., came from the brown micaceous sandstone of Pabba which represents these beds.

2.—*The zone of Ammonites Ibex* is likewise found in the neighbourhood of Cheltenham reposing on the preceding. The bed consists of a yellowish coloured clay in which numerous hard calcareous nodules are imbedded; in these we find *Am. Ibex*, Quenst., *Am. Maugenesti*, d'Orb, *Am. Henleyi*, Sow., *Am. bipunctatus*, Röm., with several conchifera as *Crenatula ventricosa*, Sow., *Mytilus scalprum*, Sow., *Arca elongata*, Quenst.,

Pinna folium, Young and Bird, *Cardinia attenuata*, Buck., &c. This zone is well developed in Northamptonshire, as I have examined fine specimens of *Am. Ibex.*, Quenst., and *Am. bipunctata*, Röm., collected near Watford.

3.—*The zone of Ammonites capricornus* is well developed in England, and wherever the Middle Lias is fully exposed the laminated micaceous clays, often richly charged with the peroxide of iron, representing this zone are found; in the western escarpment of the Cotteswolds, as at Hewlitt's Hill, near Cheltenham, at Witcombe Park, near Birdlip, and at Mickelton Tunnel, near Evesham, it was at one time admirably exposed, and where it contained a very rich fauna. On the coast of Yorkshire, as at Staithes, and Boulby Cliff, this zone attains a great thickness and yields a long list of organic remains.

Fossils from the zone of Ammonites capricornus in Gloucestershire.

Cephalopoda.

Belemnites umbilicatus, *d'Blain.*
" elongatus, *Mill.*
" paxillosus, *Schloth.*
Nautilus striatus, *Sow.*
Ammonites Henleyi, *Sow.*
" capricornus, *Schloth.*
" fimbriatus, *Sow.*
" Davæi, *Sow.*

Gasteropoda.

Chemnitzia capricorni, *Wr.*
Cylindrites capricorni, *Wr.*
Trochus imbricatus, *Sow.*
Pleurotomaria Anglica, *Sow.*
" expansa, *Sow.*
" undosus, *Schübl.*

Conchifera.

Pholadomya ambigua, *Sow.*
" decorata, *Hartm.*
Pleuromya unioides, *Röm.*
Leda rostralis, *Lamk.*
" complanata, *Röm.*
" acuminata, *Goldf.*
" inflexa, *Röm.*
Astarte capricorni, *Wr.*
Mytilus hippocampus, *Young & Bird.*
Cypricardia cucullata, *Goldf.*
Cardinia attenuata, *Stutch.*
Goniomya capricorni, *Wr.*
Cardium truncatum, *Phil.*
Unicardium Janthe, *d'Orb.*
Cucullæa Münsteri, *Ziet.*
Arca elongata, *Quenst.*
" truncata, *Buck.*
Modiola scalprum, *Sow.*

Limea acuticosta, *Goldf.*
Avicula longiaxis, *Buck.*
Monotis inæquivalvis, *Sow.*
Inoceramus ventricosus, *Sow.*
" substriatus, *Goldf.*
Pecten æquivalvis, *Sow.*
Pecten priscus, *Schloth.*
" diversus, *Buck.*
" liasinus, *Nyst.*
Gervillia lævis, *Buck.*
Plicatala spinosa, *Sow.*
Gryphæa cymbium, *Lamk.*

Brachiopoda.

Terebratula punctata, *Sow.*
Spirifera rostratus, *Schloth.*
Rhynchonella rimosa, *von Buch.*
Rhynchonella variabilis, *Schloth.*
Orbicula scaliforme, *Wr.*
Lingula Beanii, *Phil.*

Echinodermata.

Cidaris Edwardsi, *Wr.*
Acrosalenia, *Nov. Sp.*
Pedina, *Nov. Sp.*
Uraster Gaveyi, *Forb.*
Tropidaster pectinatus, *Forb.*
Ophioderma Gaveyi, *Wr.*
Acroura Brodiei, *Wr.*
Pentacrinus robustus, *Wr.*
" punctiferus, *Quenst.*
" subangularis, *Mill.*

On the coast of Yorkshire, as at Staithes, Boulby, and Skinningrave Bay, where the Middle Lias is largely developed and finely exposed in magnificent coast sections, the shales with *Am. capricornus* = *Am. maculatus*, form the base of the cliffs. From Skinningrave Bay, I have specimens of *Ophioderma Gaveyi*, and it was here that *Plumaster ophiuroides*, Wr., was found, and from the same zone in Robin Hood's Bay, *Luidia Murchisonæ*, Will., was collected. On the Dorsetshire coast, as near Charmouth, this zone forms the upper portion of the grey micaceous marls, or "Green Ammonite bed" of the local collectors. In this stratum a great number of very fine Ammonites, with the shell well preserved, are found as *Am. capricornus*, Schloth., *Am. Loscombi*, Sow., *Am. fimbriatus*, Sow., *Am. latæcosta*, Sow., *Am. Bechei*, Sow., *Am. Henleyi*, Sow.

4.—*The zone of Ammonites margaritatus* forms an important sub-division of the Lias formation; the Marlstone and Ironstone series of Yorkshire, and the Marlstone of the Midland Counties, being comprised in this and the following zone. In Gloucestershire the lower portion of the Marlstone consists of a series of yellowish, grey, and brown Sands, with thin bands of calcareous Limestone and ferruginous nodules; the upper of a

rock-bed of an impure Limestone, weathering brown, but blue in the interior. In the eastern part of the county it is highly ferruginous, and varies from 1 to 10 feet in thickness. The rock-bed forms the surface of several tabulated promontories, as at Gretton, Bredon, Churchdown, and Stinchcombe Hills; and which produce fine picturesque effects in the physiographical features of the western escarpment of the Cotteswold range.

5.—*The zone of Ammonites spinatus* forms the upper portion of the Marlstone in this district, and must be studied in connection therewith. At Leckhampton Hill the Marlstone series is 115 feet thick, and this is its estimated thickness in general around the western flanks of the Cotteswolds. It may be studied at Chipping Campden, Stow-on-the-Wold, and Ebrington Hill, which formed the northern promontory of the ancient coast line.

The Marlstone attains a great development in Yorkshire, and is fully exposed in the fine coast section near Staithes, and at Boulby Cliff; the grandeur of this section can only be realised by the pedestrian, who at ebb tide sets about its exploration, and examines at low water mark the vertical wall of rock, built up of so many courses or zones of the Lias beds. Many of the *Brachiopoda*, *Conchifera*, and *Gasteropoda*, from the underlying zones of the Middle Lias, lived in the ocean from whence the Marlstone was deposited; but besides these species other forms appear to be special to it, of which the following may be enumerated:—

Cephalopoda.

Ammonites margaritatus, *Montf.*
" Englehardti, *d'Orb.*
" Normanianus, *d'Orb.*
" fimbriatus, *Sow.*
Ammonites heterophyllus, *Quenst.*
" Amaltheus, *Schloth.*
" spinatus, *Brug.*
Belemnites breviformis, *Ziet.*

Echinodermata.

Hemipedina Jardinii, *Wr.*
Uraster carinatus, *Wr.*
Astropecten Hastingiæ, *Forb.*
Ophioderma Milleri, *Phil.*
Ophioderma Egertoni, *Brod.*
" carinata, *Wr.*
" tenuibrachiata, *Wr.*
Ophiolepis Murravii. *Forb.*

From an investigation of the fauna of the Middle Lias, it would appear that the Asteriadæ and Ophiuridæ are found in greater numbers in this division of the Lias than any others, a fact which, perhaps, may be accounted for on the supposition that these beds were littoral formations.

IV.—Toarcien ou Lias Supérieur.

When M. A. d'Orbigny substituted the phrase étage Toarcien for Upper Lias, he had in view the town of Thouars, *Toarcium* (Deux Sèvres,) in the vicinity of which he had seen one of the finest sections of this formation, and which he regarded as its best French type; and for that reason I shall give it in detail here.

Lias supérieur, Thouars, (Deux Sèvres)*

a Thick bed of very white argillaceous Limestone, containing Silex, with *Belemnites tripartitus.*

b Ferruginous Limestone and clay, with *Ammonites Jurensis*, Ziet. Alternate beds of blue clay and Limestone passing in the upper portion to a ferruginous clay, with *Ammonites insignis*, Schub., and *Belemnites irregularis.*

c Blue Clay with *Ammonites radians*, Schloth., *Am. variabilis*, d'Orb., *Belem. tripartitus.*

d Grey granular Limestone, with *Ammonites Thouarsensis*, d'Orb.

e Compact Limestone, without fossils.

f Thin band of ferruginous clay, with *Ammonites serpentinus*, Schloth.

g Thick bed of sandy Limestone, worked for building stone.

h Foliated saccharoid Limestone, with *Ammonites bifrons*, Brug.

i Thick bed of yellowish Limestone containing grains of Quartz, and forming the basement bed of the section.

In other departments of France the Toarcien attains a considerable development, as in Cher, Lozère, and Aveyron, where some of the sections have a thickness of nearly 500 feet.

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* Cours Elementaire de Paléontologie et Géologie Stratigraphique, tome II., p. 469.

In the Côte-d'Or, M. J. Martin recognises the following divisions :—

a Marnes jaunâtres à *Ammonites mucronatus*, d'Orb.
b " brunes à *Turbo subduplicatus*, d'Orb.
c " et calcaire marneux à *Ammonites complanatus*, Brug.
d Calcaire marneux et Marnes schisteuses à *Ammonites serpentinus*, Schloth.

M. Martin's cabinets contained a good collection of the Ammonites from these beds, among which I found *Am. bifrons*, *Am. serpentinus*, *Am. complanatus*, *Am. Holandrei*, representing the species found in beds *c* and *d;* and *Am. Thouarsensis*, *Am. radians*, *Am. insignis*, *Am. variabilis*, *Am. mucronatus*, the species belonging to beds *a* and *b*. Now this assemblage of Ammonites, and the stratigraphical distribution of the species in the beds, was of great interest to me, as I have long maintained, in papers and discussions in our Club, that if the Cotteswold Hill sections of Upper Lias were to be read correctly we must go to France to learn the true character of their Toarcien types. When examined palæontologically the Thouars section admits of a sub-division into two stages, the beds *a*, *b*, *c*, *d*, forming the upper, and the beds *e*, *f*, *g*, *h*, *i*, the lower zone; and this is precisely the condition which prevails in some of our most typical sections, as at Frocester Hill, (Fig. IV,) where I include all the marly, argillaceous, and arenaceous deposits found between the Marlstone and Inferior Oolite in the Upper Lias, and group these beds into two stages, each containing a special fauna. The lower is in general an argillaceous formation, with occasional and inconstant bands of calcareous nodules. The shells of this division are nearly all specifically distinct from those of the Marlstone on which it rests. The Ammonites of the group Capricorni, which formed so striking a feature in the life of the Middle Lias, are all absent from the Upper Lias beds, and in their stead have appeared great numbers of species belonging to the groups Falciferi and Planulati. In England one of the most dominant forms is *Ammonites communis*, Sow., from which I have derived the name of this zone.

The upper zone is mostly an arenaceous formation in Gloucestershire, and partly an argillaceous one in Yorkshire,

although it possesses some species in common with the zone of *Ammonites communis* below, and that of the *Ammonites Murchisonæ* of the Inferior Oolite above; still it contains a fauna sufficiently numerous in specific forms, that are special to it, to justify its separation from the lower zone. Most of the Ammonites found in the upper zone belong to the group FALCIFERI, and a few are common to both: the group LINEATI is represented by one remarkable species the *Am. Jurenses*, Ziet., which is special to the upper zone, and from whence its name is derived.

I.—*The zone of Ammonites communis* is seen in the escarpments of the Cotteswold Hills, and on the summits of Bredon, Alderton, Gretton, and Churchdown Hills, all outliers from the main chain; it consists of:—

1.—Brown marly clays of variable thickness according to the amount of erosion.

2.—Bands of nodular argillaceous Limestone from 6 to 8 inches in thickness, called the "Fish-bed," containing fine specimens of *Pachycormus*, *Leptolepis*, *Tetragonolepis*, &c., with the wings of Neuroptera, as *Libellula Brodiei*, and elytra of Coleoptera.

3.—Bluish mottled clay, more or less laminated, containing *Cerithium*, *Rostellaria*, *Trochus*, *Natica*, and of *Conchifera Arca*, *Leda*, *Posidonomya*.

4.—Brachiopoda bed, with *Leptæna*, *Spirifer*, *Terebratula*.

5.—Blue clay, with *Ammonites falcifer*, Sow., *Am. communis*, Sow., *Am. bifrons*, *Am. serpentinus*.

FAUNA OF THE AMMONITES COMMUNIS ZONE, GLOUCESTERSHIRE.

REPTILIA.

Teleosaurus.
Ichthyosaurus.
Plesiosaurus.
Pterodactylus (coracoid of).

FISHES.

Pachycormus latirostris, *Ag.*
Leptolepis concentricus, *Egerton.*
Tetragonolepis discus, *Egerton.*
Dapedius, *Sp.*

CRUSTACEA.

Colea, *Sp.*

Insecta.

Libellula Brodiei, *Buck.*
Agrion Buckmani, *Brod.*

Cephalopoda.

Belemnites tripartus, *Sow.*
" acuarius, *Schloth.*
" compressus, *Voltz.*
Nautilus latidorsatus, *d'Orb.*
Ammonites communis, *Sow.*
" serpentinus, *Reinecke.*
" bifrons, *Brug.*
Ammonites annulatus, *Sow.*
" falcifer, *Sow.*
" Lythensis, *Young & Bird.*
" Raquinianus, *d'Orb.*
" cornucopia, *Young & Bird.*
" heterophyllus, *Sow.*
Belemnosepia, ink-bag and osselets.

Gasteropoda.

Turbo capitaneus, *Münster.*
Trochus bisertus, *Phil.*
Rostellaria, *Sp.*
Pleurotomaria, subdecorata, *Münster.*
Cerithium.
Trochus, *Sp.*

Conchifera.

Astarte lurida, *Sow.*
Posidonomya Bronni, *Voltz.*
Nucula Hausmanni, *Roem.*
" ovum, *Sow.*
Lima, *Sp.*
Tancredia laviuscula, *Lyc.*
Placunopsis sparsicostatus, *Lyc.*
Inoceramus dubius, *Sow.*
Monotis substriata, *Goldf.*
Arca inœquivalvis, *Goldf.*
Cucullæa Münsteri, *Ziet.*

Brachiopoda.

Leptæna Moorei, *Dav.*
" liasina, *Bouch.*
" granulosa, *Dav.*
Thecidium rusticum, *Moore.*
" Bouchardii, *Dav.*
Lingula Beanii, *Phil.*
Spirifer Ilminsterensis, *Dav.*
" Münsteri, *Dav.*
Rhynchonella pygmœa, *Mor.*
Terbratula globulina, *Dav.*
" Lycetti, *Dav.*

Echinodermata.

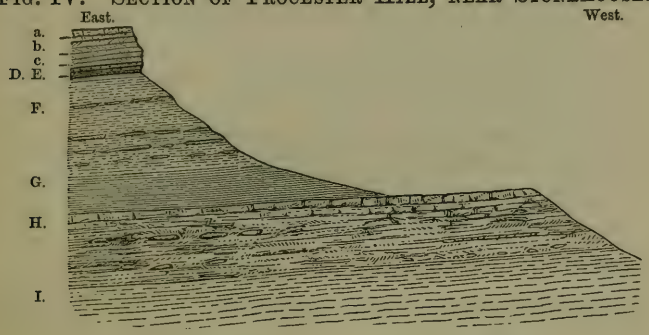
Acrosalenia crinifera, *Quenst.*
Pseudodiadema Moorei, *Wright.*
Pentacrinus, *Sp.*

II.—*The zone of Ammonites Jurensis* is well exposed in a few localities in Gloucestershire, as in the fine section at Frocester Hill, and in small exposures near Nailsworth and Brimscombe. It is seen likewise in Somerset and Dorset, and at Blue Wick, near Robin Hood's Bay, on the coast of Yorkshire. In all

these places it exhibits certain lithological characters, some of which are present in one locality and absent in another; but throughout the fauna is nearly identical.

The following section of Frocester Hill, near Stonehouse, affords the best type of the zone:—

Fig. IV. Section of Frocester Hill, near Stonehouse.



		ft.	
a, b, c.	Inferior Oolite	70	
D. E.	Calcareo-ferruginous sandstone, Cephalopoda bed, *Ammonites opalinus*...	6	Upper Lias Sands.
F.	Yellow and brown sands with inconstant and concretionary bands of calcareous sandstone = *Am. Jurensis zone*	150?	
G.	Upper Lias shale = *Am. communis zone* ...	80	
H.	Marlstone = *Am. margaritatus zone.* Hard calcareous sandstone resting on brown and grey sands, with bands and nodules of ferruginous sandstone...	150	
I.	Middle Lias shale = *Am. capricornus zone*...		

Inferior Oolite.

		ft.	in.
a.	A fine grained oolitic Limestone, the upper beds obliquely bedded, the flaggy layers resting horizontally on inclined beds of Freestone	50	0
b.	A coarse cream coloured, gritty, crystalline Oolite, traversed at intervals by shelly layers; the rock consists chiefly of the *débris* of Shells, Echinidæ, and Crinoids, and glistens brilliantly when sunlit. It represents the "*calcaire à Entroques*" ...	10	0

		ft.	in.
c.	A hard, light brown, fine-grained, oolitic, sandy Limestone, containing fossils	8	0

UPPER LIAS SANDS = JURENSIS ZONE.

D.	A coarse dark brown calcareo-siliceous rock, full of small dark grains of hydrate of iron. It contains an immense number of Ammonites, Nautili, and Belemnites	4	6
E.	A hard brown mudstone, with rows of irregular nodules, of micaceo-ferruginous sandstone ...	0	9
F.	Fine, brown, and yellowish micaceous sands, passing into greyish coloured micaceous sands, with inconstant bands of greyish calcareous sandstone, which are sometimes fossiliferous ...	150	0?

ZONE OF AMMONITES COMMUNIS.

G.	Blue clay and shale, with Ammonites	80	0

ZONE OF AMMONITES MARGARITATUS.

H.	Marlstone, a hard calcareous sandstone, resting on brown and grey sands, with bands and nodules of ferruginous sandstone	150	0

ZONE OF AMMONITES CAPRICORNUS.

I. Dark shaly clays of the Middle Lias, forming the western slope of the hill ... ...

In our comparison of the different zones of the Lias formation I have endeavoured to demonstrate the strict correlation of the different strata entering into its composition, and have shewn how closely the terrains in the Côte-d'Or agree with their equivalents in Gloucestershire. I now proceed to the examination of the great Jurassic series so well developed in France, Germany, and Switzerland; in this group of deposits, however, we shall find the study much more difficult, arising from a diversity of opinion among authors on the sub-division of the formations, and their true relation to the standard English type; the geologists of these different countries having formed opinions on the limits and development of certain subordinate

members of some Jurassic groups which do not always agree with the notions of English students on the same. It is but fair to remind the reader that Dr. William Smith* was the first geologist who described the English oolitic rocks, and prepared a classification of, and nomenclature for the same, and that his work has remained intact to our day. The labours of "the Father of English Geology" on these rocks having formed the foundation on which all subsequent students of Jurassic geology have built up their systems. By keeping these facts steadily in view, and taking Dr. Smith's classification and limitation as the standard for comparison, we shall find that the apparent difference of opinion between English geologists and those of some foreign schools, consists more in a want of agreement about the definition and limitation of certain subordinate groups, rather than in any real difference about the rocks themselves.

Oolithe Inférieure = Inferior Oolite.

In the departments of the Côte-d'Or, Saone-et-Loire, and the Rhone, the Inferior Oolite, or Étage Bajocien, is well developed, and resembles in many respects the correlative divisions of this stage in the Cotteswold Hills. A very able "Mémoire sur le Groupe Oolitique Inférieur des environs de Mâcon Saone-et-Loire" was contributed by Mons. M. de Ferry to the "Mémoires de la Société Linnéene de Normandie."† From this we learn that l'étage Bajocien in that region rests upon the sands of the Upper Lias, and is overlaid by l'étage Bathonien, as shewn in the following diagram representing a generalized section of the Inferior Oolite in the Jura Maconnais. I am the more anxious to introduce this section to the knowledge of the members of the Cotteswold Club, as it shews how well the structure of their classic ground is repeated in the centre of France, and how truly the laws of stratigraphical geology are exemplified by a comparison of l'étage Bajocien, near Mâcon, with Cleeve Hill, near Cheltenham, (Fig. VI,) and Brown's Hill, near Stroud.

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* Strata identified by organized Fossils: 1815.

† Tome xii: 1861.

Lithology.	Stages.	Leading Fossils.
Light coloured yellowish marls, readily becoming disintegrated.	*Étage Bathonien,* Calcaires marneux.	*Ammonites bullatus*, and *Ammonites arbustigerus.*
Brown ferruginous Oolite, with Shelly *débris.*	*Fuller's Earth?* Couche ferrugineuse.	Fragments of Shells.
Thin bedded Oolite, perforated by Lithodomi.	*Oolithe inférieure,* Lithophagous bank.	*Lithophaga Bajocensis.*
Ferruginous Limestone, with large Oolitic granules, and hydrate of iron.	Calcaires à Collyrites Ringens.	*Collyrites ringens* and *Ammonites Parkinsoni, Amm. Garantianus, Amm. subradiatus.*
Sandy marls, with Brachiopoda.	Calcaires à Terebratula Phillipsii.	*Terebratula Phillipsii, T. carinata, Ammonites Truellei, Amm. interruptus, A. Parkinsoni, Rhynchonella plicatella.*
Light coloured compact coralline Limestone, with calcareous spar.	Calcaire à Polypiers.	*Thecosmilia, Isastræa, Thamnastræa, Latomeandra* and other *Anthozoa*, with various species of *Polyzoa.*
Thick bedded, brownish compact saccharoid Limestone, traversed by very fossiliferous marly bands.	Calcaire à Entroques	*Ammonites Murchisonæ, Belemnites giganteus, Pholadomya fidicula, Trigonia striata, Myoconcha crassa, Hinnites tuberculosus, Terebratula plicata, T. carinata.*
Brown siliceous Limestone, enclosing large siliceous nodules (chailles) disposed in parallel beds.	Calcaire à Pecten personatus.	*Pecten personatus.*
Ferruginous sands, with Fucoids.	Couche à Fucoides.	*Ammonites opalinus,* Reinecke, = *Ammonites primordialis,* Schloth. *Chondrites scoparius.*

I shall now describe the several beds of the above section in detail:—

"L'étage Bajocien des environs de Mâcon repose toujours" says M. de Ferry "sur le Lias supérieur, ou plutôt sur la couche à *Fucoïdes* (*Chondrites scoparius* Thiolliére) avec Ammonites ramaniés (*Amm. primordialis*, Schloth.,) qui participant déjà aux caractères minéralogiques des calcaires à *Pecten personatus*, Goldf., base des formations de *l'oolithe inférieure*." This bed is clearly the representative of the upper portion of the liassic sands of Frocester Hill, (see Fig. IV., p. 169,) and *Amm. primordialis*, Schloth., is certainly *Amm. opalinus*, Reinecke, which I have already shown to be one of the most characteristic fossils of this bed, (p. 169). Having determined the true place of the basement bed of the section, let us now proceed:—

Calcaires à Pecten personatus is a compact, sandy, yellowish Limestone, often tinted with blue and red stripes, and containing very large siliceous nodules, (chailles) disposed in beds parallel with the strata. The Lumachelles, with *Pecten personatus*, occupies the superior part; the lower portion is non-fossiliferous. The bed is about ten mètres in thickness; it is used for building, but is a bad material, as it readily breaks up when frozen.

Calcaire à Entroques is a thick bedded, compact, saccharoid Limestone, the colour of which varies from red (its usual tint) to white or blue. The whole is traversed by thin marly beds, full of Sponges, Polyzoa, and numerous fragments of the tests and spines of Echinides. The great abundance of the spathic *débris* of Crinoids, with plates and columns of Pentacrinites, contained therein has suggested the name by which it is generally known. It contains the following fossils:—

Cephalopoda.

Ammonites Murchisonæ, *Sow.*
Belemnites giganteus, *Schloth.*
Belemnites Berthandi, *Ferry.*
" curtus, *Berthauld.*

Gasteropoda.

Pleurotomaria Ebrayana, *d'Orb.?* moulds supposed to belong to this sp.

Conchifera.

Pholodomya fidicula, *Sow.*
Ceromya, abducta, *d'Orb.*
Astarte detrita, *Goldf.*
Trigonia striata, *Sow.*
Myoconcha crassa, *Sow.*
Mytilus Sowerbyanus, *d'Orb.*

Lima semi-circularis, *Goldf.*
" Berthandi, *Ferry.*
" Coquandi, *Ferry.*
Lima proboscidea, *Sow.*
Avicula digitata, *Desl.*
Trichites costatus, *Ferry.*
Pecten Silenus, *d'Orb.*
" personatus, *Goldf.*
" articulatus, *Goldf.*
Hinnites tuberculosus, *d'Orb.*
Ostrea subcrenata, *d'Orb.*
" sublobata, *Desh.*

Brachiopoda.

Rhynchonella quadriplicata, *d'Orb.*
" costata, *d'Orb.*
" Babeauana, *Desl.*
Terebratula Kleinii, *Lamk.*
Terebratula carinata, *Lamk.*
" plicata, *Buck.*
" globata, *Sow.*
Thecidea cristagalli, *Fer.*

Polyzoa.

Berenicea diluviana, *Lamx.*
" Archiaci, *Haime.*
Spiropora Deslongchampsii, *Ferry.*
" straminea, *Haime.*
Theonoa clathrata, *Lamx.*
Theonoa sulcata, *Ferry.*
Heteropora conifera, *Edw.*
" pustulosa, *Haime.*
" reticulata, *Haime.*
Neuropora Defrancei, *Haime.*

Echinodermata.

Cidaris Courteaudina, *Cott.*
Heterocidaris Trigeri, *Cott.*
" spinulosa, *Roem.*
Rabdocidaris maxima, *Desor.*
Pseudodiadema depressum, *Desor.*
Stomechinus serratus, *Desor.*
Pygaster Ferryi, *Cott.*
Galeropygus sulcatus, *Cott.*
" Ferryi, *Cott.*
Pentacrinus Bajocencis, *d'Orb.*
Stellaster Berthandi, *Wright.*
Nov. Sp.

Anthozoa et Spongia.

Trochocyathus Magnevillianus, *Edw. and Haime.*
Siphoneudea entrochorum, *Ferry.*
Discœlia glomerata, *Fer.*
Stenocœlia Ferryi, *E. de From.*
Monotheles Bajocencis, *Fer.*
Stellispongia Cotteaui, *Fer.*
Oculospongia Fromenteli, *Fer.*
Sparsispongia pustulosa, *Fer.*
Cupulochonia sub-helvelloides, *Fer.*
Actinofungia Matisconensis, *Fer.*

Calcaire à Polypiers forms vast reefs which are built upon the calcaire à Entroques and extend, north and south, the length of the massive of crystalline rocks that at the west limit the sedimentary terrains of the Mâconnais, and serve as their support.

This formation is well characterized and extended, but is not always found between the "calcaire à Entroques" and the "calcaires à *Terebratula Phillipsii*," for like all true reef-like structures it is an inconstant member of a stratified series. The following may be considered to be the leading fossils of this bed:—

Cephalopoda.

Ammonites Sauzei, *d'Orb.*

Conchifera.

Pinna inornata, *Fer.*
Lithophaga Waterkeyni, *Chap.*
Lima semicircularis, *Goldf.*
Pecten articulatus, *Goldf.*
Ostrea subcrenata, *d'Orb.*

Brachiopoda.

Rhynchonella quadriplicata, *d'Orb.*
" costata
Rhynchonella parvula, *Desl.*
Thecidea triangularis, *d'Orb.*

Polyzoa.

Stromatopora dichotomoides? *Haime.*
Berenicea Archiaci, *Haime.*
Heteropora pustulosa, *Haime.*

Echinodermata.

Cidaris Courtandina, *Cott.*
Pygaster semisulcatus, *Phill.*

Anthozoa.

Thecosmilia ramosa, *d'Orb.*
Cladophyllia Babeauana *Edw. & Haime.*
Favia Fromenteli, *Fer.*
Confusastræa ornata, *de From.*
" consobrina, *d'Orb.*
Isastræa Bernardana, *Edw. & Haime.*
" variabilis, *Fer.*
" Lamartine, *Fer.*
" multistriata, *Fer.*
Latomeandra decipiens, *Fer.*
" Flemingi, *Edw. & Haime.*
Thamnastræa crenulata, *Edw. & Haime.*
" Mettenses, *Edw. & Haime.*
" Defranceana, *Ed. & Haime.*
" major, *Fer.*
Centrastræa Mc. Coyi, *Edw. & Haime.*
Goniocora prima, *de From.*
Microsolena dendroidea, *Fer.*

Calcaires à Terebratula Phillipsii.—Fine sandy marls cover up the surface of the ancient coral reefs, and these are succeeded by calcareous beds composed of the *débris* of crinoids, the plates

and spines of Echinidæ, fragments of shells, and other triturated organic remains. The most abundant fossils are the following:—

Cephalopoda.

Belemnites giganteus, *Schloth.*
" unicanaliculatus, *Hartm.*
Nautilus lineatus, *Sow.*
Ammonites Truellei, *d'Orb.*
" niortensis, *d'Orb.*
Ammonites interruptus, *Brug.*
" Martinsii, *d'Orb.*
" Humphriesianus, *Sow.*
" Garantianus, *d'Orb.*
" Ebrayi, *Fer.*

Conchifera.

Panopæa Jurassi, *d'Orb.*
Pholadomya fidicula, *Sow.*
Ceromya abducta, *d'Orb.*
Pinna ampla, *Sow.*
Mytilus reniformis, *d'Orb.*
Avicula digitata, *Desl.*
Hinnites tuberculosus, *d'Orb.*
Ostrea acuminata, *Sow.*

Brachiopoda.

Rhynchonella plicatella, *Sow.*
" quadriplicata, *d'Orb.*
" Garantiana, *d'Orb.*
" phaseolina, *Desl.*
Rhynchonella angulata, *Sow.*
Terebratula emarginata, *Sow.*
" carinata, *Lamk.*
" Phillipsii, *Mor.*

Polyzoa.

Berenicia diluviana, *Lamx.*
" Archiaci, *Haime.*
Proboscina Jacquoti, *Haime.*

Echinodermata.

Rabdocidaris crassissima, *Cott.*
Pseudodiadema depressum, *Desor.*
Acrosalenia aqualis, *Cott.*

Spongia.

Lymnoreotheles mamillata, *d'Orb.*

Calcaires à Collyrites ringens.—This is in reality a continuation of the preceding, although separated from it by some sterile beds. Its mineralogical facies is however different, for it is charged with ferruginous Oolites similar to those of Bayeux, and is likewise very fossiliferous. It is the highest bed of the Inferior Oolite series, and is capped by a small bank pierced by lithophagous mollusca. The fossils collected from the ferruginous Oolite are:—

Cephalopoda.

Belemnites giganteus, *Schloth.*
" unicanaliculatus, *Hartm.*
Nautilus lineatus, *Sow.*
" clausus, *d'Orb.*
Ammonites subradiatus, *Sow.*
" Parkinsoni, *Sow.*
" Garantianus, *d'Orb.*
" Martinsii, *d'Orb.*
" Humphriesianus, *Sow.*

Gasteropoda.

Chemnitzia procera, *Desl.*
Natica Bajocencis, *d'Orb.*
Eucyclus ornatus, *Desl.*
Pleurotomaria granulata, *d'Orb.*
" dentata, *Desl.*
Melania scalariformis, *Desl.*
Cerithium Piettei, *Fer.*

Conchifera.

Panopæa Jurassi, *d'Orb.*
" calceiformis, *d'Orb.*
" sinistra, *d'Orb.*
Pholadomya fidicula, *Sow.*
" angustata,
" Murchisonæ, *Ag.* non Sow.
" Heraulti, *Ag.*
Goniomya v. scripta, *Sow.*
Anatina pinguis, *Ag.*
Ceromya abducta, *d'Orb.*
Astarte trigona, *Desh.*
Trigonia costata, *Sow.*
" signata, *Ag.*
" clathrata, *Ag.*
Isocardia Bajocensis, *d'Orb.*
Arca oblonga, *Chap. et Dewal.*
Pinna ampla, *Sow.*
Pinna cuneata, *Phil.*
Mytilus reniformis, *d'Orb.*
Lithophaga Bajocensis, *Fer.*
Lima gibbosa, *Sow.*
" subduplicata, *Chap. et Dewal.*
Limea duplicata, *Goldf.*
Avicula digitata, *Desl.*
Gervillia Zieteni, *d'Orb.*
Pecten articulatus, *Goldf.*
" Saturnus, *d'Orb.*
" Silenus, *d'Orb.*
" subvagans, *Fer.*
" Hedonia, *d'Orb.*
Hinnites tuberculosus, *d'Orb.*
Ostrea acuminata, *Sow.*
" subcrenata, *d'Orb.*
" Phædra, *d'Orb.*
" sulcifera, *Phil.*

Brachiopoda.

Rhynchonella plicatella, *Sow.*
" varians, *Desl.*
" sub-obsoleta, *Dav.*
" spinosa, *Sow.*
" quadriplicata, *d'Orb.*
Terebratula Ferryi, *Desl.*
Terebratula Phillipsii, *Mor.*
" Eudesi, *Oppel.*
" perovalis, *Sow.*
" carinata, *Lamb.*
" emarginata, *Sow.*
" sphæroidalis. *Sow.*

Polyzoa.

Berenicea diluviana, *Lamx.*
Stromatopora Terquemi, *Haime.*
Berenicea microstoma, *Haime.*

Echinodermata.

Collyrites ovalis, *Leske.*
" ringens, *Ag.*
Clypeus Plotii, *Klein.*
Holectypus hemisphœricus, *Desor.*
Hyboclypus gibberulus, *Ag.*
Pseudodiadema depressum, *Desor.*
Magnosia Forbesii, *Wright.*
Cylocrinus rugosus, *d'Orb.*

In the Côte-d'Or the Inferior Oolite is essentially the same as in the preceding section, and is divisible, in descending order according to M. Martin, into—

1. Calcaire fissiles à Gervillies = to the Calcaires à *Collyrites ringens.*
2. Calcaire Polypiers.
3. Calcaire à Entroques, à *Pecten Bajocencis.*
4. Calcaire marbre inferieur, à *Ammonites Murchisonæ*, et *Pecten personatus.*
5. Feuillet grezeux, à *Chondrites scoparius.*

M. L. Guillebot de Nerville in his Légende explicative * groups the Inferior Oolite, under the general name Calcaire à Entroques, and divides it thus :—

Calcaire à Entroques.
- Calcaire schistoïde silicieux.
- Bancs très riches en polypiers, quelques uns étant sub-oolithiques et s'enlevant par laves.
- Calcaire à Entroques proprement dit, compacte grisâtre ou bien ferrugineux et roussâtre.

Such being the case, I now proceed to correlate these divisions of the étage Bajocien of central France with the Inferior Oolites of Gloucestershire.

I have proposed to divide this formation in our district into three zones :—1st the Inferior, or zone of *Ammonites Murchisonæ,* in many cases resting upon the sands of Upper Lias, containing *Ammonites opalinus.* 2nd the Middle, or zone of *Ammonites Humphriesianus,* and 3rd the Upper, or zone of *Ammonites Parkinsoni* and *Collyrites ringens.* We shall see as we proceed how exactly these sub-divisions agree with those of M. Martin and M. de Ferry, already enumerated in detail.

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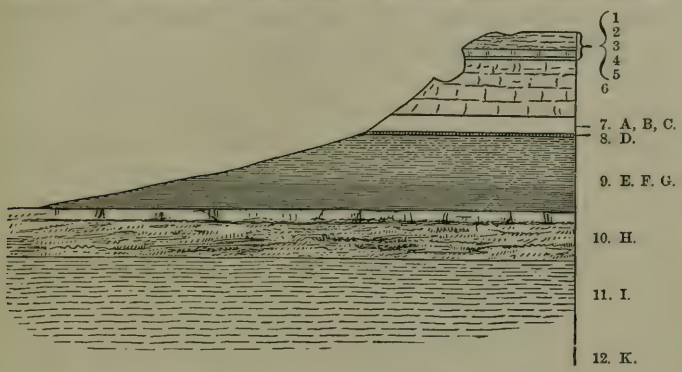
* Légende explicative de la Carte Géologique du Département de la Côte-d'Or. 1853.

FIG. V. SECTION OF LECKHAMPTON HILL, NEAR CHELTENHAM.



1. Upper Trigonia bed.
2. Gryphæa grit.
3. Lower Trigonia bed.
4. Upper Flaggy Freestone.
5. Fimbria bed.
6. Lower thick-bedded Freestone.
7. A,B,C. Pea Grit and Ferruginous Oolite.
8. D. Lias Sands, with *Ammonites opalinus.*
9. E,F,G. Upper Lias Sands and Upper Lias Clay.
10. H. Marlstone, with *Ammonites spinatus.*
11. I. Middle Lias Clay, with *Ammonites capricornus.*

Leckhampton Hill, near Cheltenham, exhibits one of the best sections of the Inferior Oolite in Gloucestershire, and the following beds are well exposed and may be advantageously studied in that locality:—

No. 1.—Upper Trigonia Grit, consisting of thin-bedded brown oolitic ragstone, containing many fossils, chiefly as moulds and impressions of *Trigonia costata, T. formosa, T. signata, Rhynchonella spinosa, R. globata, Ammonites Parkinsoni, Amm. Martinsii, Clypeus Plotii.*

No. 2.—Gryphæa Grit is composed almost entirely of the valves of *Gryphæa sublobata,* imbedded in a fine hard calcareo-siliceous matrix. This ancient oyster-bank is found in many localities in the northern Cotteswolds, but is absent south of Rodborough Hill. Besides its dominant shell it contains *Pholadomya Heraulti, Terebratula Meriani, Gervillia tortuosa,* and *Hyboclypus caudatus.*

No. 3.—*Lower Trigonia bed*, light or brownish-coloured, thin bedded, oolitic ragstone, often iron-shot, containing in some localities many fossil shells in fine preservation. *Perna rugosa, Gervillia Hartmanni, Tancredia donaciformis, Lima gibbosa, Echinobrissus clunicularis, Pedina rotata, Holectypus depressus*, and *Magnotia Forbesii*, appear in this bank for the first time.

No. 4.—*Upper flaggy Freestone*, non-fossiliferous, 34 feet thick: it appears to be the equivalent of a bed at Cleeve Hill which contains a rich fauna.

No. 5.—*Fimbria bed*, or *Oolite Marl*, a cream-coloured mudstone resembling chalk marl, 8 feet thick. The dominant shell is *Terebratula fimbria;* it contains likewise *Terebratula carinata, Lucina Wrightii, Lima pontonis, Natica Leckhamptonenses, N. adducta, Mytilus pectinatus, Astarte elegans, Nerinæa, Chemnitzia*, and masses of coral *Thamnastræa Mettensis, &c.*

No. 6.—*Lower thick-bedded Freestone* a compact, light-coloured, fine-grained, oolitic limestone, extensively used for building purposes; it attains a thickness of 150 feet.

7, A.—*Pea Grit*, a brown, coarse, rubbly oolite, full of flattened concretions cemented together in a calcareous matrix. When the block weathers the concretions resemble flattened peas. It contains many fossils in fine preservation, as *Ammonites Murchisonæ, Pecten personatus, Pseudodiadema depressum, Pygaster semisulcatus, Galeropygus agariciformis, Stellaster obtusus, Acrosalenia Lycettii, &c.*

7, B.—A hard, cream-coloured, pisolitic limestone, composed of similar circular and flattened concretions.

7, C.—A coarse brown ferruginous rock, which readily breaks up and is reduced to mud by the frost, with few fossils. These three beds are upwards of 40 feet.

No. 8, D.—*Ammonite bed*, with *Ammonites opalinus* feebly represented here, but largely so in the southern Cotteswolds, as at Haresfield, Nailsworth, Frocester, &c.

No. 9, F.—*Upper Lias Sands*, very thin, about 20 feet; they thicken out in their course southwards, and attain a great thickness at Frocester Hill, Uley Bury, &c., resting on—

9, F.—Nodular band, with *Ammonites Walcotii, Am. communis*, 200 feet.

No. 9, G.—Blue shales of the Upper Lias, with *Ammonites radians, Am. serpentinus.*

No. 10, H.—*Marlstone*, with *Ammonites spinatus*, 115 feet.

No. 11, I.—*Clays of the Middle Lias*, forming the northern slope of the hill; they are well shewn in the brick-yards near the base, and contain *Ammonites capricornus, Am. Henleyi, Am. Ibex, Am. bipunctatus.*

No. 12, K.—*Jamesoni zone*, base of the Middle Lias.

1st.—Zone of Ammonites Murchisonæ.

Assuming that the "Feuillet grézeux à *Chondrites scoparius*, Thiollière," and other Fucoids, with the remains of *Ammonites opalinus*, is the equivalent of the Ammonite bed, capping the sands of the Upper Lias, we can have no difficulty in instituting a rigid comparison between the lower division of the Inferior Oolite, as given in M. de Ferry's section, and those exposed in the Cotteswold Hills.

The calcaire à Pecten personatus and calcaire à Entroques are, with us, represented by the Pea Grit and its underlying ferruginous bed, and in some localities, as at Frocester Hill, (Fig. IV., p. 169;) this zone is a light, cream-coloured, gritty, crystalline oolite, traversed at intervals by extremely crystalline shelly layers. A great portion of the rock is composed of the fragments and plates of Crinoidea, the plates and spines of Echinidæ, and comminuted fragments of the shells of Mollusca. This calcaire à Entroques at Frocester Hill has a most remarkable crystalline character, and, when lit by the sun's rays, glistens most brilliantly.

In the neighbourhood of Cheltenham (as at Cleeve, Dowdeswell, Leckhampton, Crickley, and Birdlip,) it is well developed; but in the southern Cotteswolds it becomes thinner, and at Dundry Hill, near Bristol, and in Somersetshire and Dorsetshire, a mere rudiment of this division is found. If we apply the Palæontological test to the physical correlations, we find additional evidence of their identity, for all the leading fossils collected by M. J. Martin, and enumerated in M. de Ferry's lists, are the characteristic species of our Murchisonæ zone. Thus we have:—

Cephalopoda.

Ammonites Murchisonæ, *Sow.*
Belemnites giganteus, *Schloth.*
Nautilus truncatus, *Sow.*
Belemnites spinatus, *Quenst.*

Conchifera.

Pholodomya fidicula, *Sow.*
Ceromya concentrica, *Sow.*
Trigonia striata, *Sow.*
Pecten articulatus, *Goldf.*
" proboscidea, *Sow.*
Hinnites tuberculosus, *d'Orb.*
Trichites nodosus, *Lyc.*
Avicula digitata, *Desl.*
Mytilus Sowerbyanus, *d'Orb.*
Myoconcha crassa, *Sow.*

Brachiopoda.

Terebratula simplex, *Buck.*
" plicata, *Buck.*
" carinata, *Lamk.*
Rhynchonella Wrightii, *Davids.*
" decorata, *Davids.*
" oolitica, *Davids.*

Echinodermata.

Cidaris Fowleri, *Wright.*
Pseudodiadema depressum, *Desor.*
Acrosalenia Lycetti, *Wright.*
Stomechinus germinans, *Phill.*
Pygaster semisulcatus, *Phill.*
Galeropygus agariciformis, *Forb.*
Stellaster obtusus, *Wright.*
Pentacrinus Desori, *Wr.* Nov. Sp.

My friend S. Sharp, Esq., F.G.S., discovered a magnificent Star-fish (*Stellaster Sharpii*, Wr.) in this zone, near Northampton; and Professor Berthand, of Mâcon, has found in the Calcaire à Entroques, near Mâcon, a nearly-allied species of the same genus. A mould of this Star-fish he has kindly communicated, and which I have described as *Stellaster Berthandi* in a note appended to Mr. Sharp's paper recently read before the Geological Society.

The *Calcaire à Polypiers*, composed of the ancient coral reefs in the Côte-d'Or and Saone-et-Loire, is likewise well represented in the Cotteswold Hills. Many years ago I discovered one of these reefs at Crickley Hill, near Cheltenham, and collected therefrom several species of corals appertaining thereto. At Brown's Hill, near Stroud, there is another fine section of the same reef. This coral bed, unfortunately, is largely used for road mending, and the size of the reef, which formed a complete bluff of coral rock, is now rapidly becoming smaller, and will soon disappear. It consists of large

masses of madreporic Limestone, embedded in a fine-grained cream-coloured mudstone. The corals are in a highly crystalline state, and their specific forms are determined with difficulty, unless the specimens have been long exposed to the air. The following section exhibits the true relation of this coral bed to the underlying and superincumbent strata.

SECTION OF CORAL REEFS IN THE LOWER DIVISION OF THE INFERIOR OOLITE, NEAR BROWN'S HILL, GLOUCESTERSHIRE.

LITHOLOGICAL CHARACTERS, and thickness.	BEDS.	ORGANIC REMAINS. LEADING FOSSILS.
	UPPER FREESTONES.	
Cream - coloured marl, with inconstant layers of mudstone, upper part passing into a loose friable freestone 20 feet thick.	Oolite Marl, Middle Coral bed.	*Thamnastræa, Isastræa, Axosmilia, Terebratula fimbria, T. carinata, T. maxillata, Rhynchonella Lycetti, Lucina Wrightii, Lima pontonis.*
Fine grained, thick bedded, oolitic Limestone, very white and emitting a metallic ring when struck with the hammer.	BUILDING FREESTONES.	Shelly fragments, indeterminable.
Coarse brown ferruginous Oolite.	LOWER RAGSTONES.	*Terebratula plicata.*
Nodular masses of Coralline Limestone embedded in a light-coloured mudstone, the corals highly crystalline.	LOWER CORAL REEF.	*Latomeandra, Thamnastræa, Isastræa, Axosmilia, Thecosmilia, Pecten Dewalquei, Trichites, Lucina Wrightii, Nerinæa.*
Brown ferruginous Oolite, pisolitic, the flattened concretions not much exposed.	PEA-GRIT.	*Lima sulcata, Hinnites abjectus, Ceromya Bajociana, Avicula complicata, Nerita costata, Trochotoma carinata Pygaster, Galeropygus, Cidaris, Acrosalenia, & Pseudodiadema.*

I think, therefore, there can be no doubt that the coral beds in the zone of *Ammonites Murchisonæ* in the Cotteswold Hills are the true equivalents of the Calcaire à Polypiers of the Côte-d'Or. Not only did the reef-building *Anthozoa* belong to the same genera, but several of them are the identical species. The corals in the lower reef are the following:—

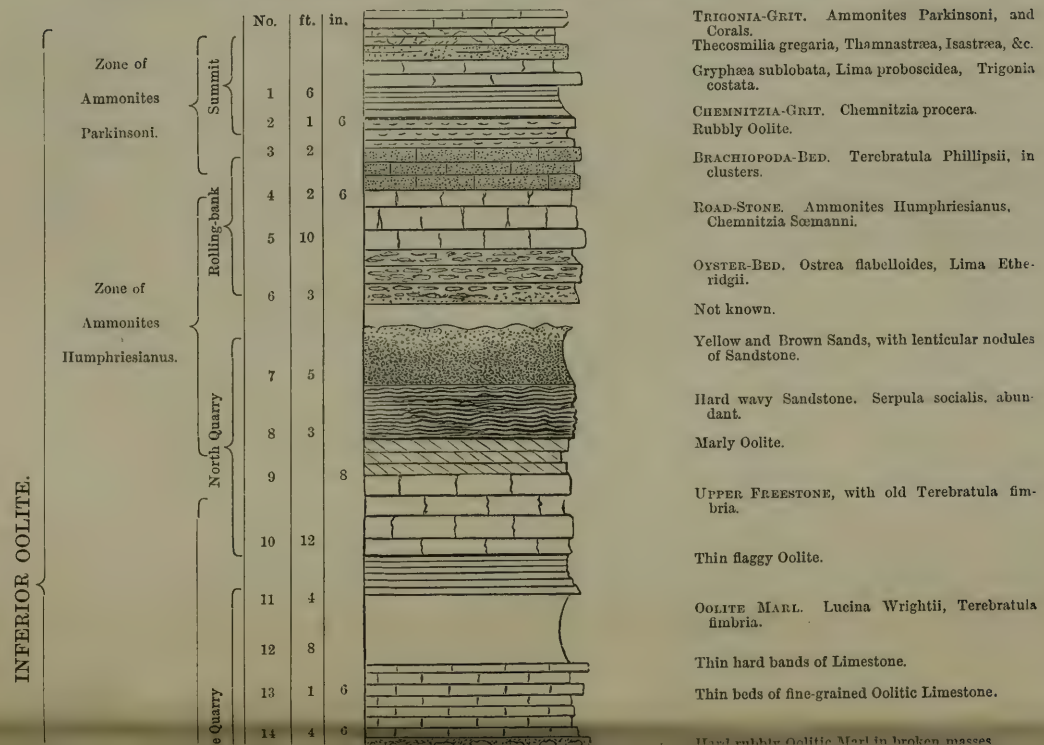
Montlivaltia Delabechii, *Ed. & Haime.*		Isastræa tenuistriata, *Ed. & Haime.*	
" tenuilamellosa	"	Thamnastræa Defranciana,	"
Axosmilia Wrightii	"	" Mettensis	"
Latomeandra Flemingii	"	" Mc Coyi	"

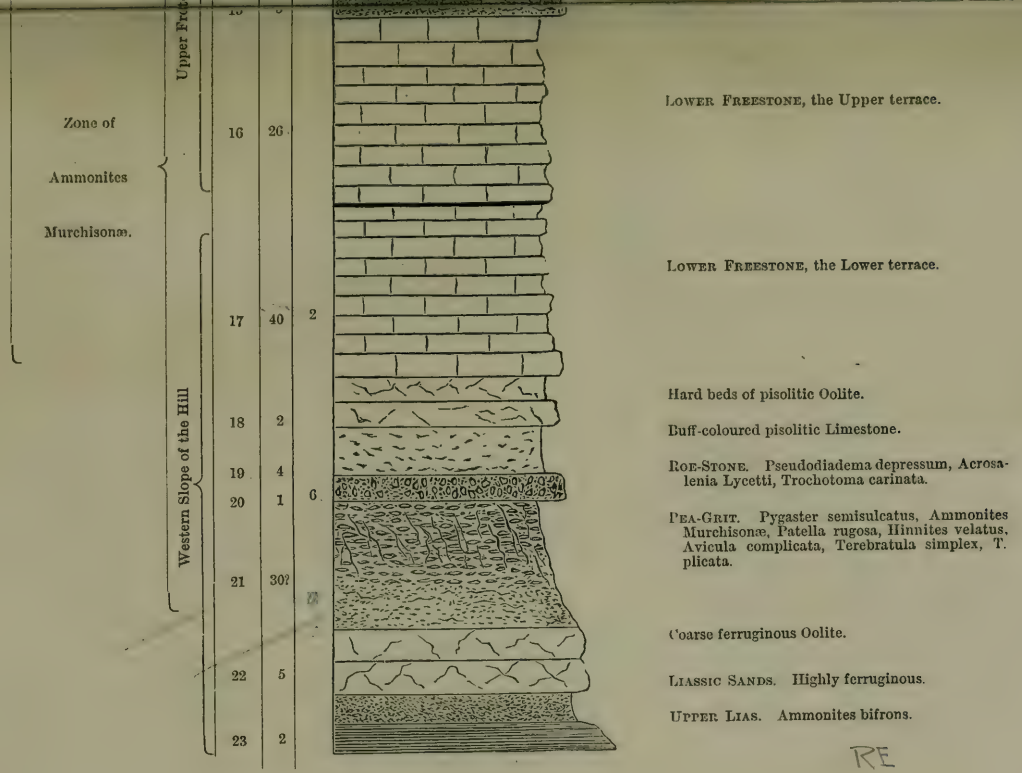
The middle coral bed is included in the oolite marl, which is interstratified between the lower and upper freestones. This bed at Frith, Leckhampton, Sheepscombe, Swift's Hill, and others, contains masses of *Thamnastræa*, *Isastræa*, and *Latomeandra*, and large numbers of *Terebratula fimbria*, *T. maxillata*, *T. carinata*, and *Rhynchonella Lycetti*. At Scar Hill, near Nailsworth, it is charged with *Nerinæa* and *Chemnitzia*, and forms a persistent stratum in the middle and northern Cotteswolds, extending across this portion of the plateau from the vales of Moreton and Bourton on the east, to the escarpment overlooking the Severn valley on the west, thinning out and disappearing in the southern part of the range.

The *Calcaires à Terebratula Phillipsii* are the representative of the middle division of the Inferior Oolite, or zone of *Ammonites Humphriesianus*. This zone forms, in some regions, a well marked sub-division, with a rich fauna special to it; in other localities it thins out or becomes blended with the higher beds. The best types of this zone are the ferruginous Oolites of Dundry, Yeovil, and Burton Bradstock, in England, and the lower half of the Oolithe ferrugineuse of Bayeux, in France. In the Cotteswold Hills it is well represented in the section at Cleeve Hill, a figure of which accompanied my paper on that subject, and which I have reproduced here to establish the correlation of the strata now under consideration.

This zone consists of the Brachiopoda, Roadstone, and Oyster beds, Nos. 4, 5, 6.

Fig. VI. SECTION OF THE INFERIOR OOLITE AT CLEEVE HILL.




Zone of
Ammonites
Murchisonæ.
Upper Free
Western Slope of the Hill
16
26
17
40
2
18
2
19
4
20
1
6
21
30?
22
5
23
2
Lower Freestone, the Upper terrace.
Lower Freestone, the Lower terrace.
Hard beds of pisolitic Oolite.
Buff-coloured pisolitic Limestone.
Roe-Stone. Pseudodiadema depressum, Acrosalenia Lycetti, Trochotoma carinata.
Pea-Grit. Pygaster semisulcatus, Ammonites Murchisonæ, Patella rugosa, Hinnites velatus, Avicula complicata, Terebratula simplex, T. plicata.
Coarse ferruginous Oolite.
Liassic Sands. Highly ferruginous.
Upper Lias. Ammonites bifrons.
RE

The Brachiopoda bed (No. 4 section) is a hard, compact, crystalline, buff-coloured Limestone, containing great numbers of *Terebratula Phillipsii*, Mor., which is the dominant fossil, with some specimens of—

Terebratula perovalis, *Sow.*	Rhynchonella spinosa, *Scholth.*
" carinata, *Lamk.*	" subtetrahedra, *David.*
" Buckmani, *David.*	" angulata, *Sow.*

The Roadstone (No. 5 section) is a hard, brown, ferruginous, oolitic Limestone, with a small assemblage of Mollusca; as—

CEPHALOPODA.

Ammonites Orbignianus, *Wright*	Ammonites Brocchi, *Sow.*
" Humphriesianus, *Sow.*	" Braikenridgii, *Sow.*
" Sowerbii, *Mill.*	Nautilus lineatus, *Sow.*

GASTEROPODA.

Chemnitzia Sœmanni, *Oppel.*	Pleurotomaria fasciata, *Sow.*
" lineata, *Sow.*	" elongata, *Sow.*
Turbo lævigata, *Sow.*	" constricta, *Desl.*

CONCHIFERA.

Ostrea flabelloides, *Lamk.*	Mytilus explanatus, *Mor.*
Hinnites tuberculosus, *Goldf.*	Pholadomya Heraulti, *Agass.*
Lima proboscidea, *Sow.*	Homomya crassiuscula, *Lyc.*
" Etheridgii, *Wright.*	Myoconcha crassa, *Sow.*
" duplicata, *Sow.*	Pteroperna plana, *Lyc.*
Trichites undulatus, *Lyc.*	Trigonia costata, *Sow.*
Astarte excavata, *Sow.*	" striata, *Sow.*
Cypricardia cordiformis, *Desh.*	" decorata, *Agass.*
Myacites calceiformis, *Sow.*	Modiola imbricata, *Sow.*
Gervillia consobrina, *d'Orb.*	Pinna fissa, *Phil.*

The Oyster bed (No. 6 section) consists of a coarse, brown, ferruginous, sandy marl, with inconstant rocky bands, and contains the fossils in sandy seams; these are—

CONCHIFERA.

Ostrea flabelloides, *Lamk.*	Gresslya abducta, *Phil.*
" pyxiformis, *Wr.*	Pleuromya tenuistriata, *Ag.*
Pecten demissus, *Goldf.*	Pholadomya Heraulti, *Ag.*
Lima proboscidea, *Sow.*	" ovulum, *Ag.*
" Etheridgii, *Wr.*	" media, *Ag.*
Monotis tenuicostata, *Wr.*	" Dewalquei, *Lyc.*

ANNULOSA.

Serpula grandis, *Goldf.* Serpula limax, *Goldf.*

ECHINODERMATA.

Clypeus Michelini, *Wr.* Pseudodiadema depressum, *Deser.*
Stomechinus germinans, *Phil.* Acrosalenia Lycetti, *Wright.*

In instituting a careful comparison between the Palæontology of this zone and that of the "*Calcaires à Terebratula Phillipsii,*" it is evident they are the true equivalents of each other; many of the fossil species are identical, and all present the general facies of the zone.

The "*Calcaires à Collyrites ringens,*" or "Calcaires fissiles à Gervillies," are represented in the counties of Gloucester, Somerset and Dorset by the zone of *Ammonites Parkinsoni,* (see section of Cleeve Hill, Fig. VI.) I am not aware that any Collyrites have been found in these strata in the Cotteswold Hills; but in Dorsetshire *Collyrites ringens* and *C. ovalis* are collected in considerable numbers, with *Ammonites Parkinsoni, Amm. Martinsii,* and other leading fossils of this stage, so that the true relative position of the beds is determined by these very characteristic urchins of the Inferior Oolite. This uppermost division, or zone of *Ammonites Parkinsoni,* consists of—1st, Upper Trigonia grit; 2nd, Gryphite grit; 3rd, Lower Trigonia grit; and 4th, Chemnitzia grit. It contains a very large assemblage of fossils, which are very characteristic of this stage; several of the species which appear for the first time in these beds extend throughout the Great Oolite, Forest Marble, and Cornbrash. I have already stated, in reference to this zone, that the fauna of the Lower Trigonia grit presents a remarkable contrast to that of the freestones on which it rests. Many species of Fish, Ammonites, Conchifera, Echinodermata, and Anthozoa, which now appear for the first time, lived through the subsequent stages and flourished in the Cornbrash, in which they all died out. It is a remarkable fact that the fauna of the Parkinsoni zone has many more palæontological characters in common with the Cornbrash than with the lower divisions of the Inferior Oolite.*

* *Quarterly Journal of the Geological Society.* Vol. xvi., p. 39.

The zone at Cleeve Hill contains several species of large corals, and in other localities coralline masses are found in the upper beds; in fact, this coral bed formed the upper reef of the Inferior Oolite, the lower reef resting on the Pea Grit, the middle on the Freestone, and the upper occupying the horizon of the Upper Trigonia Grit. The following section shews the true position of the upper coral bed:—

SECTION OF THE QUARRY AT WORGIN'S CORNER, NEAR SLAD VALLEY.

Masses of coralline Limestone, highly crystallized, 4 feet thick.	UPPER CORAL REEF.	*Thamnastræa, Isastræa, Thecosmilia, Magnotia Forbesii, Stomechinus intermedius, Trigonia costata, Latomeandra.*
Hard shelly Limestone, full of the shells of Brachiopoda, 5 feet thick.	BRACHIOPODA BED.	*Terebratula globata, Rhynchonella spinosa, Pholadomya fidicula, P. Heraulti, Gervillia, Ostrea, Trichites.*
Hard shelly sandy Oolite, full of the shells of Gryphæa, 6 feet thick.	GRYPHÆA BED.	*Gryphæa sublobata, Lima proboscidea, Gervillia tortuosa, Hybodlypus caudatus.*

I have obtained the following fossils from this zone:—

CEPHALOPODA.

Belemnites canaliculatus, *Schloth.*
" giganteus, *Schloth.*
Nautilus lineatus, *Sow.*
" polygonalis, *Sow.*
" sinuatus, *Sow.*
Ammonites Parkinsoni, *Sow.*
" Garantianus, *d'Orb.*
" Martinsii, *d'Orb.*
" subradiatus, *Sow.*
" Truellei, *d'Orb.*

GASTEROPODA.

Chemnitzia procera, *Desl.*
Pleurotomaria fasciata, *Sow.*
Natica adducta, *Phil.*
Trochotoma carinata, *Lyc.*
Melania scaliformis, *Desl.*
Neritopsis Bajocencis, *d'Orb.*

CONCHIFERA.

Trigonia costata, *Sow.*
Pholadomya fidicula, *Sow.*
" Heraulti, *Agass.*
" ovulum, *Agass.*
Myopsis dilatata, *Phil.*
Goniomya angulifera, *Sow.*
Lima proboscidea, *Sow.*
" gibbosa, *Sow.*
" compressa, *Wr.*
Gervillia Hartmanni, *Goldf.*

Gervillia tortuosa, *Desl.*
Trichites undulatus, *Lyc.*
Opis cordiformis, *Lyc.*
Modiola Sowerbii, *d'Orb.*
Modiola bipartita, *Sow.*
" imbricata, *Sow.*
Ostrea acuminata, *Sow.*
Anatina pinguis, *Ag.*

Echinodermata.

Stomechinus intermedius, *Agass.*
" bigranularis, *Lamk.*
Magnotia Forbesii, *Wr.*
Hyboclypus gibberulus, *Ag.*
" caudatus, *Wr.*
Holectypus hemisphericus, *Desor.*
" depressus, *Leske.*
Clypeus Plotii, *Leske.*
" Agassizii, *Wr.*
" altus, *Mc Coy.*
Collyrites ringens, *Desml.*
" ovalis, *Leske.*
Pedina rotata, *Wright.*
Pygurus Michelini, *Cott.*

Anthozoa.

Thecosmilia gregaria, *Edw. & Haime.*
Isastræa tenuistriata, " "
Thamnastræa Defranciana, " "
Latomeandra Davidsonii, "
Montlivaltia Wrightii, " "
Montlivaltia Delabechii, *Ed. & Haime*
" trochoides, "
" Wrightii, "
Trococyathus Magnevillianus, *Mich.*
Discocyathus Eudesi, *Mich.*

Bathonien = Great Oolite.

In the north of France l'étage Bathonien is composed of Terre à Foulon, Grande Oolithe, Calcaire de Caen, Oolithe de Caen, Calcaire de Ranville, and Calcaire à Polypiers. In the departments of the Côte-d'Or and Saone-et-Loire it admits of the following sub-division. M. J. Martin, for the Côte-d'Or, classifies the stages thus:—

Bathonien ou Grande Oolithe	Dalle nacrée et calcaire marneux inf. à *Prionastræa, Pentacrinus, Buvignieri*, et nombreux Bryozoaire. Calcaires en plaquettes à Bryozoaire. *Ostrea costata, Terebratula coarctata*, etc. Calcaires sub-oolithiques et marnes à *Terebratula, digona, obovata, ornithocephala et intermedia.* Calcaire gris sub-oolithique et marnes à *Terebratula cardium* et *hemispherica Apiocrinus Parkinsoni, Hemicidaris Luciensis, Heteropora pustulosa*, etc.
	Calcaires compactes ruiniformes à *Acrosalenia Lamarckii.*
	Oolithe blanche miliare à *Purpura glabra*, et *Purpura minax.*
	Calcaires marneux, à *Ammonites bullatus, Ammonites arbustigerus* et *Pholadomya Vezelayi.*
	Calcaires marneux inférieur à *Pholadomya bucardium.* Marnes à *Ostrea acuminata* et *Ammonites Parkinsoni.* Oolithe canabine à *Pholadomya gibbosa* et *Ostrea acuminata.*

In a paper,—"de l'étage Bathonien et de ses sub-divisions dans la Côte-d'Or,"* M. J. Martin has given many details, and a diagrammatic section of this stage, from which it appears that the Bathonien, considered stratigraphically, is divisible into six successive periods of deposits, separated from each other by an equal number "d'arrêts dans la sedimentation," and which constitute so many "*d'étages distincts.*" Studied in descending order we find beneath the "Callovien zone à *Ammonites athleta*" the following sub-divisions:—

1st,—The strata with *Pentacrinus Buvignieri*, d'Orb., and *Heteropora conifera*, Haime, of which the *débris* is found in all points of the massif, becoming extremely abundant at the last period of sedimentation.

2nd,—Beds with *Terebratula obovata*, Sow., and *Isastræa limitata*, Edw., which abound profusely in certain strata, and are sparse in others.

3rd,—Beds with *Terebratula cardium*, Sow., and *Apiocrinites Parkinsoni*, Schloth., these fossils characterizing a limited horizon comprised between the zone with *Terebratula obovata* above, and the Limestones with conchoidal fracture below.

4th,—The thick-bedded Limestones, with *Rhynchonella decorata*, d'Arch., which are considered by M. Payen to represent the Great Oolite, and by M. G. de Nerville and others as the Forest Marble.

5th,—The oolitic Limestones, containing *Pecten laminatus*, Sow., in abundance, a shell which is seldom found out of this zone.

6th,—The Marls, with *Ostrea acuminata*, Sow., which form the base of the stage. This small curved oyster is very abundant in the lower part of the zone and becomes rare in the upper.

In summing up his observations on these sub-divisions M. Martin observes,—"Il y a mieux, non-seulement chacune de ses périodes sédimentaires a vu se développer et pulluler durant sa formation une ou plusieurs espèces particulières, mais encore

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* Bulletin de la Soc. Geol. de France, 2e Série, t. xviii, p. 640: 1861.

ce développement et cette profusion numérique ont toujours exactement coïncidé avec le commencement des dépôts qui recèlent leurs dépouilles. Cela devait être en effet, car, ainsi qu'il arrive de nos jours au sein des mers actuelles, la faune de cette époque reculée, subissant dans son ensemble les influences de milieu, de profondeur, et de configuration orographique, n'a pu faire autrement que de se modifier à l'apparition de chacune des nouvelles phases de sédimentation. Telle espèce, trouvant à telle période des conditions de vie mieux appropriées à son genre d'organisation, s'y est extraordinairement multipliée, tandis que telle autre, par une raison inverse, y a chétivement vécu, ou n'y a même conservé que de rares représentants.

Contrairement à l'opinion reçue, il y a donc dans l'étage Bathonien de la Côte-d'Or six zones paléontologiques parfaitement distinctes. Ces zones, qui n'ont rien de l'arbitraire des sub-divisions admises jusqu'ici, sont naturelles et partout stratigraphiquement délimitées avec une admirable précision. Elles caractérisent chacune une des périodes de sédimentation que j'ai indiquées, et l'ensemble de leur faune suffit toujours à les faire reconnaître en l'absence de l'élément stratigraphique qui peut faire quelquefois défaut dans la pratique." *

Mons. M. H. de Ferry enumerates the following beds in l'étage Bathonien as developed in the environs of Mâcon, Saone-et-Loire, in descending order:—

L'étage Bathonien.	Calcaires à Polypiers.
	" à Pholadomyes.
	" à Rhynchonelles.
	" à Échinodermes.
	" rugueux et perforés.
	" à Ammonites.

The Limestones at the base are marly and of a yellowish white colour, and contain *Amm. linguiferous*, *Amm. arbustigerus*, *Amm. planula*, and *Amm. bullatus*. They pass into the hard compact Limestones, having a rugose aspect, almost without fossils, and of which the superior part, when visible, presents

* Bulletin de la Soc. Geol. de France, 2e Série, t. xviii, p. 646: 1861.

perforated banks of a very characteristic aspect. This is the Great Oolite, properly so called, in the environs of Mâcon. It is replaced at Tournus by the *l'Oolithe blanche miliare.* This rock contains many fossils in the marly beds :—

Cephalopoda.

Ammonites bullatus, *d'Orb.*
" microstoma, *d'Orb.*
Ammonites discus, *Sow.*
" biflexuosus, *d'Orb.*

Conchifera.

Goniomya angulifera, *Sow.*
Pholadomya bellona, *d'Orb.*
Ceromya peregrina, *Ferry.*
Thracia viceliacensis, *d'Orb.*
Mytilus Sowerbyanus, *d'Orb.*
Lithophaga flabella, *Desl.*
Lima gibbosa, *Sow.*
" rigidula, *Phil.*
Lima hippia? *d'Orb.*
Avicula costata, *Smith.*
Gervillia acuta, *Sow.*
Pecten vagans, *Sow.*
" Luciensis *d'Orb.*
" rhetus, *d'Orb.*
" obscurus, *Sow.*
Plicatula cotyloides, *Desl.*

Brachiopoda.

Rhynchonella spinosa, *Sow.*
Terebratula globata, *Sow.*
Terebratula Buckmani, *Dav.*
Thecidea triangularis, *d'Orb.*

Polyzoa.

Stromatopora dichotoma, *Lamx.*
Berenicea diluviana. *Lamx.*
Disastopora Michelini, *Edwards.*
Spiropora cespitosa, *Lamx.*
" compressa, *Haime.*
Alecto dichotoma, *Lamx.*

Echinodermata.

Collyrites ovalis, *Leske.*
Echinobrissus clunicularis, *Llhwyd.*
Holectypus depressus, *Lamx.*
Hyboclypus gibberulus, *Agass.*
Pseudodiadema Wrightii, *Cotteau.*
" homostigma, *Ag.*

Collyrites ovalis is always very abundant, and with *Rhynchonella spinosa*, serves, according to M. de Ferry, to characterize this stratum in the environs of Mâcon.

The calcaires marneux à *Oursins* form a distinct bed persistent in its characters and fossils over an extended area.

The calcaires à *Rhynchonelles* are a marly bed, containing *Ostrea costata, Terebratula cardium, T. intermedia, Rhynchonella Boueti, Hemicidaris Luciensis, Acrosalenia spinosa*, etc.

The calcaires à *Pholadomyes* contain many of these molluscs embedded in fine marls in the normal position in which they lived,—as *Pholadomya Vezelayi*, *P. bucardium*, *Scalprum carinata? Ceromya striata*, *Anatina ægea*, *Terebratula coarctata*, *T. intermedia*, *Ammonites Bakeriæ*, *Amm. hecticus*, etc.; lastly, the series is terminated by compact Limestones, of which the upper part is perforated by lithophagous molluscs, covered by large oysters, and these beds serve to support the first ferruginous deposits of the *Callovien* stage.

M. G. de Nerville * classifies the Bathonien as follows:—

Groupe de la Grande Oolithe.
- *Cornbrash.*—Calcaire oolithique roux, à larges taches bleuâtres, à Oolithes miliaires bien égales. Cette assise renférme quatre à cinq petits bancs marneux.
- *Forest Marble.*—Calc. compacte, par gros banc, de couleur blanc-grisâtre, à structure très-massive.
- *Grande Oolithe.*—Calc. oolithique, blanc, à structure très-variable. *Terre à foulon et calcaire blanc jaunâtre marneux.*

Assise marneuse; à la base très-argileuse et même plastique, et passant à un calcaire jaunâtre marneux oolithique contenant beaucoup de fossiles, tels que *Ostrea acuminata*.

M. Ed. Piette has described the Étage Bathonien, in the department of the Meuse, as consisting of three groups which he thus characterizes:—

a.—*Calcaire marneux d'Etain* avec Rhynchonella concinna, Terebratula obovata, Ter digona, Ter cardium, Clypeus patella, Echinobrissus clunicularis. 15 mètres.

b.—*Marnes grises de Rouvres:* contenant, Pholadomya texta, Mytilus Sowerbyanus, Terebratula ornithocephala, Holectypus depressus, &c. 60 mètres.

c.—*Marnes et Calcaires à Ostrea acuminata de Montmédy* avec Ammonites Parkinsoni, Pholadomya Vezelayi, Ceromya rostrata, Lima gibbosa, Ostrea acuminata, Ostrea Marshii, Rhynchonella concinna, Rhyn. varians, &c. 80 mètres.

Group *a* appears to be synchronous with the Forest marble and Bradford clay; group *b* to represent the Fullers Earth of Box Tunnel, near Bath; and group *c*, in part at least, the zone of *Ammonites Parkinsoni*, Inferior Oolite, Gloucestershire.

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* Légende explicative de Carte Géol. du Départ. de la Côte-d'Or.

A Table showing the correlation of the sub-divisions of the Great Oolite Group in France and England.

Normandy.	Côte-d'Or.	Saone-et-Loire.	England.
Fossiles remaniés du Cornbrash.	*Pentacrinus Buvignieri* et *Heteropora conifera*	Calcaires compactes avec Lithophaga et Ostrea.	Cornbrash.
Grande Oolithe supérieure ou Calcaire à Polypiers.	*Terebratula obovata* et *Isastræa limitata.*	Calcaires à Polypiers.	Forest Marble.
			Bradford Clay.
	Terebratula cardium et *Apiocrinus Parkinsoni.*	Calcaires à Rhynchonelles.	Forest Marble.
Grande Oolithe inférieure ou Oolithe miliare.	*Rhynchonella decorata.*	Calcaires à Échinodermes.	Great Oolite.
			Shelly Freestones.
	Pecten laminatus.	Calcaires rugueux et perforés.	Stonesfield Slate.
Calcaire marneux, Fullers Earth, Calcaire de Caen.	*Ostrea acuminata.*	Calcaires à Ammonites, et Couche Ferrugineuse.	Fullers Earth.

In Gloucestershire the sub-divisions of the Great Oolite, which correspond to l'étage Bathonien, are arranged in stratigraphical order in the fourth column of the above table, and more fully explained in the following, in which, at the same time the most salient characters of the Lithology of the formations, and leading Fossils contained therein, are given.

Lithology.	Formations.	Leading Fossils.
A rubbly thin bedded Limestone, with uneven surface, and occasional partings of marl and clay, containing fossils.	Cornbrash.	*Terebratula intermedia, T. obovata, Avicula echinata, Pygaster Morrisii, Echinobrissus orbicularis.*
A coarse fissile false-bedded Oolite, with bands of marl or clay interstratified therewith.	Forest Marble.	*Ostrea rugosa, O. acuminata, O. costata.*
Yellow clay, locally developed.	*Bradford Clay.*	*Terebratula digona, T. coarctata, T. maxillata, Apiocrinus Parkinsoni.*
Siliceous sands, sandy Limestone, and oolitic freestone.	Forest Marble.	*Ostrea rugosa, O. acuminata, O. costata.*
Shelly oolitic Limestone; thin bedded rubbly Oolite; hard brown oolitic Limestone, full of shells and oysters.	Great Oolite.	*Purpuroidea, Pteroceras, Alaria, Cerithium, Chemnitzia, Nerinœa, Clypeus Mulleri, Echinobrissus Woodwardii.*
A hard sandy fissile Oolite, capable of being split into roofing slates.	Stonesfield Slate.	*Trigonia impressa, Gervillia acuta,* Bones of Mammals and Pterodactyles, Palates of Fishes.
Brown or blue clay, sometimes breaking up into conchoidal fragments.	Fullers Earth.	*Pholadomya Vezelayi, Ceromya plicata, Pygurus Michelini, Acrosalenia spinosa.*

Fullers Earth.—Is a thick argillaceous deposit, separating the Inferior from the Great Oolite formations, and consisting of regularly bedded, blue, brown, and yellowish clay, shales and marls, with inconstant bands of nodular Limestone; at Box Tunnel, near Bath, it is about 150 feet thick, and in Sapperton Tunnel, Stroud Valley, 70 feet; near Amberley church there is a fine exposure of this rock, full of the small curved oyster, *Ostrea acuminata,* so abundant in this formation. At Symonds Hall Hill, the Fullers Earth is well seen in *situ.*

Fig. VII. Diagram shewing the Strata between Symonds Hall Hill and Wotton-under-Edge.

I am indebted to my old friend Professor Ramsay for the accompanying section, which he kindly made for me some years ago. The hill is capped by the Great Oolite, (7;) beneath this is the Fullers Earth, (6,) which here is 128 feet thick, and overlies the Limestone of the Inferior Oolite, (5,) which is 80 feet thick, resting on the hard sandy bands of the Upper Lias, (4,) with specks of the silicate of iron, containing Ammonites and Belemnites; to these succeed the soft sands of the Upper Lias, (4,) with lenticular concretions, having a thickness of 123 feet; these rest on the Upper Lias shale, (3,) and the latter on the Marlstone, (2,) which has a thickness of nearly 200 feet; the middle and Lower Lias shales and Limestones, (1,) stretching westward towards the vale.

Stonesfield Slate.—So well exposed on Sevenhampton Common, Eyeford, and Naunton, consists of sandy flags, slates, and blue Limestones which are often fissile and capable of being split into slates for roofing, disclosing in the sections *Trigonia impressa, Ostrea acuminata,* and *Avicula ovata, Lima cardiiformis, Pecten lens, P. vagans,* with very beautiful specimens of Star-fishes, *Astropecten Cotteswoldiæ,* and *Astropecten Wittsii.* The unique *Solaster Moretonis* was extracted by the workmen from a bed of rock in the Windrush Quarry, Gloucestershire, equivalent in age with the Stonesfield slate of the northern Cotteswolds.

Alternating with this marine fauna are certain shales which have been deposited in an estuary, for in them we find the remains of plants, the elytra of Coleoptera, and other parts of insects, belonging to the families Blapsidæ, Buprestidæ, Coccinellidæ, Pimpelliidæ, and Prioniidæ.

Many bones of *Pterodactyles*, teeth of *Megalosaurus*, and the palates of fishes are found in the slates at Eyeford. The fine state of preservation in which these fragile fossils lie, affords sufficient proof of the tranquil conditions that prevailed in the estuary where they were entombed. The Stonesfield slate is well exposed at Througham, two miles north of Bisley.

Great Oolite.—Many fine sections of this formation are seen in the county of Gloucester, as in the open cutting at Sapperton Tunnel, and Tetbury Road, Great Western Railway, Sherborne Park, Windrush Quarries, &c. The large quarries on Minchinhampton Common, that have been worked from ancient times, fully expose several of the strata of this formation; the lowest bed of the Great Quarry immediately overlies the Fullers Earth, and the vertical wall of rock, about 36 feet in height, admits of the following sub-divisions according to my friend, Dr. Lycett.*

A.—Planking consisting of several beds of a coarse shelly Limestone, the oolitic grains being sparsely distributed therein. Some of the beds separate into thin horizontal divisions or planks. *Purpuroidea*, *Pteroperna*, *Macrodon*, and other large shells are found here.

B.—Soft, pale, thin-bedded, rubbly Oolite, with occasional sandy partings, containing few shells and crystallized carbonate of lime, and therefore readily disintegrating on exposure to frost.

C.—Soft, yellowish, shelly Oolite, the testacea being arranged in layers which assume every kind of inclination within a short distance, and having numerous perforations bored by *Lithodomi.*

D.—Weatherstone in two or three beds, a brownish oolitic Limestone full of shells, crystalline carbonate of lime, and shelly *débris*, with oyster shells at the base.

E.—Basement bed consisting of a coarse, grey, or brown, and blue hard argillaceous Limestone, full of small oysters, *Ostrea acuminata.*

Upwards of 300 species of Mollusca have been collected from the Oolite in this locality, the greater number of these are found both in the lower and upper beds, and others abound at

* The Cotteswold Hills Hand-book, p. 93.

particular horizions. *Cephalopoda* are rare, but *Gasteropoda*, and *Conchifera* very numerous, the shells forming seams in the rock, which are often crowded to excess. In the following lists I have catalogued only the most abundant forms from the shelly Limestones :—

Gasteropoda.

Alaria armata, *Mor. & Lyc.*
" hamulus, *Desl.*
" paradoxa, *Desl.*
" trifida, *Phil.*
Cylindrites acutus, *Sow.*
" altus, *Mor. & Lyc.*
" cuspidatus, *Sow.*
Eulima communis, *Mor. & Lyc.*
Monodonta formosa, *Mor. & Lyc.*
" Lyellii, *d'Arch.*
" Labadyei, *d'Arch.*
Natica Michelini, *d'Arch.*
Nerinæa Voltzii, *Desl.*
" funiculus, *Desl.*
" Dufrenoyi, *d'Arch.*
Nerita rugosa, *Mor. & Lyc.*
" cancellata, *Mor. & Lyc.*
" hemisphærica, *Rœm.*
" minuta, *Sow.*
Ceritella acuta, *Mor. & Lyc.*
" unilineata, *Sow.*
Cerithium quadricinctum, *Goldf.*
Delphinula alta, *Mor. & Lyc.*
Patella Aubentonensis, *d'Arch.*
" inornata, *Mor. & Lyc.*
" rugosa, *Sow.*
Phasianella elegans, *Sow.*
" Leymerieri, *d'Arch.*
" conica, *Mor. & Lyc.*
Pileolus lœvis, *Sow.*
" plicatus, *Sow.*
Purpuroidea glabra, *Mor. & Lyc.*
" Morrisii, *Buvig.*
" nodulata, *Sow.*
Trochotoma obtusa, *Mor. & Lyc.*
" conuloides, *Desl.*
Trochus obsoletus, *Rœm.*
" spiratus, *d'Arch.*

Conchifera.

Arca æmula, *Phil.*
" Prattii, *Mor. and Lyc.*
" cucullata, *Roem.*
" Hirsonensis, *d'Arch.*
Astarte excavata, *Sow.*
" excentrica, *Mor. and Lyc.*
" rhomboidalis, *Phil.*
" squamula, *d'Arch.*
Avicula echinata, *Sow.*
" costatula, *Desl.*
Cardium Stricklandi, *Mor. and Lyc.*
Corbis Madridi, *d'Arch.*
" Bathonica, *Mor. and Lyc.*
Corbula involuta, *Goldf.*
Cypricardia cordiformis, *Desh.*
Cyprina Loweana, *Mor. and Lyc.*
" nuciformis, *Mor. and Lyc.*
" trapeziformis, *Goldf.*
Gervillia monotis, *Desl.*
" ovata, *Sow.*
" socialis, *Mor. and Lyc.*
Hinnites velatus, *Goldf.*
Lima cardiiformis, *Sow.*
" duplicata, *Sow.*
" impressa, *Mor. and Lyc.*
" ovalis, *Sow.*
Limopsis ooliticus, *Desl.*
Lithodomus inclusus, *Desl.*

Lucina despecta, *Phil.*
" Bellona, *Mor. and Lyc.*
" rotundata, *Roem.*
Mytilus furcatus, *Goldf.*
" sublævis, *Sow.*
" imbricata, *Sow.*
Nucula variabilis, *Sow.*
Opis lunulatus, *Sow.*
" similis, *Sow.*
Ostrea acuminata, *Sow.*
" gregarea, *Sow.*
" rugulosa, *Mor. and Lyc.*
Pecten clathratus, *Roem.*
" lens, *Sow.*
" vagans, *Sow.*
Placunopsis Jurensis, *Roem.*
" socialis, *Mor. and Lyc.*
Tancredia axiniformis, *Phil.*
" brevis, *Lyc.*
" planata, *Lyc.*
Trigonia costata,, *Sow.*
" Goldfussii, *Münst.*
" Moretonis, *Mor. and Lyc.*

Brachiopoda.

Terebratula perovalis, *Sow.*
Rhynchonella concinna, *Sow.*

Echinodermata.

Acrosalenia hemicidaroides, *Wr.*
" spinosa, *Ag.*
Hemicidaris Luciensis, *d'Orb.*
Pseudodiadema depressum, *Desor.*
Nucleolites clunicularis, *Llhwyd.*
Hyboclypus caudatus, *Wr.*
Pygaster semisulcatus, *Phil.*
Clypeus Mülleri, *Wr.*

Dr. Lycett,* whose critical knowledge of the specific forms of this district is unsurpassed, states that the Great Oolite of Minchinhampton has produced:—

	Species.			Species.
Gasteropoda ...	165	of which are found in the Inferior Oolite	Gasteropoda ...	20
Conchifera ...	171		Conchifera ...	45
	336			65

So that twenty-two per cent. are common to both formations in the Cotteswolds generally. The 336 species represent eighty genera of Gasteropoda and Conchifera, and of this number only nine genera occur, which are not found also in the Inferior Oolite: we may say, therefore, in general terms that of the fossil Mollusca collected from the shelly beds of the Great Oolite at Minchinhampton, seventy-eight per centum are proper to that formation, and twenty-two, species common to it and the Inferior Oolite.

* The Cotteswold Hills Hand-book, p. 3.

Bradford Clay.—In the Minchinhampton district the soft upper beds of the Great Oolite are succeeded by a bed of very hard, white, or cream-coloured Limestone, eagerly sought out for the kiln, and raised for that purpose; this rock is remarkable for its hardness and the closeness of its texture. It is well seen in many places, as at Bussage, Cowcombe, near Cirencester, and in the open cutting of the Sapperton Tunnel; at Bussage and Cowcombe it contains a great many remarkable shells, the tests of which are preserved in the form of highly crystallized carbonate of lime, such as *Pachyrisma grande, Natica Michelini, N. grandis,* and *Purpura nodulata;* the hard white Limestone is considered as the uppermost member of the Great Oolite in this district. At the Tetbury Road Station of the Great Western Railway, a bed of yellowish clay is exposed, containing *Terebratula digona, T. orbicularis, T. maxillata, T. coarctata, T. cardium, Avicula echinata, Pecten hemicostatus, Cidaris Bradfordensis, Pseudodiadema homostigma.* These forms characterize the clay above the Great Oolite in Wiltshire, known as the Bradford clay; this rock is not a persistent stratum, but is frequently wanting, as near Bradford, where the Forest marble being visible is seen resting on the Great Oolite at Pickwick and Wormwood.* The Bradford clay ought not to be considered as an independant formation, separating the Great Oolite from the Forest marble, but rather as one of the inconstant argillaceous bands of the latter formation; this clay, above the upper Oolite, sometimes attains a thickness of from 40 to 60 feet at Farleigh; in other localities it is much thinner. Near Bradford, Wilts, it contained a great number of fine specimens of Crinoids, *Apiocrinus Parkinsoni,* and numerous Brachiopoda, *Terebratula digona, T. coarctata, T. cardium, &c.* When the Bradford clay is wanting, it is almost impossible to distinguish the upper beds of the Great Oolite, from those of the next formation.

Forest Marble.—This formation consists of a coarse fissile Oolite full of false bedding, and having interstratified therewith

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* *Lonsdale,* the Oolitic district of Bath, Trans. Geol. Soc., 2nd Series. Vol. iii., p. 255.

bluish marls and shales, or bands of clay in yellow siliceous sands, containing large spherical blocks of sandy Limestone: a capital section through the Forest marble and Great Oolite at Crickley-Barrow, shows the lithological characters of these two formations:—

FOREST MARBLE.	Shelly Oolite formed of organic *débris*, obliquely laminated in different directions.	Small oysters, Pectens, &c., in great profusion on the slabs.
GREAT OOLITE.	Hard, white, sandy Limestone, thickly and regularly bedded.	Not very fossiliferous. Terebratula maxillata, numerous.

The organic remains in the Forest marble are abundant in individuals, but not numerous in species, and in this respect the formation presents a striking difference to the Hampton freestones; many of them are specifically identical with those of the Great Oolite, there being only a small minority which are not found in the basement beds of the Minchinhampton quarries.

Cornbrash.—Is a coarse thin-bedded Limestone, having bands of brown and grey marls alternating, and interstratified therewith. Near Chippenham, Wilts, it is well exposed and very fossiliferous, containing numerous *Brachiopoda* and *Anatinidæ*. I have collected all the fossils in the subjoined list from the Wiltshire Cornbrash:—

CONCHIFERA.

Gresslya peregrina, *Phil.*
Myacites securiformis, *Phil.*
Homomya gibbosa, *Sow.*
Myacites calceiformis, *Phil.*
Ceromya concentrica, *Sow.*
Pholadomya Heraulti, *Ag.*
Lima duplicata, *Sow.*
" cardiiformis, *Sow.*
" pecteniformis, *Schloth.*
Modiola Sowerbii, *d'Orb.*
Avicula echinata, *Sow.*
Trigonia costata, *Sow.*
Astarte excavata, *Sow.*
Goniomya litterata, *Phil.*
Gervillia crassicosta, *Mor. and Lyc.*
Modiola bipartita, *Sow.*
Avicula costata, *Sow.*
Pecten lens, *Sow.*
" vagans, *Sow.*
" rigidus, *Sow.*

BRACHIOPODA.

Terebratula intermedia, *Sow.*
" maxillata, *Sow.*
Terebratula obovata, *Sow.*
Rhynchonella concinna, *Sow.*

Echinodermata.

Clypeus Plotii, *Leske.*
Nucleolites clunicularis, *Llhywd.*
" orbicularis, *Phil.*
Holectypus depressus, *Lamk.*
Acrosalenia hemicidaroides, *Wright.*
" spinosa, *Agass.*
Pseudodiadema depressum, *Desor.*
Pygurus Michelini, *Cotteau.*

Nearly all the Conchifera in the above list are likewise found in the zone of *Ammonites Parkinsoni*, Inferior Oolite. They lived in the seas that deposited the Minchinhampton series, and passed into those of the Cornbrash. Several of the Brachiopoda are special to this formation, others have a wider range. All the Echinodermata made their appearance in the Parkinsoni zone of the Inferior Oolite, where they attained their most perfect development; some of the species became dwarfed in the Great Oolite seas, and again assumed their pristine condition in the Cornbrash; indeed, it would appear that the Parkinsoni zone of the Inferior Oolite and the Cornbrash had many conditions in common, as proved by the life-vigour of the same forms in both.

When studied, as a whole, we find very few species characteristic of the Great Oolite group, special to any of its sub-divisions, although the same species is found to assume certain varieties in the different beds in which it recurs; an evidence that the several members of the group were deposited under many changes of physical conditions.

The two sub-divisions of this series that have hitherto given rise to most discussion in our attempts to correlate these strata are the *Fullers Earth* and the *Bradford Clay*, which exhibit considerable variety as to presence, development, and fossils. These two deposits more properly belong to that class of beds which the Germans would call "einlager," or beds inconstantly interposed between others that are more permanent members of a group. In this sense these two clay beds would be "einlagers" of the upper division of the Lower Oolites. Thus *Ostrea acuminata, Ceromya plicata, Avicula echinata, Pholadomya Heraulti, Pecten vagans,* and *Pygurus Michelini,* found in the *Fullers Earth,* occur in all the other beds of the group. The *Stonesfield Slate* is not a constant member of the series, and

when present is often found to contain a special flora; jaws of Mammalia, belonging to the genera *Amphitherium* and *Phascolotherium*, and the bones and teeth of *Megalosaurus* and *Pterodactyles*, which were entombed in these slates, are likewise special to them; but the Mollusca and Echinidæ of the same beds are found in other members of the series. The *Great Oolite of Minchinhampton* contains a very rich fauna, many of the Molluscs extending through all the sub-divisions of the group, whilst others, as *Purpuroidea, Alaria, Pterocera, Pachyrisma*, &c., are special to it, and constitute exceptions to the general facies of the fauna which has a much more extended range through other formations. The *Bradford Clay*, with *Apiocrinus Parkinsoni, Terebratula digona, T. corarcta*, and *T. cardium*, is not always present; and even when present exhibits many phases of development, and appears to belong to one of the inlying argillaceous bands of the *Forest Marble*. This formation forms an important division of the group, and, although very fossiliferous, contains no species of mollusc, urchin, or coral, which can be said to characterize it, although the thinness of its beds and the amount of false bedding and oblique lamination its sections disclose, show that it was formed under very different conditions to the regular strata of thick-bedded Limestones, which preceded and followed this remarkably disturbed deposit. The *Cornbrash*, especially the development of this formation in Yorkshire, contains some species that as yet appear to be special to it; an examination of the list I have given of the fossils from the Cornbrash of the Yorkshire coast, contained in the cabinet of my old worthy friend John Leckenby, Esq., F.G.S.,* by whose assiduous collecting habits they have been accumulated, and by whose liberality they were communicated for publication, will satisfy the student of this fact. This list is the more important, as in making it out I had the advantage of my friend's most accurate critical knowledge in guiding me in determining the true character of all the species.

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* *Quarterly Journal of the Geological Society.* Vol. xvi., p. 27: 1860.

Oxfordien = Oxford Clay.

Oxfordien or Oxford Clay.	I.—*Marnes supérieures* à grandes *Ammonites plicatilis*, et *Pholodomya parcicosta*. II.—*Calcaires pseudo-lithographiques* à *Pholadomya ampla*, *Ammonites Babeanus*. III.—*Marnes Oxfordiennes inférieures* grises, et calcaires gris cendrés à Spongiares et *Ammonites biplex*, and *Amm. plicatilis*. IV.—*Marnes ferrugineuses oolithiques* à *Ammonites cordatus*, *Amm. perarmatus*, *Amm. oculatus*. V.—*Marnes Calloviennes* et calcaires marneux à *Ammonites athleta*, *Amm. lunula*, *Amm. Duncani*, *Pholadomya lineata*, *Poladomya decussata*, *Collyrites elliptica*.

I.—The marnes calloviennes et calcaires marneux, which represent the Kelloway rock at the base of the Middle Oolites of England, consist of marls and limestones of variable hardness and with an earthy fracture. The terrain has a rusty yellowish colour above, and is bluish, greyish, or blackish below, having a large quantity of oolitic iron disseminated throughout. Judging from the number of specimens in M. Martin's cabinets it must be a highly fossiliferous formation. The following is a list of the more common forms noted by me :—

Cephalopoda.

Ammonites calloviensis, *Sow.*
" macrocephalus, *Schloth.*
" anceps, *Reinecke.*
" Bakeriæ, *Sow.*
" modiolaris, *Llwhyd.*
Belemnites hastatus, *Blain.*
Nautilus hexagonus, *Sow.*
Ammonites Duncani, *Sow.*
" lunula, *Ziet.*
" athleta, *Phil.*
" coronatus, *Brug.*
" bipartitus, *Ziet.*

Conchifera.

Gryphæa dilatata, *Sow.*
Ostrea Marshii, *Sow.*
" gregarea, *Sow.*
Pecten fibrosus, *Sow.*
" vagans, *Sow.*
Isocardia tenera, *Phil.*

Brachiopoda.

Terebratula bicanaliculata, *d'Orb.*
" lagenalis, *Schloth.*
" Smithii, *Oppel.*
Terebratula calloviensis, *d'Orb.*
" pala, *von Buch.*
Rhynchonella Royeriana, *d'Orb.*

ECHINODERMATA.

Collyrites elliptica, *Ag.*	Pseudodiadema complanatum, *Ag.*
Pygurus Marmonti, *Ag.*	" superbum, *Ag.*
Holectypus striatus, *d'Orb.*	" calloviensis, *d'Orb.*
Polycyphus textilis, *Ag.*	Millericrinus Beaumontianus, *d'Orb.*
Pedina Gervillii, *Ag.*	" nodotianus, *d'Orb.*
Stomechinus calloviensis, *Cott.*	" sub-echinatus, *d'Orb.*
Acrosalenia radians, *Desor.*	" aculeatus, *d'Orb.*

II.—The marnes ferrugineuses oolithiques, à *Ammonites cordatus, Am. perarmatus, Am. oculatus,* &c., appear to correspond with some of the inferior beds in our lower calcareous grit.

III.—The marnes grises et calcaires gris cendrés avec couches de Spongiaires, consist of calcareous nodules in a similar matrix a few feet thick, containing many *Anthozoa* and *Spongia* of large dimensions. The fossils are very numerous and well preserved, they consist of *Ceriopora striata,* Goldf., *C. angulosa,* Goldf., *Scyphia obliqua,* Goldf., *S. pertusa,* Goldf., *S. paradoxa,* Münst., *Asterias scutata,* Münst., *Cidaris Blumenbachii,* Münst., *C. marginatus,* Goldf., *C. coronatus,* Goldf., *Trigonia clavellata,* Sow., *Pecten subtextorius,* Münst., *Terebratula bucculenta,* Sow., *T. pectunculus,* Schloth., *T. tetragona,* Roem., *Ammonites canaliculatus,* Münst., *Am. Henrici,* d'Orb., *Am. Eucharis,* d'Orb., *Belemnites Royerianus,* d'Orb., &c., &c.

IV.—The calcaires pseudo-lithographiques, à *Pholadomya ampla,* pass into—

V.—The highest terrains which extend throughout the northern part of the arrondissement, and are composed of the marnes supérieures à grandes *Amm. plicatilis,* et *Pholadomya parcicosta.* According to M. BEAUDOUIN * this zone is nearly 100 mètres = 328 feet in thickness, and contains some beautiful crystals of the metastatique carbonate of lime, balls of calcareous marls, very analogous to the chailles of the Franche-Comté, and probably on the horizon of those of l'Yonne. The fossils are not numerous, and those which retain their test have passed into a siliceous condition. The leading specimens are *Gryphœa dilatata,* Sow., *Pholadomya parcicostata,* Ag., *Trigonia clavellata,* Sow., *Melania striata,* Sow., *Ammonites plicatilis,* Sow.

* Bulletin de la Soc. Geol. de France, 1re Série, t. xiv, p. 155: 1842.

M. G. de NERVILLE * divides his group of "*Marnes Oxfordiennes et calcaire marneux Oxfordien*" into six beds which, in descending order, are :—

Marnes Oxfordiennes et Calcaire marneux Oxfordien.

6.—Marne jaunâtre, argileuse, assez coquillière, donnant du cement hydraulique, *ciment de Molesmes.* 10 mètres.
5.—Une assise d'un *calcaire marneux*, gris de fumée, alternant avec des lits marneux. 30 mètres.
4.—Calcaire marno-compacte Oxfordien. Cette assise présente souvent, vers sa base, des cherts (*chailles*) siliceux bien distincts de ceux qu'on rencontre aussi accidentellement plus bas à la base du Groupe Corallien. 30 mètres.
3.—Marnes mélangées d'un grande nombre de bancs lenticulaires et de *rognons* de calcaire marno-compacte d'un gris bleuâtre. 15 mètres.
2.—Assise purement marneuse, des *marnes Oxfordiennes* proprement dites; composée de marnes bleuâtres, très-coquillières, à fossiles souvent pyriteux. 15 mètres.
1.—Couche de *Minerai de fer* hydroxidé à Oolithes miliares, à gangue calcaire et marneuse. Horizon geognostique d'une sûreté absolue. 3 mètres.

M. JULES MARCOU † has shewn that Nos. 4, 5, 6, of M. de NERVILLE's section are synchronous with his *Argovien;* Nos. 2 and 3 with his Marnes Oxfordien; and No. 1 with the Fer de Clucy in the Jura franc-comtois.

The Oxfordien is well developed in the adjoining department of the Haute-Marne, where, according to M. E. ROYER, ‡ it is divisible into—

1.—*Marnes Oxfordiennes supérieures.*
2.—*Marnes Oxfordiennes moyennes.*
3.—*Marnes Oxfordiennes inférieures*, ou marnes bleues avec *Ammonites biplex* et autres petites Ammonites pyriteuses.
4.—*Marnes Oxfordiennes ferrugineuses*, ou terrain *Kellovien*, which contains a great number of fossils of this stage.

The Jura of Haute-Saône has been most carefully described, bed by bed, by M. THIRRIA. § In the lower portion are—1st, brownish marls, very rich in "minérai de fer hydroxidé oolithique," with *Ammonites macrocephalus.* 2nd, blackish grey marls, with *Ammonites Lamberti, Am. Mariæ, Am. dentatus, Am. coronatus, Rynchonella Thurmanni, Pentacrinus pentagonalis*, &c. 3rd, argiles avec chailles, or yellowish clay, representing the upper portion of the Oxford Clay, or the *couches d'Argovie* ou *Argovien* of M. MARCOU.

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* Légende explicative. † Lettres sur les roches du Jura, p. 163.
‡ Bull. Geol. Soc. France, tome viii, p. 582: 1851.
" " tome viii, 2e Série, p. 600.
§ Statistique géolog. de la Haute-Saône: 1833.

M. J. Thurmann, * in his admirable essay, "sur les soulèvemens Jurassiques du Porrentruy," has described the Oxfordien group in the Jura as it exists in Mont-Terrible. The division and palæontology of these beds agree substantially with the condition of things existing in the departments of France, just described.

M. Jules Marcou † has contributed a most valuable memoir on the Jura salinois, in which he has described the physical and biological contents of the Jurassic rocks in the Franche-Comté. The same learned author has, likewise, in a later publication, a series of letters to my late friend Professor Oppel, compared the synchronism of the middle and upper Jura franc-comtois with corresponding formations described in the memoirs on the Haute-Saône, by M. Thirria; the Côte-d'Or, by M. de Nerville; the Haute-Marne, by M. E. Royer; the Meuse, by M. Ed. Piette; the Moselle, by MM. Terquem and Piette; the Ardennes, by M. Piette; the Cévennes by MM. Em. Dumas and Paul de Rouville; and the lower Jura with the works of different English authors,—Professor Phillips, Mr. Edward Hull, and Dr. Wright.

Dr. William Smith long ago divided his Clunch, or Oxford Clay, into the argillaceous strata, or Oxford Clay proper, forming the great mass of the formation and including subordinate beds of yellow sandy Limestone, which he first found at Kelloway Mill, Wilts, and which he called Kelloway rock. Subsequent discoveries have proved that the distinction was correct, and that a classification of the upper beds of the group may be made by a critical study of their organic remains. Keeping steadily in hand the key that has helped us to unlock the sub-divisions of the Lias and Lower Oolites, let us proceed with the beds of the middle oolitic formations.

Many years ago, during the construction of the Great Western Railway between Chippenham and Trowbridge, the lower beds of the Oxford Clay down to the Cornbrash were cut through, and an immense number of Ammonites and other

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* Mémoires de la Soc. d'Hist. Naturelle, de Strasbourg: 1832.

† Recherches géol. sur le Jura salinois, Mem. Soc. géol. de France: 1846.

shells were obtained therefrom. The laminated clays of Christian Malford were likewise extensively worked for fossils, and from these various sources of knowledge we learn that the Oxford Clay of Wilts may be thus divided into three zones, taking the dominant Ammonite in each zone as characteristic of it. The following table explains the sequence of the beds in the Trowbridge railway cutting:—*

	Lithology.	Zones.	Leading Fossils.
		Coralline Oolite.	
Calcareous Grit.	Soft variegated siliceous sands alternating with calcareous grits and bands of siliceous sandstone containing shelly fragments; the beds full of oblique lamination, near Calne.	Ammonites Perarmatus.	Ammonites perarmatus, Amm. cordatus, Amm. Lamberti, Amm. Sutherlandiæ, Amm. Crenatus.
Oxford Clay.	Dark bituminous slaty clay containing septaria and veins of stone with large Ammonites; the laminated clays have the shells of Ammonites and other Mollusces well preserved, but much compressed as at Christian Malford.	Ammonites Jason.	Ammonites Jason, Amm. lunula, Amm. Reginaldi, Amm. Comptoni, Belemnites Puzosianus, B. abbreviatus, Acanthoteuthis antiquus, Sepia, Loligo, Alaria armigera, Turritella muricata, Trigonia clavellata, Nucula Phillipsii, Ostrea deltoidea.
Kelloway Rock.	Rusty, yellow-coloured, sandy Limestone, passing into grey, Kelloway Mill and railway cuttings. Wilts. Scarboro', Yorkshire.	Ammonites Calloviensis.	Amm. calloviensis, Am. Gowerianus, Am. modiolaris, Am. Königii, Ancyloceras callovicense, Isocardia tenera.
Kelloway Shales.	Dark, drab, or bluish clay containing many nodules, having Ammonites for a nucleus, railway cutting, near Trowbridge.	Ammonites Macrocephalus.	Am. macrocephalus, Amm. modiolaris, Am. Gowerianus, Am. Chamusseti, Am. funiferus.
		Cornbrash.	

* A very good section of the Trowbridge cutting, carefully measured and accurately described by Reginald Mantell, Esq., C.E., was published in the *Quarterly Journal of the Geological Society*, Vol. xvi, p. 310: 1850. The lists of fossils and description of new species by Professor Morris, F.G.S.

I.—*Zone of Ammonites macrocephalus.* Beneath the Kelloway Rock, in Wiltshire, there is a bed of dark blue clay containing many Ammonites and argillaceous nodules, having chiefly young Ammonites and other molluscs for their nuclei; this bed was well exposed in the railway cutting near Trowbridge, and I fortunately possess a very complete suite of the fossils collected therefrom. The clay was especially rich in Cephalopoda, as the following list shews:—

CEPHALOPODA.

Ammonites macrocephalus, *Schloth.*	Ammonites Gowerianus, *Sow.*
" modiolaris, *Llhwyd.*	" Königii, *Sow.*
" Chamusseti, *d'Orb.*	Belemnites abbreviatus, *Mill.*

CONCHIFERA.

Trigonia clavellata, *Sow.*	Modiola bipartita, *Sow.*
Avicula expansa, *Phil.*	Nucula Phillipsii, *Mor.*

On the Yorkshire coast the Kelloway rock is largely developed and separated from the Cornbrash by a bed of dark-bluish clay, more or less laminated, varying in thickness from four inches to six feet: this, the so-called "clay of the Cornbrash," appears to represent the zone of *Am. macrocephalus*, as it contains several species of shells which are rarely, if ever, met with in the Cornbrash, as *Ammonites macrocephalus*, Schloth., *Sanguinolaria parvula*, Bean., *Cardium latum*, Bean., *Opis triangularis*, Bean., *Belemnitis tornatilis*, Phil.* The claws and carapaces of two crustacea, *Glyphœa rostrata*, Phil., *G. Birdii*, Bean., occur in round argillaceous nodules in this clay at Cayton Bay, with *Hemipedina Woodwardii*, Wr., collected therefrom, and given to me by the late Dr. MURRAY.

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* *Sanguinolaria parvula* and *Cardium latum*:—These very doubtful species, founded on solitary examples, are really unworthy of being continued in any list of Cornbrash fossils. The first is no true Sanguinolaria. *Opis triangularis*, Bean, is hardly even a variety of *Isocardia nitida*, Phillips; it is not an Opis; and I have struck it out of my list of Cornbrash fossils. *Ammonites macrocephalus*, Schloth., is not peculiar to the clay, but is found much more abundantly in the true Cornbrash below. The only characteristic fossil, therefore, is the species referred to, *Belemnites tornatilis*, Phillips; but I cannot refer it to any of the varieties of *B. Oveni* in which Prof. PHILLIPS now includes *B. tornatilis*—it comes nearer to *B. abbreviatus*. Note by J. LECKENBY, Esq.

II.—*The zone of Ammonites calloviensis*, or Kelloway Rock, was first discovered by Dr. WILLIAM SMITH, at Kelloway Mill, Wiltshire, and afterwards *in situ* in the Castle Hill, Scarborough. This is the true correlative formation to the *Marnes calloviennes* and *Calcaires marneux*, of Mr. MARTIN. From this stone, in Wiltshire, I have collected:—

CEPHALOPODA.

Belemnites tornatilis, *Phil.*
Ammonites calloviensis, *Sow.*
" Gowerianus, *Sow.*
" Lamberti, *Sow.*
" Hecticus, *Hart.*
" Guillelmi, *Sow.*
Ammonites Duncani, *Sow.*
" athleta, *Phil.*
" modiolaris, *Llhwyd.*
" Königii, *Sow.*
" sublævis, *Sow.*
Ancyloceras callovicense, *Mor.*

GASTEROPODA.

Alaria bispinosa, *Phil.*
Littorina punctura, *Sow.*
Turbo elaboratus, *Lyc. and Mor.*
Pleurotomaria granulata, *Sow.*

CONCHIFERA.

Pholadomya acuticosta, *Sow.*
Astarte minima, *Phil.*
" carinata, *Phil.*
Isocardia tumida, *Phil.*
" tenera, *Phil.*
Nucula lachryma, *Sow.*
Goniomya v. scripta, *Sow.*
Trigonia clavellata, *Sow.*
" costata, v. pulla, *Sow.*
Myacites recurvus, *Phil.*
" decussatus, *Phil.*
" calceiformis, *Phil.*
Gresslya perigrina, *Phil.*
Unicardium depressum, *Phil.*
Cardium cognatum, *Phil.*
" striatulum, *Phil.*
Lucina lirata, *Phil.*
Cucullæa minima, *Leck.*

BRACHIOPODA.

Terebratula ornithocephala, *Sow.*
Rhynchonella varians, *Schloth.*

My old esteemed friend, J. LECKENBY, Esq., F.G.S., of Scarborough, has contributed a valuable paper on the Kelloway Rock of the Yorkshire coast,* and which I quote here as an important addition to my very imperfect notes on this formation in Wiltshire. It is seen in the cliff to the south of Gristhorp Bay, the projecting point of Red Cliff, and at the Castle Hill,

* *Quarterly Journal of the Geological Society.* Vol. xv, p. 4: 1859.

Scarborough, where a fine section near the pier may be easily and advantageously examined. It consists of the following:—

		ft.	in.
A.	Moderately compact irony sandstone $1\frac{1}{2}$ feet thick, traversed by darkened veins of the same metallic character; it contains *Am. Königii*, *Am. flexicostatus*. Special to the bed *Bel. tornatilis*	1	6
B.	Loose friable sandstones, without fossils	4	0
C.	Similar to A, but richer in organic remains, containing, besides those enumerated, *Am. modiolaris*, *A. Gowerianus*, *A. Chamusseti*, *Pholadomya acuticosta*, *Modiola pulchra*, and *Gryphæa dilatata*. It is a more nodular cherty bed than A	1	6
D.	Compact almost unfossiliferous sandstone, sometimes an Ammonite or a Belemnite in the large blocks ...	20	0

The following is a catalogue of the fossils collected by J. Leckenby, Esq., from Kelloway Rock, of Yorkshire, with descriptions of some new, or imperfectly understood species.*

Cephalopoda.

Ammonites sublævis, *Sow.*
" ordinarius, *Bean*, MS.
" rugosus, *Leck.*
" Gowerianus, *Sow.*
" reversus, *Simp.*, MS.
" vertumnus, *Bean*, MS.
" poculum, *Bean*, MS.
" Chauvinianus, *d'Orb.*
" alligatus, *Bean*, MS.
" Arduennensis, *d'Orb.*
" binatus, *Bean*, MS.
" Königii, *Sow.*
" athleta, *Phil.*
" gemmatus, *Phil.*
" Guillelmi, *Sow.*
" Murrayanus, *Simp.*, MS.
" placenta, *Bean*, MS.
" Lamberti, *Sow.*
Ammonites putealis, *Bean*, MS.
" turgidus *Bean*, MS.
" gregarius? *Bean*, MS.
" lunula, *Zieten.*
" Chamusseti, *d'Orb.*
" lenticularia, *Phil.*
" funiferus, *Phil.*
" hyperbolicus, *Simp.* MS.
" glabellus, *Bean*, MS.
" conterminus, *Bean*, MS.
" bipartitus, *Zieten.*
" Baugieri, *d'Orb.*
" flexicostatus, *Phil.*
Belemnites tornatilis, *Phil.*
" Puzosianus, *d'Orb.*
a. " hastatus, *Blain.*
a. " gracilis, *Phil.*
c. Nautilus hexagonus, *Sow.* (*b*) 2.

Note.—Of the foregoing list of *Ammonites*, one species *Am. alligatus* ascends to the Calcareous Grit above. All the others (except *Am. binatus*, of which a dwarfed variety is found in the Oxford clay,) are peculiar to the Kelloway Rock.

(*b*) 2 Two species named above are found in the Calcareous Grit; and to the above list should be added *Am. perarmatus* and *Am. hexicostatus*. The former also ascends to the Calcareous Grit. *Am. putealis* is a variety of *Am. Hecticus*. Note by J. Leckenby, Esq.

* *Quarterly Journal of the Geological Society.* Vol. xvi., p. 4: 1859.

Gasteropoda.

a. Alaria bispinosa, *Phil.*
(*d*)4. Natica, (a cast)
b. Chemnitzia vittata (?) *Phil.*
(imperfect casts.)
Cerithium abbreviatum (NS.)
" Culleni (NS.)
b. Littorina punctura, *Bean*, MS.
b. " ornata, *Sow.*
Turbo sulcostomus, *Phil.*
b. Turbo elaboratus, *Lyc. and Mor.*
Pleurotomaria guttata, *Phil.*
" arenosa, *Bean*, MS. (*a i*)
b. " granulata, *Sow.*
a. " depressa, *Phil.*
" striata, *Bean*, MS.
Patella? graphica, *Bean*, MS.
a. Actæon retusus, *Phil.*
c. Dentalium annulatum, *Bean*, MS.

Brachiopoda.

(*e*)5 *b.* Terebratula ornithocephala, *Sow.*
c. Rhynchonella varians, *Schloth.*
Lingula lævis, MS.
Discina (Orbicula) centralis, MS.

Mr. Bean's Collection.

Conchifera.

b. Gryphæa bullata, *Sow.*
c. " dilatata, *Sow.*
c. Anomia inæquivalvis, *Phil.*
Ostrea canaliculata, *Bean*, MS.
" procerula, *Bean*, MS.
" A peculiarly elongated smooth species approaching *Vulsella.*
" striata, *Bean*, MS.
c. Pecten demissus, *Phil.*
b. " fibrosus, *Phil.*
c. " vagans, *Sow.*
c. " abjectus, *Phil.*
c. " arcuatus, *Sow.*
b. Lima duplicata, *Sow.*
" Phillipsii, *d'Orb.*
" notata, *Goldf.*
c. Avicula inæquivalvis, *Sow.*
a. " ovalis, *Phil.*
c. " Brammburiensis, *Phil.*
" clathrata, *Bean*, MS.
b. " rugosa, *Goldf.*
a. Pinna mitis, *Phil.*
c. Modiola bipartita, *Sow.*
c. " cuneata, *Sow.*
" pulcra, *Phil.*
a. Cucullæa æmula, *Phil.*
b. " elongata, *Sow.*
b. " clathrata, (NS.)
" minima, (NS.)
Solemya Woodwardiana, (NS.)
c. Nucula lacryma, *Sow.*
c. Trigonia costata, v. pulla, *Sow.*
c. " elongata, *Sow.*

(*a i*) *Pleurotomaria arenosa* is merely the well-preserved condition of *P. guttata.* The test in the type of the latter has perished except the thick nodular portion upon the sutures, from whence its name. In the well-preserved *arenosa* the guttæ appear less prominent by comparison with the highly ornamented diameter of the other parts of the shell. Note by J. Leckenby, Esq.

(*d*) 4 Natica Guerrei, *Deslongch.* Note by J. Leckenby, Esq.

(*e*) 5 Terebratula Buckmani, *Davidson.* Note by J. Leckenby, Esq.

(c)3. Trigonia clavellatta, *Park.*
c. " variety much less produced posteriorly, and with the tubercles crowded on the anterior margin.
Ostrea undosa, *Bean*, MS.
Ostrea archetypa, *Phil.*
c. " Marshii, *Sow.*
b. Cardium cognatum, *Phil.*
b. " citrinoideum, *Phil.*
" subdissimile (?) *d'Orb.*
a. " Crawfordii, (NS.)
Lucina lirata, *Phil.*
b. " crassa, *Sow.*
Corbis ovalis, *Phil.*
" lævis, *Sow.*
b. Astarte lurida, *Sow.*
b. " minima, *Phil.*
b. Astarte politula, *Bean*, MS.
b. Unicardium depressum, *Phil.*
b. " sulcatum, *Bean*, MS.
c. Isocardia tumida, *Phil.*
b. " minima? *Sow.*
b. " nitida, *Phil.*
" ? clarissima, *Bean*, MS.
c. Anatina undulata, *Sow.*
" versicostata, *Buvig.*
b. Pholadomya acuticosta, *Sow.*
b. " ovalis, *Sow.*
" carinata? *Goldf.*
b. Myacites calceiformis, *Phil.*
b. " decussatus, *Phil.*
b. " securiformis, *Phil.*
a. " recurvus, *Phil.*
c. Goniomya, v. scripta, *Sow.*
c. Gresslya peregrina, *Phil.*

CRUSTACEA, ANNELIDA, &c.

c. Glyphæa rostrata, *Phil.*
c. Serpula intestinalis, *Phil.*
Cidaris, imperfect fragments.
Encrinital stems.

Note.—The species marked *a*, in the above list, occur also in the bed above, or the Oxford clay; the letter *b* indicates that the species is found in the bed below, or the Cornbrash; *c*, that it is common to all the three deposits.

The Zone of Ammonites Jason.—Dark-coloured slaty shales of the Oxford Clay, in parts unctuous and bituminous, and emitting a gas which burns with brilliancy when lighted. It contains many Belemnites and compressed Ammonites, with their white calcareous shell well preserved; here, likewise, was found *Acantholeuthis antiquus*, *Sepia*, and *Loligo*, with ink-bags attached. This is the division of the Oxford Clay which was so long successfully worked by the late Mr. WILLIAM BUY, at Christian Malford, and from whence all the fine specimens that he distributed throughout the country were obtained.

(c) 3 *Trigonia clavellata* should not be inserted, as I have lately added three new species of clavellated Trigonia, including the form thus noted, which will be described and figured by Dr. LYCETT in his forthcoming work on the genus *Trigonia*. One of these is from a seam only quite lately explored and which has yielded *Tancredia curtansata*, *Mya modria*, (dwarfs,) *Gervillia acuta*, not hitherto found in the Kelloway rock. Note by J. LECKENBY, Esq.

Cephalopoda.

Ammonites Jason, *Reinecke.*
" Guillelmi, *Sow.*
" Comptoni, *Pratt.*
" Lonsdalii, *Pratt.*
" Brightii, *Pratt.*
" Reginaldi, *Mor.*
Ammonites fluctuosus, *Pratt.*
" cordatus, *Sow.*
" modiolaris, *Llhwyd.*
Belemnites Puzosianus, *d'Orb.*
" hastatus, *d'Blain.*
Acanthoteuthis antiquus, *Pearce.*

Gasteropoda.

Turritella muricata, *Sow.*
Alaria composita, *Sow.*
Alaria bispinosa, *Phil.*
" trifida, *Phil.*

Conchifera.

Gryphæa dilatata, *Sow.*
Ostrea gregaria, *Sow.*
Avicula inæquivalvis, *Sow.*
" ovalis, *Phil.*
Modiola bipartita, *Sow.*
Pholadomya deltoidea, *Sow.*
Nucula Phillipsii, *Mor. and Lyc.*
" elliptica, *Phil.*

The Zone of Ammonites perarmatus,—or lower Calcareous Grit, is the equivalent of the "marnes ferrugineuses oolithiques à *Am. cordatus, Am. perarmatus, Am. oculatus*, &c.," of M. Martin. This formation is by most English geologists "considered a subordinate member of the Coral Rag, though containing some fossils peculiar to itself, and being principally an arenaceous instead of a calcareous rock." With some continental authors it is the upper member of the Oxfordian stage, as having greater palæontological affinities with the other divisions of this group than with the coralline Oolite which rests upon it.

It consists of a series of soft, variegated, siliceous sands, alternating with calcareous grits, and bands of siliceous Limestone, with fossils. The beds of Calcareous Grit are very irregular, and frequently present the phenomena of oblique lamination or current-bedding.* It varies in thickness from 20 to 80 feet. In the bands of calcareous sandstone, fossils are plentiful, though generally fragmentary. This zone is well developed near Calne, Wilts; Headington Hill, near Oxford;

* Memoirs of the Geol. Survey, Expl. of Sheet 13, p. 5, by Messrs. Hull and Whitaker.

Abingdon and Marcham, Berks; Weymouth, Dorset; &c. The following are the leading fossils I have collected from the first of these localities:—

Cephalopoda.

Ammonites perarmatus, *Sow.*	Ammonites Lamberti, *Sow.*
" cordatus, *Sow.*	" Arduennensis, *d'Orb.*
" Sutherlandiæ, *Sow.*	" crenatus, *Brug.*

Without making a special study of the Calcareous Grit it would be impossible to give a correct table of its conchifera, as our lists have for the most part been made from the Coral rag and Calcareous Grit taken together. Although the Ammonites I have named are found in the upper part of the Oxfordian, still I think that portion of the bed more properly belongs to the zone of *Am. perarmatus*, than to the slaty bituminous shales of the true Oxford Clay on which it rests.

Corallien = Coralline Oolite.

The Corallien in the Côte-d'Or consists, according to M. Martin, of the following sub-divisions:—

A. Oolithe corallienne à Diceras et calcaire compacte.
B. Calcaire fissile sub-oolithique et calcaire blanc à Polypiers.
C. Calcaire grumeleux compacte, calcaire à chailles et marnes inferieures à *Glypticus hierogliphicus*, *Cidaris florigemma*, *&c.*

The Coral Rag and Pisolite of Dr. William Smith is, in part only, the equivalent of this stage, which is so well developed in Wiltshire, Berkshire, Oxfordshire, Buckinghamshire, Dorsetshire, and Yorkshire, and forms such an important feature in the sedimentation of the Middle Oolites. During the Oxfordian age, Ammonites, numerous in species and multitudinous in individuals, crowded the seas from which were deposited the middle Jurassic formations from the macrocephalus to the perarmatus zones of life; but with the commencement of the coralline stage, on the study of which we now enter, a great change in the physical conditions of the bed of that sea seems to have taken place; the comparative shallow water in which the Oxfordian Cephalopoda disported, was now changed into

a deep ocean in a slowly subsiding area,—a condition of things, probably analogous to the coral sea within 30° of each side of the equator in our day. The Jurassic waters were then studded with coral reefs, extending over an area equal to a great portion of modern Europe, as shown by the geographical distribution of the coralline formations, which stretch through England in a diagonal line from Yorkshire to Dorsetshire; through France, from the coast of Normandy to the shores of the Mediterranean, forming besides a chain extending obliquely through its central portion from the department of the Ardennes in the north, to Charente Inférieure in the south, including Savoy, the Hautes-Alpes, and Basses-Alpes; the Jura of the Haute-Saône, and the Jura franc-comtois, and the Swiss Jura chain throughout its entire length; from Schaffhausen on the Rhine, to Coburg in Saxony, and along the range of the Swabian Alps, and the Franconian Jura. The corallian, was, therefore, a widely extended formation, and appears to have been formed under conditions similar both in their physical and biological relations.

The Ammonites that have hitherto helped us to determine the limits of the Jurassic formations are unfortunately rare in the corallian strata, and we must seek among the leading fossils of these beds for other genera, whereby to ascertain their correlations; fortunately we find excellent substitutes in the *Corals, Echinidæ,* and certain genera of *Mollusca* so abundant in the different stages thereof. Examined by this test the corallian terrains in France, Germany, and Switzerland admit of a division into three zones, which, in descending order, may be thus defined:—The upper zone consists of fine white earthy or siliceous limestones like chalk, with numerous species of *Nerinœa,* and *Diceras arietina,* which characterize it. The second zone is remarkable for the large number of corals it contains, and which form a Madreporic Limestone; in fact, the fossil reefs of a coral sea. The third zone contains many Echinoderms, among which *Cidaris florigemma* and *Glypticus hieroglyphicus* are conspicuous; the spines of *Cidaris florigemma* alone forming an excellent leading fossil when the test is absent.

Lithology.	Zones of the Coralline Oolite.	Leading Fossils.
Calcaires à Astartes. Calcaires à Nérinées. Calcaires à Diceras.	I. Nerinæan Zone.	*Astarte minima, Exogyra Bruntrutana, Nerinœa Bruntrutana, N. Calypso, Diceras arietina.*
Calcaires compactes et sub-oolithiques avec calcaire à Polypiers.	II. Coral Zone.	*Thecosmilia annularis, Stylina tubulifera, Montlivaltia dispar, Isastræa explanata, Thamnastræa arachnoides, T. concinna, Cosmoseris irradians.*
Calcaires grumeleux compactes. Terrain à Chailles. Marnes inférieures.	III. Echinidian Zone.	*Cidaris florigemma, C. Blumenbachii, Hemicidaris crenularis, C. coronata, Echinus perlatus, Glypticus hieroglyphicus, Millericrinus echinatus.*

Of these three zones we can correlate the Coralline Oolite, Coral Rag, and Pisolite of Smith with II. and III., but the Superior, or Nerinæan, zone is absent in England.

M. G. de Nerville* divides his groupe Corallien of the Côte-d'Or into eight formations, which, in descending order, are as follows:—

Groupe Corallien.

8.—*Calcaire à Ptérocères.* Calcaire jaune, a points verts, sableux, renfermant quelques minces bancs de marnes sableuses. Caracterisé par le *Pterocera Oceani.*

7.—*Calcaire à Astartes.* A la base se trouve un banc marneux.

6.—*Calcaire à Nérinées.* Calcaire blanc mat, à pâte fine, crayeuse, oolithique, renfermant beaucoup de Nérinées.

5.—*Oolite corallienne,* formée de gros grains oolithiques, et pisolites oblongues, soudées par un ciment calcaire très-solide.

4.—*Calcaire compacte et piqueté corallien.* Calcaire compacte, à pâte fine, à fond blanc grisâtre piqueté de petites taches rondes roussâtres.

3.—*Calcaires fissiles et sub-oolithiques coralliens.*

2.—*Calcaire Madreporique.* Calcaire blanc-grisâtre composé en grande partie de coraux.

1.—*Calcaire compacte inférieur grumeleux corallien.* Tres-fossilifère, riche surtout en *débris* de grasses Apiocrinites et d'Oursins. Renfermant en quelques points de nombreux cherts (*chailles*) siliceux.

This classification differs from that of M. Martin, (p. 145.) The *Calcaire à Ptérocèren* (8) is grouped with his Kimméridien;

* Legende explicative de la carte géolog. du Depart. de la Côte-d'Or: 1853.

the *Calcaire à Astartes*, (7) and *Calcaire à Nérinées* (6) forming his Séquanien, and the stages (5, 4, 3, 2, 1) constituting his Corallien. The facts are the same, the grouping alone being different.

M. THIRRIA † has given an admirable description of the petrography and stratigraphical relations of the Jurassic Rocks in the Haute-Saône, which adjoins the Côte-d'Or, and from his memoir we learn some important details on the Corallien of that department, and which I quote.

Calcaires à Astartes.

a. Calcaire un peu marneux, grisâtre, avec *Astarte minima.*
b. Marne grise.
c. Calcaire un peu marneux, schisteux et grisâtre, avec *Astarte minima, Exogyra Bruntrutana.*
d. Marne grise.
e. Calcaire un peu marneux, schisteux et grisâtre, avec *Astarte minima, Trigonia suprajurensis.*
f. Calcaire grisâtre, compacte, avec *Astarte, Ostrea, Apiocrinus.*

Calcaire à Nérinées.

a. Calcaire compacte, grisâtre, avec Oolites miliares et *Nerinea* et *Crinoids.*
b. Calcaire blanchâtre, oolithique.

Oolithe Corallienne.

c.—Calcaire dit *Vergenne* ou pierre blanche, avec Oolites cannabines avec *Nerinea Bruntrutana, Diceras arietina, Calamophyllia, Isastræa.*
d.—Calcaire jaunâtre, avec grasses Oolites.

Calc. compactes et sub-oolithiques avec fossiles siliceux.

a.—Calcaire compacte.
b.—Calcaire compacte, très-oolithique, avec coraux siliceux.
c.—Calcaire compacte, grisâtre, avec entroques et coraux.
d.—Calcaire compacte, alternant avec des couches de calcaires marneux, avec entroques et coraux. *Serpula grandis, Thecosmilia annularis, Stylina tubulifera, Montlivaltia dispar, Isastræa explanata, Thamnastræa arachnoides.*

Argile avec Chailles, pars.

a.—Argile jaune, siliceuse, avec chailles géodiques et *Hemicidaris crenularis, Pedina sublœvis, Cidaris Blumenbachii, C. Parandieri, C. florigemma, C. coronata, Echinus perlatus, Glypticus hieroglyphicus, Apiocrinus Roissyanus, Millericrinus Milleri, M. rosaceus, &c.*

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† Statistique géologie de la Haute-Saône: 1833.

From these sections we observe that the three zones already described, are present in the departments of the Côte-d'Or and Haute-Saône, and extend into those of the Doubs and Jura, as shewn in M. Marcou's memoir on the Jura salinois; the upper zone attaining a considerable development in that region. M. Martin's cabinets contain a very fine series of fossils from all the three divisions. Many of those from the Echinidian and Coral zones were forms well known to me, from their specific identity with some of the Echinidæ and Anthozoa of our own Coralline Oolite. I was not unfamiliar with the large Nerinæas and Diceras from the upper zone, as M. Etallon had, several years ago, sent me a very fine series of Mollusca and Polypifera from the Dicératien zone of the environs of St. Claude in the Haut-Jura.

Coralline Oolite.—This important member of the English Oolitic system was described by Dr. William Smith as "Coral Rag and Pisolite," and by Conybeare and Phillips as "the Superior or Oxford Oolite with Calcareous Grit and Sand, forming the lowest beds." It comprises a series of strata from one to two hundred feet in thickness, ranging obliquely north and south from Weymouth, in Dorset, and passing through the counties of Wilts, Oxon, Berks, and Bucks to Yorkshire, where it is well developed and exposed. Near Calne, Wilts, it consists of—1st, Calcareo-siliceous or Upper Calcareous Grit, underlaid by a band of 10 feet thick of ferruginous clay; 2nd, Coral Rag composed of thick-bedded oolitic freestones and rubbly Oolite, about 80 feet, resting upon irregular beds of rubbly Oolite, 40 feet thick, containing corals; 3rd, Clay and fissile Oolite, 40 feet, containing the tests and spines of numerous Echinidæ, as *Cidaris florigemma*, *Hemicidaris intermedia*, *Pseudodiadema versipora*, &c.; and, 4th, Lower Calcareous Grit, consisting of sand, with beds of calcareous grit and impure Limestone, containing large *Ammonites perarmatus*, and Star-fishes, *Astropecten rectus*,—this formation passing into and resting upon the Oxford Clay. The Coral Rag freestones, representing the middle zone, are well seen at Calne: the corals, at Steeple Ashton, and the beds with Echinoderms, representing the

lower zone, near Calne and Lynham. Everywhere the coral rag or middle zone has the character of being an ancient coralline sea-bed, interposed between two arenaceous deposits, (the upper and lower calcareous grits,) and is remarkable for the vast assemblage of reef-building polypifera, and the tests, spines and *débris* of Echinidæ it contains compared with the small proportion of Mollusca found with them.

Steeple Ashton, Wilts, was long a famous locality for corals. The surface of the fossiliferous beds of the Coral Rag were there exposed in many fields, and the corals annually turned out by the plough were exposed to the air and weathered. I have collected the following species from this locality:—

Corals from Steeple Ashton.

Stylina tubulifera, *Phil.*
" Delabechii, *Edw. & Haime.*
Thecosmilia annularis, *Keferstein.*
Calamophyllia Stokesii, *Edw. & Haime.*
Cladophyllia Conybearii, *Ed. & Haime.*
Goniocora socialis, *Röem.*
Isastræa explanata, *Goldf.*
Thamnastræa arachnoides, *Park.*
" concinna, *Goldf.*
Comoseris irradians, *Edw. & Haime.*

The Coral Rag at Farringdon, Berks, consists of irregularly bedded coralline Limestone, with beds of clay intercalated therewith; the corals are, for the most part, species of *Thamnastræa*, *Thecosmilia*, and *Isastræa*, &c., lying in the position in which they grew in the lagoon of the coral sea. At Marcham, Garford, Fyfield, and Bradley, near Cumner, there are several quarries of this rock. At Headington, a good section of the whole series is obtained. "The formation here divides itself into a lower and upper series. The lower beds are of the more usual description, and are well shewn in a quarry 100 yards south of the Windmill, near Workhouse Farm. They are formed of enormous quantities of fragmentary corals, besides *Conchifera*, in great abundance. The corals are of the genera *Thecosmilia* and *Isastræa*, &c., and are generally imbedded in thin coatings of clay. In this section the thickness of the rock is 12 feet, and at the base we find the soft brown sands of the lower calcareous grit. Further to the north-east we find the higher beds of the coralline Oolite well

exposed in quarries at the base of the Kimmeridge clay; they consist of coarse oolitic Freestone, yielding large blocks of building stone, which has been extensively used at Oxford for buildings later than the fifteenth century. This Freestone is 12 feet thick, which gives a total of 25 feet for the Coral Rag in this locality." *

The coralline Oolite is well developed and admirably exposed near Malton, Yorkshire, where large quarries of compact thick-bedded freestones are worked, near the town, and yield a rich harvest of organic remains. A beautiful fine-grained building stone, containing much siliceous matter, is extensively quarried near Hildenley, for church decoration, from which Sir C. Strickland, Bart., whose property it is, has collected a very fine series of fossils. At Hackness, Ayton, and Seamer, near Scarborough, there are many exposures, from whence the madreporic beds of this formation are extensively raised for road material; they consist of old coral reefs, in beds of from 10 to 15 feet in thickness, composed of layers of crystallized coral rock from 18 to 24 inches in thickness, largely consisting of *Thamnastræa concinna*, Goldf., and other Anthozoa; each layer being separated from the others by rubbly clay and mud. The largest quarry is near Ayton, another is near Seamer, and others are in the neighbourhood of Wykeham and Brompton. The Ayton quarry, which may be considered as the type, contains large nodulated masses of madreporic Limestone, the beds composing it having an irregular undulating surface. The corals appear to have grown in areas of depression in the coralline sea, for the rock consists of large masses of a very hard and highly crystalline madreporic Limestone, forming nodulated eminences and concave curves in beds of from 12 to 18 inches in thickness, a stratum of yellowish clay filling up the hollows, and forming a horizontal line in the stratification of the bed. A stratum of nodulated crystalline Limestone is covered by a layer of clay, and thus the rock is made up just

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* Memoirs of the Geol. Surv. The Geology of parts of Oxfordshire and Berkshire, (Sheet 13,) by EDWARD HULL, B.A., and WILLIAM WHITAKER, B.A.: 1861.

as modern reefs are filled in by the erosion and fracture of the outer walls of the reef; the accumulation of the *débris* being ground down to mud and sand and washed into the interstices, and plates, and branches of the polypes that are building other parts of the living mass. The Ayton reef is exposed to about 10 feet in section, and rests upon another reef forming the floor of the quarry, and which descends many feet deeper. The corals are perforated by boring shells *Gastrochæna*, and numerous Molluscs that nestled in the creeks and crannies of the lagoon are here entombed as they died. Of these *Phasianella striata*, Sow., *Pecten vemineus*, Sow., *Pecten lens*, Sow., *Turbo muricata*, Sow., are most conspicuous; besides numerous other shells as *Chemnitzia*, *Nerinœa*, and other genera of the family *Pyramidalidæ*, that had their home in the lagoons of the coral sea. The following species collected from the coralline Oolite of Yorkshire, are preserved in the Museums of York, Scarborough, and Whitby, and likewise in the cabinet of J. Leckenby, Esq.:—

Anthozoa from the Coralline Oolite.

Montlivaltia dispar, *Phil.*
Rhabdophyllia Phillipsii, *Ed. & Haime.*
Thecosmilia annularis, *Flem.*
Thamnastræa concinna, *Goldf.*
" arachnoides, *Park.*
Stylina tubulifera, *Phil.*
Isastræa explanata, *Goldf.*
Cosmoseris irradians, *Edw. & Haime.*
Isastræa inæqualis, *Phil.*
Cladophyllia Conybearii, *Edw.*

The following list of Cephalopoda has been made for this paper by my excellent friend John Leckenby, Esq., F.G.S., whose accurate critical knowledge of the Palæontology of the Yorkshire Oolites is unsurpassed. He has likewise kindly added a list of the Mollusca found in the Coral Reefs around Scarborough:—

Cephalopoda

Found in the Coralline Oolite of Yorkshire.

Belemnites abbreviatus, *Mill.*
Nautilus hexagonus *Sow.*
Ammonites plicatilis,* *Sow.*
" Williamsoni, *Phil.*
" (syn.) Arduennensis, *d'Orb.*
Ammonites Goliathus, *d'Orb.*
" perarmatus, *Sow.*
" cordatus, } *Sow.*
" var. excavatus }

* Not found in the calcareous grit below.

Cephalopoda

Obtained in the Calcareous Grit of Yorkshire.

Belemnites hastatus, *de Blain.*
" abbreviatus, *Mil.*
Nautilus hexagonus, *Sow.*
Ammonites Williamsoni, *Phil.*
" (syn.) Arduennensis, *d'Orb.*
" Vernoni, *Phil.*
" Bakeri, *Sow.*
" convolutus ornati, *Quenst.*
" " parabolis, "
" Goliathus, *d'Orb.*
Ammonites perarmatus, *Sow.*
" " var.
" athleta, *Phil.*
" cordatus, *Sow.*
" " v. excavatus, *Sw.*
" " v. vertebralis "
" " v. Scarburgensis, [*Y. and B.*
" canaliculatus, *Munst.*

Ammonites solaris, p. 4, Fig. 29, *Phillips'* Geo. of Yorkshire, must have found its way into the collection of the Scarborough Philosophical Society by accident. It is from the Lower Lias of the south of England, and may still be seen in the Society's Museum.

Am. Williamsoni, Phil., = *Am. Arduennensis,* d'Orb., is found from 1 inch to 16 inches in diameter, and the same observation applies to *Am. cordatus,* Sow.

List of Mollusca in the Coral Reefs.

Gasteropoda.

Turbo funiculatus, *Phil.*
Trochotoma ternata, *Phil.*
Littorina muricata, *Sow.*
Phasianella striata, *Sow.*
Natica Clymenia, *d'Orb.*
Nerita lævigata, *Sow.*
Nerita bellulata, *Bean.*
Neritopsis Guerrei, *Desl.*
Cerithium limæformis, *Roem.*
Nerinæa fasciata, *Voltz.*
" fusiformis, *d'Orb.*
Trochus tornatilis, *Phil.*

Conchifera.

Exogyra mima, *Phil.*
Placunopsis inæqualis, *Phil.*
Pecten vagans, v. sub-fibrosus, *Sow.*
Myoconcha texta, *Buvig.*
Modiola Lycetti, *Whit.*
" inclusa, *Phil.*
Arca quadrisulcata, *Sow.*
" æmula, *Phil.*
Cucullæa pectinata, *Phil.*
Astarte rhomboidalis, *Phil.*
Sowerbia triangularis, *Phil.*
Gastrochæna Moreana, *Buvig.*

The beds of clay, with Echinidæ forming the *Zone of Cidaris florigemma* occur at Calne and Lynham, Wilts, and at one

time yielded a large number of beautiful specimens; the clay in which the Urchins were found formed the bottom of the quarry; unfortunately this rich mine has become flooded, and the fossiliferous beds are now under water. The following species were collected many years ago from this zone near Calne.

Echinodermata.

Cidaris florigemma, *Phil.*
" Smithii, *Wright.*
Hemicidaris intermedia, *Flem.*
Pseudodiadema hemisphæricum, *Ag.*
" versipora, *Phil.*
" radiatum, *Wright.*
" mammillanum, *Roem.*
Hemipedina corallina, *Wright.*
" tuberculosa, *Wright.*
Glypticus hieroglyphicus, *Goldf.*
Stomechinus gyratus, *Ag.*
Acrosalenia decorata, *Haime.*
Holectypus oblongus, *Wright.*
Pygaster umbrella, *Lamarck.*
Echinobrissus dimidiatus, *Phil.*
" scutatus, *Lamarck.*
Clypeus subulatus, *Young and Bird.*
Collyrites bicordata, *Leske.*
Pygurus pentagonalis, *Phil.*
" Phillipsii, *Wright.*
" Blumenbachii, *Koch & Dunke*
" Hausmanni, "
Millericrinus echinatus, *Schloth.*

The *Coral rag*, and beds with *Cidaris florigemma*, and *Glypitcus hieroglyphicus*, constitute the two divisions of the Coralline Oolite in England, and represent the two zones into which M. Martin divides the Corallien of the Côte-d'Or. The upper zone, included in M. de Nerville's section of groupe corallien, in descending order, includes calcaire à Nérinées, calcaire à Astartes, and calcaire à Ptérocères,—the two first form M. Martin's

Séquanien.

This group is composed, according to our author, of—

Séquanien.
- Calcaires marno-compactes à *Astarte minima.*
- Calcaires marneux à *Terebratula humeralis.*
- Calcaires durs ou blancs crayeux à *Nerinœa Bruntrutana.*
- Calcaires blanchâtres à *Ostrea solitaria* et *Hemicidaris diademata.*

These terrains are considered by some to belong to the upper division of the Corallian, and by others to constitute a distinct formation intermediate between the Oxfordian and Kimmeridge stages. The Séquanien is largely developed in several departments of France, especially in the Franche-Compté, comprising

the Haute-Saône, Doubs and Jura. As this region was formerly inhabited by a powerful Celtic race, the Séquani, their name has been given to the group. M. THURMANN * described these beds as they are seen at Mont-Terrible,—1st, as *Calcaires à Astartes*, Calcaires compactes, à cassure conchoïde, avec *Astarte minima* et très-peu de fossiles, 20 mètres in thickness; 2nd, *Calcaires à Nérinées*, Calcaires blancs, compactes-conchoïdes, ou crayeux, avec Nérinées, 20 mètres; 3rd, *Oolithe Corallienne*, Calcaire oolithique, cannabines ou pisaire inégal, souvent sub-crétacé; relief superficiel de la décomposition des oolithes presentant fréquemment une concentricité remarquable, avec *Nerinœa Bruntrutana*, *Diceras arietina*, &c., 5½ mètres. This author erroneously considered them to be synchronous with the English coral rag.

M. THIRRIA † in his description of the Jura of the Haute-Saône followed a like division of the Séquanien, as may be seen in his section given at p. 217. M. JULES MARCOU ‡ has described these strata in his groupe "Séquanien, Kimméridien et Portlandien" and establishes the synchronism of the Séquanien or Groupe de Besançon with the Calcaire à Astartes of the Haute-Marne, the Meuse, the Côte-d'Or, and Haute-Saône, in his Roches du Jura. §

M. ETALLON ‖ divides the Terrain Jurassique Supérieur into two stages,—1st, *Calcaire Corallien*. 2nd, *Dicératien*. The first are the rocks that belong to the coral rag, and have been already described: the second represent that portion of the Séquanien which is characterized by *Nérinées* and *Diceras*. "Les *Diceras* se trouvent en immense quantité; c'est de beaucoup le fossile le plus abondant, et parmi eux domine le *Diceras Münsteri*, Goldf. *Diceras speciosa*, Goldf., est aussi très-commun, mais sa grande

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* Essai sur les Soulèvemens Jurassiques du Porrentruy: 1832.

† Statistique géolog. de la Haute-Saône: 1833.

‡ Recherches sur les Jura salinois, p. 116: 1846.

§ Les Roches du Jura, p. 174: 1860.

‖ Esquisse géol. du Haut-Jura, p. 47: 1857. Statistique géolog. du Départ. de la Meuse: 1852.

taille ne permet de l'obtenir que rarement entier. L'oolithe n'étant pas spéciale à cette sub-division, j'ai cru devoir adopter le nom de Dicératien."

M. Buvignier, in 1852, and M. Ed. Piette, in 1857, have made important works on the department of the Meuse, the "*Calcaire à Astartes de Verdun*" formé à la partie supérieure de calcaires blancs crayeux, quelquefois gris marno-compactes; et à la partie inférieure d'argiles grises ou jaunâtres assez passantes, avec *Ostrea Bruntrutana, Astarte minima, Melania striata, Ceromya inflata, Cardium Buvigineri.* This formation attains here a thickness of 130 mètres and rests upon the coral rag de St. Mihel, consisting of white chalky Limestones of great purity, containing *Nerinæa Bruntrutana, N. nodosa,* and *Diceras arietina* in its upper portions; *Ostrea gregaria, Cidaris Blumenbachii, Hemicidaris crenularis, Thamnastræa affinis, Calamophyllia flabellum,* and *Cal. articulosa* in its lower division. The coral rag attains a thickness of 130 mètres = 400 feet.

Séquanien.

The *Séquanien or Nerinæn zone,* which forms so important a member of the Corallian series in France and Switzerland, is not represented in England. The fine white Limestones, for the most part, composing these rocks are formed of the *débris* of coral-reefs that played so important a part in the seas of the upper Jurassic epoch; and if strata synchronous with those forming this stage ever existed in our area they have been eroded and subsequently removed from English soil by denudation. This fact affords a good illustration of an observation previously made in reference to the existence and development of different zones of the Lias and Lower Oolites. In some localities, for example, we find certain terrains largely thickened and containing few characteristic fossils; in others the zone may be absent, or present and feebly developed, and the thin rudimentary beds composing it may be largely charged with their leading shells; so that in studying the Jurassic formations, with a view to establish their synchronism, it is on the palæontology

of each stage, more than on its lithological character and physical development, that we must depend for a true determination of its age and correlation.

Kimméridien = Kimmeridge Clay.

The upper Jurassic rocks present a greater diversity of character in different regions than the members of the middle and lower divisions, and the difficulty of establishing the synchronism of their several stages increases in our ascent from the Coral Rag to the summit of the Purbeck series; several reasons may be given for this, but our chief obstacle is the want of a better classification, and more detailed study of the Kimmeridge clay and Portland formations of England, and this is the reason for my reticence regarding the correlation of some of these deposits. M. Martin defines l'étage Kimméridien thus:—

Kimmêridien.	Marnes et calcaires marno-compactes à *Ostrea virgula.* Calcaires à Ptérocèren avec quelques *Ostrea virgula.*

M. G. de Nerville* includes the calcaire à Ptérocèren in his groupe corallien of which it forms the uppermost terrain, and thus defines it "*Calcaire à Ptérocères.* Calcaire jaune, à points verts, sableux, renfermant quelques minces bancs de marnes sableuses, caractérisés par le *Pterocera Oceani.*" The marnes à *Ostrea virgula* he makes the base of his groupe Kimméridien et Portlandien, and describes as "marnes blanchâtres renfermant une grande quantité de Gryphées virgules, *Terre à fours.*" In the Haute-Saône M. Thirria unites the two in one group, as "calcaires et marnes à Gryphées virgules," and describes as marne grisâtre, divisée en plusieurs assises par de minces bancs de calc. marn. avec *Ammonites gigas, Nautilus giganteus, Pterocera Oceani, Pholadomya protei, Ceromya excentrica, Ceromya inflata, Exogyra virgula, Exogyra Bruntrutana, Ostrea solitaria, Nerinæa grandis, Nerinæa cylindrica*, &c. These beds form the groupe de Porrentruy of M. Marcou in his Jura salinois, and they are les argiles à *Ostrea virgula* de Loxeville, of M. E. Piette, in the department of the Meuse, and are

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* Legende explicative de la carte géolog. du Départ. de la Côte-d'Or: 1853.

defined as "argiles composées d'alternances de marnes grises ou bleues avec intercallations de calcaires blancs grisâtres ou jaunâtres avec *Ostrea virgula*, *Ostrea spiralis*, *Pterocera ponti*, *Ammonites nucleus*, *Trigonia supra-jurensis*, &c." These strata have a thickness of about 80 mètres.

M. Thurmann makes this group his second division, or *marnes Kimméridiennes*, and which he defines as "marnes jaunâtres et calcaires marno-compactes, grumeleux, avec exogyres et nombreux fossiles, à l'état de moule intérieur," and in his later letters on the Jura considers the thickness of these marnes to be 35 mètres.

During the formation of the Great Western Railway by Wotton Bassett a section of the Kimmeridge clay was made, and from this I obtained some of its characteristic fossils, as *Ammonites decipiens*, *Amm. mutabilis*, *Pleurotomaria reticulata*, *Ostrea virgula*, *Ostrea deltoidea*, &c. This formation is, however, feebly exposed in Wiltshire. Near Farringdon, Berks, it consists of a dark blue or olive-coloured clay, with sandy or calcareous bands containing fossils, and is overlain by the Sponge gravel beds of the Lower Greensand; and at Culham by the blue laminated clay of the Gault, containing *Ammonites interruptus*. At Headington Hill it is seen in position resting upon the Coralline Oolite, and here contains *Exogyra virgula*, *Ostrea deltoidea*, *Rhynchonella inconstans*, *Ammonites biplex*, with large bones of Dinosaurians belonging to the genera *Pliosaurus*, *Ichthyosaurus* and *Steneosaurus*.

The fine section on the Dorset coast, between St. Alban's Head on the east, and Gad Cliff on the west, embracing its type locality—Kimmeridge Bay, affords a magnificent exposure of this formation, which is best seen by sailing along the coast; near the shore it forms the lower portion of the cliffs, and consists of dark blue bituminous clay, overlain at Swyre Head by Portland sand and stone.

Portlandien = Portland Oolite.

M. Martin defines these terrains as—

Portlandien.	*a*	Calcaires marneux et marno-compactes à *Trigonia Boloniensis* et *Pinna supra-jurensis*.
	b	Calcaires marno-compactes à *Amm. gigas*.

M. G. de NERVILLE* likewise divides this groupe Portlandien into—

a	Calcaires jaunâtres, compactes, bréchiforms en bancs épais perforés d'une infinité de trous sinueux et lisses	30 mètres.
b	Calcaire marno-compacte, de couleur jaune nankin, criblé de dendrites noirâtres par petits bancs ...	20 "

M. MARCOU † includes these two bancs in his Calcaires de Salins, and M. THIRRIA ‡ enumerates the following beds in his Calcaires Portlandiens in the Jura de la Haute-Saône :—

Calcaires Portlandiens.	*a*	Calcaire compacte, gris-jaunâtre	1 , 50
	b	Calc. lumachelle	0 , 18
	c	Calc. avec *Nerinea*	0 , 20
	d	Calc. grisâtre	0 , 10
	e	Calc. avec *Nerinea*	0 , 16
	f	Calc. grisâtre en plaquettes	1 , 30
	h	Calcaire marno-compacte, gris-blanchâtre en bancs peu épais, séparés par petites couches de marne grisâtre avec *Exogyra virgula*, *Trigonia concentrica*, *Terebratula*	10 , 00
	i	Calc. avec fragments de *Trichites*	0 , 15
	k	Calc. compacte non-fossilifère...	5 , 00
	l	Calc. blanc-grisâtre avec *Nerinea*	3 , 00

In the department of the Meuse the Portlandien is well developed, and has been described in detail by M. BUVIGNIER in his Statistique géologique; and, subsequently, by M. ED. PIETTE, from whose memoir we learn that the Portland terrains are described as "*Oolite du Barrois*," and appear to resemble, in physical and palæontological characters, the Portland Oolite of England. The group is divided thus :—

a	*Sous-groupe supérieur des calcaires de Brillon*, formé de calcaires compactes, d'un gris verdâtre, avec intercallations de bancs d'Oolithe vacuolaire et de calcaires lumachelliques appelés roches fromtelles; et aussi contenant des bancs de calcaires sub-compactes dolomitiques; avec *Anomya supra-jurensis*, *Pholadomya Barrensis*, *Trigonia gibbosa*, *Melania crenulata*, *Delphinula vivauxea*, *Cerithium Dammariense*, &c.	40 , 00

* Légende explicative: 1853.

† Roches du Jura, p. 162: 1860.

‡ Statistique géolog. de la Haute-Saône: 1833.

b *Sous-groupe moyen des calcaires de Ligny;* formé de calcaires très-dures, compactes, criblés de cavités irregulières et appelé calcaires cariés, avec *Ammonites gigas, Cerithium supracostatum, Ostrea virgula* ... ... 95 , 00

c *Sous-groupe inférieur des calcaires blancs et argiles blanches d'Auberville;* formé d'alternance de bancs de calc. blanc, crayeux, gris ou meme jaunâtre, et d'argile de même couleur; avec *Ostrea virgula, Trigonia gibbosa, Lima argonnensis, Pholadomya acuticosta, Panopœa Voltzii, Ammonites gigas,* &c. ... 60 , 00

M. Thurmann * has described the *Calcaire Portlandien* in the coupe du Banné près Porrentruy, where it attains a thickness of 20 mètres, and consists of—

a Calcaires compactes, marno-compactes ou oolithiques. Cassure sub-conchoïdale. Cohesion moyenne. Couleurs claires très-variées.

b Structure en grand distincte et régulière. Dendrites, filets, nœuds spathiques.

c Fossiles assez nombreux à l'état de moule intérieur, excepté les genres *Terebratula, Pinna, Ostrea, Trichites,* etc. Test calcaire. Absence de fossiles siliceux.

d Calcaires compactes, sub-conchoïdaux, de couleur claire; de fines Oolithes que je n'ai jamais vu dépasser et rarement même atteindre la dimension miliare, et que, au contraire, sont souvent d'une ténuité remarquable. La présence des protos, des exogyres, et des grosses isocardes paraît aussi assez constante.

e Dans les parties inférieures, les alternances marno-compactes et marneuses se multiplient. Les fossiles deviennent plus nombreux, et la stratification plus obscure.

In the department of the Pas-de-Calais and in the coast section near Boulogne-sur-Mer the Portlandien is seen resting on the Kimmeridge clay at Crèche, Couple, Share, Falaise d'Alprecht, and Moulins de Ningle: it consists of a light-coloured sandy Limestone, full of crystallized carbonate, and in the upper stage contains many fossil shells identical with the Portland Oolite of England. Here are found—

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* Les soulèvemens Jurassiques du Porrentruy, p. 11.

Pecten lamellosus, *Sow.*
Cardium dissimile, *Sow.*
Perna Suessi, *Oppel.*
Trigonia incurva, *Sow.*
Trigonia gibbosa, *Sow.*
Natica elegans, *Sow.*
Buccinum naticoides, *Sow.*
Ammonites giganteus, *Sow.*

ECHINODERMATA.

Cidaris Boloniensis, *Wright.*
Hemicidaris Davidsoni, *Wright.*
" Purbeckensis, *Forbes.*
Acrosalenia Kœnigii, *Desml.*
Echinobrissus Brodieii, *Wright.*
" Haimei, *Wright.*
Astropecten Loriolii, *Wright.*
Ophidiaster Davidsoni, *Wright.*
Pentacrinus Bouchardi, *Wright.*

My late friend, M. BOUCHARD-CHANTEREAUX, kindly sent me a series of all these specimens from the Portlandien of Boulogne, and which I have critically compared with those of the same species found in the Portland formation of the island of Portland, and from beds of the same age at Brill, Bucks; and Tisbury, and Swindon, Wilts.

In the department of the Pas-de-Calais, in the environs of Boulogne-sur-Mer, the Kimméridien and Portlandien stages are well exposed in the coast section between Cap Gris-Nez in the north, to Eguihen in the south. These terrains have been the subject of important studies made by Professor HEBERT, M. SÆMANN and others; and lately an admirable monograph has been published by my friend M. P. de LORIOL and M. E. PELLAT, in the "Mémoires de la Société de Physique et d'Histoire Naturelle, Genève." * As this important work gives a most accurate account of all the beds by M. PELLAT, and descriptions and figures of the fossils by M. de LORIOL, it forms an epoch in the natural history of the upper division of the Jurassic rocks of France, and a most valuable guide to a more detailed examination of their correlative formations in England. Having been long acquainted with the fossils of the Portlandien of Boulogne, from several communications of the same made to me by my late friend M. BOUCHARD-CHANTEREAUX, I can fully

* Monographie Paléontologique et Géologique de l'étage Portlandien des environs de Boulogne-sur-Mer. Genève: 1866.

appreciate the sterling value of this work, and commend it to all who wish to extend their knowledge of the formations on which it treats.

M. de Loriol gives the collective name terrain Kimméridien to all the deposits comprised between the "terrain Oxfordien, et les couches de Purbeck," and forms four sub-divisions in the terrain Kimméridien,—1° L'étage *Portlandien.* 2° L'étage *Virgulien.* 3° L'étage *Ptérocèrien* ou Strombien. 4° L'étage *Séquanien* ou Astartien. These four stages, taken together, correspond very nearly to the Superior Oolite of several authors, and to "l'étage des calcaires du Barrois" of Professor Hebert, and M. E. Piette.

L'étage Séquanien consists of a yellow Limestone, with *Nerinœa Goodhalli,* and the sandstones and clays of Wirvigne; the former rests upon a compact Limestone, with *Cidaris florigemma* and *Phasianella striata;* the Nerinæan Limestone contains a great abundance of *N. Goodhalli* and *Terebratula humeralis.* The Sandstone of Wirvigne contains a great number of Echinidæ, as *Pseudodiadema mamillanum* and *Pygurus Royerianus. Ostrea virgula* appears here for the first time.

L'étage Ptérocèrien consists of thin beds of argillaceous Limestones, having other coloured bands interstratified with them, and containing *Pholadomya hortulana, Ceromya,* and *Pinna granulata.*

L'étage Virgulien, with *L'étage Portlandien,* constitute the entire escarpment of the Jurassic cliffs of the Bas-Boulonais; the former consists of an intercalation of dark-coloured clays, limestones, sands, and sandstone, with *Ammonites longispinus, Trigonia variegata, Trigonia Rigauxiana, Ostrea virgula, Pholadomga acuticostata,* and has a thickness of 80 mètres.

L'étage Portlandien admits of a three-fold division,—the 1st, or *inferior stage,* from 15 to 20 mètres in thickness, consisting of sands and sandstones, with *Ammonites gigas, Natica Marcousana,* and *Perna rugosa;* they are all well exposed in the Cap de la Crèche and in the railway cutting at Terlincthun; the fossil shells are numerous, as *Trigonia Micheloti, Tr. Barrensis, Tr. Boloniensis, Mytilus Morrisii, Ostrea virgula, Astropecten Loriolii,* and *Hemicidaris Purbeckensis.*

The *middle stage*, or argiles glauconieuses à *Cardium Morinicum*, et *Ostrea expansa*, is 30 mètres in thickness and contains *Ammonites biplex*, *Cidaris Boloniensis*, *Acrosalenia Königii*.

The *upper stage*, or grès à *Trigonia gibbosa* and *Tr. incurva*, from 8 to 10 mètres thick, was identified by Dr. FITTON as the equivalent of the Portland stone of England; it contains, likewise, *Ammonites giganteus*, *Cardium Pellati*, *Serpula coacervata*, *Pecten lamellosus*, *Echinobrissus Brodieii*, *Echinobrissus Haimii*, *Natica Ceres*, *Astarte sociales*. This stage forms the summit of the cliff, where it is well exposed; likewise at Mont de Couple, Falaise d'Alprecht, and at la Butte de Ningle. I have endeavoured to epitomise the admirable section given by M. PELLAT, in the following table:—

(See opposite page.)

Classification of the Upper Jurassic Rocks of Boulogne-sur-Mer.

Stages.	Formations.	Leading Fossils.
Wealden Clay and Hastings Sands.		Cyrena ferruginea.
Terrain Kimméridien. — Étage Portlandien.	Upper Portland, with Cardium dissimile.	*Cypris, Astarte socialis, Cardium dissimile, Natica Ceres, Trigonia gibbosa, T. incurva, Amm. giganteus, Card. Pellati.*
	Middle Portland, with Cardium Morini.	*Astarte Sœmmani, Acrosal. Königii, Ostrea expansa, Perna Bouchardi, Lima Boloniensis, Amm. biplex, Card. morinicum, Ostrea Bruntrutana.*
	Lower Portland, with Ammonites gigas.	*Pterocera Oceani, Natica Marcousana, Perna rugosa, Trigonia Micheloti, T. Pellati, T. variegata, Amm. gigas.*
Étage Virgulien.	Upper Clays, with Ostrea virgula.	*Amm. mutabilis, Thracia supra-jurensis, Pinna granulata, Gervillia Kimmeridiensis, Ostrea virgula, Ostrea deltoidea, Pygaster macrocyphus, Trigonia variegata.*
	Sandstone Ostr. virgula	
	Middle Clays, with Ostrea virgula.	*Amm. longispinus, Pholadomya acuticostata, Trigonia Rigauxiana, Gervillia Kimmerid., Ostrea virgula.*
	Sandstone Ostr. virgula	
	Lower Clays, with Ostrea virgula.	Fossils as in the upper beds
Ét. Ptérocèrien.	Limestone of Bréquerêque.	*Pholadomya hortulana.*
Ét. Séquanien?	Grès of Wirvigne.	*Ostrea virgula, Pygurus Royerianus.*
	Oolite, with Nerinæa.	*Nerinæa Goodhalli, Terebratula humeralis,*
Terrain Oxfordien.		*Cidaris florigemma.*

The Portland Oolite is well exposed at Swindon, Tisbury, Chicksgrove, and other places in the vale of Wardour, Wilts; at Shotover, Oxon; at Hartwell, near Aylesbury; at Brill and Stone, Bucks; and in the island of Portland and other localities in Dorset. It consists of Sands and Sandstones below, gradually becoming calcareous as we ascend, and passing into light-coloured Limestones above. Many of the beds contain layers of chert, alternating with them like flints in the upper cretaceous rocks. The Portland beds are divisible into—

a. Portland stone, consisting of fine white calcareo-siliceous Limestones with oolitic structure, and known locally as "Stonebrash" and "Roche" by the workmen; with these are interstratified layers of clay and masses of chert, 90 feet thick.

b. Portland sands, consisting of brown and yellow sands, and sandstone, the lower portion full of green grains of the silicate of iron, Glauconite, 80 feet.

c. Kimmeridge clay.

Several very fine sections are exposed in different quarries in the island of Portland, where the marine beds of the Portland Oolite are overlain by the estuarine series of Purbeck beds, consisting of clays and limestones crowded with freshwater mollusca, the soil of old land or "dirt beds," with the roots and stems of trees, *Cycadeæ* seen in the position in which they grew prior to their submergence beneath the Neocomian wave. A very interesting section of upper oolitic strata is seen in a hill near Hartwell, by Aylesbury, where the Portland, Purbeck, Wealden, and Neocomian strata are found in position resting on Kimmeridge clay, which is worked for brickmaking, and contains many fossils in fine preservation, as *Ammonites biplex*, *Belemnites Souichii*, *Astarte Hartwelliensis*, with the bones of *Pliosaurus*. My late friend, M. Sæmann of Paris, examined this locality and made a section of the beds in 1866, with the intention of correlating the English Portland beds with the Portlandien stage, which he had previously studied at Boulogne-sur-Mer. His notes and section have been published by my friend M. P. de Loriol and M. E. Pellat in their Monograph on l'étage Portlandien des environs de Boulogne-sur-Mer.

From the Hartwell brickyard, situated in the valley, consisting of a black sandy Kimmeridge clay, M. Sæmann collected *Ammonites biplex, Belemnites Souichii, Pleuromya Tellina, Thracia depressa, Cardium Morinicum, Perna Bouchardii, Mytilus Boloniensis, Pecten Morini, Lima Boloniensis, Ostrea expansa,* and many other shells in a fine state of preservation, of which only one—*Astarte Hartwelliensis,* Sow.—appears to have been figured. *Ammonites biplex* is very abundant, and sometimes it is most perfectly preserved in the clay, or enclosed in géodes. These fossils are found at Hartwell in the same proportion and abundance as at Boulogne, and their association proves undeniably the existence of the middle Portlandien of the Boulonais in England. The clays, with *Cardium Morinicum,* are overlain by sandy and argillaceous beds, some of which are fossiliferous, containing *Pleuromya, Unicardium,* and *Thracia angulare.* This bed likewise occurs at Shotover, where it contains Ammonites. The upper portion of the sand is concealed by vegetation, and above this is a quarry of Portland stone, with *Ammonites giganteus,* extensively worked at Hartwell; both the flat and inflated varieties of this shell occur; the flattened forms resembling the Ammonites of the Middle Portlandien of the Boulonais, with *Natica elegans, Natica Ceres, Cardium Pellati, Cardium dissimile, Trigonia incurva, Trigonia Pellati, Lima rustica, Pecten lamellosus, Ostrea expansa,* and *Serpula coacervata.* Numerous traces of this annelide are seen on the Ammonites. These Portland marine beds are overlain by the estuarine Purbeck strata, consisting of shales, clays, and marly limestones, full of freshwater organisms, as *Cyrenæ, Cyprides,* and fishes, with the remains of insects, and lacustrine plants. The Wealden beds are likewise represented in this instructive section, as we have *Cyrena, Unio,* and *Paludina,* with the Wealden plant *Endogenites erosa.* The hill is capped by Lower Greensand, or Neocomian strata, containing *Exogyra sinuata, Pecten obliquus, Ostrea macroptera,* &c. From this section it is inferred, 1st,—that the Lower Portlandien of the Boulonais, with *Perna rugosa* and *Pterocera Oceani,* is not represented here, 2nd,—that the dark sandy clays of Hartwell

are identical with the representative of the argiles glauconieuses of the Boulonais, or Middle Portlandien. The Portland sand of Fitton comprises the "sables glauconieux," which correspond to the "couches sableuses et glauconieuses" of the upper portion of the Middle Portlandien of the Boulonais; these sands contain, at Shotover, the same fossils as the sub-adjacent clay of Hartwell, and are related like the beds with *Astarte Sæmanni* of the Boulonais to the Middle Portlandien. The upper portion of the sands, without the silicate of iron, Glauconite, are destitute of fossils, these M. Sæmann unites with the Portland stone, and groups as Upper Portlandien. The sands are overlain by a bed with *Cardium Pellati*, which contains at Swindon *Perna Bouchardi*, and at Hartwell *Pecten lamellosus* and *Ostrea expansa*. At Swindon this bed is covered by a hard blueish rock, containing *Ammonites giganteus;* above this are twenty feet of sands with inconstant layers of sandstone, and some beds containing Trigonias intercalated with them. The sands are overlain by a series of Limestones and marly sediments, in the lower portion of which we find *Cerithium Portlandicum*, corresponding to the great horizon of the Island of Portland, and in the upper portion *Lucina portlandica*, *Cyrena rugosa*, and *Neritoma sinuosa*.

If this reading of the Hartwell section is correct, the conclusion is—

1st,—That in England the *Lower Portlandien*, or the beds with *Perna rugosa* and *Pterocera Oceani*, is absent.

2nd,—That the *Middle Portlandien* is represented by the dark sandy clays of the brickyard at Hartwell, containing *Ammonites biplex*, *Cardium Morinicum*, and *Ostrea expansa*, &c. A portion likewise of the overlying fossiliferous sand, with green Glauconite grains, belongs to this group.

3rd,—The *Upper Portlandien*, so largely developed in England, has at its base the non-fossiliferous sands without Glauconite, and in its middle and upper portions the true calcareo-siliceous Limestones and other beds forming the Portland stone, and containing *Ammonites giganteus*, *Cerithium portlandicum*, *Natica elegans*, *Natica Ceres*, *Trigonia incurva*, *Trigonia gibbosa*, *Cardium dissimile*, *Pecten lamellosus*, &c.

The Kimmeridge clay so well exposed on the Dorsetshire coast, and traceable through Wiltshire, Buckinghamshire, Lincolnshire and Yorkshire, is everywhere characterized by *Ostrea deltoidea.* This formation is, comparatively speaking, a barren deposit in our island, and good fossiliferous beds have not yet been exposed. Our present knowledge of this great argillaceous deposit is most imperfect, and until a good series of its fossils is obtained it is impossible to correlate its beds with those of the "*Argiles Virguliennes*" of the Boulonais.

My observations have greatly exceeded the limits I had originally prescribed to this memoir, and I have to apologize for their unavoidable extension. I was anxious to place before my associates the notes I had made in France on a subject most interesting to all persons who study Jurassic Geology; and especially to those of our members who have taken a part in the discussions which, from time to time, have occupied our attention in our many meets among the charming Cotteswold Hills,—the miniature Jura of Gloucestershire. If these remarks should perchance awaken in any of my colleagues a taste for the study of Comparative Geology, my work will not have been in vain. Having been for many years an earnest student of Jurassic Palæontology, in connection with my large work on the Oolitic Echinodermata, I have become deeply impressed with the importance of this kind of knowledge, not only to those who, like myself, may take up special branches of investigation,—for to all such it is indispensable,—but to those also who desire to acquire larger views of natural phenomena, and who strive to emancipate their minds from the narrow ideas and insular prejudices that unconsciously entwine themselves around the observer who limits his investigations to particular localities, and excludes from his enquiry any knowledge of similar phenomenain other regions or other lands;—to all such persons Comparative Geology offers a vast field of investigation, replete with instruction, charming from associations and recollections, and affording materials for a more philosophical survey of nature, and a truer conception of the wonderful laws by which the fabric of our globe has grown, and been developed into its present condition.

Address to the Cotteswold Naturalists' Field Club by the President, Sir W. V. Guise, Bart., F.L.S., F.G.S., *read February* 23*rd,* 1871.

THE ANNUAL MEETING OF THE CLUB

was held at the Spread Eagle Hotel, Gloucester, on Wednesday, the 23rd of February, when the President's Address was read, and you were again pleased to testify your continued confidence by re-electing me to the honourable office of President of the Cotteswold Field Club. Mr. T. B. Ll. Baker, Dr. Wright, and Mr. Lucy being chosen Vice-Presidents, and Dr. Paine, Secretary.

After the conclusion of the official business, two papers were read by Professor Church, of the Agricultural College, Cirencester, the first "On the Analysis of certain Oolitic Rocks," the second "On the Colouring Matter in the wings of certain Birds." In illustration of the first paper the learned Professor exhibited four examples, of which No. 1. was a white rock of extreme hardness and closeness of texture, derived from the upper beds of the Great Oolite; this was found to be almost a pure carbonite of lime containing nearly 95 per cent of that mineral and only 5 per cent. of silica. This stone was used by the Romans for tesseræ, both at Cirencester (*Corinium*) and *Uriconium*, and is the same which at Bussage has yielded the remarkable form of *Pachyrisma grande*, which is limited to that stratum. No. 2.—A Calcareous Sandstone, miscalled "Chert," from Sandy Lane, near Cirencester, was found to contain 55 per cent. of silica and 42 per cent. of lime. No. 3.—A Clay of a

remarkably close and compact nature was obtained from vertical fissures in the Great Oolite, and is probably derived from the Boulder Clay; it is remarkable for its high percentage of oxide of iron, and almost entire freedom from lime. It was found to consist of silica 51 parts, oxide of iron and alumina 32 with a trace of oxide of manganese; this clay the Professor stated was admirably adapted for the manufacture of pottery. No. 4.—From the Forest Marble showed the blue centre, &c., characteristic of the limestones of that formation. This blue centre was shewn to contain a much larger proportion of iron and sulphur than the surrounding lighter portion. The Professor shewed that the lighter coloured portion of stone surrounding the blue centre never penetrates to a greater depth than from one to two inches, the difference of colour being due to peroxidation, produced by the percolation and absorption of water.

Professor Church exhibited experiments connected with his researches into the colouring matter in the wings of certain African Birds, the Touracos and Plantain-eaters. The wing feathers of these birds, of a splendid magenta crimson, are found to part with their colour by maceration in water, and when this action is intensified by the addition of an alkali, and the result is precipitated by an acid, a solid crimson floccose deposit is the result, which upon analysis proves to be indebted for its colour to the presence of copper.

The whole question of the process whereby nature colours with unerring exactitude the feathers of birds, is among those marvels of life-action which human knowledge may never explain, because it is carried on in a laboratory so secret and by processes so fine and imperceptible as to escape detection by the keenest observation and the most delicate tests. But in the instance under review the marvel is intensified by the fact that the colouring matter—itself the product of a rare metallic agent—is applied only to a certain and exactly defined portion of the plumage, while another portion in immediate contact, on the same feather, shews no trace whatever of the peculiar mineral.

After dinner Mr. G. F. Playne drew the attention of the

Club to a quantity of chips, knives, arrowheads, and other implements in flint, found by him in a tumulus he had lately opened at Nailsworth; this tumulus was described as circular, about 50 feet in diameter and 3 feet 6 inches in height. At the level of the ground were marks of cremation, and in a hollow in the centre was a handful of burnt human bones; with the worked flints were found portions of rude hand-made pottery; at the same time it was pointed out that the finding of these flint implements in the mound did not necessarily shew that the tumulus was the work of the "Flint Men," as worked flints are found scattered broad-cast, and locally, in great abundance over the Cotteswold Hills, so that now in many places it would not be possible to throw up a mound of earth without enclosing therein many specimens. In the discussion which ensued, the Rev. W. S. Symonds urged the opinion formed by Mr. John Evans and others, from similar evidences in Hampshire and the Isle of Wight, that the wide dispersion of these wrought flints from local centres was due to the transporting power of surface-ice and snow in the Glacial or Sub-glacial period.

Wednesday, 18th May.—The Club met at the Brimscombe Railway Station. The Programme for the day embraced a visit to the

RAILWAY TUNNEL AT SAPPERTON,

thence through Hayley Wood to the

CANAL TUNNEL

by boat along the summit level of the Canal by Trewsbury Castle and Thames Head to the Somerville Aqueduct, and thence to the Agricultural College at Cirencester. Your President being engaged with Militia duties, was not able to join the Club till late in the afternoon, and is indebted to your Secretary for the following notes:—

The day's proceedings were principally Geological. The route as above described enabled the Club to examine several good sections of the upper beds of the Great Oolite, and the commencement of the Forest Marble beds. The first halt was at a

road-side quarry on the Cirencester Road above Sapperton. Here the Forest Marble occurs with *Terebratula maxillata* in abundance, of which, in a limited time a good number of specimens were procured. The next halt was at the Tunnel, where, under the guidance of Mr. Franks, Engineer to the Great Western Railway Company, those who were interested in the subject descended into the cutting and examined the beds of white limestone, which are here developed to a greater extent than usual. The drive through Hayley Wood was most delightful, the freshness and delicate tints of the foliage diversified by the lights and shadows of a glorious spring day, calling forth frequent expressions of pleasure and enjoyment. On reaching the open country, the members quitting the carriages embarked on board the Canal Company's barge, which had been considerately placed at their disposal by Mr. Taunton, and pursued their course by water, stopping by the way to see the quarries at Trewsbury.

The next object of interest was the source of the Thames, or, as it is called, the "Thames Head,"—a title which it shares in common with the head springs of many other tributaries. The fact is, "Old Father Thames" is many-headed, and it is fortunate for the old river-god that it is so; for a few heaps of stones in a hollow near the canal, and apparently quite dry, were the sole representatives of what once claimed the proud title of the "source of the Thames." An explanation was soon supplied by the presence of a huge pumping engine, which was discharging water for the supply of the canal at the rate of 250 gallons per stroke—water which, had it flowed from its natural source, should have supplied the spring-head which was now dry. After an examination of the pumping machinery, the party proceeded by the canal boat to Somerville Aqueduct, where they left the boat and proceeded on foot to the Agricultural College.

On arrival at the College, the Club was received in the library, where many objects of interest were inspected, and a most agreeable half hour spent previous to dinner, which was served in the College hall shortly after four o'clock. A vote of thanks

to the PRINCIPAL was proposed by the PRESIDENT, and seconded by Dr. PAINE, the Honorary Secretary, who took occasion to acknowledge his obligations to Professor CHURCH for the kind interest he had taken in the arrangements for the day. The party then adjourned to the lecture-theatre of the College, when Mr. TAUNTON read an interesting paper on the Canal Tunnel, in which he traced its history and progress from the formation of the Company in 1782. Numerous old documents were produced, and in particular a parchment deed signed by Messrs. BOULTON and WATT, by which they granted a license to use their patent; and a letter from the contractor for the work, in which he begged the consideration of the Company on account of his being detained at Bisley for six days owing to the bad state of the roads. The paper was illustrated by two sections—one of the Railway Tunnel, the other of the Canal Tunnel. Mr. TAUNTON explained the geological features of the hill through which the tunnels run, and especially the evidence which had been obtained of an extensive fault, by which the Forest Marble had been thrown down to the extent of 75 feet, and which he considered had been overlooked in the Geological Survey. This led to a short discussion, in which Dr. WRIGHT and others took part. The pleasure of the day was somewhat marred by an accident of a serious nature which befell the Rev. E. R. NUSSEY, the Vicar of Longney, who was one of the party. He slipped from the deck of the barge, and in trying to save himself he thrust his right hand through one of the cabin windows, inflicting thereby a very serious wound, dividing several important vessels. Fortunately for the reverend gentleman several of his associates were able to render him valuable surgical aid, and the carriage of the Rev. Mr. DYKE, of Bagendon, being opportunely at the Thames Head, Mr. NUSSEY was conveyed in it with all speed to Cirencester, where, under the surgical care of Messrs. CRIPPS and FOWLER, the bleeding vessels were secured, and the patient was sufficiently recovered in the course of the evening to rejoin his friends and to return home to Longney. But for the prompt attention he received on the spot this accident might not improbably have proved fatal.

Wednesday, 15th June.—The Club met at

ROSS.

The day was all that could be desired, and except that the time was too limited to permit the entire programme to be carried out, no excursion could have been devised more interesting to the lover of the picturesque or the student of geological science. On the arrival of the party at Ross, a brake was in waiting which conveyed them to Huntsholme. Crossing the peninsula and the ferry they climbed to the summit of Symond's Yat, the fine prospect from whence is well known. Here the Rev. Mr. Symonds, President of the Malvern Field Club, in a lucid and well-arranged address, gave a sketch of the complicated geological problems comprehended in the wide expanse of country which the eye takes in from that exalted station.

Beginning with the distant range of the Malverns he carried his auditors through the "Silurians" of the May Hill of Fownhope and Woolhope; over the "Old Red" of Herefordshire, ten thousand feet in thickness, held by many geologists to represent vast fresh-water lakes similar to those covering such extensive tracts in North America. Here he pointed out how the uppermost "Old Red" beds on the opposite side of the Wye dip down underneath the Carboniferous Limestones of Symond's Yat and the Doward, and re-appear again in a vast "synclinal" above Monmouth. Thence he led them to the coal-fields of South Wales and of the Forest of Dean, shewing how these had been brought up and made serviceable for man by elevating forces, while other forces of an eroding and denuding character had swept away whole provinces of a like nature, which had once overlain by a thousand feet the present valleys and uplands of the "Old Red" country. The lecturer concluded an address, which was loudly cheered, by a few pertinent references to the gravels on the sides of the hills, in which lie entombed the bones of the Mammoth, the Rhinoceros, and the Hippopotamus, who were the undoubted contemporaries of man in those remote epochs when arctic and glacial conditions still prevailed in Europe.

From Symond's Yat the party proceeded in the direction of English Bicknor, by the lovely walks which command at every turn combinations of wood, rock, and river scenery, which for picturesque beauty cannot be surpassed in any part of the world. By the way a huge boulder formed the subject of some very interesting and instructive remarks by Mr. Symonds and Dr. Wright. The former first drew attention to this block of sandstone so different in character from the limestones on which it rests, and shewed that this was a block of "Pennant" or Coal-measure Sandstone, derived probably from the distant Forest of Dean coal-field, and lying perhaps a thousand feet below its proper horizon. He shewed that this block owed its present position to transport by ice in those distant glacial periods to which reference has already been made. That this is no matter of conjecture was demonstrated by Dr. Wright by reference to the transported blocks strewn along the flanks of the Jura, one of which, the celebrated "Pierre à bot" near Neuchâtel (40 or 50 feet square of solid granite) has been shewn to be derived from the distant chain of Mont Blanc, having been transported on ice across the lakes of Geneva and Neuchâtel.

Thus pleasantly sauntering and gathering such instruction as the circumstances afforded, the party found it necessary to turn their attention to their homeward route, which lay in the direction of Whitchurch, where the carriages were appointed to meet them. A descent to the level of the Wye down a break-neck path tried the powers of a good many. All, however, got to the bottom without a mishap, and passing the point where a tunnel is being driven on the projected line of rail to Monmouth, they crossed the ferry, and in due course reached Whitchurch and Ross, where dinner awaited them at the Royal Hotel.

Wednesday, 20th July.—The Club assembled at

PAINSWICK CAMP.

The programme for the day embraced a visit to the Potteries at Cranham, and to the Roman Villa at Whitcomb, terminating with a dinner at Painswick.

To those who have never visited the point known as Painswick Camp, or whose residence at a distance may make them for the first time acquainted with the character of the great western escarpment of the Cotteswolds, it would be difficult to find in the whole range of mountain scenery a prospect more striking than that which greets the eye from that exalted station. Those old præ-historic tribes, who had their fortified camps on every commanding height, never selected a position better adapted either for defence or observation than this, where an enclosure of triangular form sufficiently protected on the western face by the precipitous nature of the ground, is defended on the other two faces by a double line of rampart and foss, which, stockaded as they probably were, must have presented an obstacle almost insurmountable by the rude assailants to whom they would be opposed. The ground in the interior of the fort is disturbed and thrown into heaps and hollows, which at first sight would seem to be the effects of quarrying, but inasmuch as the rubbly beds of ragstone are not adapted for road material, and on the slope close by are freestone beds, easily worked and of suitable character, it is not probable that materials for such a purpose would be sought within the circuit of the camp in preference to more easily accessible localities outside its precincts. The probable interpretation is that the disturbed condition of the floor of the camp is due to the exfoliation of materials for the construction of the ramparts, and that from some cause the ground was never levelled. Some of the depressions bear considerable resemblance to rude hut-circles, and one more profound than the rest, towards the western face, may have been intended for the collection of rain-water, on which alone the occupants must have relied for their water supply. This is probably an ancient British camp—whether at any time occupied by the Romans there is nothing to shew, though it is more than probable that all these outposts were at one time or another occupied by that people.

From hence a pleasant drive through Cranham Woods brought the party to the Potteries, where a manufacture of common earthenware has been carried on from a very remote

period, owing its origin doubtless to the combination on the same spot of a suitable clay—that of the Upper Lias,—a spring of water, and abundance of wood for fuel. The latter material is now superseded by coal, but the manufacture is still maintained, though evidently upon a very limited scale.

A walk through the shady woodland glades to Buckholt, and thence down a steep hill brought them to the Roman Villa at Whitcomb, discovered in the last century, and reported upon by the antiquary Daniel Lysons in an elaborate essay to be found in the pages of the *Archæologia*. The beauty of the situation must strike every beholder, shewing the taste with which these wealthy Romans made choice of sites for their residences. The tesseræ of the floors were of three colours—red, white, and blue. It was pointed out by Mr. Witchell that the white tesseræ were obtained from the compact white limestone of Sapperton and Bussage, which would seem to have been in great request for the purpose, as the Club on their visit to Shropshire in 1869 discovered the same in the small tesselated pavement at Uriconium. Having regained the carriages the party proceeded to Painswick, where dinner was served in the Parish-room, which under the care of Mr. Gardner, the worthy surgeon of the place, had been tastefully decorated for the occasion.

After dinner a small collection of antiquities from the recently-discovered Roman Villa at Highfold was handed round for inspection, and it was arranged that a committee should be appointed to confer with Mr. Adey, the proprietor, with a view to future excavations on the spot. In this matter no further steps have since been taken. The matter has, however, not been lost sight of, and I hope that in the course of the present summer means may be found for carrying out some careful examinations of the site.

A committee was likewise appointed to co-operate with Mr. Cummington, of Devizes, and other local antiquaries and antiquarian societies, in moving Government to adopt measures for the protection and better preservation of our national antiquities. Your secretary has been in communication with Mr. Cummington

on this subject, and I have to report that it is probable we shall be asked to join other clubs in petitioning Parliament in the course of the present month.

Mr. Niblett exhibited a Roman horse-shoe in beautiful preservation; it had evidently never been in use, found five feet below the present Roman pavement of Gloucester, from which fact Mr. Lysons was disposed to attribute to it an antiquity prior to the date of the Roman occupation. This horse-shoe has been figured by Mr. Fleming in his beautiful and exhaustive book on "Horse-shoes and Horse-shoeing." Mr. Fleming gives it as Roman.

Wednesday, 17th August.—The Club was summoned to meet at

MORETON-IN-MARSH,

where a programme extending over two days and embracing visits to several points of interest failed to attract a single member, and Mr. Lucy, who, in the absence of the Secretary, went prepared to act as guide over ground to which his lately published paper on Gravels and Drifts has given a special importance, found himself absolutely alone. This should not have been. The locality is no doubt inconveniently placed as regards communication, which rendered it almost impracticable to accomplish any useful result without breaking into a second day. This, doubtless, was deterrent to many; still, as the Club had appointed the place of meeting, it is much to be regretted that none could be found to support the Vice-President on this occasion, the first since I have had the honour of presiding over the Club when such an occurrence has to be registered.

It will be well to bear in mind that, having regard to the limits of the county within which we carry on our operations, it every year becomes more difficult to offer the attraction of novelty in the localities selected as places of meeting—and with a view to obtaining such a stimulus we are constrained to avail ourselves of the utmost limits our boundary will admit of. Occasionally some of the meets may be appointed at places which involve a little trouble to reach, but I would urge that members should

either abstain from making such appointments or, that having sanctioned them, they should make some sacrifice of time and convenience to reach them.

On Wednesday, 5th October, the Club met for an excursion extending over two days to the

COAST SECTIONS AT WATCHET

in North Somerset. To those who have enjoyed the privilege of a ramble along that beautiful coast which extends from Watchet by Minehead and Porlock to Lynmouth, thence over the so-called "Devonians" to Ilfracombe and Morthoe, and over Woolacombe Sands to Croyde Bay and Baggy Point—to such as these the enjoyment of the scenery is enhanced tenfold by the interest of the geological problems which lie yet unsolved along that stretch of country. At Watchet, from "St. Audries Head" to "Blue Anchor" extends one of the finest and most instructive sections to be met with anywhere of the beds from the "Keuper" to the "Bucklandi" beds of the "Lower Lias." At Dunster and Minehead set in the red rocks of the "Devonian" series, which at Lynmouth change their characters, and alternating with inter-bedded limestones at Combe Martin, pass at Morte Point into slates, which are seen at Croyde Bay to occupy a vertical position on the shore. These beds have long been a *crux* to the geologist, and it becomes not one who is a mere amateur to offer a decision upon points respecting which there is still a large divergence of opinion amongst the most competent observers. The eminent authority of Sir Roderick Murchison, supported by that of Mr. Etheridge, the accomplished palæontologist of "the Survey" regards these beds as a condition of the "Old Red" of Herefordshire and Scotland; while Professor Jukes, the late head of the Irish Survey, believed that he had found in these slates the representative of similar beds in Ireland, which belong unquestionably to the Carboniferous series.

The key to the mystery lies in the position to be accorded to the red beds at Dunster, Minehead, &c., which underlie the

whole series. If these be, as Mr. Etheridge contends, the *lowermost* beds of the "Old Red," then doubtless the upper and middle beds will be found to lie between them and the "Culm" or Coal of Bideford. But if, on the other hand, as some competent observers hold, these beds are the "Brownstones" or *uppermost* beds of the "Old Red" of Herefordshire, then it would certainly seem to follow that the slaty beds above belong to the lower Carboniferous series, and this is the question which still awaits solution.

To revert to the Cotteswold Club. A party, about nine in number, assembled at the Egremont Hotel at Williton, a most comfortable hostelry, two miles from Watchet.

There being time for a ramble before dinner, some of the party made their way to the coast, while others walked a distance of two miles to the ruins of Cleeve Abbey, of which the ruins are picturesque and extensive. Of this monastic foundation, the work of William de Romara in the 12th century, little appears to be known, though the remains shew its former importance. It is now in a lamentable state of neglect, being dovetailed into a farmhouse. The chapel has been replaced by cowsheds, and barn and granaries occupy the place of dormitories and refectories. Still enough remains to shew the extent and importance of the original structure. The refectory is a noble apartment, full 50 feet long, with a fine vaulted roof of carved oak, having wall-springers representing angels resting on corbels. The earliest portions now existing do not appear to date back beyond the middle of the 13th century.

The architecture of the dormitory is of much earlier date than the refectory, probably about the end of the 13th century. The lower story has good double lancet windows, divided by shafts with boldly worked bases and capitals. The dormitory itself is a fine apartment, with very small lancet windows (each parted by a plain block of stone) which evidently were never glazed.

I am indebted to our colleague, Rev. Mr. Fowler, for the following account of the Gate-house:—

"Arched entrance flanked by buttresses; an inscription over the arch in old English letters, from age and contractions not

easy to decipher, but probably

"Porta pateat omni honesto
Clausa sit omni scelesto."

Above this is a square window, and then a niche surmounted by an image of the Virgin and Child. On the inner façade of the gate-house there is a large crucifix (N.B. The hair and beard) under an enriched canopy, with fan-tracery in the head, flanked by two niches which no doubt once held statues. Below is a curious inscription—

'DOVEN Quære Domino Venerando.'

The gate-house is, no doubt, fifteenth century work."

Thursday, 6th.—The party proceeded to Watchet, and thence took the line of coast eastwards to St. Audries' Head. The faults along this escarpment are numerous and instructive. At one point the "Bucklandi beds" of the "Lower Lias" are faulted against the "Keuper," the strata of which are much contorted. The "Liassic beds" abound in huge Ammonites, and represent evidently a very rich zone of life. But it is at St. Audries Head that the finest section presents itself. Here in one grand escarpment are seen in succession, resting on the gypsiferous marls of the "Keuper," the "Tea-Green Marls," "Black Shales," and "White Lias" of the "Rhætic" series; the "Ostrea" and "Planorbis beds" of the Lower Lias, succeeded by the "Angulatus" and "Bucklandi beds" of the same group. These abound in their characteristic fossils, and the "Rhætic beds" in particular are seen in fine sequence; while the dip of the beds brings each in succession to the sea-level, where every yard may be measured and studied with the greatest exactitude.

Friday, 7th.—The course this day was westwards along the coast in the direction of Blue Anchor and Dunster. This section is even more complicated by faults than that which had formed the study of the previous day, and is in this respect even more instructive; some of the more difficult problems known as "trough faults" being here brought under the observation of the student. But as a consequence of this repeated "faulting,"

added to the fact that the "Rhætic beds" are everywhere more or less displaced by slips, there is nowhere exhibited so complete a sequence as that at St. Audries' Head. It was, therefore, not without design that the line of travel on the previous day had been taken in that direction. The Club was fortunate in finding the state of the tide most favourable to their purpose. They were thus enabled not only to traverse the beach at their leisure, but to examine the beds seawards where they crop out at low water.

On nearing Blue Anchor an unexpected obstacle, before which a party in advance had turned back, presented itself. This was a party of volunteers carrying on a prize rifle competition on the beach. A notice of "danger" was conspicuously posted, and on turning an angle of rock the party found themselves in a line with the butts, at which a red danger-signal was flying, while another was energetically waved to warn them off. But among the party were some old volunteers who were not disposed to be turned from their purpose. An apology for the interruption was offered to the sergeant at the butts, who courteously directed the intruders to take ground some forty or fifty yards to the right, which they did, and the firing went on. The whizzing of the bullets was a new sensation to some of the party, but there was in truth no danger, as the squads were firing at a distance of 1000 yards, so that the trajectory of the bullets carried them far over the heads of the geologists.

Arrived safely at Blue Anchor, a delightfully situated and much frequented hostelry "by the beach'd margent of the sea," the party halted for luncheon, and spent half an hour very pleasantly. At this point rain came on, which did not cease during the remainder of the afternoon. From Blue Anchor the route lay through the village of Carhampton, and across Mr. Luttrell's park to Dunster. At Carhampton they halted to see the interior of the Church, in which a richly-carved screen of 15th century workmanship, originally painted and gilt, has been restored with admirable success. It gives a special feature to the Church, in which the work of restoration has been carried out with care, simplicity, and good taste.

Dunster Castle stands grandly on a wooded eminence overlooking the town. The park is extensive and beautiful, and the Grabbist Hill a fine feature. Through this park lay the path to Dunster, and many were the exclamations of delight which the beauty of the surrounding scenery called forth.

At Dunster the party halted to examine the Church, which presents the peculiarity of a recent nave built on to a more ancient conventual church; the tower, which was originally at the west end of the latter, being now in the centre. Of course all the interest centres in the older building, in which are some interesting monuments to the families of Mohun and Luttrell, and an elegant ogival arch in the aisle of very unusual construction.

This terminated the day's work and with it the objects for which the Club had been assembled. It is obvious that in so limited a time it was not possible to do anything like justice to the Watchet sections. A week's work at least would be required to be devoted to them. Their correlation is none of the easiest, and nothing has been attempted (critically) relative to the sequence and palæontology of the Watchet coast. Nothing was seen by the Club of the coast to the east of St. Audries, where days of work are required to work out the "Black Shales," "Planorbis beds," "Angulatus" and "Bucklandi" beds, all of which are repeated in fine condition at Little Stoke.

The Vale of Somerset offers different conditions to that of Gloucester, and these have to be considered and elucidated under different views and arguments. To the Cotteswold Geologist these Watchet sections possess a peculiar interest, as their correlation with those in our well-known section at Westbury has yet to be worked out.

It is with great pleasure that I am able to announce to the Club an important contribution in connection with this subject from the pen of our friend and colleague, Mr. Etheridge, of "Notes upon the Physical Structure of the Watchet Area, and the Relation of the Secondary Rocks to the Devonian Series of West Somerset." This paper is illustrated by sections and lists of fossils, which cannot fail to be of the greatest assistance in

correlating and working out the geology of this complicated and most interesting line of coast sections.

Nothing remains for me now except to conclude this record of our work during the past season, and to express a hope that the season which opens to-day may shew no slackness or falling-off in the numbers, energy, or activity of the Cotteswold Club.

Sapperton Tunnel on the Thames and Severn Canal.

Paper read at a Meeting of the Cotteswold Club, on the 18*th May,* 1870, *at the Royal Agricultural College, Cirencester, by* John H. Taunton, Mem. Inst. C. E.

Mr. President and Gentlemen,

In connexion with the localities which we have been visiting to-day, it may be thought a legitimate variation of our usual investigations, if we turn for the occasion from the oft discussed pit dwellings and superficial burrows of our *pre*-historic ancestors to the more extensive burrows executed within historic times—during later periods—and by our immediate forefathers. For although the object and intention of such more recent excavations is not problematic, and they possess therefore less charm for the exercise of the imagination, yet they are alike interesting as records of efforts to meet the supply of social wants, and as steps in the large history of civilization.

The general introduction of the Canal system in this country dates but about a century ago, for the first boat-load of coals sailed over the Barton Aqueduct of the Duke of Bridgewater's Canal to Manchester, in July, 1761; and the Duke of Bridgewater's Canal of James Brindley was the pioneer to Canals in this Country, just as the Stockton and Darlington Railway of George Stephenson has been the pioneer to Railways: yet as Tramways preceded Railways, so the knowledge of Canals was well understood, but had not been applied until Brindley's time.

The great navigation works in Egypt, supposed to have formed a communication between the Red and Mediterranean Seas, and to have been maintained for about 600 years before, and 800 years after the Christian Era, had existed, and were well known to our ancestors. The Bœotian Canal, said to have drained the Lake Mœris by several Channels carried in tunnels through high mountain Barriers.

The celebrated Canals of China—The Conduits of Imperial Rome, and those of Jerusalem, (which are now being carefully

explored.) The navigation works executed in Spain by the Moors, and particularly those in the Valley of the Guadalquiver, all had been visited by or described to them. Again, about the 12th century, Canals had been introduced into Italy, and about the same time into Holland, for the purpose both of inland navigation and of irrigation.

It was in the 15th century that the Canal Lock, with a gate at each end, was constructed by two engineers of Viterbo in Italy, with which also our forefathers were familiar.

Still, in this country, and in that part of Gloucestershire which we have been visiting to-day, there were neither Canals nor, I believe, any Tramways in the year 1770, and the two main roads between Stroud and Cirencester, the one (as I see in the old maps) by Bisley, and the other by Minchinhampton, carried the main Traffic of these parts a century ago.

At this date these two roads were probably in fair condition, and supplied by stage waggons, pack horses, and public conveyances, which no doubt were constantly passing to and fro over them, although I see in Arthur Young's "Six Weeks Tour through the Southern Counties of England and Wales" published in 1769, he says, from Gloucester to Newnham, a distance of twelve miles a "cursed road, infamously stony, with ruts all the way," in reference to our Gloucestershire roads of that date. Still the impetus given to road-making consequent on the inconvenience suffered by our Troops from want of roads during their advance to crush Prince Charles Edward's rebellion, in Scotland, in 1745, had led to their extensive formation, particularly in the North of England. Old Metcalf, the blind roadmaker, who played his fife at Falkirk, in King George's cause, and was I believe also at Culloden, had been busily at work, and had constructed many good roads. This wonderful old man, who had been blind since six years of age, from small-pox, did not die until 1810, in his 93rd year, leaving behind him 4 children, 20 grand-children, and 90 great grand-children.

In 1706 there was a stage coach running between London and York, as the old hand-bill in the hotel at the latter place (of which I have obtained this photograph) gives the particulars.

YORK FOUR DAYS STAGE-COACH.

Begins on Friday *the* 12*th of* April, 1706.

ALL that are desirous to pass from *London* to *York*, or from *York to London*, or any other Place on that Road; Let them Repair to the *Black Swan* in *Holbourn* in *London*, and to the *Black Swan* in *Coney-street* in *York*.

At both which Places, they may be received in a Stage Coach every *Monday*, *Wednesday* and *Friday*, which performs the whole Journey in Four Days, *(if God permits.)* And sets forth at Five o'clock in the Morning.

And returns from *York* to *Stamford* in two days, and from *Stamford* by *Huntingdon* to *London* in two days more. And the like Stages on their return.

Allowing each Passenger 14*l*, and all above 3*d*. a Pound.

Performed By { *Benjamin Kingman*, *Henry Harrison*, *Walter Bayne's*,

Also this gives Notice that Newcastle Stage Coach, sets out from York, every Monday, and Friday, and from Newcastle every Monday and Friday.

The condition of the district even so late as 1784-85, as to convenience of locomotion is exhibited to some extent by the circumstance that, (as I find from the old correspondence,) in August, 1784, the contractor to the Tunnel was kept in confinement at Bisley for four weeks, and again in January, 1785, for many days at Minchinhampton, in both cases for debt, previously to his being sent to Gloucester Gaol.

The first reference to the Canal Tunnel, which I find is in the preliminary report of Robert Whitworth, the Engineer, applied to by the promoters of the Navigable communication proposed to unite the Rivers Thames and Severn, dated 22nd December, 1782, which was after the formation of the Stroudwater Navigation, a work that was carried out after much previous opposition and difficulty, under an act obtained in 1775. This was early in the period of the Canal mania, which appears to have culminated in the years 1790 to 1794, during which four years not fewer than 81 Canal and Navigation Acts were obtained.

As in the case of Railways at a subsequent period, works which might without pressure upon the national resources easily have been done if spread over a longer period, were undertaken *all at once*, and the same consequences ensued of panic, depreciation, and loss. Still the public have been the gainers, and some 2600 miles of Navigable Canals have been formed in England, 276 in Ireland, and 225 in Scotland.

It is interesting and significant to note how the development of the steam engine, as perfected by James Watt, was coincident with the introduction of the means of supplying that engine with fuel, at a reasonable cost, by the establishment of the Canal system throughout the country, without which the development of steam power must have been postponed.

James Watt's patent for his improvements in the steam Engine, was first granted for a term of 14 years, in 1769, and in 1775 he obtained an Act of Parliament extending his patent right to 1800. About 1790 therefore, he was in full enjoyment of the exercise of his licences for the use of his inventions, which had become very valuable. It may be interesting to the

Club to see one of these licences dated 1st January, 1791, granted to the Proprietors of the Thames and Severn Navigation, for their engine at Thames head, which was constructed by BOULTON and WATT about that time. The document is executed by WATT and by his partner BOULTON.* This Engine was taken down and replaced by an ordinary Cornish Pumping Engine, in 1854. Before WATT's Engine the springs were lifted into the Canal by a Wind Engine.

But to return from this digression to ROBERT WHITWORTH, who was an able pupil of, and successor to JAMES BRINDLEY.

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* This after reciting that in the 5th January, 9th George III (being 1769) James Watt obtained his first patent for the term of 14 years and subsequently that he obtained an Act of Parliament in the 15th George III (being 1775) extending his right of patent 25 years (to 1800) and that the Canal Company wished to avail themselves of his invention and patent, proceeds to say, *Now this Indenture witnesseth* that the said Company of Proprietors of the Thames and Severn Navigation have covenanted promised and agreed, and by these presents, for and on behalf of themselves and their successors do covenant promise and agree, to and with the said James Watt and Matthew Boulton their executors administrators and assigns, That they the said Company of Proprietors of the Thames and Severn Navigation, shall and will on or before the first day of September one thousand seven hundred and ninety-one at their own proper cost and charge set up erect complete and finish at Thames Head aforesaid or at upon or near some other part of the said canal a steam engine of his the said James Watt's invention as described in the said hereinbefore in part recited letters patent and Act of Parliament or one of them and according to the plans and directions to be furnished by the said James Watt and Matthew Boulton their executors administrators and assigns of the dimensions hereinbefore recited. And also that they the said Company of Proprietors and their successors shall and will at all times from and after the erecting of the said engine during the then residue of the said term of twenty-five years granted by the said Act of Parliament or during such part thereof as the said engine shall continue to be used or worked for the purposes of the said Canal at their own proper costs and charges maintain and keep the said engine in good order and repair. *And* in order to give and make to the said James Watt and Matthew Boulton a compensation and satisfaction for such consent and agreement to the setting up erecting using working and exercising the said engine during the remainder of the term of twenty-five years granted by the said Act of Parliament they the said Company of Proprietors of the Thames and Severn Navigation for and on behalf of themselves and

In his report to the Promoters of the Thames and Severn Canal, he gives elaborate estimates, which contain the following item:

To Tunneling from Sapperton to Hayley Wood. This is an uncertain piece of business in point of expense, upon account of the different strata of matter through which it must be made, yet that it is practicable at this day will not be doubted, though it is much longer, and to admit 12ft. boats, must be wider than any that has yet been done. This Tunnel I have supposed to commence where the ground becomes 24ft. above the surface of the water, (which will be 30ft. from the bottom), according to which the length will be 3850 yards as appears by the annexed profile. I have likewise annexed a section of the form and dimensions, that I judge, too, will be proper to make the Brickwork to admit boats of 12ft. wide, so that they may have a sufficient waterway at the different heights of the water in the summit level; and as the ground is from 24ft. to 203ft. high, the deep part will be more expensive than the other, upon account of sinking shafts, and drawing up the earth, and letting down the materials, therefore, I will suppose one half of the length to cost £10, and the other £9, per yard, running at which rate, 3850 yards comes to	36575	0	0
To 97680 cubic yards of extra cutting to the mouth of the Tunnel, at 6d. per yard	2442	0	0
	£39017	0	0

also for and on behalf of their successors do hereby further covenant promise and agree to and with the said James Watt and Matthew Boulton their executors administrators and assigns that they the said Company of Proprietors of the said Navigation and their successors shall and will yearly and every year during the residue and remainder of the said term of twenty-five years or such part thereof as the said engine shall continue to be used or worked at or upon any part of the said Canal of Navigation aforesaid or in any other place well and truly pay or cause to be paid unto the said James Watt and Matthew Boulton their executors administrators or assigns by two equal half-yearly payments *in every year the sum of one hundred and twenty pounds* lawful money of Great Britain the first of which payments to begin and be made at the end of six calendar months next after the day on which the said engine shall begin to be used or worked

At the time WHITWORTH reported to the Promoters of the Canal (in December, 1782) two schemes for connecting the Severn with the Thames were examined by him, the one from Tewkesbury, viâ Cheltenham, tunneling under Sandywell Park, into the Valley of the Colne, which it traversed, and joined the Thames at Lechlade; the other, which was the less expensive, but involved the longest tunneling, was by the Stroud Valley, and in communication with the Stroudwater Navigation, being the route adopted.

It will be seen that WHITWORTH speaks of the proposed Tunnel as being much longer, and if formed to allow the passage of Thames boats, (which are 12 feet wide; ordinary canal boats being but 7 feet, and Severn barges 15 feet wide) wider than anything that had yet been done, although in his opinion quite practicable. It was a bold work, therefore, to undertake in 1782. However, the Promoters went to Parliament for powers, which they obtained the following year, and were incorporated as the Company of Proprietors of the Thames and Severn Canal Navigation. On the 7th October, 1783, the

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with effect and to be continued regularly at the end of every six calendar months during the remainder of the said term of twenty-five years or so long thereof as the said engine shall continue to be used as aforesaid.

(Signed) JAMES WATT
MATTHEW BOULTON

BOULTON'S interest in WATT'S patent was acquired from DR. ROEBUCK, who was WATT'S first partner, and held two-thirds of the invention for money advanced, &c. But there was so much difficulty in introducing WATT'S engine, that poor ROEBUCK, although a most able and bold man, failed altogether; sinking his own and his wife's fortune, besides large sums of money obtained from friends. He is described in a Cyclopædia of Biography, recently published in Glasgow, thus:—

"JOHN ROEBUCK, a physician, and experimental chemist, born at Sheffield, 1718, died, after ruining himself by his projects. 1794."

He was grandfather to JOHN ARTHUR ROEBUCK, late M.P. for Sheffield. The value of the share in WATT'S patent was thought so small, that it was not even included in the list of assets at the time of ROEBUCK'S failure. After BOULTON joined WATT, they had great difficulties, and could sometimes hardly pay their workmen on Saturday night; but ultimately by the extension of the patent, they succeeded, and acquired both wealth and reputation.

Committee of Management met and received tenders, at the George Inn, Stroud, when they came to an arrangement with one CHARLES JONES, mason and miner, of Manchester, to execute the excavations for a Tunnel 15 feet high by 15 feet wide, for the low sum of seven guineas per yard forward.

This was to include the sinking of the shafts, but not the gins or winding tackle, (which the Company were to supply,) or bricks, &c.

The original tender of C. JONES is as under, £8 8 0 per yard, but this was modified on its acceptance.

A preposal to make the Tunnel Through Sapporton hill and Haley Wood 15 feet wide and 16 feet high at £8-8-0 per yard—and the undertaker to Sink all the Shafts as may be wanted in the whole Tunnel—the Co to find Timber and Carpenter's work for making Gins Senters as maney as may be wanted to Compleate the Tunnel in the Time as may be fixed by the Committees Engineer and the Co to finde all Barrowes and planks and Ropes and Bricks and Basketts to Compleate all the works Through Hill

Stroude October 7th 1783 C. JONES

This was made the subject of an agreement between JONES and the Company, which was executed on the following day, viz., 8th October, 1783, under which agreement the Tunnel should have been completed on the 1st January, 1788. JONES, however, did not get on well with the work, and the usual difficulties with the contractor ensued. He did not complete altogether 100 yards of the work at the Sapperton end, where "Marle Rubble and Loose Rock" were encountered, and the shafts were deep, but he ultimately completed about 1400 yards at the Coates end, where the work was easier.

He seems to have been treated rather strictly by the Committee of Management, I think, for in March, 1784, I find the acting Engineer, Mr. JOSIAH CLOWES, certifying that it is necessary to make the excavations wider and deeper by 2½ feet each way, so as to allow of a lining of rammed clay and brickwork; and on the 5th of April of the same year JONES signed an agreement at the Swan Inn, Stroud, under which he recognizes this addition as an "incident to the Contract" and that he cannot claim anything for it as extra work. This became one of JONES' chief points in the Chancery proceedings, which he, or his

assignees, subsequently instituted against the Company, when in his pleadings he alleged that the Committee made him drunk, at the Swan Inn, at Stroud, before he signed this agreement; an allegation, which of course had no real foundation.

JONES the contractor, seems to have been unequal to the execution of the work which he had undertaken. He was constantly in custody at Bisley, or Minchinhampton, or in Gloucester Gaol, where in the spring of 1788 he was detained for 10 weeks: the works at the Tunnel being in progress, and very far from completion. Some idea of the sort of man JONES was may be formed from the following letter, which he addressed to the Canal Company's Manager, Mr. SMITH, on his coming out of Gloucester Gaol, in 1785:

Mr. Smith, Sir,

This is to Let you Know that I Left Glouster the Last night about half-past Six O'clock—I Gave Single Bale and Then Spasol Baile—Dirickly—To the Ashon—so Know I Shall be advised by you what more to Do—in This matter—but I Think if we Could Get Lawden To a faire Setteling would be the Bast—But youl hear what Mr. Perrey says in His Letter on wensday Nax, and Then Please to Let me Know—Lawen and His attorney would very fain have had me To have Ordered it another way but would not—Lawden Dust not Star one Inch out of the Settey, if he had he would have Been Taken into Custety—but I sopese the Folch Devel Node That—I should be very Glad if you would Take the Truble to wright a fue Lines to Mr. Gabson the attorney and Let him Know the Tru State of Lawden's affaires—for Prue and him has Tould Mr. Gabson all the Dambs Lyles that Could be Formed by men, and for want of Being Better Informed he believed Them—I have Been Thrue the works This Day and we want Lime at Both ends—please to Send Sum as Soon as posoble you Can,

from Sir your most Humbl Servt.

Coates Janry 23th—1785— CHAS. JONES—

Sir,

P.S.—Know I want sum Bills to be paide off—wich I Hope you will be so Kind as to make it None to the Gentlem and Let me have Sum money in a very Short Time—as I may not be hald and mald in This manor, for it is eneff to make amen go Quite mad and of is sances, my Paseshons is Quite wore out, with every Body Stating and Tareing at me—Just Like a Pack of Dogs after a haire—I have Paide a vest Deail more Money Till I have Reced, but it is the Contery the Grates Part, wich must be Paide to Them again or I can have no Content at all for I am all ways uneasey about it,

if sum Part was Paide at one Time and sum at another, Time, Then it would make Them more Content and me Boath, and Let us Get Sut with This Damb Lawden as Soon as Posoble we can—

Sir—Whenever the Racking Coms please to Com to Coates and pay Thire, as I am Determed never to go Into aney Publick house aney more at Sapperton nor Hayley Wood, never while This Tunnel His Doing, for a Reson as I have Gott—

In September, 1784, I find George Jones (a son of Charles Jones) threatening to murder the Canal Company's Manager, and using abusive language towards him, in consequence of which, the said George Jones was obliged to leave the neighbourhood; and he and his father give a joint undertaking, that he shall forthwith leave the works, and not come within 20 miles of any part of the Canal for 5 years, or molest, directly or indirectly the Manager, during his lifetime, or any of the Canal Company's servants.

In the end, the Canal Company discovered that low tenders are not always the cheapest. They had to take some of the work into their own hands to get rid of Charles Jones, and engage other contractors in order to finish the Tunnel, which ultimately cost a very large sum of money, the exact amount of which cannot be ascertained from the Company's books; and it was not completed for the passage of boats until the month of April, 1789.

The exact date of the opening of the Canal is fixed by the Annual Register, under date November 19th, 1789, Gloucester, and is announced in the following terms:—

"This day was effected the greatest object of internal navigation in this kingdom,—The Severn was united to the Thames by an intermediate canal ascending by Stroud through the vale of Chalford, to the height of 343 feet, by 28 locks; there entering a tunnel through the hill of Sapperton for the length of two miles and three furlongs, and descending 134 feet by 14 locks, it joined the Thames near Lechlade. With respect to the internal commerce of the kingdom, and the security of communication in time of war, this junction of the Thames and Severn must be attended with the most beneficial consequences, as even stores from the Baltic, and provisions from Ireland may

reach the capital, and the ports at the mouth of the Thames, in safety. And all the heavy articles from the mines and founderies in the heart of Wales, and the counties contiguous to the Severn may find a secure and certain conveyance to the capital. In short, this undertaking is worthy of a great commercial nation and does great credit to the exertions of the individuals, who have promoted and completed a work of such magnitude, at an expense of nearly two hundred thousand pounds. The arched tunnel carried through the bowels of a mountain nearly two miles and a half long and 15 feet wide at a level 250 feet below its summit, is a work worthy admiration; and the locks ascending from Stroud, and descending from the summit are executed in a manner deserving great commendation."

In the Siddington books under date December 9th, 1790, is the following entry :—

"This day the Company's vessel, *The Success*, CHARLES PHELPS, Captain, passed with Bilston Coal from Brimscombe to Cricklade for the Company's account."

The Tunnel was considered a great work at the time of its execution ; old KING GEORGE III came to look at it, and that part of the Canal being the open cutting at east (Coates) end of the Tunnel, is called, I suppose in consequence—"The King's Reach."

The length of the Tunnel is 3817 yards, and the ordinary water level of the Canal in it is 363 feet above the sea, being 133 feet below the level of rails, at the summit of Great Western Railway ; (between the two Tunnels on that railway.) It is wide enough for the passage of vessels with 12 feet beam, and in places two boats 7 feet wide can pass one another easily. But the working of vessels eastward and westward is regulated alternately for certain fixed hours during the day and night, so that vessels ought never to meet one another.

The Tunnel is arched, and lined with brickwork or stonework, during 2427 yards of its length, the rest 1390 yards being in rocking, as shown on the longitudinal and cross sections. In the rocking, however, there are very few places (only a total

length of about 400 yards in the whole Tunnel) where the rock is so homogeneous, and free from fissures and faults, as to hold the water without clay side lining and walls supporting the same, which are carried above the water level, as shown on Cross Section No. 3. This arrangement is general through the rocking. Similar clay lining is also carried behind the side walls in a great portion of the arching, and a bottom lining of pounded clay, or of clay puddle is continuous throughout the Tunnel, except where it is formed through sound clay in the Fullers Earth. Where fissures in the rock had to be encountered, doors of oak were fixed across the side walling, and linings into two grooves cut on either side of, and some little distance from such fissures into the rock, so as to block the flow of any side leakage towards such fissures, which probably answered very well at the time; but these wooden doors have since occasioned much trouble. In consequence of the decay of the timber, cavities have been formed where they existed, and the leakage, which it was intended to prevent, has been aggravated by them.

Where bottom springs enter the Tunnel, and in other bad places, large trunks made with 2½ inch thick planking at the bottom, and 2¼ inches thick at the sides, were designed, as shewn on the Cross Section No 4, &c., to carry the Canal.* Every expedient

* The Engineer's Specification of the work for this Trunking is as follows:—

The Planking is to be put on the thickness ordered, and the seams to be well caulked and pitched like the sides of a ship. The Planks to be fixed on with trunnels and spikes.

At different distances, according as the holes of the springs have at any time appeared, trunks of 10 inches square inside (made of 2-inch oak plank) must be constructed and fixed cross the floor, from the orifice of the said springs and up the sides behind the side planking, with discharging mouths like the nozel of a pump; so that the water of the said springs may discharge their produce 3 inches above the water level of canal, and not to drink any out of it.

Between the sleepers or cross timber well-tempered clay, not over wet, must be ram'd well down and under each breadth of plank as the work advances.

Walling of brick or stone must be built between and behind the side timbers, for the purpose of steadying the framed work of the sides from any blows or thumps of barges; and the said walling must be carried up and over the side rails until that work meets the incumbent rocks of the ceiling where it is not arched.

was resorted to in order to prevent leakage, and the engineering seems to have been of a perfect character. At the present day little more could be designed to insure security, except, possibly, that concrete would be largely employed in substitution of, or in addition to, some of the work.

There were 24 shafts, 22 of which are now traceable on the ground, and are shewn on the Longitudinal Section, but none of them are now open, and notwithstanding the smoke made by vessels in passing the Tunnel, no difficulty is experienced about its ventilation. Indeed, when one of the shafts (that in the valley where the Great Western Railway crosses over the Tunnel,) fell in some few years ago, I thought of keeping it open permanently, but found that the ventilation was rather injured than improved by its being left open, as it had a decided tendency to interfere with the set of the ventilating current; and whilst it remained open there were many complaints from boatmen of the Tunnel having got more smoky than it was formerly; I therefore caused it to be again closed, and such complaints ceased.

It is unfortunate that in consequence of the closing of the shafts no section of the hill can now be seen, except at the valley shaft, (before referred to, No. 9 from the Coates face on the longitudinal section,) where the slabs covering it may be easily removed and the beds of the Great Oolite, through which it is sunk, seen; but on the line of the Tunnel itself there can be no doubt whatever about the identity of the strata which have been pierced. Beginning at the west (Sapperton) end, after passing through but little detritus and talus which has tumbled from the face of the hill above, the Fullers Earth is soon reached. (This constitutes the "Marle, Rubble and Loose Rock" before mentioned in reference to Charles Jones' work here.)

The Fullers Earth was fully exposed on June 25th, 1868, when a portion of the roof of the Tunnel fell in at the point marked on the section, as well as at other times when repairs to the arch or side walls have been executed. At about 580 yards from the Sapperton face the Fullers Earth is passed, and

the Tunnel—formed according to Cross sections, Nos. 2 and 3—pierces the upper beds of the Inferior Oolite for a distance of about 930 yards. Good sections of these beds are visible in the Tunnel, their dip being here from south-east to north-west four degrees is plainly seen and indicates the up-throw which caused the hill. *Rynchonella spinosa* is found in the spoil heaps at shaft No. 2, (from Sapperton face,) and *Terebratula fimbria* at shafts Nos. 3 and 4.

The various rockings at this part of the Tunnel are very interesting, and quite worth a visit. It was here that the fissures in the rock caused so much trouble originally—and continue to do so—from the decay of the timber in the planking and doors, before referred to, used as a casing over the fissures. There seems to be a slight inaccuracy in the Ordnance Geological Map, which shows the Fullers Earth at a higher elevation at Sapperton than it is proved by the Tunnel excavations to be placed, and assigns to that formation the out-throw of the spring, issuing just below Sapperton village, instead of to the clays of the Forest Marble, to which its development is due. In this view the isolated capping of Forest Marble, shown at "Ash Hill," should be extended further to the eastward, and include Sapperton.

The first fault which is intersected by the Tunnel (passing towards the east) is in the exact position indicated on the Ordnance Map; and near here the "Long Arching," shewn on the longitudinal section, begins, and extends for a distance of about 1190 yards. Nothing can be seen in this interval in the Tunnel beyond the probable position of the fault, which I have taken to be indicated by the point shewn on the section, where the Cassey-well springs and others pour in considerable volume into the Tunnel through the roof and northern side wall. The large portion of the work, here entirely in arching, is without doubt carried through the Fullers Earth, which has been disclosed on different occasions during frequent repairs; and this is also evident from an examination of the spoil heaps at the various shafts.

The second fault encountered is near but somewhat west of

the position indicated on the Ordnance Map, and a little west of the spot where the G.W.R. crosses over the Tunnel which now enters the Great Oolite, through which it passes for a distance of about 1120 yards, to the Coates or eastern face.

The Great Oolite beds may be readily inspected at the valley shaft, and in the various lengths of rocking left between the arching, as shown on the section.

The general dip of these beds is very slight towards the south-east, except at the first rocking, east of the long arching, where it is very decided (in that direction); but past the shaft, at the crossing of the G.W.R., it is for a little distance in the opposite direction, so that it is slightly synclinal, following in a modified way the surface formation of the valley above, through which the Railway passes. The structure of the Cotteswold ridge at Sapperton has been further illustrated by the construction of the G.W.R. Tunnel, which was carried out by Mr. R. P. Brereton, Mem. Inst., C.E., between 1843 and 1845, (then acting as Assistant Engineer to the late Mr. I. K. Brunel.)

That Tunnel was originally designed at a lower level than ultimately was adopted,—shafts were sunk, and a heading upwards of one mile in length was driven through the Hill,—between 1837 and 1841, when it was found necessary to reduce the expenditure required for the construction of the Cheltenham and Great Western Railway in every possible way, in order to get the Railway completed and opened for traffic; and, amongst other things that were done, the late Mr. Brunel's first idea of a longer Tunnel at Sapperton Summit, with a better gradient up the Stroud Valley than has been formed, was modified, and the Directors of the Company determined to raise the level of the Summit Tunnel and make it much shorter. Hence the present Tunnel and defective gradient leading to it from Stroud.* But the effect of the operations of

* The Railway Company obtained their Act of Parliament in 1836, and opened a part of their Line between Swindon and Cirencester, first (about 1841;) afterwards on May 12th, 1845, they opened it between Kemble and Gloucester. Mr. Jonathan Nowell was the Contractor who constructed the Railway Tunnel.

the Railway Company in piercing the hill, in such various directions, has been to obtain a perfect and exact knowledge of its stratigraphic condition down to the level at which their lowest heading passed, and to enable Mr. BRERETON, the Engineer, to prepare the admirable section accompanying this paper, which he has very kindly allowed me to copy and use for the information of the Cotteswold Club. That section has been reduced to the same scale and referred to the same datum (being that of the Ordnance, viz., mid-tide sea level) as the section of the Canal Tunnel. The ridge in one case attains an elevation of 613 feet, and in the other of 593 feet above mid-tide sea level, and read together the two sections show the structure of the hill at Sapperton without any speculation or doubt for a depth of 250 feet to 270 feet down from the summit.

The Drawings which accompany this Paper are as follows:—

A is a longitudinal section of the Canal Tunnel, on a scale horizontal 400 feet, and vertical 40 feet to the inch, prepared from my own working sections, and is illustrated by the cross sections, viz:

No. 1 where the Tunnel is formed in Fullers Earth Clay.
No. 2 " " in loose Oolitic Rock.
No. 3 " " in ordinary Rocking.
No. 4 where Trunk Forming was used in consequence of springs entering in at, or towards, the bottom of the Tunnel, with longitudinal section and plan referring to same.

All these cross sections are on a scale of 8 feet to the inch.

B is a longitudinal section of the Great Western Railway Tunnels, prepared from working sections of the Engineer, (Mr. R. P. BRERETON, Mem. Inst. C. E.) on scale 400 feet horizontal, and 40 feet vertical to the inch.

No. 5 is the general cross section to same, on a scale of 8 feet to the inch.

C is a General Plan, on a scale of 20 chains to the inch, showing the exact positions of the two Tunnels at Sapperton.

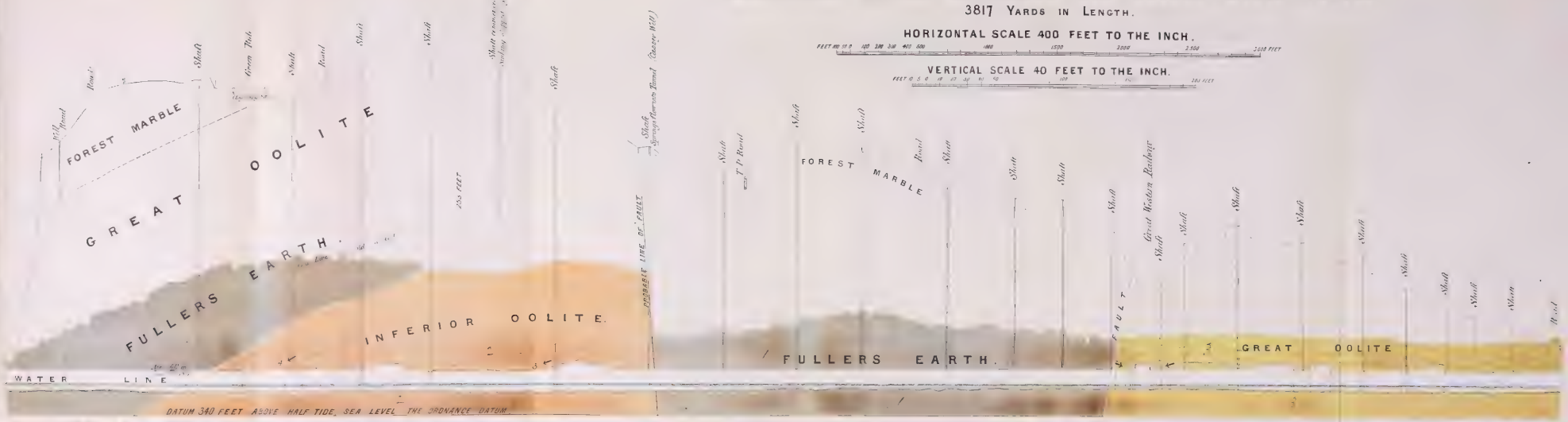
A.

Longitudinal Section of Thames and Severn Canal Tunnel.

3817 Yards in Length.

Horizontal Scale 400 Feet to the Inch.

Vertical Scale 40 Feet to the Inch.



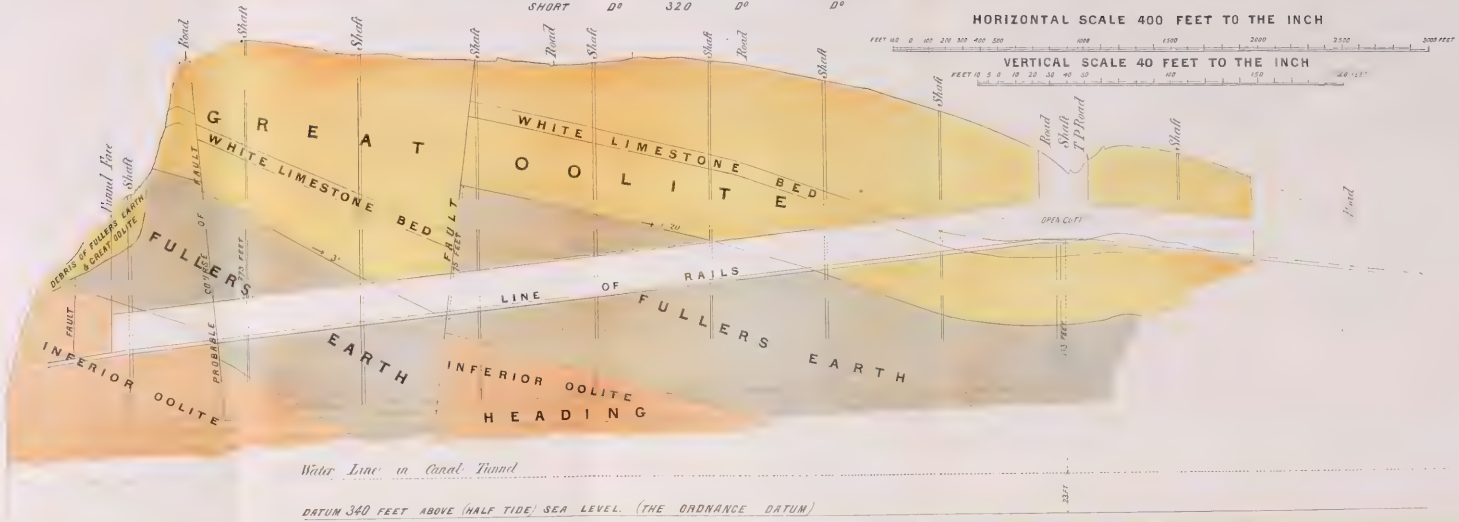
John H Thomas, Nov. Inst. C.E.
April 17th 1871

B. LONGITUDINAL SECTION OF GREAT WESTERN RAILWAY TUNNELS

LONG TUNNEL 1760 YARDS IN LENGTH
SHORT Do 320 Do Do

HORIZONTAL SCALE 400 FEET TO THE INCH

VERTICAL SCALE 40 FEET TO THE INCH



G.W. RAILWAY TUNNEL.

CROSS SECTION.

Nº 5

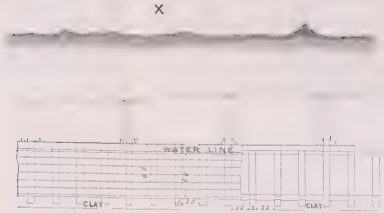
SCALE 8 FEET TO THE INCH.

C.

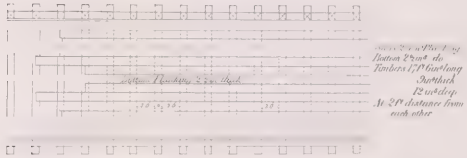
T & S. CANAL TUNNEL.

John H Trenton, Mem Inst C.E.
April 17th 1871

LONGITUDINAL SECTION.



PLAN.

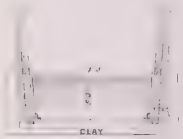


CROSS SECTION FOR ARCHING IN CLAY Nº 1.

CROSS SECTION FOR ARCHING IN LOOSE ROCK. Nº 2.

CROSS SECTION FOR ROCKING Nº 3.

CROSS SECTION FOR TRUNK FORMING Nº 4 XX (on Longitudinal Section)



SCALE 8 FEET TO THE INCH.

INCHES 0 1 2 3 4 5 6 7 8 9 10 11 12 FEET

John Bellows Lith Gloucester

On some Flint-flakes, from the Valley of the Churn, at Cirencester.
By W. T. Thiselton Dyer, B.A., B.Sc.

It may be considered worth while to record in the Proceedings of the Club, the occurrence at Cirencester of small flint-flakes in considerable numbers. They are found in the top spit of mould beneath the turf, when this is removed to allow of the excavation of the gravel at the Barton Pits. My attention was called to them in 1869, by Mr. Ohrly, a student at the Agricultural College, who has paid a good deal of attention to Geology, and is a keen observer. I afterwards found them myself *in situ* in the layer of mould, varying from nine inches to a foot in thickness, which is exposed in the section formed by the pit side. The gravel is apparently derived from the Inferior Oolite, as it contained rolled examples of *Terebratula fimbria*, and other characteristic fossils. I found, as might be expected, no flints in this, but only in the superincumbent soil.

The flakes which I collected were very rude; some were flat with a triangular outline, others oblong, and of about the same size as those figured by Mr. Jones, from Stroud Hill.* They were, however, far less regularly formed than these, as I also ascertained by examining some in the possession of Mr. Wichell. I showed the most presentable of what I found to Mr. Franks, at the British Museum. He accepted a few of them as being of human manufacture, and selected examples for the Christy collection. Supposing, as it is not impossible many persons will do, that these flints are too

* Proceedings, vol. iii., p. 103.

indeterminate to be considered as having been used for any purpose by man, it is still puzzling to give them a history. The nearest flint gravel to Cirencester is at Minety,* but this is lower down the Churn valley. In reading, however, Mr. Lucy's memoir on the Gravels of the Cotteswolds, I met with a passage (page 100) in which he mentions the occurrence about Moreton-in-the-Marsh, of "a great quantity of flints, some very small, having a chipped appearance." It is by no means impossible that this may be the clue to the flint-flakes at the Barton Pits.

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† Proceedings, 1869, p. 104.

Thlaspi perfoliatum. Perfoliate Penny Cress.

On Thlaspi perfoliatum, L. *By* W. T. Thiselton Dyer, B.A., B.Sc.

It has been pointed out by Mr. Watson* that the most *local* species of British flowering plants belong to two classes as regards their distribution, namely, those which are found only in the south of England, and secondly the assemblage of Alpine and Arctic plants peculiar, as far as Britain is concerned, to the Eastern Highlands of Scotland. *Thlaspi perfoliatum*, L., is an example of the first class, as in Britain it has only hitherto been gathered on the Oolites of Gloucestershire and Oxfordshire. Mr. Watson, in his latest publication on the distribution of British plants, places Oxfordshire within brackets, by which it is intended to show that probably the *Thlaspi* is no longer to be found in that county, so that Gloucestershire now stands alone as a locality for it.

In Dr. Hooker's Student's Flora, p. 38, *Thlaspi perfoliatum* is said to affect 'limestone pastures.' I believe, however, that when growing it will generally be found to prefer weathered limestone rubbish. As it is an annual of small dimensions and very short duration, it would be quite an exceptional thing for a plant so constituted to be able to hold its own against the perennial vegetation of pastures.

In Oxfordshire it was originally found "among the stone pits" (quarries) between Witney and Burford, (Ray's Synopsis, Ed. iii., p. 305), and more recently, a specimen in the British Museum was collected by Mr. Bicheno, 4½ miles from Witney, on the Burford Road. Some years ago my friend, Mr. Boswell,

* Cybele Britannica, vol. iv., p. 445.

met with it in cultivated ground near Woodstock; but, although he searched the spot in several after years, he never saw it there again, nor had I any better success on visiting the place with him. For Gloucestershire many localities have from time to time been recorded. Mr. Buckman met with it in the neighbourhood of Sapperton;* it occurred in "old quarryings" over both the north and also the south end of the railway tunnel. Other localities given by Mr. Buckman in the North Cotteswolds are Eyeford, Stow-on-the-Wold, the Seven Springs, and Bourton-on-the-Water; Naunton may be added on the authority of Dr. Boswell-Syme,† and Upper Slaughter, where it was gathered by Mr. Borrer.‡

In 1869 I myself met with a small patch of the *Thlaspi* growing on a rather bare bank by the roadside just outside the village of Sapperton, and afterwards in great abundance on the embankment, and even on the ballast between the rails of the Great Western Railway near Tetbury Road Station, towards Hailey Wood.

Thlaspi perfoliatum like a few other of our native Crucifers, is a very early plant, such as *Erophilæ verna* and *Teesdalia nudicaulis*. On the 1st of May I found the seeds fully formed and the plant almost out of condition for collecting.

Britain possesses no plant peculiar to it, and therefore no spot which is the object of pilgrimages to foreign botanists, like the mountain side in Carinthia, where alone in the whole world the splendid *Scrophulariacea*, *Wulfenia carinthiaca*, Jacq., conceals the ground with its magnificent assemblage of flowers of gorgeous blue. The *Thlaspi*, for example, though so local in England extends through Middle Europe to Western and Northern Asia, and southwards to Northern Africa.

The neighbourhood of the Cotteswolds produces a few other plants very local in Britain. *Arabis stricta*, Huds., confined

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* See Proceedings, vol. i., p. 109, and Appendix, p. 4; also the Phytologist for 1850. p. 942.

† Eng. Bot., Ed. iii., vol. i., p 204.

‡ There are specimens in the British Museum Herbarium.

with us to Clifton and Cheddar, does not extend beyond Central Europe. *Cephalanthera rubra*, Reich., extends through Europe to West Siberia, but in England was hardly more than traditionally known as having been found on Minchinhampton Common; it was said to have been met with in 1836, on the Quantock Hills in Somerset, but recently has been collected in some plenty in Pitchcombe Wood after the trees had been cut.* Lastly, *Carex tomentosa*, L., which is distributed throughout Europe, is only found in the British Isles at Marston-Maisey in Wiltshire.

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* Eng. Bot., Ed. iii., vol. 9, p. 128.

On the Early Occupation of the Cotteswold Hills by Man. By G. F. Playne. *Read at Williton, October 5th,* 1870.

In common with many districts of England, the Cotteswold Hills retain traces of their occupation by early races of men, of whose existence we have little evidence except the remains of their works. These remains consist of portions of the dwellings in which they sheltered, of defensive works by which they protected themselves, of structures whereby they marked the graves of their dead, and accompanying these larger works are found various implements, ornaments, and weapons of stone, earth, and metal. These relics, from the imperishable character of their materials, have suffered comparatively little by the ordinary effects of nature; but by the agency of man very many have been injured, and numbers have doubtless disappeared altogether. The plough has been the great leveller of earthworks; the mere value of the materials has led to the removal of many structures formed of massive stones; the treasure-seeker has marred the antiquarian interest of numbers of barrows; and the researches of antiquaries have aided in the destruction of these ancient works. Those which have remained to the present time are now subjected to these various destructive agencies in a rapidly increasing ratio,—by the inclosure of "common" lands, whose hitherto untilled surfaces have preserved in a remarkable manner even slight depressions or mounds made many centuries ago; by the more thorough cultivation of long existing farms, for which barrows or other works before spared are now removed; and by the restless activity of antiquaries, whose investigations threaten to leave to the future few vestiges of these ancient works intact. It therefore appears desirable to take note of the present state of these remains, and to gather up the evidences they afford before they altogether disappear.

I shall not attempt to give a detailed account of all the

camps, barrows, and other traces of the early occupation of the Cotteswold range, but having recently devoted considerable time and labour to an examination of those which are found in my own neighbourhood, I trust that a condensed report of them may not be without interest; believing that this district, though certainly rich in such remains, is by no means exceptional, and that other districts, carefully examined, yield similar evidences.

The accompanying map embraces an area of five miles square, having the village of Nailsworth nearly at its centre. On this map the valleys are shaded, the higher grounds are unshaded. In the valleys few remains of early man have been met with, whilst it will be seen at a glance how numerous they are on the higher land,—not only are extensive earthworks there traced, but many tumuli stud the surface.

The following table contains particulars of nineteen tumuli, which occur in the area embraced by this map, whilst for the purposes of comparison the dimensions of the well-known Uley Bury Tumulus are given at the head of the list.

No. on Map		Form	Length	Width	Height	Direction of highest part
			Feet	Feet	Feet	
	Uley Bury Tumulus.....	Oval	150	70	12	E.N.E.
1	"The Toots" on Selsley Hill	"	210	90	11	"
2	Bown Hill Tumulus.....	"	180	50		"
3	"Whitfield's Tump"	"	75?	36?	...?	E. S. E.
4	Gatcombe Tumulus	"	200	84	8	E.N.E.
5	"Tingle Stone" Tumulus ...	"	130	70	6	N.
6	Avening Tumulus.....	"	160	60	6	E.
7	Lechmore Tumulus	"	120	65	6	E.
8	Near Bown Hill Tumulus ...	Circular	60? in diam., ploughed down			
9	" Hampton Common.....	"	60	"	"	"
10	" The Hyde.....	"	65?	"	"	"
11	In Gatcombe Wood	"	35	"	2 ft. high	
12	"The Oven," Avening Copse	"	50	"	5 "	
13	In Hazlewood	"	75?	"	now 3 ft. high	
14	Near Hazlewood Copse	"	65?	"	ploughed down	
15	" Lechmore Tumulus ...	"	45	"	5 ft. high	
16	" Chavenage Green	"	60?	"	ploughed down	
17	" " "	"	60?	"	"	"
18	Horsley Wood Tumulus	"	52	"	3 ft. 6 in. high	
19	The Hyde Tumulus	Oval	80 long, 60 wide, 10 high, E by N			

Nos. 1 to 7 of the above table are very similar as regards their external form to the Uley Tumulus, and have probably all contained stone chambers. A few remarks will suffice as to

PLATE I

SKETCH MAP OF THE NEIGHBOURHOOD OF NAILSWORTH.

Scale 1 mile to 1 inch.

The Valleys shaded. The plateau above escarpments white.

A. *Ancient Earthwork in Hazlewood Copse*

B. *The Amberley Earthworks*

C. *The Minchinhampton Earthworks*

D. *Earthworks on Selsley Hill.*

E. *Earthworks on Rodborough Hill.*

their present condition, and serve to show how much injury they have suffered even during the present century.

The largest tumulus of this district stands on Selsley Hill; it is known as "The Toots," and has been opened in three places, but I am not aware that any record has been preserved of the results of this disturbance. The Bown Hill Tumulus (No. 2) was opened by the Club in May, 1863, and found to have been formed over stone chambers; particulars of this examination are given in the "Proceedings of the Club," Vol. III., page 199. The tumulus on Minchinhampton Common, popularly known as "Whitfield's Tump," has been so thoroughly disturbed as to render it difficult to ascertain its original form and dimensions.

The belief that these tumuli contained treasure led to the disturbance of the remarkably fine barrow (No. 4) which occupies the ridge immediately above the northern entrance to Gatcombe Park. About sixty years ago, a poor woman, who, from the faith she placed in her dreams of hidden treasure, gained the sobriquet of "Molly Dreamer," spent much time in digging into this and other barrows of the neighbourhood. Within the present year this tumulus has been opened by our associate, Canon Lysons, and at the eastern end two very large stones occupying the centre of the mound were uncovered. Dwarf walls neatly constructed of Stonesfield slate curve in from the east and terminate at these stones, and by openings made in the sides of the tumulus indications were obtained that this dwarf wall extends round the whole mound.*

* Note.—April, 1871. At the time the above-mentioned examinations were made no chamber was met with, but since then a fine stone chamber has been accidentally discovered by a workman in Mr. Richardo's employ. It occupies a spot on the northern side, nearly at the widest part of the tumulus, and is 8 ft. long, 4 ft. wide, 5 ft. 6 in. high, and has an entrance porch 3 ft. square; this porch was faced by two stones so placed as to give access by a small opening between them. This structure is formed by seven stones placed on edge, and the sepulchral chamber is covered with a massive stone, 9 ft. 6 in. long and 5 ft. 6 in. wide. The spaces between the upright stones are filled in by walls of Stonesfield slate very neatly arranged, and in some parts these are brought over towards the top so as to meet the covering stone. One skeleton was found; the corpse had apparently been placed in a sitting position at the farthest end of the chamber. The skull measured 8 inches in length, and 5 inches in breadth.

Near Gatcombe Park there is another tumulus (No. 6 of the foregoing table) which is interesting as forming in several respects an exception to the other oval tumuli of the district. It does *not* occupy, as the others do, the highest level of its neighbourhood, for, although placed on a slight knoll, it is overlooked from rising ground on its eastern side. In its direction also it is exceptional, being placed due N. and S., the broadest part being at about one-third of the entire length from the north end of the mound. It is also the only example in the district of a *crowned* burrow,—on the broadest part stands a large stone, 6 feet in height, which bears the name of "Tingle Stone."

The Avening Tumulus (No. 6) was opened in the year 1809 by the Rev. N. Thornbury, Rector of Avening; three stone chambers were taken out, removed to a grove in the rectory garden, and there carefully set up in the forms and relative positions they had occupied in the tumulus, so that even in their present state they afford good examples of such sepulchral chambers. The largest is 7 feet long, 7 feet wide, and 4 feet high, and has one side formed by two stones so placed as to give access to the chamber.

The Lechmore Tumulus contained so recently as 1812 one chamber, but the stones of which it was constructed have since been removed for building material, and the mound itself is now reduced in size year by year by the operation of the plough.

Two ancient monuments, probably coeval with these large oval tumuli, remain to be noticed. A few hundred yards to the north of the Gatcombe Park Tumulus stands a fine monolith, known as "The Long-stone." (Plate 2.) It is 7½ ft. high above ground, and is *popularly believed* to be as much beneath the surface. It is a block of a peculiar stratum of Great Oolite, which in this district immediately underlies the surface soil. From the circumstance that this stratum is pierced by irregular holes, which become larger on exposure to the air, this monolith presents a singular appearance. A much smaller stone stands 30 feet from the "Long Stone," and a third stone is stated to have been removed during the present century.

LONG STONE, NEAR MINCHINHAMPTON.

On the Ordnance Map there is marked as standing on the hill-top south of Nailsworth, "The Picked Stone," but this monolith, which is well remembered by many people of the neighbourhood, has been removed, and is believed to have been used in the building of a stack of stone steps in a farm-yard near Barton End. "The Picked Stone" was about 4 feet high, and occupied the highest spot on the hills in that locality.

In addition to the seven oval barrows already mentioned, there occur in the area included in the sketch map eleven tumuli of a very different construction. They are circular, and do not inclose stone chambers, but are simply mounds of earth and stone, varying from 35 feet to 60 feet in diameter, and were originally about five feet in height. These smaller tumuli have not suffered by the hand of man so generally as the larger; the latter, from their great size and the conspicuous situations they occupy, have attracted the interest of the curious for many generations past, and, as already mentioned, have been greatly injured; whilst these smaller grave-mounds, where they have enjoyed the protection of surrounding woods, have retained their original form and height, and even such as have been brought under cultivation and reduced in height have yet retained the deposit of ashes and bones over which they were placed, undisturbed by the action of the plough.

I must plead guilty to having destroyed for future antiquaries the interest of eight of these circular tumuli. In 1851 I assisted in opening the one marked "12," which stood on the hill-side west of the village of Avening. It was 50 feet in diameter and 5 feet in height. On what had been the original surface, charcoal and ashes were scattered, and at the centre of the mound a handful of burnt human bones were found. No flints were *then* observed, although ten persons were engaged in the opening; but on a recent visit to this tumulus two worked flints were picked up from its surface.

Of nearly equal dimensions to the last is a circular tumulus which stands a few hundred yards directly south of the Lechmore oval tumulus. This I thoroughly examined in November, 1869. The materials forming the central portion of the mound were

removed down to the original surface of the ground. The upper portion was found to consist of stone and rubble to the depth of 18 inches; the remaining 3 feet 6 inches was fine mould. In this fine mould 80 flints were found, also 4 small pieces of pottery, and a few teeth of oxen. On what had been the surface soil before the construction of the barrow, traces of the action of fire were perceptible,—charcoal, burned bones, and small pieces of a human skull lay scattered about; whilst exactly at the centre of the tumulus a hole, 8 inches in depth, had been made, and in it lay a few burned human bones. The flints were found in every part of the heap of fine mould,—some were flakes, thin and sharp-edged, forming scraping or cutting implements, and including the "knife," figured on Plate 4, fig. 4; but the majority were mere chippings. One flint arrow-point (see Plate 4, fig. 1) of an uncommon type lay near the deposited bones. No trace of metal was observed. The pottery, rude in structure, was ornamented by a pattern formed by dotted lines.

The "Journal of the Archæological Association" (Vol. IV., page 50) contains an account of the discovery of a number of interments in a field near Chavenage, from which were obtained iron spear-heads, bronze fibulæ, silver ear-rings, stone, clay, and amber beads, all characteristic specimens of Anglo-Saxon workmanship. These interments were met with in the year 1847 by workmen employed to level down two circular tumuli, which stood 300 feet due N. and S., one from the other. This levelling-down process, though uncovering the secondary graves, did not disturb the central portions of the original grave-mounds, and these I have carefully examined during the present year. In one, charcoal, burned bones, small pieces of pottery, and worked flints were found on the original surface, and a few inches higher a very well worked flint javelin-point (see Plate IV., fig. 2.) What remained of the other tumulus was still protected by stones, which covered a deposit of fine soil, in which were found some pieces of iron-stone and of charcoal, but no trace of any interment; and neither bones, pottery, or flints were met with.

In Gatcombe Woods, a small mound, occupying nearly the highest spot of the hill, was found on examination to be formed of stones, the weathered edges of which attested that they had long lain exposed on the surface before they were thus heaped together. Underneath these protecting blocks of stone lay, at the centre of the mound, very small pieces of pottery, burned bones, and one thin sharp-edged worked flint. The calcined bones were of small size, and amongst them lay a tooth which a competent authority has decided to be "a left central incisor of the permanent set from a child not more than four years old." The mound was very carefully searched for other relics, but beyond traces of charcoal on the original surface nothing else was met with. It is therefore reasonable to conclude that this tumulus was raised in honour of a mere child.

The circular tumulus (No. 9) occupied a field near the Windmill on Minchinhampton Common. Two years ago the occupier of this place *dreamed* that this tump contained a crock of gold, and set workmen to dig into it. His reward was to find that the central position consisted of fine mould, but the only treasure found was an iron ring and a few fragments of bronze. Professor Church has kindly analysed this bronze, and states that "it consisted originally of an alloy of copper, with a good percentage of tin, a very little zinc, a trace of iron, and no lead. It is thoroughly corroded into sub-oxide and green carbonate of copper. It is certainly ancient and unlike in composition any of the Romano-British mixed metals which I have examined from Gloucestershire."

On the hill above Hyde a circular tumulus (No. 10) had been ploughed down all except 30 inches. On opening the centre of this, I found stones thrown together protecting a layer of grey coloured tempered earth, eight inches in depth; beneath this was a circular excavation in the original soil, 5 feet in diameter and 10 inches in depth. The sides of this hole were protected by stones placed on edge around it, and it was filled with earth burned to the consistency of brick, and this contained fragments of burned human bones. On the upper surface of the grey deposit lay charcoal, rude pottery, pebbles, unburned bones of

sheep (?), a small piece of bronze, apparently part of an ornament, and a beautifully formed leaf-shaped arrow-point (Plate IV., fig. 3.)

The circular tumulus (No. 18) having been until recently surrounded by woods, had retained nearly its original form and size. On opening it I found it to consist of fine earth firmly consolidated, as though it had been thrown together when thoroughly moistened by water. A heap of ashes and thoroughly burned human bones occupied the usual position at the centre of the tumulus, and on a level with the surrounding surface. One small piece of pottery and two ox teeth were met with, but not one piece of flint or metal.

It will be observed that in every case now described these circular tumuli have been made over interments preceded by cremation,—that the ashes of the dead were unprotected by urns,—that metal has rarely been met with, bronze in two cases, and iron* in two also,—and that in three instances flint implements (Plate IV., figs. 1, 2, and 3) have been deposited near the remains of the departed.

The fine tumulus (No. 19) which stands on the brow of the hill above the village of The Hyde, and which was visited by the Club in May, 1869, is probably of a much later age than the circular tumuli which have just been mentioned. From the dimensions given in the table at page 278, it will be seen that it differs in its external form from the oval tumuli Nos. 1 to 7. It was opened in the year 1848 by the occupier of the field in which it stands, and was found to contain "a space inclosed by large unhewn stones," and in this chamber lay burned bones and ashes, and a bronze fibula of a Roman type.

The next relics of the early occupants of our hills to be described are the remains of their defensive works. A good example of one of these is still traceable in a copse one mile

* I am indebted to Professor CHURCH for an examination of specimens of iron found in circular tumuli and in pit-dwellings. The former are natural iron-stones, and may have been used for sling-stones; the latter are artificial iron-slags. Iron, both in the form of ore and in the condition of slag, occurs scattered in the surface-soil of the Cotteswolds. In some localities, as near Avening, it occurs in considerable quantity.

south east of Nailsworth. It incloses an area of about ten acres in extent, and is formed by slight mounds and ditches constructed on curved lines, as shown by the plan on Plate III., fig. 4. In one part are three parallel lines, two of which have the ditches outside their mounds, whilst the third has the ditch inside. The outer line—A, B, C, D,—has an elevation of 4 feet from the bottom of the ditch to the top of the bank, and may possibly have been a later work added to strengthen the camp, and so constructed that the area A, B, C, forms an independent inclosure. The other lines of earthworks are very slight, and the whole works could have presented little defence unless, as was probably the case, they were strengthened by palisadings of trees and branches. The site of this camp being covered by a copse wood, I have been unable to find any flints within it on the surface of the ground, and only a few by careful digging in the ditches, but the arable fields immediately outside the line A, E, have yielded abundance, more than 1000 having there been gathered up ,including several javelin-points, scrapers, flakes,* and two arrow-heads.

One mile north of Nailsworth, on the hill-top immediately above Amberley, is the earthwork marked B on the map. A simple slight ditch and mound run on the curved line A, B, C, D, from the village of Littleworth to the escarpment above Spriggswell, including an area of about 50 acres in extent. Across this area a much more important work has been constructed on the line B, E. Half a mile eastward there is another series of intrenchments, commencing at the head of a deep combe above the village of the Box at F; this work also runs in an irregular curve on the line F, G, H, I, K, there it is protected by a parallel line L, and this again by another parallel line M, which terminates at the head of a combe, the whole work inclosing more than a square mile. At H there is a passage through the mound and across the ditch, which a careful examination proved to have been part of the original design. Between K and I some portion

* Flakes found on the surfaces of fields are usually much broken, but on this spot several whole flakes have been met with, one of which has an artificially serrated edge, which will yet "saw" horn and bone.

of the intrenchments have been destroyed in the construction of a park and a turnpike road.

To the north-west of Amberley Camp, at a distance of less than two miles, is Selsley Hill, on which there is an earthwork at D. There a very slight mound and ditch, O, P, form an irregular line, and in the area between this and the hill sides can be counted some 130 of those depressions in the surface which are believed to have been the floors of human habitations. As pointed out by the Rev. A. S. PAGE, not one of these pits is found outside the line of defence formed by the mound and ditch. To picture out the appearance of this work when occupied by its constructors, we may suppose, erected over each of these depressions, huts formed of branches and trees, and thatched, whilst the protecting mound would be strengthened by a palisading of stakes or branches.

The requirements of the occupiers of the camp on Selsley Hill did not lead them either to extend it beyond its original dimensions, or to strengthen it by the addition of other lines of defence, but with the Amberley Camp (B) it was otherwise. The series of entrenchments already mentioned as extending for two miles eastward of the slight work, A, B, C, D, are of the same character and strength as the line B E, and with that present a series of five parallel lines of defence, the ditches being in all cases on the eastern sides of the mounds. Pit-dwellings are found in great numbers, not only in the Amberly Camp, but in the area bounded by the lines C, G, F; altogether 700 have been counted, and it would be probably no exaggeration to say that 300 more have been obliterated by the opening of quarries and the construction of roads. A slight mound may be traced on the line C, G, and it is noteworthy that scarcely any pits have been made to the north of the line A, C, G. The dwellings were most numerous near the escarpment, which may be accounted for not only from the greater shelter this part enjoyed from cold winds, but also from its proximity to fine springs of water thrown out by the Fuller's Earth at the base of the escarpment.

On Rodborough Hill, one mile north of the Amberley Camp,

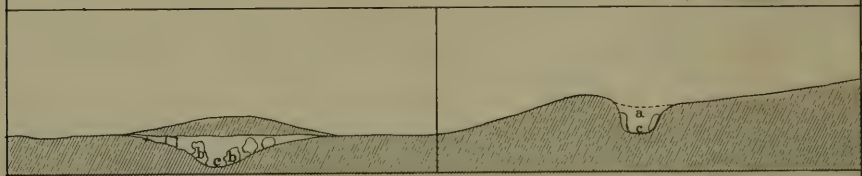
Longitudinal Section *Transverse Section*

(1) PIT DWELLING ON RODBOROUGH HILL.

a *Burned Stones*

b *Charcoal*

Scale 8 feet to Inch

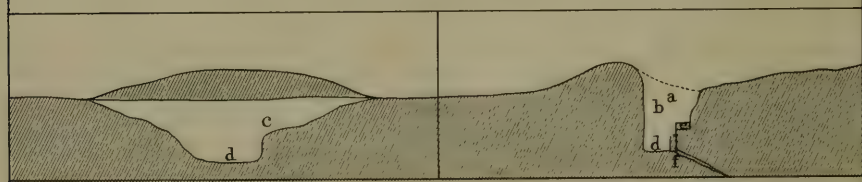


Longitudinal Section *Transverse Section*

(2) PIT DWELLING ON RODBOROUGH HILL.

a *Turf 3 inches thick* bb *Flat stones placed against sides.*

c. *Charcoal, burned stones, and two worked flints*

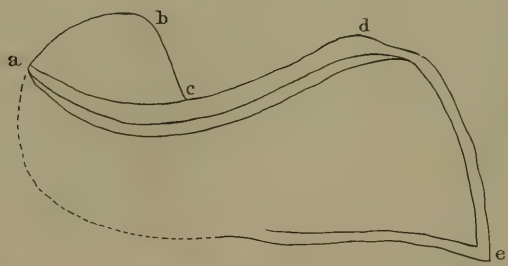


Longitudinal Section *Transverse Section*

(3) PIT DWELLING ON MINCHINHAMPTON COMMON.

a *Turf and Mould 9 inches thick* c *Abundance of Charcoal* e. *Seat.*

b *At 14 inches deep 1 flint.* d *Small pieces of Charcoal.* f. *Fissure in the rock.*



(4) PLAN OF HAZLEWOOD-COPSE CAMP.

there are a large number of pit-dwellings, to which the attention of the Club was first directed by Mr. Witchell in 1864*; nearly 400 have been counted, and cultivated inclosures and roads have probably removed all traces of 200 or 300 more. They are very numerous on the slope of the hill opposite Woodchester, at a part protected on the south-east by a deep combe. A mound and ditch of considerable strength remains at the spot E, as marked on the map, but cultivation has left only a short length of this work unlevelled.

Having examined a large number of these pits on Minchinhampton Common and on Rodborough Hill, it may be well to place on record the results. Their usual form is shown by the sections drawn on Plate III., fig. 1. The soil which was thrown out in making the pit forms a mound on *one* side. Where the surface of the ground is sloping, this mound is almost invariably cast up on the lower side; but where the pit has been constructed on a level surface, it is more generally on the north or north-east side. One interesting exception to the usual form is shown at fig. 3, Plate III.; it occurred on Minchinhampton Common, where the thin-bedded Great Oolite is so compact that, with care in excavating the present contents of the pit, its original size and shape were accurately ascertained. It was 3 feet 6 inches deep at the middle, with a straight and upright side nearest the mound; on the opposite side a seat, 18 inches high, had been formed, on which was placed a flat stone. Another stone at F protected the opening to a natural fissure in the rock, by which the pit must have been effectually drained; the abundance of charcoal at the spot marked E indicated the position of a fire-place.

On Minchinhampton Common the Pits are remarkably uniform in size, being from 10 to 13ft. in length, 3ft. wide and about 30 inches deep, at the middle. On Selsley Hill these depressions are much larger, being from 20 to 25ft. long, 10 to 12ft. wide, though not so deep as those on Hampton Common. On Rodborough Hill both these types are found.

These pits have yielded but few objects to throw light on the

* Transactions, Vol. III., page 249.

condition or habits of their occupants. In some cases a few specks of charcoal, in others, one or two burned stones, or a small shard of pottery, a pebble, or a chip of flint, are the only relics met with. These objects are not all found at the bottom of the original excavations, but are scattered throughout the present contents in such a manner as to suggest the probability that much of the filling up took place during the time of their occupation. On Minchinhampton Common many of the pits are filled nearly level with the surrounding surface, vegetable soil and turf having accumulated in them to the thickness of eight inches. On Rodborough and Selsley where the strata are the more barren Inferior Oolites, there is a very thin covering of soil and turf, and the pits contain only a small accumulation of rubbly stone.

These pits and mounds afford a considerable shelter from wind even without further protection, but in all probability they were surmounted by a hut formed of poles or branches and thatch. In size they compare favourably with the hut shelters of many modern savages, as for instance, the natives of Australia and Patagonia, and we need not go farther than our hills for illustrations of man living in dwellings equally slight. I measured this year on Rodborough Hill a gipsy's tent in which the man, wife, and four children lived, and found it only 6 feet long, 5 feet wide, and 3 feet 6 inches high. The gipsy who uses his tent for a sleeping place, and for shelter from wind and rain, makes his fire on the open ground outside; these arrangements were probably the same with the early pit-folk, as in only one or two exceptional cases have traces of a fire-place been met with in the pits.

There are on Minchinhampton Common several bowl-like depressions; they are circular, from 20 to 30 feet across, and their depth varies in proportion to their diameter, the largest having been originally 7 feet in depth. Several occur on the line B, C, G, and in the ditch G, F, and from their evident connection with these defensive works I regard them as *watch-pits.*

In addition to the works already mentioned as existing on

Minchinhampton Common there remain to be described numerous low mounds, to which the attention of the Club was especially directed on the occasion of its visit there in May, 1869. The following is a brief summary of 40 of these mounds:—

Five are circular, from 20 to 40 feet in diameter, and about 18 inches high; thirty-five are oblong, from 30 to 180 feet in length, about 24 feet in breadth, and 24 inches in height. In the construction of these oblong mounds great uniformity has been observed in their width and height. Their directions are very various—sixteen are nearly N. and S., and ten nearly E. and W. The object for which these mounds were made is as yet an unsolved enigma. The examinations made by the Club in 1869 under the valued superintendence of Mr. Cunnington, and the many previous and subsequent openings made, have failed to bring to light any evidence that they are places of interment. The original surfaces of the soil beneath them are not found to present any sign that cremation has there taken place, and no human remains burned or unburned have as yet been detected in the mounds. In some instances they have been formed by first placing the mould in the centre, and then heaping over it rubble; in other cases the lines of the original turf and mould remain *in situ*, covered directly with rubbly soil. Scattered *sparingly* in the mounds are found pottery, charcoal, iron slag, pebbles, and *a few* flint chips. In one small circular mound near Amberley, *numerous* small pieces of pottery were observed to lie on what had been the surface of the mound before the formation of the present turf, whilst none were found in the body of the mound. Having sent a description of these earthworks to the Rev. Canon Greenwell, of Durham, he very kindly replied—"I have observed a large number of circular mounds, evidently artificial, and which in many cases were close to larger mounds, in which burials have been found. These smaller mounds occur in groups of sometimes fifty or sixty. I never found the least trace of any burial in them, or the slightest fragment of pottery or chipping of flint. My explanation is that they covered unburnt bodies, interred without vase or implement, and that from the slight covering over them, so allowing the air

free admission, all trace of the body has disappeared. This explanation is, I confess, not satisfactory to my own mind, but I cannot suggest any other which appears to be more reasonable. I have also opened several oblong mounds in Yorkshire and Westmoreland with the like results. In Westmoreland they are called 'giants' graves,' and are very numerous; the size is, however, very much less than those you refer to in your locality, being not more than from 20 to 30 feet long, and from 6 to 8 wide, and about 1½ to 3 feet high. All those I opened had never suffered from the action of the plough or from any other disturbance."

As stated above, all the examinations which have been made lead to the conclusion that these low mounds on Minchinhampton Common are not sepulchral. On finding how in the case of one small circular mound the pottery, &c., lay on the original surface, it occurred to me that this was possibly a place on which the pit-folk assembled for feasting, and that all these low mounds occuring as they do in the midst of so many hut-shelters, may have been constructed and used for special social purposes. The practices of modern savages throw light on the subject of hut-shelters. The inhabitants of Tierra-del-Fuego in our own day have *various* descriptions of wigwams.—"First, the winter wigwam, or 'Gool'ucurh,' which means log-house, is substantially built of logs, laid as closely together as possible, converging to a point at the top, and in the centre about eight feet high. The floor is sunken within, and is generally about two feet lower than the surface of the ground without. The second class of wigwam is the 'Murana,' or summer wigwam; it is made wholly of boughs and branches. The third class is the 'Keena,' which is a long shed, built of large logs but open at both ends. This is used in the summer and is wholly set apart for celebrating religious ceremonies, and superstitious practices."*

In the description of the Hazlewood Copse Camp, mention was made of the flints found in the adjoining fields. Similar flints are scattered over the surface of the whole of the district under consideration. They are met with sparingly in the valleys,

* "South American Missionary Magazine," July, 1869.

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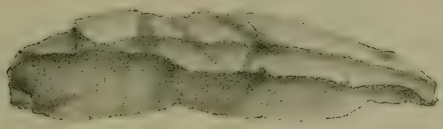

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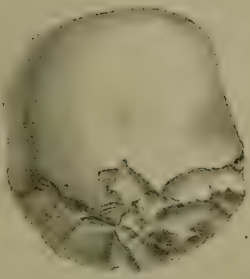

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and on the sides of the hills more abundantly, but in ever varying quantity on the high lands. A large proportion of these flints exhibit no mark of human workmanship, others bear marks of flaking but have no definite form, whilst some are such finished implements as the arrow-point fig. 6, Plate IV., which was found in a field in Avening Parish. Others again are javelin-points, rudely-flaked discs probably used as sling or hurl-stones, and good specimens of the well-known "scrapers," as figs. 8, 9, and 10.

In extending the subject of the early occupation of our hills by man from the limited area around Nailsworth to the whole range of the Cotteswolds, it may be observed that on the map of the Ordnance Survey, 25 "Ancient Encampments" or "Camps" are marked on the hills. With one or two exceptions the outlines of these camps consist of irregular curved lines, *very distinct in their character from the regular forms considered characteristic of Roman work.* One form which these defensive works take is that which has been noticed in describing the Amberley and Minchinhampton Camps, namely a bold curved line, the ends of which rest on the abrupt escarpment of the hill; such is the form of the Cleeve Hill Camp. In others, as at Nottingham Hill, Broadbarrow Green, and Horton Castle, a projecting promontory is cut off from the adjoining table land by a curved line. At Uley Bury, the Camp occupies the whole summit of the hill, and the works conform exactly to the outline of the natural escarpment. The most decided exception to these irregular forms is that of Little Sodbury Camp, which is a parallelogram inclosed on three sides by series of mounds and ditches constructed with great regularity, whilst the fourth side is bounded by the escarpment of the hill. This work contrasts finely with the neighbouring Horton Castle, where a bold promontory projecting into the Vale is cut off from the plateau by a single mound formed on a curved line. The areas inclosed by these camps are generally small, in some cases not exceeding eight acres, and in this respect the Minchinhampton works present a striking contrast, as they contain 800 acres. Whilst the smaller camps were well adapted to serve as "castles" in

time of actual war, this larger work was probably an established settlement of a British tribe, who first constructed with a slight mound the Amberley Camp, and then extended it as their need required. Of the eastern inclosure of 600 acres a small part has remained common land, and it is noteworthy that no pit-dwellings are traceable there, but from its great extent, its southern aspect, the abundant springs of water it contains it was well fitted for a cattle-camp. If this was its use, it would be the means, in conjunction with the streams on either hand, yielding fish, and the covert offered for wild animals by the adjacent wooded valleys, of providing the means of subsistence to a numerous community.

In endeavouring, in the absence of historical data, to assign an age to these camps, there is in addition to the character of their earthworks, one other item of evidence bearing upon the question, namely, the relics which are found in connection with them. It has been shown in the foregoing remarks how scant is the evidence these have afforded in the case of the earthworks on the hills round Nailsworth. The pottery met with only as fragments in the camps and pits of Minchinhampton Common, although of rude material and often imperfectly burned is with one or two exceptions, "wheel-made." The paucity of flints is remarkable considering how abundantly they lie scattered on other high-lands of the district. These evidences therefore appear to lead to the conclusion, that the works on Minchinhampton Common were constructed and occupied by a people about, or shortly prior to the first Roman invasion of Britain, when by intercourse with the Continent, the Britons had acquired the knowledge of the potter's-wheel, and when in the construction of weapons and implements, flint had been superseded by metals.

It has been mentioned that the small inclosure marked on my map as Hazlewood Copse Camp was probably the work of a very early people, as evidenced by the numerous worked flints found in its immediate neighbourhood; careful investigation may lead to a similar conclusion respecting the age of other camps on our hills. That Roman coins and other Roman

works are met with from time to time in these camps merely tends to prove their occupation, but not their original construction by that people.

These defensive works once made would be used during times of internal wars, or foreign invasions. A local tradition points to the hollow between the last two parallel mounds east of the town of Minchinhampton as the scene of a bloody encounter between Saxon and Dane, and the locality is known as "Woeful Dane Bottom."

On the Ordnance Map the positions of some Tumuli are marked, but many are omitted and the distinction of long and circular barrows is not indicated. The evidences afforded by the relics found in these tumuli as to the date of their construction are extremely scant. The oval barrows, according to the valuable researches of Dr. Thurnam were the work of a race of people differing decidedly from the constructors of the circular barrows, in the form of the skull and as far as negative evidence proves, in their ignorance of the use of metals. The two peoples may have been co-temporary, as *amongst modern savages instances occur* of tribes occupying the same countries, and yet differing in race, physical condition, and custom.

The chief evidence of the occupation of the Cotteswolds by a "pre-historic" race consists in the flint implements scattered so widely over their surface. These indicate a condition of existence of which no record has reached us, and serve to point out by the analogies of modern savage races, the condition of the Aboriginal inhabitants of our hills. From the fact that flint implements, such as those drawn on plate IV., figs. 1, 2, and 3, are found in round barrows, accompanied by bronze and iron, and evidently intentionally deposited near the remains of the dead, we may infer that from custom or superstitious association these *stone* implements were valued even after the knowledge of working metals had been acquired.