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PROCEEDINGS
OF THE
Cotteswold Naturalists'
FIELD CLUB
For 1895—1896

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M. W. COLCHESTER-WEMYSS

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The Council of the Club wish it to be distinctly understood that the Authors alone are responsible for the facts and opinions contained in their respective papers.

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HONORARY SECRETARY

REV. E. CORNFORD, M.A.

Vol. XII. Part I.

1896
ANNUAL ADDRESS

TO THE

COTTESWOLD NATURALISTS’ FIELD CLUB

MAY, 1896

BY

M. W. COLCHESTER-WEMYSS, PRESIDENT

The Annual Meeting of the Club was held at the Bell Hotel, Gloucester, on Tuesday, May 7th.

The Treasurer presented his financial statement with the very satisfactory result that the Club possessed a credit balance (exclusive of arrears of subscriptions) of £125 16s. 3d.

Since the death of Professor Harker, Mr Madan had most kindly performed the duties of Hon. Secretary, and he was earnestly pressed to continue to fill an office for which he was so exceptionally fitted. To this he was unable to agree; and the Rev. E. Cornford was then appointed Hon. Secretary of the Club.

The other officers of the Club were unanimously re-elected.

I greatly regret that I have to record the death of Mr Raitt, of Broughtons, who had been for several years a member of the Club, during which time he has been most regular in his attendance at the Field and Winter Meetings. His geniality and his hearty appreciation of all matters that interested the Club made him a most pleasant and acceptable companion; and his loss will long be felt by the members.

A
It was decided that the Field Meetings for the year should be held at
Yate and Chipping Sodbury
Cirencester and Uley
Caerleon and Caerwent
Newent.

During the winter Papers were read by:—
Mr Cornford on "The Hibernation of Animals."
Mr Wethered on "The Death of the Sea in Past Epochs."
Mr John Sawyer on "The Pre-Saxon Occupation of the Central Cotteswolds," and by
Mr Buckman on "Geological Non-sequence."

These papers, which were all of great interest, will be printed in the forthcoming volume of Proceedings.

The first Field Meeting of the Club was held on Monday, 27th May, when about 20 members met at Yate Station, and first visited the Eggshill Colliery, where many characteristic fossils of the coal period were exhibited, and also the remains of a pump made of oak, which there is reason to believe was used earlier than the introduction of the first Newcomen Engine in 1712.

On the way to Yate Court a stay was made to enable members to see some celestine deposits which are being quarried just below the surface of the ground. The existence of celestine in this locality is a comparatively recent discovery, but it has now been traced in the Triassic Marl from near the base of Sodbury Hill across the plain to Aust Cliff. Its chief commercial value is for sugar refining, and for this purpose it is largely exported to Germany. Mr Madan described the chemical processes which are rather numerous and complicated, but the main facts are these: from Celestine (the native form of Strontium Sulphate) is prepared Strontium Hydrate, a substance very analogous to "slaked lime," and this substance when added to solutions containing sugar, forms with the sugar a compound which readily separates
from the other ingredients present in the solution, such as treacle, gum, extractive matter, &c. Thus a fine compound of sugar is obtained, from which the Strontium Hydrate can be separated, and the sugar crystallised out. Before this process was used, about half the sugar present in the beet-root or cane juice was simply lost.

Yate Court is a very interesting old building, of which the chief features are a fine gate-way with portcullis grooves, and the lower halls of what apparently was a tower; and a moat still exists in almost its original entirety. The property has changed hands so often that nearly all its records are lost, but there is evidence that it existed in the days of Richard I. In the time of Henry VIII Lord Maurice Berkeley bought the property and built a house upon it, in which he incorporated some portions of the earlier building. In the Civil War of the 17th century it was garrisoned by the Parliamentary forces, who, it is said, on leaving it, set it on fire and reduced it to ashes. A farm-house now on the site contains portions of the old structure, including a staircase made of solid blocks of oak.

The party next went to Yate Church which has a history dating back to Norman times. The original edifice was cruci-form, with a chapel on the north side of the chancel. Early English builders considerably changed the character of the building, and it appears to have remained as they left it until the perpendicular era. Late in the 15th and in the early part of the 16th centuries the church was practically re-built. To some extent, however, the building still tells its own history. There are very clear traces of Norman work in the south transept, and the eastern limb, and of early English architecture at the base of the tower arch, and in the south wall of the nave. The eastern end of the arcade between the nave and the nave aisle, and the arch opening into the south transept, are half-a-century later in date than the western end. The
staircase to the rood-loft still remains, with its lower steps jutting into the north-west angle of the north chapel. The present church consists of a nave, chancel chapels on the north and south sides of the chancel, a south transept, north nave aisle, south porch, and a tower nearly 100 feet high. Henry VII, it has been suggested, had directly or indirectly a connection with the building of the tower, for on the entrance door-way and around the turret are the fleur-de-lys and the Tudor rose. On a gable over the chancel arch a sanctus bell-cot still remains.

After lunching at the Portcullis Inn, the party paid a visit to Chipping Sodbury Church, which we are told by Mr Pope in a paper in Vol. XIII of the Transactions of the Bris. and Glos. Archaeological Society, was erected in the 13th century. The chancel was probably built first; the older builders almost invariably commencing at the east end, so that the offices of religion might be celebrated with becoming decency and reverence as soon as possible. Some early side chapels, into which existing arcades must have opened have disappeared. Possibly some relics of them are the 13th century capitals used as corbels for the north aisle roof, which is of 15th century date.

The eastern end of the north aisle is 14th century work, and it is suggested that it was part of a design for a church on a grand scale, but which the black death prevented being carried out. As the town prospered, first the north aisle in the early part of the 15th century, and then the south aisle in the latter part of the same century, were erected. A stone pulpit of 15th century work forms a part of the first pier of the north aisle, and at the back is an inscription "Tobias Davis his charge." In the north chapel is a beautiful incised slab, which probably commemorates a Flemish Merchant who had settled in the town. The ancient altar slab, with four dedication crosses upon it, has been appropriated as a grave-stone.
To Cheltenham visitors one feature of the church has a special interest, because of its connection with Richard Pate, founder of the Cheltenham Grammar School. In the reign of Henry VI, a religious guild was founded in Chipping Sodbury, and dedicated to the Virgin Mary. Its objects, to quote the quaint language of the period, were “to erecte a chauntry for ij priests to celebrate at thalter of S. Mary within the Chapell or Church of the seid Chipping Sodbury prayeng for the good estate of the seid King, and after his deceasse for his sowle, the ffounders’ sowles, and all Xpen (Christian) sowley.” The chantry chapel was behind the north chancel of the church and has disappeared. Part of the possessions of the guild were, in the reign of Henry VI, bought by Richard Pate, as one of the King’s Commissioners, and several years later Pate sold a portion of them to the Burghers of Sodbury, part for a Town Hall and part for an Almshouse.

The members then drove to Little Sodbury, to see the Manor House, and the little that remains of its parochial church. The Manor House stands on the hill slope, a short distance below the Roman Camp, and Mr John Bellows is of opinion that it occupies the site of the signalling station belonging to the Camp. The house has a long and interesting history, which has been carefully traced by Mr Bazeley, of Matson. It was built, he tells us, by Sir John Walshe, who in 1490 was the King’s receiver for the Berkeley lands which had been alienated from the Berkeley family by William, Marquis Berkeley, and entailed on the King and his heirs male. This appointment was a profitable one, and Sir John Walshe who died in 1492 left his son-heir to several manors. Sir John Walshe (the 2nd) was the champion of Henry VIII at his coronation, and was a great favourite with the young King. He married, first, Ann, daughter of Sir Robert Poyntz, and secondly, Ann, daughter of John Dinley, of Hampshire. The house owes much of
its interest to the fact that William Tyndale lived there for a short time as tutor of Sir John Walshe's children, and also because it was visited by Henry VIII and Anne Boleyn on the 21st August, 1535. The next owner was Maurice Walshe, son of Sir John. In 1556 while he was at dinner in the Hall with his family, "a fiery sulphurous globe" passing from one window to another, killed him and one child, and so injured six more children that they all died within six months. Two sons, however, remained, Nicholas, who succeeded, and Henry. Nicholas married Mary, daughter of Sir John Berkeley, of Stoke Gifford. He died 1577, leaving a son Henry, who was slain in a duel by Sir Henry Wintour, and was succeeded by his cousin Walter, who was seized of the Manor in 1602. Soon afterwards the three Manors of Old, Little, and Chipping Sodbury were sold to Thomas Stephens, of Lypiatt. The Stephenses seem to have resided in the old Manor House, as various members of the family are described in the pedigree as of Little Sodbury. In 1728 on the failure of heirs male, the Manors came to Richard Packer, whose mother was a Stephens; and on his death, without male issue, they passed to Elizabeth, second wife of David Hartley, D.D., whose descendants still hold them. The house seems to have been "restored" at the latter end of the 17th century, but it still contains many traces of the original structure, such as a beautiful oriel window, a fine porch with wood moulding, and several 15th century windows heavily barred. In the interior, the dining hall, although dismantled, is much, as regards its structure, as it was in the time of Tyndale and Sir John Walshe.

The family and their guests sat at a raised dais at the south end, whilst the retainers sat at tables placed along the east and west walls. Part of the old hall has been partitioned off, but the original north end, with its two doors, remains intact. Over the entrance from the
kitchen and buttery was the minstrel's gallery, the entrance to which still remains. On the east side of the dais, high up in the wall, is a mask through which the ladies in the ladies' gallery could watch the revelry below.

A few yards to the east of the Manor House are the ruins of Little Sodbury Church, consisting simply of a porch and a fragment of the north wall with the aumbrey, where the sacred vessels were kept.

On the summit of the hill above the Manor House is the well-known Roman Camp, with its well-preserved lofty mounds and deep ditches. Enclosing the Roman Camp is an earth fortification, which may be a British Camp or may be of Post-Roman date. The remains of a circular building and other erections are very similar to remains upon Cleeve Hill, a matter which Mr G. B. Witts discusses in detail in his paper on Sodbury Camp, in the Archaeological Society's Transactions.

A survey of the camp brought the labours of the day to a close, and the party drove to Wickwar, en route for home.

For its second Meeting, the Club selected a bit of Cotteswold country rich in geological and antiquarian interest, and about a score of members met at Stonehouse, on Thursday, 27th June. Starting in the direction of Frocester, the first halt was at a gravel-pit, just above Stanley Downton, where Mr Charles Upton recounted to the members his recent find, in a pot-hole in the gravel, of a reindeer's antler. He remarked that it was an interesting specimen, nearly two feet long, bearing upon its surface marks which appear to be undoubtedly the result of blows inflicted with some rather blunt-edged weapon at the hands of man. With regard to the gravel itself, Mr S. S. Buckman pointed out that it is a river accumulation, deposited by the river Frome when it ran at a much higher level than at the present day. The valley of the Frome is now some 50 feet lower than where these beds
are situated, a fact which means that the valley has been
deepened to this extent since the gravel was deposited.

The drive was then continued to the foot of Frocester
Hill. There the members left the break, and, under the
guidance of Mr S. S. Buckman, examined the geology.
Attention was first drawn to a roadside section, showing
beds yielding Ammonites bifrons and A. falcifer, species
characteristic of the Upper Lias.

The geological structure of the hill was then explained:
a short distance up the hill is the Marlstone, a hard rock
of the Middle Lias, which generally forms a particular
feature of the Cotteswold landscape as a lower subsidiary
escarpment of the hill flank, projecting beyond the more
lofty escarpment of the Oolitic rocks. Above this is a
considerable thickness of clay beds—the Upper Lias upon
which the members were standing: and they are of
economical importance as being one of the water-bearing
beds of the district. The clay is capped by an immense
development of the Cotteswold Sands—in the present
case nearly 250 feet thick, as ascertained by measurement
with the level, and these are covered by iron-shot,
calcareous, marly strata, surmounted by some Oolitic
rocks. By means of a coloured diagram showing sections
of various localities between Frocester Hill and the coast
of Dorset, Mr Buckman explained both here, and when
the party arrived at the top of the hill, the result of his
work during the last ten years, namely, that the sands of
the Cotteswold Hills, over which there had been so much
controversy, as the annals of the Club can testify, were
not deposited contemporaneously with the sands of Bath
and Dorset, though they are similar in colour and appear-
ance. The fact is, he said, that the sands of the
Cotteswolds had all been deposited, and part of the
over-lying cephalopod bed had been laid down, long before
sands began to form in Dorset; and that the underlying
clay beds in Dorset which have always, on account of
similarly in lithology, been called "Upper Lias," and thought to be contemporaneous with bifrons beds at Frocester Hill, are shown by their fossil contents to have been deposited at a later date—contemporaneously with the over-lying cephalopoda bed of the Cotteswolds, a bed nearly 300 feet above.

Leaving the roadside section, the members ascended the hill, Mr Buckman pointing out the scenic features made by the Marlstone, and noticing other points of interest shewn by the Vale of Severn. Higher up he drew attention to a bed about the middle of the Cotteswold Sands yielding "Ammonites bifrons," and recalled the fights this find had occasioned among some Cotteswold geologists in days gone by.

Arrived at the top of the hill, the geological guide continued his remarks upon the strata as compared with those of other localities. Then he drew the members' attention to the false bedding exhibited, and explained its cause.

From the top of Frocester Hill the party drove to Uley Bury Camp, the unusual fortifications of which were seen with special interest by those members of the club who had not previously visited Uley. The possible date of the camp was the subject of some discussion. That it was occupied by the Romans is beyond question: it was one of the long series by which they strengthened the "scientific frontier" of the Cotteswold escarpment in coping with the Silures. But it probably is of much earlier than Roman date. In some of its features, Mr John Sawyer pointed out, it resembles the admittedly British Camp on the Malvern Hills; while the occurrence within it of numbers of worked flints, and without of long and round barrows are also evidence that it was constructed in pre-Roman times, possibly by the early Celts.
From the camp the members made a short descent into the adjacent Coaley Wood, being shown an interesting quarry wherein Mr Buckman drew attention to the Upper Trigonia grit—resting upon the lower beds of Inferior Oolite, the bearing of which he explained later. They were also being shown the cephalopoda bed in this locality, when the Secretary's whistle hurried them to the next item in the programme.

This was a visit to the famous long barrow of Uley Bury, locally known as "Hetty Pegler's Tump." It is one of the few long tumuli in Britain which have been opened and yet preserved in their original condition; and those members who for the first time crawled through its narrow entrance, and then in stooping posture, and with lighted tapers, explored its chambers, expressed their gratification that such an interesting memorial of far-off days is protected under the Ancient Monuments' Act, mingled with their regret that there is not sufficient scientific enthusiasm in this country to keep these monuments in a condition, such as obtains in France in like circumstances.

Half-a-mile to the north, at Nympsfield, is another barrow of similar type, which was opened by the Cotteswold Club in 1862, and described in the Club's Proceedings by the late Professor Buckman; but this is now minus its roof and covering earth-mound. Since the last visit of the Club to these tumuli, anthropology has made enormous strides, and very much light has been thrown upon the history of the men who made these early Cotteswold burial-places. Seating themselves upon the dry greensward of the Uley barrow, the party listened to a short paper by Mr Sawyer. He pointed out that the first fact to note about the tumulus is that there can be no doubt as to its relative age. Near its highest part, and about six inches below the surface, was found a skeleton, with which were three Roman coins. If the coins may
be regarded as indicating the age of the skeleton, the mound is obviously of Roman or post-Roman date. But this evidence of age is of little moment compared with that afforded by the plan of the barrow, and by what has been found in it. Its special features are its ovoid-form, and the peculiar horned shape of the walling at the wider end. Tumuli of similar plan are found in almost every county between John O'Groats and Land's End, indicating that they are the work of one race. It has been suggested that, as no one race has occupied Great Britain in historic times, this wide-spread occurrence of the burial mounds of one race is very strong proof that that race occupied the country before the arrival of the Roman invaders. The evidence is no doubt very strong, but it is not conclusive, because the distribution may be due to the race being driven, as other races unquestionably have been driven, from one part of the kingdom to another, by powerful and persistent enemies. Still, although the supposed Roman supra-interment and the widespread occurrence of this type of barrow may be insufficient proof, the evidence afforded by the contents is absolutely conclusive that the tumulus is of pre-historic age. Long-chambered barrows have been opened all over the country, and their contents carefully observed; and in not one of them has there ever been found the slightest trace of metal. Implements and weapons are of constant occurrence, but all are flint, stone, or bone. When Caesar invaded Britain he found to his cost that the natives were armed with metal weapons: the beginning of the bronze age, in fact, dates back to a time long before the Roman invasion. The men who made the long barrows lived at a time when the use of metal was to them unknown. They belong, in fact, to that period in the history of man known as the age of stone.

Mr Sawyer then pointed out the nature of the evidence by which the stone age is divided into older and newer—
the older dating back to a time before the North Sea had divided England from the Continent, and before the Severn Valley had been scooped out, and the newer being, so far as is known confined to the period within which the country had assumed its present configuration.

Next he showed that the men who made the long barrows belonged to the earlier part of the newer stone age, and that in the opinion of anthropological experts they were Iberians, a race which at one time inhabited a great part of Western Europe. When the Uley and Nympsfield barrows were constructed it was, he concluded, impossible to determine; it was best to follow the advice of the Duke of Argyll, and to treat pre-historic chronology not as time-absolute but as time-relative.

From Uley Bury the party retraced their steps to the top of Frocester Hill, and then drove to Selsley Common, stopping on the way to see the Nympsfield tumulus in a field on the road-side. At the top of Selsley Hill the members left the break, and walking across the down were shown the different beds of the Inferior Oolite by Mr Charles Upton. His intimate knowledge of the strata of this hill, and of the fossil contents of each bed, was fully placed at the disposal of the party.

At the quarry on the west side of the hill Mr Upton drew attention to the Oolite Marl and Upper Freestone overlaid by Upper Trigonia-grit: and Mr Buckman, by the aid of a diagram, explained the result of his recent investigations in the Cotteswolds—shortly to be published by the Geological Society—saying that though to their eye the Upper Trigonia-grit followed the Upper Freestone in a perfectly regular manner, yet other localities shewed, as separating their deposits, more than 60 feet of strata, all of which are absent here. He said that the same state of things obtained at Birdlip, and that it was due to erosion before the time when the Upper Trigonia-grit was deposited. At Birdlip this erosion had cut out a
trough in the Inferior Oolite beds some six miles wide and 30 feet deep.

Other sections on the hill were visited under Mr Upton's guidance. He drew attention to particular features of the Upper Freestone, and to a very noticeable trough-fault where the Upper Trigonia-grit had been let down some 10 feet. The remaining sections of the Pea-grit and the lower beds of the Inferior Oolite had to be hurried over for want of time.

As the party walked across the common, the Rev. E. Cornford directed attention to the very large number of shallow depressions which many antiquaries regard as remnants of Pit-dwellings. In a brief paper Mr Cornford summarised the evidence for and against this theory, leaving members to form their own conclusions. As a further aid in doing so, Mr Upton pointed to a slight mound and ditch following an irregular line across the hill, and to the fact that all the depressions are on one side (the western) of this line. Descending the precipitous hillside, the members rejoined the break at Selsley Church, and drove through Stanley Park and Dudbridge to Stonehouse.

The most largely attended Field Meeting of this Club in recent years was that held on Friday, July 26, when about forty members and friends arrived at Newport, ready for a drive to Caerleon and Caerwent. The latter place was visited by the Club in 1876, when it was included in a day's journey from Portskewett to Sudbrook Camp and Caldicot Castle. This was the first time, however, that the Club had gone to Caerleon, a fact which partially accounted for the large attendance; for those who are acquainted with the history of the Roman invasion and settlement in the western part of the kingdom, are aware that the first Roman force that occupied the Cotteswold area and then built Gloucester, afterwards pushed forward into South Wales, and
constructed strongly fortified camps at Caerwent and Caerleon, the latter place ultimately becoming one of the nine Roman colonies established in Britain. The members also had the great advantage of being accompanied by their colleague, Mr John Bellows, as guide, philosopher, and friend; for no one is better qualified, if indeed there is anyone so well qualified, to speak of the connection between the Roman settlements in Gloucestershire and those in South Monmouth, and to tell the story of why and how the settlements were planned and carried out.

CAERLEON

Caerleon, to which place the party first drove, is a quiet village about three miles north-east of Newport, and close to the river Usk. The wall built by the Romans more than eighteen hundred years ago may still be traced in its entire length, and in some places it is ten or twelve feet high. Within its area a large number of Roman remains have been found, most of which are preserved in a small museum. Outside the walls is a well-preserved amphitheatre, very much like that at Cirencester. Giraldus says that in his time the stone seats might still be seen. They have, however, long since disappeared, because, probably, local builders looked upon them with utilitarian, rather than antiquarian eyes. The name Isca Silurum, which the place bore in Roman times, has of course fallen out of general use, but strangely enough, a few houses on the south side of the river are still known among the cottagers as "Ultra Pontem," a name which eighteen centuries has not effaced! The bridge which connected the two places was in existence a hundred years ago, for Archdeacon Coxe describes, how in crossing it, he was nearly being precipitated into the river, because the planks were loose, and how, in reply to his remonstrance, he was told that the planks could not be nailed.
down, because the nails would split the wood. Mr Bellows ventured the explanation that the loose planks were a survival from Roman times, as Pliny states in his Natural History, that it was an article of religious faith never to nail down the planks of a bridge. Of course, the object in leaving them loose was, that they might instantly be removed on the approach of an enemy.

While the party were gathered in the Caerleon Museum, Mr Bellows gave an exceedingly lucid address upon the invasion of Britain by the Romans, and their settlement in the country, illustrating it by allusions to local events, and local remains of Roman rule. He began by pointing out the composition of a Roman legion, and traced its history and developments originally. A legion consisted of 3,000 foot and 300 horse, but by degrees it was enlarged, until in the time of Caesar it comprised over 4,000 foot and 300 horse, besides being associated with a large body of auxiliaries.

About the beginning of the Christian era, the Emperor Augustus raised a legion with the title "Legio Secunda Augusta," named in honour of himself, and bearing as a badge the sign of Capricorn, under which he was born. Vespasian, when a young man, became an officer in this legion, and accompanied it to Thrace, where it was recruited with several cohorts (or regiments) of Thracian horsemen. From Thrace, the legion was drafted up the Danube, and down the Rhine to Holland, taking with it six cohorts of this auxiliary cavalry, one of which was recruited in Holland. On the Rhine were also at this time two other of the Roman legions, which had been sent there under Germannicus, to avenge the Roman defeat by the Germans; and in the year 43 A.D. these three legions (the second, fourteenth, and twentieth), joined later by the ninth, which had served in Africa with their auxiliaries, formed the invading army of Britain, and numbered in all, at least 50,000 men.
The plan of the Claudian invasion of Britain was next dealt with by Mr Bellows.

The popular idea that the invaders came from Rome and followed the line of Julius Caesar's march across Gaul, is, he said, a mistake. A force sufficiently large was already stationed near the mouth of the Rhine, with ample means of transport, and with nothing to do there, for the Germans were effectually conquered, and kept in entire subjection. In the century which had elapsed since Julius Caesar's abortive invasions, England had ceased to be a "terra incognita" to the Romans, for Strabo says the Romans during the reign of Augustus were brought into intimate relationship with Britain, and he mentions four "principal" ports on the continent which were used for traffic with this island, namely, the mouths of the Rhine, the Seine, the Loire, and the Garonne. A definite plan of invasion could therefore be arranged; and Mr Bellows hinted at his belief that this plan was really the work of Julius Caesar, and laid in the pigeon-holes at the war office at Rome until the Emperor Claudius found a fitting opportunity to carry it out. The reason for this belief is that Julius Caesar was the first man to devise the policy of making great rivers the boundaries of the Empire; and we have the clearest archaeological evidence that the Claudian invasion made the securing of the Severn its primary object. The order for the invasion was given in the year 43 A.D., and it was given to Aulus Plautius, under whom Vespasian was placed as a General of Division. Dion Cassius says that as they sailed along, they were discouraged by contrary winds, but encouraged by a meteor, which fled from east to west, the direction in which they were sailing; so that clearly they sailed past Dover and along the English Channel, and not from Boulogne, or Calais, north, as many take for granted. There is also good evidence that they landed on the shores of Southampton Water, and entrenched themselves
at Wareham, where there are still remains of strong defences on the northern side.

Having firmly planted their feet on British soil, the invaders set about their conquest with two leading ideas clearly in view. The first was as we have said, to make rivers the boundaries of the subjected parts of the country; the second was, as Dr Hübner has shown, to advance northward in parallel lines from east to west. It has long been known that Camulodunum (Colchester) where the ninth legion was stationed, was one of the earliest spots garrisoned by the Romans, but until twenty years ago, the site of the other end of the line, of which it was the commencement, was not known, nor was there any evidence of where the second legion was quartered.

To Mr Bellows belongs the credit of having solved both problems. In 1876 he contributed to the "Proceedings" of the Cotteswold Club a paper descriptive of a number of discoveries he had made in Gloucester, clearly proving that it was a garrison of the second legion; and shortly afterwards, Dr Hübner, of Berlin, one of the greatest authorities living, on Roman history, published an article in a German Archaeological Serial, in which he said Mr Bellows had supplied the missing link in the history of the Roman invasion of Britain, by showing that Gloucester was the western end of the line of which Colchester was the eastern end.

But Mr Bellows' discoveries did something more than reveal the first location of the second legion, and the relation of Gloucester to Colchester. They prove beyond question the intention of the Romans to make the Severn the north-western boundary of the province with Gloucester as the key to it. The Romans had, it is true, previously crossed the river. Dion Cassius tells us that soon after landing they received the submission of the Boduni, who occupied the Cotteswold Hills, and whose chief town, according to Ptolemy, was Corinium,
(Cirencester) and that leaving a garrison among them, they came to the banks of a "large" river, beyond which the enemy lay in fancied security. That river could only have been the Severn, and the place where the enemy lay was probably Newnham.

Among the Roman auxiliaries were a number of splendid swimmers, and at low water the passage would not be difficult; and crossing the river they fought the Britons in a decisive battle. But they did not remain on the Forest side of the Severn; that was not a part of their plan. They made their way to Gloucester, upon building which they spent more pains than they did upon any other camp in Britain; as no fewer than four different lines of water defence had to be crossed, before the actual wall of the fortification could be reached on the western side.

But the intention to make Gloucester the north-western boundary, at least for a time, was frustrated by the Silures, who lived on the western side of the Severn. In the Annals of Tacitus, we are told that "the Silures were not so easily quelled; neither levity, nor rigorous measures could induce them to submit. To bridle the insolence of that warlike race, Ostorius judged it expedient to form a camp in the heart of their country." There can be no doubt, that in this brief notice Tacitus refers to the foundation of Caerwent, or as the Romans called it "Venta Silurum." This fortress stands about four miles inland from Portskewett, where the camp to cover the landing of troops after the passage of the Severn is still in excellent preservation. On the former visit of the Cotteswold Club to Caerwent, the Great Western Railway Surveyors happened to be at the Tunnel works, which adjoins the camp, and at the request of some of the members, they took the exact average height of the ramparts, 19 ft. 3 in., this being 20 Roman feet. On the south-western side of this camp is an excellent beach for running the boats on, used in the passage. It has even
been suggested that the name “Aust” passage is a corruption of Augusti, in “Trajectus Augusti”—that is the crossing place of the “Augustan,” or second legion. It may be remarked, while laying no store on this etymology, that it is in accordance with the general tendency of the western Celtic dialect to suppress the “g”- thus in Cornwall the miners of a generation ago, always pronounced “engine” and “angel” as “Inyan” and “Ain-yel.” Similarly the town in North Italy has changed from Augusta to “Aosta.”

This settlement of Caerwent, however, could not have finally secured the conquest of the Silures, for about the year 80 the Roman General and Engineer, Julius Frontinus, was charged with the task of subduing them. In this he succeeded, and it must have been as a sequence of this conquest that the head-quarters of “Legio Secunda Augusta” were removed from Glevum to Isca Silurum; that is, that Caerleon became the permanent camp of the legion till nearly the close of the Roman occupation of Britain.

In reply to a question, Mr Bellows said that the reason the Romans called the town Isca was that the true pronunciation is nearer this than Usk, the “u” in Welsh being sounded as “e.” The word Esk, in Scotland is the same and means “water.” The Exe was also called Isca by the Romans, but owes its native form to a peculiarity of the Devon dialect, which transposes the “sk.” Thus from “Pysq” the Cornish for witchcraft or sorcery, we have the Cornish “Piskie,” a sprite; but the Devonshire folk make this “Pixie.” In the same way they make “Esk” into “Exe.”

The name Caerleon, it is scarcely to be doubted, is a corruption of Cair-legion. This has been disputed by an eminent Welsh scholar, on the ground that the Welsh language has a word of its own for legion, which would have been used, and not the Latin form. As against this,
however, we must place the fact that the dialects of Celtic varied, and that which prevailed in the districts with which we are dealing showed some affinities with Cornish, which are not found in standard Welsh. One of them is the eliding of the sound of "g," as already mentioned—so that the Cornish form of the Latin "legionis" would be "leon." As the place was a colony, and so specially connected with the "Legio Secunda," and as the Latin name of the village across the Usk has remained unchanged till our own time (Ultra Pontem) the probabilities are strong that Caerleon is thus derived. Not only did the Roman occupation leave its impress on Caerleon and Caerwent in the circumstance that each of these places was a seat of learning, an "academy" in Saxon times; but the Legionary City was the Archbishopric afterwards removed to "St. David's." Thus in Gaul, each administrative centre under the Roman domination became the seat of a bishopric, so that the whole of the present ecclesiastical districts of France have been moulded by the Roman occupation.

The most curious of all the results of the Roman stay in Caerleon, is however, the rise of the legend of King Arthur's Round Table. As has already been mentioned, the Cotteswold Club visited the amphitheatre, which still forms a conspicuous feature in the green meadows outside the old city wall. It is a depression of considerable depth, slightly oval in form; but the strange thing about it is, that it is known locally by the name of "King Arthur's Round Table." As there are many spots in widely separated parts of England that bear the name of "Arthur," we must be prepared to seek the clue to their nomenclature in some mis-translation of a precedent British name, probably descriptive of some physical feature in the landscape. Thus we have King Arthur's Castle, at Tintagel, in Cornwall, where "Ard" or "Arth" means "high," the word Tintagel itself meaning in a still
older dialect high headland. On the Wye and in Yorkshire we have caves respectively known as King Arthur's Hall, and in Westmoreland a round evidently used for some ancient games is known as King Arthur's Round Table. At Edinburgh is "Caer Arthur"—high camp: not "Arthur's Seat." Now the Welsh "Bwr" meant a bank or round seat or camp. We have it in the name of the next Roman station after Isca—in Burricum or Usk, and in Bourton, Gloucestershire, as well as in the Cornish word Burrows for the spoil banks of mines. "Arth" was the name for a bear, so that Bur Arth would be the "Bear Pitt." That this was really the name of the Roman amphitheatre at Caerleon is confirmed by that of the field on the opposite side of the Roman street. The latter is still called the Bear-House field. It is evident that the people of the district who were accustomed on certain high-days and holidays to witness the Roman games, continued to keep up these games after the legions had withdrawn from Britain. Thus at Wareham, cock-fights, etc., were kept up in the Roman amphitheatre under the north wall, till the last century, or, beginning of the present one. But the sound of "Bwr Arth" is so near that of "Bwrdd Arth" as to be easily confused with it—and while the first means "Bear Pit" the second signifies "Arthur's Table"!

The fact of several centuries having elapsed after the death of King Arthur before any historian hints at the story of the round table, should of itself make us more cautious in accepting the story as more than a myth: and here we have the clue to the myth. Well may Wendall Holmes say that all things are in all things—and Emerson declare that nothing is wholly new, but must also contain some thread that is old.

Vespasian's founding of Gloucester, and the conquest by Julius Frontinus, of the Silures, brought Alfred Tennyson to Caerleon to compose his "Idylls of the
King," and to "Give to airy nothing a local habitation and a name."

The concluding portion of Mr Bellows' address—which was an informal talk, with interesting digressions from the main line of the story—was devoted to a comparison of the size and plan of Gloucester, as ample evidence that both places were the work of one set of builders, and to a brief description of the road connecting them. Ordnance maps of the two places, prove that Caerleon is a replica of Gloucester in size and plan, and there is evidence in the masonry of the walls that both were the work of the second legion. Besides conquering the Silures, Julius Frontinus also constructed a magnificent paved road from Gloucester through Dene Forest to Caerwent and Caerleon—a road still known as the "Julian Way," and the paving of which is still preserved in some of the Forest glades. The road crossed the Severn at Over, near Gloucester; indeed the iron bridge which carries the Great Western Railway there rests upon foundations which were laid by the second Augustan legion, eighteen hundred years ago.

Returning to Newport, the party lunched at the King's Head Hotel, and then breaks drove to Caerwent. On the way they stopped to see the remains of a Roman Villa in process of excavation in a field on the roadside. At Caerwent, time only permitted of a walk round a portion of the wall.

The sight is a very striking one of the great Roman city standing silent in the midst of the fields; its rampart for the most part buried in foliage, though here and there the solid masonry shows out twenty feet in height, and with its polygonal bastions almost intact. There has been a good deal of pilfering of the stone from the foundations, which unless stopped, will destroy this most interesting and beautiful monument of antiquity; and we hope our Monmouthshire archaeological colleagues will bestir themselves to prevent the loss to the world of Isca Silurum.
On arriving at Chepstow some of the members returned, but the majority accepted a kind invitation to tea at Pen Moel, where Mrs Price had various fossils from the great quarry set out for inspection below her house. The stay here would have been most willingly prolonged had time permitted, and with an expression of hearty thanks to Mrs Price for her hospitality, and with a graceful response on her part and a hope that in the next season the Club would pay a longer visit, the party reluctantly wended their way to the station at Chepstow, and trained home.

The fourth and last Meeting of the Club was held on Tuesday, August 20th, and the members had the good fortune to be accompanied by their old and able associates Professor R. Etheridge, F.R.S., and Mr W. C. Lucy. Driving from Gloucester, the party first went to the site of the new Gloucester Waterworks at Newent, which was visited by the Club about two years ago. Here Mr Lucy gave an interesting sketch of the distribution of the northern drift in the district, and added some generalisations upon the character of the drift period.

Tracing the drift on the route the party had driven from Gloucester, Mr Lucy said that after passing Over Bridge, it occurs at Elmore, Hempsted, and Lassington. At the Pinetum, at Highnam, is a thick bed of sand; and near to Highnam Court, a gravel pit of thirteen feet deep, containing pebbles of considerable size, with syenite, chalk flints, and what is remarkable, some oolite, having the appearance of being brought there by a strong eddy, indicating a time before the present river was formed, and when the drainage of the country was probably different from what it is now. Maisemore and Woolridge are capped with drift, and at Collen Park it is thicker still. But by far the most instructive example of glacial drift—and this was probably re-deposited—is at Limbury, an isolated hill quite flat at the top, and covering ten acres. A pit, nine feet deep, contains Silurian blocks, probably
from Malvern, with characteristic corals and brachiopods, and from it he obtained a large boulder of Caradoc limestone two feet six inches long, and one foot six inches wide, (now in the Gloucester Museum) Lickey quartz, pieces of Carboniferous Limestone, a piece of hard chalk, and Gryphoea Incuroa and other fossils from the Lower Lias. The denudation of the Lias round high hills forms an interesting chapter in drift history to trace out, and shows what must have been the position of Lias during the latter part of the quaternary period. As a rule, there is a striking continuity of drift terraces upon the slopes of the hills, ranging from forty to three hundred feet above the sea, and it is in those, that Mammalian remains are found.

Dividing the drift period into three great divisions, with several intermediate stages, Mr. Lucy said these are:—

(1) A great subsidence of the land underneath the sea and strong currents, bringing icebergs into our valleys, transporting rocks with them from Scotland and the North of England and depositing them, as seen in our Midland Counties, and, though reduced in size, in our Northern Cotswolds and on Cleeve Hill. (2) An upheaval of the land took place, and the hills appeared from beneath the sea with a less cold climate, and land ice, frozen snow, and heavy rainfall became the principal agents in distributing the drifts. (3) Another depression of the land, which afterwards rose again above the sea, and although less cold, the temperature in winter was sufficiently low to form land ice, and it is not improbable, it is to this date, that the drift brought down from higher levels and re-deposited, may be referred. Several minor oscillations of the land took place subsequently, and the sea again came up the estuary of the Severn, levelling the gravels brought down by the land ice, of which there are examples in the pits extending from Berkeley to Worcester, often two or three miles from the present
hills. In conclusion, Mr Lucy impressed upon those present, that where gravel is found on isolated hills and terraces corresponding in height, the level of the ground at the time the gravel was deposited, was probably fairly continuous, and the valleys between them have been made since. In fact the Severn valley is a valley of denudation caused by water, frost, rain, and wind.

The water is being tapped, or rather pumped, by the Gloucester Corporation, at a spot, half-a-mile from Newent. The well, said Mr R. Read, the Gloucester Corporation Surveyor, is situated in the New Red Series, nearly mid-way between two parallel faults running north-east and south-west with the syenite of the Malvern Range, about seven miles to the north-east, and the Silurian of May Hill three miles south-west. The west fault is of great extent, and has the Keuper beds of the New Red on the surface on its east side—in which the well is sunk—and the Old Red on the surface on its west side. All along the west fault, from Retford Bridge, over the Leadon, on the north, down to Great Boulsdon, in the south, small out-crops of coal are found, and some years ago the Oxenhall Colliery shaft was sunk right on the fault which yielded an abundance of water, but very little coal. The results of the Corporation boring show that the bottom Bunter beds were not completely pierced at 1,190 feet, and as these crop out on the surface with the breccia or pebble beds of the Permian, at a distance of six miles north-east, it is fair to assume that they are in a wedge-shaped trough of the New Red, 1,200 feet deep at the bore-hole, thinning out at six miles to the north-east, near Bromsberrow, where the surface is some 200 feet higher than the ground at the bore-hole, which is 102'5 feet above ordnance datum. The first 300 feet of the bore-hole consists of beds of Conglomerates, Marls, and Sandstones, but below this the whole of the beds are Sandstones of varying hardness. The well section is
much more reliable than the bore-hole section, owing to
the difficulty in boring through Conglomerates, without
destroying their character, but there is a remarkable
difference in the position of the beds in the two sections,
although they are only 300 feet apart. Red Sandstone
Rock was found at eleven feet deep, and the beds are hard
Marls, Conglomerates, and Sandstones, but chiefly Con-
glomerates of varying character and size. At nineteen
feet in a Conglomerate bed, a piece of stone like part of an
elk or stag's horn was found, and at fifty-two feet some
petrified timber. The dip of the strata is chiefly from
west to east. It is only one in sixty to about forty feet,
but then the dip increases until at 126 feet, it is one
in twelve. The water over-flowing from the bore-hole
was not affected until 26 feet had been reached, and the
water in the colliery shaft, which was 46 feet from the
surface at the commencement, was not altered until after
passing through a bed of Conglomerate 31 feet thick,
from 58 feet to 88 feet of depth of well. This bed was
very hard, with traces of iron and some large pebbles.
The next eleven feet consist of Marlstone, Sandstone, and
a dark broken Conglomerate, and from 99 feet to 110 feet
Conglomerate eleven feet thick, with large pebbles, nearly
six inches in diameter. followed by five feet of very dark
mottled Conglomerate to 115 feet in depth, then seven feet
of grey rock and Conglomerate to 122 feet deep, six feet
of hard Red Sandstone to 128 feet, and six feet of mottled
Conglomerate to 134 feet, the present depth.

As was pointed out at the visit of the Club two years
ago, it is singular that with such a large drainage, so little
water finds its way to the surface. Mr Lucy said the only
way he could explain the matter was this:—That in all
probability an under-ground current passes beneath the
bed of the Severn near Over into the very deep gravel
pit there. In the early part of their negotiations the
Corporation sank a well near Over Bridge, in the hope of
getting a good supply of water out of the gravel there, and although evidence of an ample supply was forthcoming, it was found that the water was not of a character suitable for the city. Although the place, where the boring took place, was within 40 or 50 feet of the river, that water had no connection at all with the Severn—it all passed underneath; and whether the tide was flowing or ebbing it did not make the slightest difference. Mr Fox said that his theory was that the water crossed the bed of the Severn much farther down the river than at Gloucester, and at a much lower level than that of the Gloucester meadows.

The reservoir is at Madam's Wood, about eight miles from Gloucester, and is 250 feet above the sea level, or about 50 feet below the level of the water-works at Witcombe. The service reservoir, which is simply intended to equalise flow and pressure, is 100 feet long by 60 feet broad, and 18 feet deep, and will have a capacity of 675,000 gallons. The water will be conveyed to Gloucester through 14-inch cast-iron pipes. It will be possible to lengthen the reservoir, if necessary, but inasmuch as the mains will be able to deliver this quantity of water in ten hours, and the pumping machinery being in duplicate will be able to replace the water in the tank with equal dispatch—and as with night and day pumping it would be possible to deliver a million-and-a-half gallons in 24 hours—it is not thought likely that any large tank will be required.

The members were most hospitably and sumptuously entertained at luncheon by Mr Knowles, of Newent Court, after which the journey was resumed to Clifford's Mesne, which was visited by the Club in 1887. At that time the Downton Sandstones were the only beds exposed, but a large excavation of fully 40 feet in depth has recently been made, showing some of the Limestone beds of the Upper Ludlow formation. The Downton Sandstones are generally considered to be the top beds of the
Silurian system, upon which rests the Ledbury Shales (transition beds) separating the Silurian beds from the Old Red Sandstone.

The return to Gloucester after a most pleasant day's excursion was made through Taynton.
At the beginning of this century Hutton taught that the past history of our planet is to be explained by what we see going on at the present time. The lapse of more than half-a-century has proved the truth of this assertion.

Applying this principle to the Depths of the Sea we have been at a disadvantage. Up to the time of the “Challenger” expedition our knowledge of what was to be found was very limited, and we knew less of those regions in past epochs.

We now know that at the present time calcareous deposits are taking place over very extensive areas, and that these are largely the result of the accumulation of the tests and skeletons of microscopic life. The Globigerina Ooze is an instance of this. We have, too, proof that larger creatures, mollusca, corals, etc., contribute in the same way to the building up of calcareous deposits, but this appears to be the case chiefly in shallower waters.

Modern dredging appliances have made it comparatively easy to obtain this information from the depths of the ocean of to-day, but how are we to know what took place in past epochs? It is possible that in the case of extreme depths we may always remain in ignorance, but of the shallower waters we may obtain very considerable
information by the study of limestones. These rocks are, of course, the marine calcareous deposits in the depths of past oceans, now elevated often high above the level of the sea and altered by molecular changes. In limestone then we may expect to find what is capable of preservation of the life which lived in the sea of past epochs.

Much, of course, has already been done in the study of limestones, but, strange as it may appear, the use of the microscope has been but little applied to this work in anything like a systematic investigation. In fact, comparatively little had been done with this instrument in the study of thin section of limestones till Dr. Sorby, F.R.S., called attention to the subject in his excellent Presidential Address to the Geological Society in 1879.

Generally speaking, Geologists have been content with fossils which could be detected without the use of the microscope, and this mostly for the purposes of the classification of the rocks or the study of the structure of fossils. The examination of the limestone has yet to be done, and there is much to be learnt.

After reading the report on “Deep Sea Deposits” by Mr Murray, a member of the “Challenger” expedition, it occurred to me that it would be of interest to study microscopically the marine calcareous deposits in past epochs, now represented by limestones, and still further test the teaching of Hutton relative to the depths of the sea ancient and modern.

In attempting this paper, however, it must be clearly understood that the subject is a vast one, a life’s work in fact. I can therefore only now give results so far obtained, namely from Silurian, Carboniferous and Jurassic limestones.

Commencing with the Silurian system, I have selected the Wenlock Limestone as being perhaps the most interesting calcareous deposit in the Silurian sea.
A visit to a quarry where this rock is exposed will afford proof that mollusca, corals, polyzoa, encrinites, etc., were numerous in the waters of this period. This is further proved by thin sections of the limestone which show that the rock is largely made up of the debris of these and other calcareous organisms in a very fragmentary condition. Another interesting feature is that at times these remains became either partially or entirely enclosed in a crust (Fig. 1A) which up to the time of my investigations had passed unnoticed. To such an extent has this process gone on that the crusts form a very considerable part of the limestone. It therefore becomes important that we should understand the nature of this growth. Microscopically examined thin sections of it show that it is made up of endless minute tubules, (Fig. 1B) varying in size between '01 and '05 of a millimètre in diameter. Small as these objects are, aggregations of them form dense masses of crust around the calcareous remains of other organisms, but each tubule is a separate individual with a clearly defined wall of carbonate of lime.* Living matter occupied the interior: this of course perished after death, but not so the tubules which were filled in with calcite or mud, or became closely pressed together.

When first I discovered these crusts in 1889 I recognised the organism as the little understood genus Girvanelia, first noticed and briefly described by Professor Alleyne Nicholson and Mr R. Etheridge, junr.† They figured one species, namely, G. problematica, but since then I have discovered a considerable variety of forms varying from the Silurian to the Jurassic system of rocks. Minute, and at first sight apparently insignificant, as these

* In the illustration a form of Girvanelia is represented not previously figured.

forms of life are, I shall show that at times they lived in
great profusion in the depths of the sea, and there
performed a work of incrustation around nuclei which
became a considerable factor in the formation of the
calcareous deposits and subsequent limestone rocks.

Shortly stated, the process which went on in the
Silurian sea during the formation of the Wenlock limestone
was this: the shells and skeletons of the larger marine
organisms which existed collected on the floor of the sea
in very small fragments. Whether this condition was
due to detrition or to the fact that the creatures had
served as food for large Ganoid fishes, I know not.
Judging, however, by the high percentage of inorganic
detrital material in the Wenlock limestone derived from the
denudation of existing rocks, which sometimes amounts
to as much as 30.4 per cent., I conclude that land was
not far distant. Consequently the Wenlock Limestone
represents a Terrigenous deposit, and the shells, etc.,
would probably be subject to the action of waves. This
may be an explanation of the fragmentary condition in
which they occur in the Wenlock limestone.

These remains having finally settled on the floor of
the sea, then the incrusting process of Girvanella
commenced. Tubules of this genus attached themselves
to fragments of debris as nuclei, and partially or entirely
enclosed them in a crust formed by the multiplication
and growth of the tubules.

To avoid misunderstanding I must make it clear that
there are very many exceptions to the fragmentary
conditions of the shells and other calcareous remains of
organisms which have furnished material for the building
up of the Wenlock limestone. Thus it is not difficult to
find well preserved portions of coral, especially of
polyzoa, shells, etc. These fossils, however, in the May
Hill district of Gloucestershire, are chiefly to be found
in argillaceous beds which separate thin strata of limestone.
I now pass to the Carboniferous Epoch. The calcareous deposits in the sea of this period are represented by the Carboniferous Limestone, of which the well known cliffs in Derbyshire, at Clifton in Gloucestershire, Cheddar in Somersetshire, and a great portion of the hills near Rhyl in North Wales are instances.

That mollusca, corals, crinoids, polyzoa, etc., were plentiful in the sea of this period is well known, but it is erroneous to suppose the remains of the shells and skeletons of these creatures were the chief contributors to the calcareous deposits which accumulated on the floor of the Carboniferous sea.

In certain beds of this series, remains of mollusca and coral debris became doubtless the chief factors, but if we take the great central mass, which at Clifton is 1620 feet thick, we shall find that microscopic life has in the main contributed the material of which the limestone has been built up.

Indeed microscopic life must have been quite as abundant in Carboniferous days as it was in the sea in which the chalk formation took place, and in parts of the ocean of to-day. We know that the white chalk is largely made up of the shells of foraminifera, and that the calcareous ooze dredged up by the "Challenger" was also largely made up of these minute shells, together with the remains of certain other low forms of life, including siliceous ones.

It is, of course, deeply interesting to know of the existence of these deposits, both at the present time, and during that of the period in which the white chalk was gradually formed. This interest, too, is increased when we know that a very similar condition of things existed in the still earlier Palæozoic days of the Carboniferous Limestone, a fact which is strictly consistent with the teaching of Hutton.
That foraminifera were very numerous at times in the Carboniferous sea is of course well understood, but the great extent to which the tests of these microscopic creatures contributed to the calcareous ooze which collected on the floor of the sea of this period has not been fully realised. It is of these minute shells that the great central mass of the Carboniferous Limestone in the West of England and North Wales has been so to speak constructed Fig. 2A. The only other organism which can rival the foraminifera in this respect is the remarkable and minute genus Calcisphaera which averages about .004 of an inch in diameter (Fig. 2B). This organism, so named by Professor Williamson, F.R.S.* of Manchester, consists of a hollow sphere of carbonate of lime, the interior of which was apparently occupied by living matter. When cut in section the Calcisphaerae have the appearance of rings, in which form they are seen in Fig. 2A and B. In the former they are so minute that a magnifying glass will probably be required to see them, but in Fig. 2B they will be observed without difficulty.

That the Calcisphaerae are organisms I think there is no doubt, but whether they are to be referred to the animal or vegetable kingdom is a matter yet to be decided. They must have existed in Carboniferous waters in vast multitudes, and their interest as limestone-forming organisms has not been realized. So numerous were they that I question whether a fragment of Carboniferous Limestone from the middle series of this formation could be examined without finding several of them either whole or in part.

Another important incident attached to Calcisphaera is that we have not found it to occur in any other rock but that of the Carboniferous Limestone, hence its presence is one way of determining this formation when doubt arises.

* Phil. Trans. vol. 171, pp. 520-525, 1880.
As in the case of the Wenlock sea, incrusting organisms were at work on the floor of the Carboniferous ocean. The Girvanella tubules were at times very abundant, seizing hold of calcareous fragments and enclosing them in a thick crust. In this way whole beds of limestone have been built up by the granules so formed.

At this time, too, we meet with a second incrusting organism, namely, the genus Mitcheldeania, to which reference was made in the Cotteswold Club Proceedings for 1885-1886 (pp. 77-79). The same is no guide to the nature of the organism, for it is so complicated that I thought it best not to attempt any specific naming, hence I called it Mitcheldeania, from the locality, Mitcheldean in Gloucestershire, where I discovered the first species, namely, M. Nicholsoni. The interesting nature of this organism has attracted the attention of other geologists, especially Professor Alleyne Nicholson, after whom I named the first species. He has now discovered another species in the South of Scotland, to which he has given the name M. gregaria.*

Briefly stated, the skeleton of Mitcheldeania consists of capillary tubes, with a diameter $\frac{1}{12}$ to $\frac{1}{15}$ of a millimetre, which, according to Professor Nicholson, have "porous walls and are united by a still more minutely tabulated tissue."†

At times Mitcheldeania must have lived in great profusion, usually incrusting some foreign object. In Fig. 3A I have given a representation of a fragment of a small Gasteropod shell surrounded by a Mitcheldeania crust. In Fig. 3B I have represented, by greater magnification, the minute structure of the organism. At first I was disposed to refer this to a low form of animal life, and this may still be correct, but there are certain


† Nicholson’s and Sydekker’s Palaeontology, p. 200, vol. i, 1889.
features about the fossil which would seem to indicate a vegetable origin. Possibly it may ultimately be referred to the calcareous algae, or even to some still lower form of vegetable life.

I now pass to the Oolitic Period of the Jurassic rocks. I need not remind geologists of the origin of the term oolite, but as we have present persons who are not conversant with geology in general, I may mention that the oolites are characterised by a structure resembling the roe of a fish, hence the name "roestone" or "eggstone" was given by the quarrymen, and this has been translated in the language of science into oolite. Freestone is a type of this rock.

We know that during the Jurassic Period marine life was exceedingly abundant. There were numerous types of mollusca, echinodermata, ammonites, corals, polypoia, etc.; but the interesting process which went on was the formation of the minute oolitic granules ("roestone") to which I have referred.

The process of oolitic formation is still going on in the sea of to-day, but dredging expeditions appear to have over-looked the importance and interest attached to them. The explanation probably is that it was taken for granted that the granules were simply concretions. Dr. Rothplatz however has written on oolitic granules collected in the Red Sea and Great Salt Lake, and assigns their origin to lime—secreting fission algae,* and not to a concretionary process as generally supposed.

At the British Association, in 1888, Professor H. G. Seeley, F.R.S., read a paper "On the Origin of Oolitic Texture in Limestone Rocks."†

* British Association Report, 1888, pp. 674-675.

In this the Professor argued that the oolitic texture might originate in many ways, and drew attention to the close resemblance of the internodal grains of nullipores to grains of oolite. I was also at work on the same subject, and in 1889 I wrote a paper "On the Microscopic Structure of the Jurassic Pisolite,"* in which I proved that these larger forms of oolitic granules were not concretions, but were formed by an incrusting process produced by the genus Girvanella. In fact these larger oolitic granules called "Pisolites" or "Pea Grit" are simply the work of incrusting organisms on a large scale.

More recent observations† have convinced me that all oolitic granules, large and small, are of organic origin, Figs. 4A, the majority being the work of a variety of incrusting organisms, but others apparently, originating from growth not necessarily around a nucleus. The process is illustrated in Fig. 4A, where it will be observed that the calcareous fragments which settled on the floor of the sea are coated with a crust, some being entirely enclosed and appear in the fossil state as "oolitic granules." In this way freestones have originated.

As to the nature of the incrusting and oolite-forming organisms, it is possible that they may belong to the calcareous algae. As I have said it is to this low order of vegetation that Rothplatz assigns the oolite granules in the Red Sea and Great Salt Lake. If the fossil ones have a similar origin, then there is again further proof of the teaching of Hutton that the past is to be explained by the present.

EXPLANATION OF PLATES

Fig. 1a.—Section of Wenlock Limestone × 17 Diam., May Hill, Gloucestershire, shows fragments of Calcareous organisms enclosed in crusts of Girvanella; thus forming granules. Owing to a defect in the negative this illustration is not so clear as could be desired.

Fig. 1b.—Portion of the crust of the uppermost granule in Fig. 1a × 70 Diam. Shows the Girvanella Tubules which form the crust. The lower portion of the figure is the calcareous fragment shown in the centre of the uppermost granule in Fig. 1a. This is a new form of Girvanella here described for the first time.

Fig. 2a.—Section of Carboniferous Limestone from the middle series, Clifton, Bristol, × 32 Diam. Shows the Limestone to be made up of the minute fragmental remains of microscopic life, mostly Foraminifera and Calcisphaera. Some of the former are well preserved and can be easily distinguished, but the Calcisphaera appear as very minute rings requiring a magnifying glass to see them clearly.

Fig. 2b.—A portion of Fig. 2a × 65 Diam. This higher magnification shows one of the foraminifera, and fragments of others, also several sections of Calcisphaera which appear in rings.

Fig. 3a.—Section of Mitchelleania incrusting a fragment of shell × 9 Diam. From the Lower Carboniferous Limestone Shales, Drybrook, Gloucestershire.

Fig. 3b. Tangential section of Mitchelleania Nicholsoni × 70 Diam., shewing the minute structure. From the Carboniferous Lower Limestone Shales, Drybrook, Gloucestershire.

Fig. 4a. Section of Inferior Oolite Leckhampton Hill, near Cheltenham × 16 Diam. Shows fragmental remains of Calcareous organisms enclosed in crusts of Girvanella, thus illustrating the formation of oolitic granules.

Fig. 4b. Sections of portions of the crusts of two of the granules in Fig. 4a, showing the Girvanella tubules × 70 Diam. The two crusts touch each other. The lighter part on the left is a portion of the nucleus of one of the granules.
Fig. 1a.  x 17 Diam.

Fig. 1b.  x 70 Diam.
Fig. 2a. \( \times 32 \) Diam.

Fig. 2b. \( \times 65 \) Diam.
Fig. 3a.  $\times 9$ Diam.

Fig. 3b  $\times 70$ Diam.
Fig. 4a.  x 16 Diam.

Fig. 4b.  x 70 Diam.
ON THE

HIBERNATION OF CERTAIN ANIMALS

BY

EDWARD CORNFORD, M.A., HON. Sec.

There may be some misapprehension as to the true meaning of the word “Hibernation.” Its origin, no doubt, leads our thoughts into winterly associations. But as applied to animal life it may have nothing whatever to do with winter nor a cold condition of atmosphere. A “hibernacle” is generally understood as signifying a winter shelter or covering, and could be applied to the warm retreat of the squirrel, or the hut of the Eskimo; or any winter quarters, as Carlyle writes in his “Frederic the Great”: “From the beginning of April the Russians hibernating in the interior parts of Poland were awake, and getting daily under weigh.” The scales which protect the buds of the horse chesnut and of many other trees, shielding them from sleet and frost, are hibernacula. The operculum of the snail is its outer door, and behind it, it hibernates in its dark chamber, during many months.

Hibernation has been said by some, and by many others thought to be, passing the winter in a secluded place and in a torpid state. This definition of the term is somewhat inaccurate and misleading, as I think we shall see.

It may be taken for granted that a supply of oxygen is absolutely necessary for the sustenance of animal life, and that any animal totally deprived of a supply of this gas
must, within a shorter or longer period, by no means an
illimitable one, cease to exist.

This is one of the laws of Nature, which amongst
others is inimitable and unexceptionable, and from man
to the lowest forms of life rules over all.

Another law of Nature is this: vital functions fail
without a supply of a certain amount of heat. Many
animals retain sufficient heat for their existence within
their bodies, when the temperature of the surrounding
atmosphere is extremely low; e.g., the Arctic fox and
other animals inhabiting the northern regions of the
globe, and possibly also the southern—of which we know
at present so little.

In the account of the Jackson-Harmsworth expedition,
we read that when the Thermometer registered 50°
below zero, bears came and rubbed their noses against
the windows of the Russian log-house, in which the
explorers were passing the winter.

There is therefore, if I may so express it, an internal
generation of heat, more or less independent of atmos-
pheric influences; but there can be no animal heat apart
from some measure of a supply of oxygen, and movement
of the blood is necessary. Those animals which have not
the property or gift of maintaining their internal tempera-
ture up to a certain degree—varying considerably in its
range, die: other animals having this property survive.
Nature in this direction, as in others, has its differential-
tions, and whilst some insects survive the winter, and in
tattered robes appear in the sunnier days of spring, and
give occasion for letters in provincial prints, others are
unable to resist the influence of the cold of any ordinary
winter, and though probably equally sufficiently supplied
as some others with material to withstand its rigour,
are no more, owing to their less instinctive faculties: may
it not be so?
Thus whilst that very common butterfly, the small tortoise-shell, is seen in the very early days of the year, other Lepidoptera as a rule do not hibernate, and I think it probable that no moths survive the winter.

Where then do those animals which are capable of enduring an extreme degree of cold derive the resistant power; what is the secret of the fortress which defies in some instances the rigour of a temperature of which none of us can have had any experience and probably never shall?

When animalculæ—I use the term generically—are frozen in a containing vessel of water they are not destroyed. This is a fact which may easily be verified by anyone in a very simple manner. Each of the little organisms will live for a time in a tiny uncongealed space. A minute portion of film of the surrounding fluid, by reason of the temperature of the body enclosed, is kept in an uncongelated condition. It is true that these creatures are called cold-blooded, as also others, which, really are not truly and absolutely so. If you want to make an experiment, which though not agreeable, may be instructive, I have read on good authority that if you were to make a pile of worms, leeches, snails and slugs round a thermometer you would find the mercury rise above the temperature of the surrounding atmosphere, and therefore (if this be true) these animals have some power of resisting the influence of a cold temperature, owing to their internal heat—without which they would inevitably perish. In the so-called cold-blooded vertebrata the heat of the body almost entirely depends on the temperature of the environment. It is so with fishes, (with some few exceptions) in which the blood contains a larger proportion of red globules or discs. For in birds, reptiles, and fishes the blood particles curiously differ from those of mammalia. The proportion of red blood particles in the whole mass of the blood varies greatly in
different animals. They are greatest in those which possess the highest measure of muscular vigour and activity, and which therefore consume the largest quantity of oxygen by respiration, and they are much more abundant in mammals than in reptiles or fishes. This fact throws a side-light at all events on my subject. Physiologists tell us that one function of the red particles is to convey oxygen from the lungs to the tissues and organs through which the blood circulates. When the muscular system is in active operation it requires a larger supply of oxygen: when it is at rest it wants but little; so that when roused into activity it requires an increased supply.

The quantity of oxygen which the animal takes in by its breathing apparatus, and the quantity of carbonic acid which it gives off, will therefore vary with the amount of its muscular exertion. It is in consequence evident that an animal in a state of repose requires a much less amount of oxygen than when in a state of vigorous activity of existence.

Animals in a state of lethargy, by consequence, do not require the same amount of oxygen as is necessary for an active habit of life.

Atmospheric air is necessary to the continued life of all animals, and the result of its inspiration is the giving out of carbonic acid gas. But the amount of atmospheric air absolutely necessary for the continuance of vitality is a question which perhaps no one can decide. Certain functions as I shall mention bye-and-bye are performed, but with some diminution or decrretion. Life may be apparently in abeyance for a considerable time without vitality being absolutely destroyed. The common garden snail, not to mention other instances, may be kept for a very long time without water. I kept one quite by accident more than two years, and it revived when placed in a moist atmosphere. Snakes and frogs have been
placed in ice-houses and have revived after two or three years exposure to and experience of the low temperature.

Hibernation, as I have already mentioned, is generally understood as passing the winter in a state of torpor—a mistake arising from a derivation of the word from the Latin—but it has not, strictly speaking, this restricted meaning as applied to animals. The state of hibernation is not the same thing as, or any condition of, a state of torpor.

Hibernation is a provision of nature for the preservation of life, especially for that of the insectivora, when by reason of seasonal change their sources of daily food supply are necessarily unprocurable. This, e.g., is the case with the bat, when spring and summer give place to winter, and insects as a rule disappear.

The very observant author of the "Natural History of Selborne" hardly, if at all, makes good his opinion that swallows hibernate by any reliable facts. In December, 1773, writing to Barrington, he says: "We make great enquiries concerning the withdrawal of the swallow kind, without examining into the causes, why this tribe is never to be seen in winter. The hirundines, if they please, are certainly capable of migration, and yet no doubt are often found in a torpid state." The sand martin makes a hole, round and regular, in sand or fine gravel, generally straight, with a slope upwards towards the opening, and about two feet distant from the entrance. At the end of this, in a little globular chamber, the bird builds its nest, consisting of moss, fine grasses, and feathers, which one would think would be, if anywhere, a desirable place in which to spend the winter. But says Gilbert White, speaking of this species: "These birds do not make use of their caverns by way of hibernacula as might be expected; since banks have been dug out with care in the winter, when nothing was found but
"empty nests." In September, 1781, with reference to another species, viz. the house martin, he says: "In some former letter I expressed my suspicions that many of the house martins do not depart in the winter far from your village. I determined to make some search about the S.E. end of the hill, where I imagined they might slumber out the uncomfortable months of winter. But supposing that the examination would best be made in the spring, and observing that no martins had appeared by the 11th April, I employed some men to explore the shrubs and cavities of the selected spot. The persons took pains, but without any success." With reference to swifts, which are the first to leave our country, as they are the last to arrive, Gilbert White states that the swifts left about the 1st day in August—all save one pair—which in two or three day's time was reduced to one individual. This one was watched till August 24th, and then it was found that this—which was the mother bird—was looking after two young ones, which by that time were fledged, and they were seen until the 27th; but, on the 31st, on examination, it was found that the nest only contained two stinking swifts. Reverting subsequently to the case of the sand martins, Gilbert White seems to be his own witness against his theory that some swallows hibernate, for if any species would be more likely to do so than others I should judge the sand or bank martin to be that one, seeing what a warm nesting place it has. Now in March, 1788, opportunity was taken to examine some of the holes in the banks, where that species of bird congregated. The investigator hoped that they might have slept there, and that he might come upon them just before they awoke from their winter slumbers. He dug with some diligence and perseverance into the bank. He found the nests at the end of the canal as was to be expected, they had evidently been occupied, but no birds were to be found.
Occasional late appearances of these birds prove really nothing as regards their hibernation. Their power of accumulating even a modicum of food within them must be extremely limited, and I think we are quite safe in saying that no species of hirundines hibernate (in the sense of the word as used in this paper) in this or as a matter of fact in any other country. (I know I have Von Humboldt against me.) They fly to fresh fields, and a more genial climate, and all tales of their surviving the winter in this country are (me judice) not worthy of belief.

The bat goes to sleep, and its usual food is, for a time, not a necessity of its existence, and even if the weather be abnormally mild we cannot find that it leaves its shelter until it has been there for a considerable time.

To what extent hibernation extends in the animal world has not been and cannot be accurately ascertained. The enquiry into the subject is a very difficult one, and we can only draw our conclusions from certain plain and evident facts, leaving many more which are beyond our powers of investigation. The bat, the badger, the hedgehog, and the dormouse amongst the mammalia are the most easily observed examples in our country of this singular and strange physiological condition, and this condition presents no easy problem for naturalists to solve; and it may be by reason thereof, the literature bearing on the subject is very scanty, and some even of that, not altogether reliable.

What is hibernation, from a physiological point of view? This question is the root of the whole matter and embraces many considerations of much interest, for it is evident that any animal in a state of hibernation, i.e., of more or less suspended action of its ordinary functions is, so far, in an abnormal condition. How then does it continue to exist?

Now, we are told by physiologists that the quantity of respiration is inversely as the degree of irritability of the
muscular fibres. The bird tribe have a high degree of respiration and a low irritability; the reptiles have a high degree of irritability and a low degree of respiration. This law holds good not only in the different genera of animals, but also in the different stages or states of the same animal under altered conditions. The structural changes of an animal from one condition to another, or from one stage to another, are always a change from a lower to a higher degree of respiration, and from a higher to a lower degree of irritability. Thus the changes from the egg to the bird, or from the tadpole to the batrachian, or from the larva to the insect condition, are changes in which the quantity of respiration is augmented, and the degree of irritability is diminished, whilst on the other hand, the physiological changes in the degree of activity in animals, [for example, during sleep] but especially in that remarkable condition which is called hibernation, the respiration is diminished, whilst the degree of irritability is augmented.

On what this susceptibility of change depends, and especially on what the power of taking on an augmented irritability depends, is at present unknown. But I think that in this power we may find one clue to the secret of hibernation. I take it for granted that all animals have the power, or privilege, of sleeping. During sleep, respiration is in its intervals diminished only as a rule slightly; the irritability is probably proportionately increased, and this may be one object of the period of repose. So it is that after a night’s rest we wake up and feel invigorated for the day’s work. So also if we do not sleep, or sleep only fitfully, we do not feel ourselves as fully “fit” as we should like in the morning. This phenomenon has its limits, and limits beyond which it cannot pass, so far as we are concerned. But in some animals the boundary line is beyond ours; their limit beyond ours. In them the quantity of respiration is still
further diminished, and the degree of irritability still further augmented, and the deeper sleep or lethargy of hibernation results. During this lethargy, the law of the universe ratio of the respiration and of the irritability still continues. If the respiration were to be diminished without a corresponding increase in irritability, the heart would cease to be stimulated, and the animal would die, as in the case of torpor, or of asphyxia. If the respiration were augmented, without proportionate diminution of irritability, the heart would be over-stimulated, and death in this case also would ensue, as in the instance of an animal too suddenly roused from its lethargy, or of one placed in an atmosphere of pure oxygen gas. A dormouse roused from sleep and exposed to a low temperature did not go to sleep again, but died.

One difference therefore between those animals which hibernate, and those who do not, seems to be this: that in the former, there is a power of involving, if I may so say, or somehow or other generating, an augmented degree of irritability of the muscular fibres; a power possessed by all animals within certain limits, but by hibernating animals beyond those limits.

Sleep, (however a condition both remarkable and perhaps inscrutable it may be in itself) and hibernation are really similar periodic phenomena, induced by somewhat similar causes, leading to similar effects, but differing very greatly in degree. Hibernation seems to us more extraordinary than sleep, but only perhaps because it is less familiar to us. Most animals are in fact naturally awake and asleep each day or night, some being diurnal, others nocturnal in their habits in this respect. Sleep may be called the first stage of hibernation. The faculty of passing into the second stage is really the acquisition of a greater irritability of the muscular fibres. Many have made mistakes by viewing hibernation as an effect only produced by a low temperature. The influence
of cold in inducing torpor is its too well-known power in producing a sleep which has so often resulted in death.\(^*\) The direct effect of cold on the animal frame is totally different from hibernations. Hibernation is a physiological condition—not the direct effect of cold. Torpor is on the contrary, a pathological condition, and generally only too frequently a fatal one.

The term hibernation, as I have said, has usually been employed to signify the condition in which certain animals pass the winter season, and I have also said, it is by no means an exact definition. If we may, e.g., credit Cuvier it is not so. He observes with reference to the Tenrecs: “These are nocturnal animals, which pass three months of the year in a lethargic state, although they are inhabitants of the torrid zone.” Burguierre even asserts that it is “during the great heats that they sleep.” The Germans have not only the word Winterschlaf, but also Sommerschlaf—for which Von Humboldt is responsible. If Cuvier be correct it is evident that the state of hibernation in its widest and fullest sense is not necessarily connected with a low degree of temperature; and yet, strange to say, he writes in another place: “The sole condition of lethargy is cold and the absence of irritating causes.” How on this supposition can we explain the hibernating of numerous insects during our warmest time of the year?

In the sleep of hibernating animals, respiration is more or less diminished, until it almost reaches the vanishing point, and if the temperature be taken, it will be found to be many degrees lower than if the animal were in a state of activity. The following facts have been observed and recorded. Dr. Todd made careful observations in the case of two hedgehogs, which were kept in a temperature varying from 45° to 50°. They alternately woke up, took

\(^*\) And does inevitably if the dormant cannot be roused.
food, and went to sleep again. When they were awake, their temperature, (which he found by placing a thermometer under their stomachs) was about 95°; when they were dormant, their temperature was only 45°; that of the atmosphere being 42°. In the month of February, with the atmospheric temperature at 50°, both hedgehogs were dormant, the temperature of one being 52°, and that of the other 1° lower. On the next day, the air temperature being 49°, the temperature of one hedgehog, who had woke up for a bit, was 87°; of the other, who was asleep, many degrees lower. The difference between the air temperature and that of the animals under observation was on one occasion no less than 39°. Similar observations were made in the case of dormice. These two kinds of creatures seem to wake up at call of hunger, to eat, (if they have access to food, in default whereof, I expect they perish) and then again become dormant in temperatures which may be called moderate; but the bat, which could not find its food, however swiftly and keen-sightedly it might swirl through the air, as a rule sleeps the winter through.

There are therefore degrees between ordinary sleep—broken at longer or shorter intervals, and profound hibernation. The ordinary sleep produces or rather induces less vivification, as far as the action of respiration is concerned, as also a less evolution of contained heat, with at the same time an increased power of resistance to the abstraction of a greater or less extent of atmospheric air. This sleep, in some instances, passes into true hibernation. The blood becomes less arterial and more venous for the diminution of respiration, and the muscular fibre of the heart acquires increased irritability.

Various functions of the system during the period of hibernation are, of course, much modified. The process of sanguification is, in most cases, all but arrested, possibly entirely in some. There is also a marked
difference in the effect, and therefore in the activities of the digestive organs. It is a condition of appropriated somnolence. The bat, being insectivorous, would rouse himself in vain, when the snow whitens the ground or the cut of the skates rings clear.

The hedgehog which on some unusually warm morning might find a few slugs or worms—even the dormouse a nut or two amongst the leaves fallen from the filbert trees—are not enticed out for any time, until as a rule, the increase in temperature tells them of a coming period of love and food and general enjoyment, and they then leave their hibernacula. They are not in any hurry to do this. It seems that the bat is not disposed to really wake up, except by reason of external warmth and excitement. If the air temperature be about 40° to 50°, the hedgehog rouses itself at various intervals from two to four days, when after taking food it will return to its hibernaculum. At the same temperature the dormouse will wake up daily. In proportion also to surrounding temperature, as we might expect, the action of the stomach, bowels, and kidneys of hibernating animals is almost, in varying degrees, I admit, suspended, as also that of respiration. This is proved by the absence of all detectible respiratory acts—by the absence of any but the slightest change in the air as tested by the pneumatometer—by the capability of supporting for a time the entire or nearly entire deprivation of air.

When, e.g., placed in a box, during its hibernation, the slightest knock caused the bat inside to respire more quickly, the hedgehog in a similar condition resired deeply and sonorously. If touched, it can be ascertained whether the last-named animal is hibernating or not. If hibernating, he responds with a snore, if not hibernating moves and rolls himself up more tightly. After the deep respiration, there are some gradually more and more feeble ones, and then apparently, quiescence. The bat
similarly respires, rather more quickly, but without the deep sound of the hedgehog, and then soon lapses into quietude.

It is very difficult to ascertain the comparative temperature of the animal with that of the environing atmosphere. The slightest excitement induces a quicker respiration, with the consequent evolution of an increased degree of heat. From observations, which extended continuously over many years, it was found that the temperature of some of the hibernating animals followed that of the atmosphere — of course within certain limits and with certain exceptions. A animal can endure the total abstraction of oxygen or of atmospheric air for some time. For instance, Spallanzani placed a marmot — one of the hibernates, in its hibernated state — in carbonic acid gas for four hours, and it was not killed, but a rat and a bird died at once. It seemed, therefore, that in the case of the hibernating animal, respiration was all but, if not altogether, suspended for a time.

Torpor and hibernation must then be distinguished, the one from the other. Torpor may be produced in any animal, e.g.: in man, but a man cannot hibernate. Torpor means a benumbed state of the nerves, a stiffened condition of the muscles, a loss of any desire for exertion, a strong desire to sleep. This is the direct effect of cold, and even the hibernating animal, under such surrounding influences, may be affected by them and die. True hibernation is not produced nor induced by extremely low temperatures — but rather by those only moderately low. All creatures which hibernate avoid, as much as their instinct teaches them, and their opportunities allow, exposure to extreme cold, though of course in some seasons all their precautions are in vain, and they perish in countless myriads. Such must have been the case last winter, (I speak of 1895) when we all in common with the lower forms of life experienced, and perhaps suffered from its very severe and prolonged frosts.

The safe and cosy hollow in a gnarled oak, or an old pollard willow, the cleft or cavern in the cliff, the shelter of the thatch on some country cottage, the heap of leaves in the forest, the mound of the cast-off dress of the larches and firs, provide so many hibernacula for "our humble relations." Sometimes these hibernates congregate in clusters, and it is not beyond the range of possibility that the mass of wintering snails with which gardeners are familiar, derive some amount of heat from their associate-ship. Be this as it may, the true hibernating animal, if roused from a state of rest and shelter to a state of activity, is then exposed to severe cold, it passes into a state of fatal torpor.

If we ask, what are the hibernating animals? I would say it is a question which needs further investigations than (so far as I know) it has received up to the present time. All animals, as I have already said, sleep periodically during the night or day. Some sleep several days together, especially after food, and in the colder or any other part of the year. During true hibernation, respiration and circulation are reduced to the minimum, consistent with the presence of life.

Hibernation may result in changes in some instances which, unless we had the evidence of our senses, would be absolutely incredible; but in other cases the condition of the animal hibernating is scarcely altered. I take two familiar instances. The first that of a butterfly or moth. In the pupa stage they maintain the continuity of life in a sufficient, though much changed and greatly modified condition. The environment is absolutely altered. The access to food from without is shut off, a great change is undergone in the greater or less darkness of the coffin, or place of temporary confinement, a change which may be prolonged for years, or which may take place within a very short period.
But it is a remarkable fact amongst many others of a like sort that whilst the larva of the goat moth, Cossus lipniperda, does not come to maturity for three years, the pupa hibernates only for a few weeks. I may say that owing to its size and perhaps also to the nature of its food, it afforded Lyonnet an excellent subject for his anatomical researches.

It by no means follows that during the process of hibernation the imago, or perfect insect, will become in time as handsome as the larva, or vice versa. E.g.: the caterpillar of the peacock butterfly, Vanessa io, one of the most beautiful of our country, is black spotted with white, with hind legs red, and feeds on the common stinging-nettle. The pupa is greenish and dotted with gold, whence the term Aurelia or Chrysalis. Such is the larva, and such the pupa. What is the imago? The caterpillar, I may say, is about two inches in length when fully grown. After hibernation, it sees again the full light of day. It can breathe freely, it can with its thousands of eyes look the sun in the face, it can with its delicately-feathered pinions float on the air, it can chase its fellows in a seemingly endless dance, it can direct its course from one flower to another, sipping here and there the nectar which has been provided for it. What a marvellous, and be it noted so far as we know a continuous work is going on during that period! Indeed some might almost be disposed to say, "all things are become new." In a sense it is so, but not by a new creation, but by an evolution and development of that which previously existed. It is by no means impossible, and some have asserted it to be the fact that the future form, I do not know a better word, of the perfect insect may be found in the caterpillar. It is certainly I think not beyond the range of possibility for this reason. The caterpillar feeds on those substances which will by the laws of the natural world supply it with such juices as will in its perfected state result in and
exhibit that form and colouring which is, if I may so say, (they keep as it were to their own peculiar castes) its hereditary possession. For the Lepidoptera are a very conservative species of animals and we cannot cross a red admiral with a meadow brown and get a new variety—or a peacock with a tortoiseshell—and I think that some physiologists have not given sufficient attention to this subject.

The alchemy of Nature is a mystery, and the process by which the caterpillar, by its instinctive faculties and the powers with which it is endowed, absorbs those elements which are necessary for its future development, will probably ever remain amongst the many insolubles. But still the fact remains. The larva has absorbed "a quantity"—whatever that quantity may be—or of whatever character—which it does not throw off or lay aside, except as regards its integument, when it enters into the chrysalis or pupa condition. It takes its juices with it into its coffin. It falls into a condition not far from death, insomuch that many have said of such, it is dead. But far from that. from the time it is shut up, by its own will and action, from the outer world, there is a process going on within that gold-spangled or dull coloured encasing, day by day, hour by hour, may we not say moment by moment, a marvellous, ever-progressive development of that which was, into that which shall be, and if that progression be not interrupted will result in a transformation such as could never have entered into the wildest dreams of man to conceive.

There are many secrets to be discovered in Nature, in its work and in its results, but there is no more difficult problem in my humble opinion to be solved, than that to which I have referred. The microscope can help us much in many instances, in some not at all: and though it may reveal the changes which take place hour by hour, in the condition of certain pupa, it cannot. nor can any
appliance of science reveal to us the reason of, nor the manner of, nor the operation of those changes.

I turn now to another part of my subject. It is interesting to us naturalists to know what is the relative quantity of air consumed by insects in their three states, their power of existence in certain media, and the relation which this power and the consumption of air bear to the comparative volume of the structures concerned. It is obvious that only two or three examples can be referred to on the present occasion. In larvæ we find that respiration in the very early stages of existence is feeble, but the circulation is quicker; the amount of food required is, of course, less, though in proportion to the size of the individual it is enormous; the generation of heat is less than at a later period. In the next or pupa or hibernating stage respiration is very much less in frequency and volume, circulation slows down, no food is taken, and the temperature is consequently much diminished in degree. In the imago, or perfect insect, all functions, as we might expect, are working at their full power, with this exception—that the need of food is, in most cases, if not all, not nearly so great as in the case of the larva. Many caterpillars eat daily twice their weight of leaves, and by a simple arithmetical process we conclude that this is as if an ox weighing say 60 stone, as exhibited, would require about \( \frac{3}{4} \)-ton of grass in 24 hours, or a man weighing 12 stone, something like three cwt. of food. The larvæ of flesh flies or maggots—commonly so called—in 24 hours become two hundred times heavier than they were. I mention these facts because I think they have a distinct bearing on my subject. We see the very extraordinary capacity of insects in the larval state, and the, in most cases, absence of any nutriment from outside in the pupal and succeeding state. The voracious caterpillar had, in fact, to lay up in store, in the most condensed form possible, for succeeding
generations, probably also assimilating metallic atoms. Rejecting by evacuations the coarser substances, it retained chiefly the juices of its food, and by a process which it were in vain to try to understand even if in itself there was outlined the future development of the animal, which in the pupa becomes more pronounced, so that by a momentary inspection in the case of many genera, we can see without difficulty under the temporary tabernacle, or hibernacle the eyes, the proboscis, the folded wings, and so on, of the fly that is sooner or later to break its bonds asunder.

The voracious caterpillar when changed into a moth or butterfly feeds on the daintiest of foods, and only very sparingly on those.

If we from feeding, turn to breathing, in these species of animals, we note that the parts which have to do with respiration are the tracheae and spiracles, together with their associated muscles and nerves. The tracheae are the ducts by which air is conveyed from the exterior, and the spiracles are the outer doors as it were. These are, generally speaking, nine in number on each side, and between the spiracle and tracheae there is a conical “occlusor” muscle by which the tracheae may be closed at will, and these conditions or others very similar exist in the case of the larva. Nearly all the muscles and nerves of each segment of the body are used in the act of respiration. It has not been, and here again I speak only so far as I know, definitely ascertained how air is renewed in the trachea ducts; it may be by contraction of the dorsal vessels, or the opening or closing of the muscle just referred to, or as some think, by the active over-lapping of the segments of the body. In the grasshopper (Gryllus sp. viridissimus) about 37 contractions per minute were observed when it was excited—several short inspirations being followed by one long one. In the hive bee there have been observed 110 to 160
contractions per minute of the abdominal segments when aroused or excited, and about half that number when at rest. In the account of Mr Newport’s experiments as communicated to Royal Society by Dr. Roget (1836) we find his method was as follows:—First the bulk of the insect was ascertained. It was then confined in a stoppered bottle of known capacity, and the hour and the degree of temperature were noted. After some time the bottle was put invertedly into a vessel containing lime water, and the stopper withdrawn. It remained thus for half-an-hour. The contraction in the enclosed air (allowance being made for any change of temperature and pressure) indicated the amount of carbonic acid formed, and therefore the quantity of respiration.

The following tables as the results of some of a number of experiments are given.

<table>
<thead>
<tr>
<th>Insect</th>
<th>State</th>
<th>Experiment</th>
<th>Temperature</th>
<th>Amount of carbonic acid cubic in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphinx Ligustri</td>
<td>Larva</td>
<td>5 hours</td>
<td>69°—71°</td>
<td>0.430</td>
</tr>
<tr>
<td>&quot;</td>
<td>Pupa</td>
<td>147</td>
<td>52°—58°</td>
<td>0.230</td>
</tr>
<tr>
<td>Papilio or Vanessa</td>
<td>Larva</td>
<td>12</td>
<td>70°—66°</td>
<td>0.120</td>
</tr>
<tr>
<td>urticae</td>
<td>Pupa</td>
<td>48</td>
<td>67°—78°</td>
<td>0.130</td>
</tr>
<tr>
<td>&quot;</td>
<td>Imago</td>
<td>16½</td>
<td>79°—82°</td>
<td>0.200</td>
</tr>
<tr>
<td>Bombus terrestris</td>
<td>Imago</td>
<td>1</td>
<td>60°</td>
<td>0.255</td>
</tr>
</tbody>
</table>

(4 weeks old)

(Just caught)

During hibernation, the temperature being from 20°—37°, the respiration of certain pupæ experimented upon was almost suspended, but yet distinct evidence of its being carried on in some degree was obtained; and vitality continued in spite of the low temperature and all the pupæ became imagoes. The relation of the organs of respiration to the volume of structure is this: In larvæ
the organs are proportionally very small—in the pupa state the organs much larger, though the respirations are very much less in number.

Ancient Natural History gave wonderful accounts of the existence of an animal under very unfavourable circumstances. The poor toad, a very useful—but often by ignorant people a much-abused and ill-treated creature—was the subject of experiment. That it is not a trivial matter to which I draw your attention I may gather from the fact that the occurrences to which I shall allude were the subject of papers read before the Royal Academy of Sciences in Paris, which even in the 7th decade of the last century contained members who were by no means mere sciolists. Before the members of that Academy, a paper was read by M. Guillard. He stated that in pulling down a wall which was known to have existed 100 years, a toad was found, without the smallest aperture being discernible by which it could have entered, and it had been dead only a short time. Forty years before the date of this statement, a M. Seigne before the members of the same Academy gave an account (more remarkable than the foregoing) of a toad found in the centre of a solid oak, and no place by which it could have entered could be found. From the size of the tree he calculated that it must have lived where it was found for 80 to 100 years. Other similar instances are recorded, but I have ventured to name these two, as they were gravely and by men of some scientific knowledge at all events, brought before the notice of those Frenchmen, who in their day represented the science of the period. How the assembled philosophers received the tales, history does not tell; but one M. Herissaint determined to test the truth or otherwise of these alleged facts by experiments, which however conclusive, and putting an end to such nonsense, I do not wish to justify. M. Herissaint, in February, 1771, enclosed three toads in three cases of plaster,
plaster of Paris, I presume. He then placed these cases in a box,—the size of the box is not stated—which also he covered with a thick coat of plaster. On the 8th April, 1774, i.e., about three years and two months after, he removed the plaster coverings and found two of the toads alive,—one had died. On the 15th April the survivors having had access to air, and perhaps to food for a week; he placed the two live toads in a basin of plaster, which he covered with a sealed glass case, so that he might observe their movements. On the 9th May he exhibited this case and its occupants before the members of the Academy. One was still living, the other had died the night preceding. On the 15th April he enclosed in a glass bottle another toad, and buried the bottle, after securely closing it up, and on the 9th May it was found to be well, and it croaked when the bottle was shaken.

You will observe that in these experiments the animals were in a case pervious to the air, and the waste of tissue owing to their compulsory inactivity must have been exceedingly small, and their respiration probably very slow. But the result I think is to show that all those stories which tend to prove that the laws of Nature can be almost indefinitely suspended are utterly unreliable. Nature, as I have said, has its laws, and they cannot be set aside by man or beast without direful or fatal consequences; for the laws of Nature are decreed and directed by a Higher Power. It is in my judgment absolutely impossible for a toad or any other animal to live for three years totally without any supply of moisture or air, and I do not think much of the experiments of M. Herissaint, for they prove nothing as regards the power of any living creatures of a higher or lower order to exist for any lengthened period deprived of those elements which are necessary for that existence. All animals that hibernate must have access to air (some perhaps to food).
As to the hibernation of fishes, it is evident that we cannot know anything about those which live in salt water and we may conclude, I think, that the hibernation question does not touch them. Fresh water fishes do no doubt hibernate, by compulsion, not always as a certain habit, but by instinct through force of environment, e.g., as in the instances of fish in shallow streams, which in some years become altogether iced for weeks together, and yet the fish are, I think, not destroyed. But as this statement may be questioned, I would call your attention to the case of a fish which inhabits the beds of rivers in Africa, and which is called by zoologists Lepidosiren annectens, or mud fish. Now it is known to all who have a little knowledge of the smaller rivers in tropical or sub-tropical latitudes, that at certain times of the year the rivers are in full flush, at other times only a trickling stream, or perhaps none at all—only shallow pools here and there. What then becomes of the fish which one day are swimming in a full bath and a few days after have not sufficient water even to shelter them from the burning sun? They hibernate, not owing to the cold, but owing to the heat. The heat of the sun in January or February bakes the cracked mud into so many irregularly-formed bricks. When the fish I have mentioned, by that instinct, which in similar instances is possessed by many other kindred animals, feels that the hot and dry season is coming, it wriggles its way into the mud. After burrowing, if I may so say, a sufficient depth, it curls itself round, and waits for the rain, and hibernates. When the rain falls, the water soon reaches the cell of the fish through the numerous fissures caused by the drought. It then resumes its activity. The cell, or cocoon, in which it hibernates is described as formed of clay, the hollow being quite smooth. Three specimens found in one lump of clay were immersed in water. At first the creatures were very sluggish, but after an hour or two
they became active, one however died, and one of the others lived only about six weeks. In this case you will note that they without doubt had, during their seclusion, access to air. I must, however, remark that it was and perhaps still is a moot question whether Lepidosiren is a fish or a reptile. It seems to depend on the question whether it possesses more of the piscine or reptilian characters. I myself was inclined to place it amongst the reptiles, but on consulting various authorities I have come to the conclusion that it must be classed as a fish, belonging to the order "Dipnoi," and a hibernating fish.

A number of other observations have been made, but I will allude to one instance only. The salt water Terrapin, "Malachlemys" is found in the salt marshes in North and South America. During the summer it is always on the prowl; but when the cold weather comes it excavates a hole in the muddy banks of the marsh, and there lies buried until the spring. But this is an exceptional case, as a rule, and only those animals which are found in very shallow waters, and under special circumstance, hibernate.

Allow me now briefly to sum up the leading features connected with my subject.

One of the most important characteristic of organisms and that on which the maintenance of life depends, is their metabolic power: (metabolism being the act or process by which on the one hand the dead food is built up into living matter, and by which on the other hand the living matter is broken down into simpler products within a cell or organism). Metabolic power is therefore the power which animals possess of continually using up and renewing the matter of which the body is composed. Every phenomenon of growth presupposes the reception of, and the change of, material constituents; all movements, secretions and manifestations of life depend on the exchange of matter; or in other words the breaking down and building up of chemical compounds. On this alternating destruction
and renewal of the combination of the body-substance—two properties necessary to living creatures depend—viz.: the secretion of food and the excretion of waste products. Nevertheless this important property of living creatures, viz.: metabolic action, may under certain circumstances be temporarily suspended or suppressed without thereby depriving the creature, or organism, of the power of existence. By removal of water or heat, it is possible, in the case of many of the lower organisms and their germs, to suspend the vital principle for months and even for years, and then to restore the apparently lifeless body to the full exercise of its vital properties by the simple addition of water or warmth. Such is the case with the eggs of Apus—one of the Entomostraca, of the Cypris, a cuirassed ostracod, which is found in our ponds and ditches, and other like forms, and of frogs and other animals. The intensity of respiration stands in direct relation to the energy of the metabolism. Animals which breathe by means of gills and absorb but little oxygen, are not, of course, in a position to oxidize a large quantity of organic constituents, and can only transform a small quantity of potential into active energy. They perform, therefore, not only a proportionately smaller amount of muscular and nervous work, but also produce in only a small degree the peculiar molecular movements known as heat. The source of this heat is to be sought, not in the respiratory organs, but in the active tissues. Animals, in which thermogenic activities are small, have no power of keeping independently their own internal heat when exposed to the influence of the temperature of the surrounding medium. This is also true of those air-breathing animals in which the metabolic and thermogenic activities are great, but which in consequence of their small size offer a relatively large surface for the loss of heat by radiation, as in the case with many insects and the lower orders of animals. On account of the changes of heat which are constantly
taking place between the animal body and the surrounding medium, the temperature of the former must be in such animals largely dependent on the latter rising and falling with it. Hence most of the lower animals are poikiloth-ermic, or, as they not so accurately, but more commonly, designated, cold-blooded. The higher animals on the contrary in which, on account of their highly-developed respiratory organs and energetic metabolism, the thermogenic activity is great, and which are protected from a rapid loss of heat by radiation by the size of their bodies and by the possession of a covering of hairs or feathers, or some artificial covering, possess the power of maintaining a somewhat constant temperature, which is largely independent of the rising or falling of the temperature of the surrounding medium. Such animals are called homothermic, or warm-blooded. Since they require a high internal temperature, varying only within comparatively small limits, as a necessary condition for the normal course of the vital processes, or one may say for the maintenance of life itself, they must possess within themselves a series of what may be termed regulators, whose function it is to keep the body-temperature within its proper limits with relation to the temperature of the surrounding medium. This may be effected either by diminishing the production of internal heat (diminishing the metabolism) or by increasing the loss of heat from the surface of the body (by radiation, evaporation of secretions, or cooling in water), when the temperature of the surrounding medium is high; and on the contrary, when it is low, by increasing the production of internal heat (increasing the metabolic energy) by a more plentiful food supply, more vigorous movements and so on; or also, by diminishing the loss of heat by the use of more effectually-protective coverings. When the conditions necessary for the action of what I have called these "regulators" are absent, as in the case of want of food, or, in the case of small and unprotected bodies, we find
the phenomenon of winter sleep, in which life is preserved, though there is a temporary lowering of the metabolic processes; or when the metabolic processes of the organisms do not enter into abeyance, we find the remarkable phenomenon of migration, as is the case with many birds.

NOTES

Re "IRRITABILITY"

Movement of a voluntary description is accomplished by muscles receiving through nerves their stimulus to action from the brain, which in turn is stimulated in an unknown way by the will. Thus the central nervous system is both the terminus to which messages from the organs of sense are sent, and that from which commands to the voluntary muscles proceed.

All sensory function is not sensation, and all movement is not voluntary. The nervous system may receive an influence from without and transmit it to groups of muscles without intervention of any act of consciousness. This is what is called reflex action, and in such a case the part irritated, from which the nervous impulse starts, is still said to have sensibility and the nerve to be sensory, although there is no sensation, and the movement is involuntary. Also the property of response to irritation is not confined to the nervous system; structures may alter their shape or undergo other change on application of a stimulus, and this property is termed irritability. The active part of change of shape or movement probably in all cases consists in contraction, and is hence called contractility. Irritability and contractility, although they may be well included under the terms sensory function and movement, are not, like sensation and voluntary movement, confined to animals. They are found in the vegetable world also; and it may be maintained with probability, that they are properties of every part of every living being.—Cleland's "Animal Physiology," pp. 15, 16.

The great majority (if not the whole) of the movements of the body and its parts are the effect of an influence (technically termed a stimulus or irritation) applied directly, or indirectly, to the ends of afferent nerves, and giving rise to an molecular change, which is propagated along their substance to the central nervous organ with which they are connected. The molecular activity of the afferent nerve communicates itself to the central organ and is then transferred to the motor nerves which pass through the central organ to the muscles affected. And when the disturbance in the molecular condition of the afferent nerves reaches their extremities, it is communicated to the muscular fibres and causes them to take up a new position, so that each fibre shortens and becomes thicker. Such a series of molecular changes is called a reflex action, the disturbance caused by the irritation being as it were reflected back, along the motor nerves to the muscles.

A reflex action, strictly so called, goes on without our knowing anything about it, and hundreds of such actions are going on continually in our bodies without our being aware of them. . . . We speak of "states of consciousness," but what consciousness is, we know not; and how it is that anything so remarkable as a state of consciousness comes about as the result of irritating nervous tissue, is just as unaccountable as any alternate fact of Nature.'—Huxley, "Elementary Lessons in Physiology," pp. 187, 188: see also p. 254, &c.
ON THE

PRE-SAXON OCCUPATION OF THE

MIDDLE COTTESWOLDS

BY

JOHN SAWYER

In broad outlines, the nature and extent of the occupation of the Middle Cotteswold area before the coming of the English are well known. Camps and implements and burial mounds tell of tribal dwellers in pre-historic times; roads and villas and divers remains reveal a complete and prolonged colonization in the palmy days of Rome. During the last few years the outlines have bit by bit been filled in, and a fairly good picture is now presented of what manner of men they were whose records we trace before and at the dawn of Cotteswold history.

Ethnologists are now agreed in dividing the primitive races of mankind into two ages, for which Sir William Dawson suggests the names Palanthropic and Neanthropic* and Mr Horace B. Woodward the terms Palæanthropic and Mesanthropic,† as being more scientific than the terms

* "The terms 'Paleolithic' and 'Neolithic' are objectionable, as implying that these ages can be best distinguished by the use of certain stone implements, which is not the fact."—"The Meeting-Place of Geology and History," p. 17.

† Congrès Géologique Internationale Compte rendu de la 4me Session, Londres, 1888. Appendix B, p. 29. In Mesanthropic Mr Woodward includes the Neolithic, Bronze and Iron ages.
Palæolithic and Neolithic, with which we have been familiarised by Sir John Lubbock. It is also generally believed that the men of the Palæanthropic age belonged to two distinct periods, and possibly to two distinct races. The earlier men are those whose traces are found in drift deposits on hill slopes and in river valleys; the later are those whose weapons and implements are found in and beneath stalagmitic accumulations in caverns and caves.

**THE DRIFT PERIOD**

There is some evidence of the occupation of the Middle Cottswolds by men of the Drift period. Thirty-three years ago Mr John Jones and Mr Edwin Witchell described and figured the occurrence in a drift bed on the slope of Stroud Hill of some flint implements, associated with carbonised wood, oolitic stone changed in colour by the action of fire, and the bones of animals. The bed had undoubtedly been formed by the denudation of the higher ground and had never been disturbed; and both gentlemen were convinced that the flints (some of which had cutting edges), charcoal and fire-marked oolite were the relics of men who dwelt on the top of the hill before the bed was deposited. Mr Thiselton Dyert has also recorded the occurrence at the Barton Pits, Cirencester, of a considerable number of very rude flint flakes, some of which were accepted by Mr Franks, at the British Museum, as being of human manufacture. Our late President (Mr W. C. Lucy) notes the abundance in the neighbourhood of Blockley Station of small flints, having a chipped appearance, associated with drift of a variable

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character.* In the peat-bed at Sharpness, described by Mr Lucy,† a head of Cervus Elephas was found, the antlers of which had, in the opinion of Professor Church, been cut off by some rude instrument. Mr Chas Upton has also found in a gravel pit at the mouth of the Stonehouse valley a reindeer antler bearing marks of having been cut with a sharp instrument. Diligent search and careful observation may add to our knowledge of primitive Cotteswold men; but there can be little doubt that the plateau was occupied by men who were contemporaneous with those whose remains are found in gravel beds in the valleys of the Somme and the Thames—men who, as Professor Boyd Dawkins says, hunted the reindeer, bison, woolly rhinoceros, and horse, and who were in the same rude state of civilisation as "the Palæolithic man who "hunted the extinct hippopotamus in the forests of "India; who wandered over Palestine and the valley of "the Nile; who hunted the wild boar and stag, the "mammoth, and probably the pigmy rhinoceros in the "Mediterranean," and in whose time the English Channel had not been formed, and the North Sea did not exist.

THE CAVE PERIOD

Of the existence upon the Cotteswolds of men of the Cave period there is no evidence whatever. And looking to the great changes in the configuration of the country that have taken place since their time, it is not likely that any trustworthy testimony will ever be forthcoming. The late Rev. W. S. Symonds (a distinguished member of our Club) estimated that since the relics of Cave men were

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* In "A Slight History of Flint Implements, with especial reference to our own and adjacent areas," (Cottes. Club Proc. Vol. x., p. 22) Mr Lucy discusses the general differences between Palæolithic and Neolithic flint implements, and suggests localities in this county where the former may be found.

left in the well-known King Arthur's Cave and Bannerman's Hole on the Wye, the deep gorge between Symond's Yat and the Great Doward has been excavated,* and that both caverns "are mere fragments and vestiges "of limestone fissures which were once much longer. "and have been worn away at their northern extremities "and degraded by the atmospheric denudation of ages."† In other caves, the nature and position of the deposits above the buried implements of human manufacture also indicate the prolonged action of eroding forces. It is obvious that the soft Jurassic rocks of the Cotteswolds have offered far less resistance to denudation than have the Mountain Limestone of the Wye gorge and other hard rocks in which alone caverns containing the remains of Cave men occur; and any Cotteswold caverns which existed in the Cave period have undoubtedly been destroyed in the scooping out of the river valleys.

TYPES OF TUMULI

The evidence of the occupation of the Middle Cotteswolds in the Neolithic or Nanthropic age is abundant and varied. Typical of long tumuli are those in West Wood, near Birdlip; the prominent one on Shurdington Hill; Belas Knapp, in the parish of Charlton Abbots; and others at Notgrove and Stow-on-the-Wold. Although they vary in the number and position of the chambers or cists in which the bodies were placed, they are built to one general design. A dry wall of stone determines the shape, and at one end curves inwards, giving the peculiar horned appearance which is characteristic of long barrows, and is, the late Professor Rolleston‡ said, strikingly

suggestive of the form of the entrance to a Cave dwelling. Much more numerous than the long barrows are round tumuli, of which examples may be found within any two-mile radius in the Middle Cotteswold area. As a rule, the circular barrow consists of a small stone cist (in which the human remains were placed), covered with a mound of loose stones. Besides the long and round barrows, circular mounds of loose earth or gravel are scattered about the district. Whether or not they are burial places is an open question. Canon Greenwell, who has opened a number of similar mounds in the North of England, says that he has never* found the least trace of any burial in them, or the slightest fragment of pottery or chipping of flint. Nevertheless, he thinks that they covered unburnt bodies, interred without vase or implement; while Professor Rolleston thought the absence of human remains is accounted for by the small size of the mound, which, to quote his words, "would give free access to rain and carbonic acid, to say nothing of rodents and carnivores, and the larvae of insects, all of which animals learn, and act upon the learning, the value of phosphate of calcium."† Canon Greenwell admits that the explanation is not absolutely satisfactory, and the late Mr G. F. Playne, a member of our Club, whose careful examination of a number of Gloucestershire mounds entitles his opinion to considerable weight, dissented from the view that they were ever used as places of sepulture.‡ But it is worthy of note, that at Cubberley there is a circular mound, simply a heap of earth and stones, without any trace of a chamber, yet in the centre of which, Dr. Bird records, there was found a human skull, and with it some flint flakes.§

§ Ibid., Vol. vi., p. 332.
The dates to which the long and round barrows may be assigned have been the subject of much controversy. That the long tumuli are the earlier has generally been recognised. When first studied they were also referred to a pre-historic age. Against this theory Sir James Fergusson has protested with great vigour. All the chamber-tumuli in Gloucestershire, he contends, belong to the post-Roman period. "There are," he says, "hardly "half-a-dozen tumuli in the whole county. . . . All, too, "it may be remarked, are close to Roman stations, and "surrounded by evidences of Roman occupation."* But in the quarter of a century that has elapsed since he wrote, the number of long barrows known to exist in the county has increased to about forty, and enough has been learned about them to place their pre-Roman date beyond question. First, we have the fact that flint and stone implements are frequently found in them, while in an undisturbed barrow there has never been found the slightest scrap of metal. Secondly, although long barrows are distributed over the greater part of Britain, all have the same peculiar conformation, indicating that they are the work of one race of men; and, as Professor Rolleston says, we have no record of Great Britain ever having been occupied by one single race in historic times. Thirdly, we have the authority of Professor Rolleston,† that a fairly selected set of bones from any long barrow would be distinguishable from any fairly selected set of bones from any other variety of interment in Great Britain, of whatever age. Any one of these facts is strong proof of a pre-historic occupation, but the cumulative character of all is conclusive.


† "British Barrows," p. 627.
If further evidence be needed, it may be seen by comparing and contrasting the contents of the long and round tumuli. As types of the human bones found in each, we may take those from the West Tump long barrow, and from round tumuli at Hawling and elsewhere. In a letter to Mr G. B. Witts, to whom belongs the honour of having discovered the interesting mound near Birdlip, Professor Rolleston says: “The bones from the “West Tump are like all bones from similar barrows “which have been through my hands, and in the following “points: They belonged to a short-statured but long- “headed race, who were, if we may judge at all from what “we see of living men of the same osteological character, “darkish in complexion and hair.”*

Dr. Bird, describing the skeletons from round barrows at Hawling and other places on the Central Cotteswolds which he examined, says: “The bones of the extremities “are large and strong, and the processes and ridges well “marked, thus showing that they belonged to a tall, “square-built, muscular people.”† These are exact descrip- tions of typical long and round barrow skeletons throughout Britain. Professor Rolleston also notes the not infrequent association in round barrows of skulls of dolicho-cephalic and brachy-cephalic types; †† and Dr. Bird records that in a round earth tumulus at Cubberley there was found “a small skull, long and narrow,” and “the stature of the individual was not more than five feet.”§ The implements found in the round tumuli often include metal as well as flint and stone. In a round barrow at Hyde, near Stroud, a piece of bronze

† Cottes, Club Proc., Vol. vi., p. 333.
‡ “British Barrows,” p. 627, et seq.
and a leaf-shaped arrow-point were unearthed; * in one at Snowshill some bronze spear-heads and a bronze pin, with a beautifully worked implement of stone, having a hammer-head and cutting edge; † and in one at Oddington some spear-heads and a fibula of copper. ‡ Besides the differences presented by the contents of the two types of barrows in the craniology, the skeletons and the non-metallic and metallic character of the implements, there is a third distinguishing characteristic to be noted. In all the long barrows that have been opened, over the Cotteswolds generally, burial has been by inhumation only. In the round barrows, on the other hand, there is abundant evidence that the prevailing practice in the deposition of the dead was burial after cremation, the body so treated being sometimes placed in an urn, sometimes in a small stone cist, covered with earth, and sometimes in the ground without any protection whatever.

STONE CIRCLES

At two places on the Mid-Cotteswold escarpment there are what appear to be portions of stone circles. On the south side of the small valley between Leckhampton Hill and the Crippetts are several masses of rock belonging to one of the lower beds of the Inferior Oolite. Some of these masses are so placed as to seem to form portions of two distinct circles, and on the six-inch ordnance survey map they are so described. The hill-slope bears evidence of landslips, and it may be that the position of the stones is due to accident. On the other hand, there is some evidence that their position is due to design. Old people residing near assert that

some years ago the circles were much more complete than they now are, and there is a tradition that at one time they were regarded with something akin to superstitious awe. More important, however, is the size of the circles. The only one that can be measured with any approach to accuracy has a diameter of 100 feet. This is exactly the diameter of the well-known Rollright circle, near Chipping Norton, and also of stone circles in Cumberland; and one of the circles at Stanton Drew and another in the Orkneys are of nearly the same diameter.* If, therefore, the Leckhampton circles are due to natural causes, it is a remarkable coincidence that one of them is of the same size as stone circles elsewhere which are unquestionably the handiwork of man.

In a small coppice, known as Nutter's Wood, on the slope almost immediately beneath the well-known Cleeve Hill Camp, are about half-a-dozen small stone circles. The stones are two or three feet square, but irregular in shape, and some if not all of the enclosed spaces have apparently been excavated. About fifty years ago, Mr Gomonde, a Cheltenham antiquary, printed for private circulation a small pamphlet treating of archaeological remains near Cheltenham, and to it appended a map on which he marked the undercliff at Cleeve Cloud as the site of a British village. It is therefore possible that excavation in the wood may reveal further traces of human occupation than are now to be seen.

The purpose of stone circles is a matter of conjecture. Fergusson contends that they are entirely of a sepulchral nature. Tylor, while recognising that they have often to do with burials, says that "considering how tombs are apt to become temples where the ghost of the buried chief or prophet is worshipped, it is likely that such stone circles should also serve as temples."†

† "Anthropology," p. 348.
STONE AND FLINT IMPLEMENTS

In the number and variety of its Flint Implements, the Middle Cotteswold area is exceedingly rich.* In almost any recently ploughed field, especially after rain, flints bearing undoubted marks of human manufacture may be picked up by the dozen. At the top of Crickley Hill, near the Air Balloon Inn, flints have been found in such numbers, and in such a variety of stages of manufacture, as to suggest that here was the site of a flint factory. One of the most diligent and observant Cotteswold collectors is the Rev. J. H. Cardew, Rector of Wingfield, Wilts, for some years a resident in Cheltenham. Many thousands of flints gathered on the Cotteswolds have, he says, passed through his hands, and the results he has embodied in a valuable monograph, with a great number of illustrations.† The most numerous implements, he

* The methods by which the stone and flint implements were manufactured are treated of in detail in Sir John Evans's well-known work. But on the manner in which hammers and axes, such as have occasionally been exhibited at our Club meetings, were perforated and externally shaped, it may be of interest to supplement Sir John Evans's suggestions of chiselling, grinding, and drilling, by stating how similar instruments are made to-day on the comparatively unknown islands of New Britain and Duke of York. Until the advent of the white trader a few years ago, the natives of these islands made the whole of their weapons and implements of stone, so that in this respect they are a modern type of pre-historic dwellers on the Cotteswolds. The most formidable weapon used by the New Britain natives is a stone club—a large, round ball of stone, with a long wooden handle through a hole in its centre. It is made, Mr Wilfred Powell tells us in this way:—"The native first takes a piece of suitable granite, which he places in a slow fire of cocoa-nut shells, which give an immense heat, and allows it to become red-hot. He then, by the aid of a split bamboo, in the place of tongs, removes it from the fire, and begins to drop water on it drop by drop, each drop falling exactly on the same place. That portion of the stone on which the water falls begins to crack and fly off, until the heat has gone out of the stone. He then repeats the operation until an irregular hole is formed through the centre; he then fixes a stick through it, and takes it to a place where there is a large granite rock in which is a dent like a small basin. He hits the stone upon the rock until all the rough corners are knocked off, and it is worn fairly round; then takes the end of the stick, and pressing the stone down into the hollow of the rock makes the stick revolve rapidly between his hands, weighting it with other stones fastened to the top of the stick, until that side of the stone is worn perfectly smooth and round. He then shifts the other side of the stone downwards and works at that until both are smooth and even."—Wanderings in a Wild Country," p. 160.

tells us, are scrapers, varying in diameter from less than an inch to an inch and a half. Most of them are of a shape suitable for scraping the skins of animals, while a few have the concave edge which would be specially useful for scraping arrow-shafts or bone needles. Arrow-heads are so numerous and so varied in shape, that Mr Cardew divides them into six typical varieties, some half-an-inch some two inches, from base to point. Equally variable in pattern are the knives. Some are triangular, and might easily have been fitted into a handle; others are scimitar-shaped; others are like lancets, with sides curving to a sharp point, the effect of a prod from one of which, says Mr Cardew, we would rather contemplate in the imagination than experience in the reality, for no sharper weapon could be devised with hammer and steel. Worked balls of flint, like bullets, were probably used as sling-stones. Borers and rammers are by no means uncommon, and flints with serrated edges, like miniature saws, are often found. A remarkable feature, not only of the Middle Cotteswolds but of the Cotteswolds generally, is the almost entire absence of the larger megalithic instruments, such as hammers and hatchets. The scarcity is the more remarkable from the fact that in other parts of the country pre-historic stone implements include a fairly large proportion of axes and hammers; indeed, Canon Greenwell does not believe it would be possible to find a parallel to it in any other part of Britain, at all events in so great a degree. Explanation he has none; it is not easy, he says, to understand "how a population which it might be supposed would require axes to cut down trees, adzes to work upon the wood, and hoes to break up the soil, equally with other people who appear to have lived under much the same conditions, were able to construct the essential requisites of domestic life, or to obtain some of the main products
of the soil, without such tools."* Professor Rolleston suggests that the paucity of axes and hatchets indicates that the Long Barrow people enjoyed the blessings of peace, and in support of this view he says there is an absence of evidence of cremation, reminding us also that Herman, the classical commentator, held that cremation was practised only or mostly out of necessity, such as wars or pestilence produce.†

Two other "finds" in the Middle Cotteswold area are also noteworthy. In a long barrow at Eyford, three miles from Stow-on-the-Wold, there was found a bead or amulet (apparently made of Kimmeridge slate) slightly oval in shape, much flattened, and with a large hole through its centre. This was found lying upon the breast of a skeleton of a woman, indicating that it was an ornament suspended from the neck when she was buried. Canon Greenwell records it as a remarkable and unique discovery.‡ Four years after the learned Canon's work was published, Mr Witts found in a long barrow at Notgrove a bead resembling the one found at Eyford, but larger.§

GENERAL CONCLUSION

The general conclusion to which we are led by the construction and contents of the long and round barrows, and by megalithic and ancient metal remains of human manufacture, is that in the Middle Cotteswold area, as in many other parts of the kingdom, there were in the Neanthropic age at least two successive races of men. The earlier race were of short stature, used implements

* "British Barrows," p. 444.


‡ "British Barrows," p. 519.

and weapons made only of flint, stone, and bone, and buried their dead by inhumation in long, horned-end barrows. The later race were taller and stronger, were acquainted with the use of metal as well as of stone, practised cremation, and disposed of the cremated remains beneath circular mounds of earth.

THE EVIDENCE OF HISTORY AND PLACE-NAMES

The knowledge thus obtained agrees with and is supplemented by the records of history. The long barrow men belonged to the Iberian race, which long ago inhabited a great part of Western Europe, and whose nearest modern representatives are the Basques of the Pyrenees. The round barrow men, to judge from their osseous remains and historical records, belonged to the great Celtic race which, starting from its home in the East, swept across the Southern part of the Continent, seized upon land in Spain and Gaul, and then landed in Britain. These Celtic invaders came in two swarms, and a considerable time elapsed between the two invasions. The earlier swarm were the Goidels; the later were the Brythons, from whom the name of our island is derived. Professor Rhys tells us that to the Goidelic race "belonged "the ancestors of the people who speak Gaelic in Ireland, "the Isle of Man, and the Highlands of the North;" and that the Brythonic group "is represented in points of "speech by the people of Wales, formerly one might have "added the Welsh of Cumbria, and till the last century "some of those of Cornwall."* The obvious inference is that the Goidels were pushed northward and westward by the Brythons, who were in turn driven in the same directions by a still later race.

Traces of the Celtic occupation of the Middle Cotteswolds are also to be found in place-names. A great deal

* "Celtic Britain," p. 3.
has been written about the origin of the word “Cotteswold.”
The explanation generally received is that given by Camden, that, to quote his words, “Cotteswold, which of
“wolds and cotes, that is, hils and sheepfolds tooke that
“name.” But, as Mr John Bellows once pithily said, to
imagine, as Camden does, that “cotes” is from sheeepcotes,
would require us to suppose that the hills were first
covered with sheep pasturage and then named. The fact
is that the word “Cotteswold” contains two synonymous
elements. “Cotes” is from the Celtic “coed,” “wold” is
from the Anglo-Saxon “weald;” and both words signify a
wood. Other local illustrations of Celtic names may be
found in Bredon, from “Bre,” a Celtic word for promon-
tory, and the suffix “down,” a common ending of the
names of the Severn Valley outliers, is probably a corrup-
tion of the Celtic word “dun,” a hill. As to river-names,
they, says Taylor, “are everywhere the memorials of the
“earliest races . . . . they seem to possess an
“almost indestructible vitality . . . . throughout
“the whole of England there is hardly a single river-name
“which is not Celtic.”

The Isbourne, the Chelt, the Coln, the Avon, are examples from the Middle Cottes-
wolds.

The completeness of the Saxon conquest of Gloucester-
shire doubtless abolished many Celtic place-names, and
drove off much Celtic speech. But, as Professor Rhys
says, “skulls are harder than consonants, and races lurk
“behind when languages slink away. The lineal descen-
dants of the Neolithic aborigines are ever among us,
“possibly even those of a still earlier race.”

Much ingenuity has been expended in endeavours to fix approxi-
mate dates for the order of the pre-historic invasions. In
the absence of trustworthy data, it is wise to act upon the

* “Words and Places,” p. 130.

† “Celtic Britain,” p. 275.
advice of the Duke of Argyll in reference to the first appearance of man upon the earth, and to content ourselves with the relation the order of invasions bears to time-relative rather than to time-absolute.*

THE ROMAN INVASION

It was in the middle of the first century that the Romans planted their feet upon the Middle Cotteswolds. What is now Cirencester was seized and fortified, and it is probable that the Roman rampart (a part of which still exists, and is known to every child in the town as "the city bank") followed the irregular oval line of the British entrenchment. A few years later we find the Romans occupying a chain of camps extending the whole length of the Cotteswold escarpment. Then onward for nearly four centuries the Middle Cotteswold area was occupied by a population under rigid Roman rule. The magnificence of the remains at Cirencester, and the pavements and other relics in villas like those at Chedworth, Spoonley, Wadfield, Dryhill, and Andoversford, attest a peaceful possession and cultured taste. But westward there were enemies against whom the hill-dwellers had constantly to be on their guard. The restless, warlike Silures were for a long period a source of danger. The great Roman stations of Caerwent and Caerleon were planted in Silurian territory; behind them was the strongly fortified colony of Gloucester; and behind that was, to use a famous phrase of a famous statesman, the "scientific frontier" of the Cotteswold escarpment. We know that the harassing nature of the constant conflict with the Silures hastened the death of Ostorius Scapula, by whom the escarpment camps were formed. We know that time after time, when it was supposed that their power had been broken, the Silures renewed the struggle with more

* "Primeval Man," p. 121.
or less of success. We know that when they had been conquered a strong hand was required to keep them in subjection, for they and other tribes living in the fastnesses of Wales offered a prolonged resistance, and were among the last to submit to the Imperial yoke of Rome.

ROMAN CAMPS AND ROADS

Prebendary Searth says that "when the Romans left the island they had formed a system of roads throughout its whole extent, even over its inaccessible mountains . . . . had constructed bridges, and made fords."* A glance at a map of the Cotswolds reveals large districts without Roman roads which were somewhat thickly populated in Roman times. Five great arterial roads converged at Cirencester; one of less importance can be traced from that town through Salperton and Hawling to Hailes; and the Ermine-street, which connected Cirencester with Gloucester, was continued (as the Via Julia) through the Forest of Dean to Caerwent and Caerleon. It is obvious that beyond these viae there must have been a considerable number of minor lines of communication, traces of which have altogether disappeared or can only be found by diligent and careful observation.

In endeavouring to add to the road map of the Middle Cotswolds in Roman times, we may get some help from the positions of camps and villas, the names or lines of ancient highways, and the existence of fords.

The camps at Birdlip, Crickley, Norbury (near Colesborne), Leckhampton, Dowdeswell, Cleeve, and Notting Hill must have had, in Roman times, easy means of communication, not only with each other, but also with the colonies of Corinium and Glevum, for, as Mr John Bellows has forcibly pointed out, rapidity of transport was the chief secret of Roman domination.

* "Roman Britain," p. 218.
The Roman Villa at Chedworth, which in the opinion of Mr Bellows was a government farm for the supply of horses to the posting stations,* and the important villa at Andoversford,† must also have been connected with arterial roads. From Cooper's Hill, running through Brockworth to Churchdown Hill, is a road still known by the name of Green-street; another road climbing the hill from Shurdington to Ullen Wood and across to the Seven Springs is called the Greenway: a third road termed Greenway-lane passes Battledown Knoll, on the eastern boundary of Cheltenham; and a fourth highway called Greenway follows a winding course from Andoversford to Norbury Camp, near Northleach. It is probable, as the Rev. S. E. Bartleet has suggested, that the name "Greenway" is a translation of the Roman designation "Via viridariensis."‡ From Seven Springs, skirting the side of Leckhampton Hill, and descending to Charlton Park is an ancient highway called Sandy-lane, a name which in some places is the modern name for a Roman way. In the little valley of the Churn, near Cowley, where an old road through Elkstone from the Ermine-street crosses the river, is Cockleford, a name which Mr Bellows suggests may be derived from a Welsh word signifying a ford in a hollow. In Cheltenham, a road to Bath, which is known to have existed in Saxon times, crosses the river Chelt at Sandford; and the probability that this name is a corruption of "sarn-ford," a paved-way ford, is strengthened by the presence of paving-stones in the bed of the stream beneath the bridge which carries the road. Andoversford, the site of the Roman station of Wycombe, probably derives its name from a ford

on the little river Coln, and may reasonably be identified with the Onnanford, near Withington, mentioned in ecclesiastical records of the eighth century, but which the Rev. C. S. Taylor, in an article on "Gloucestershire in the Eighth Century," says cannot now be traced. As further evidence that places whose names have the affix "ford" are upon ancient highways we have the fact that Fairford, Whelford, and Kempsford are joined by a road still called the Welsh Way.

**BRITISH TOWNS AND TRACKWAYS**

In endeavouring to ascertain what track-ways may have existed in the Mid-Cotteswold area before the coming of the Romans there are some considerations which are useful for guidance.

(1) "When the Britons," says Cæsar, "have fortified a thick wood with rampart and ditch, they call it a "town."† With such a definition, it does not require any stretch of the imagination to identify many of the Cotteswold camps as British towns. Cooper's Hill, with its double mound enclosing an area of about two hundred acres; Norbury (near Colesborne) with its area of six acres, defended by a single mound and ditch, and close to thick woods; Crickley, with its nine acres, protected on three sides by precipitous hills, and with a thick wood on the fourth side; Dowdeswell, with an even larger area, in the middle of thick woods; Cold Aston, whose entrenchments have disappeared under the plough, but in which a great number of flint arrow-heads have been found; Salmonsbury, in the parish of Bourton-on-the-Water, with a mound and ditch defending an area of sixty acres; Eubury Camp, in the village of Condicote,

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† Cæsar, "Gallic War," Book v.
near Stow-on-the-Wold, with an area of eight acres—all these camps are probably the sites of British towns, just as Cirencester to-day is the modern representative of the ancient town of the Boduni.

(2) Some of the escarpment camps bear evidence of successive British and Roman occupation. In the Nottingham Hill Camp, in 1863, Mr Witts records, during some excavations the original mound of the Britons and the superstructure erected by the Romans were laid bare.* The camp on Cleeve Hill was unquestionably occupied by the Romans, and it is probable that a long line of earthworks to the north of the camp was the boundary of a prehistoric settlement. On Leckhampton Hill there is a somewhat similar entrenchment outside the camp, and inside this area a large number of flint arrow-heads have been found; while the fact recorded by Buckman and Newmarch that in 1850 a true Roman well was still existing in the centre of the camp, is of itself sufficient evidence that the camp was occupied by the Romans.†

(3) Ancient British track-ways, says Prebendary Scarth, may be traced by their being "often worn into deep "hollows, especially near the camps and places of occupa-"tion."‡ The camps at Nottingham Hill, Cleeve Hill, Hewlett's Hill, Dowdeswell, and Leckhampton, are approached from the valley by roads sunk below the level of the adjoining land, in some cases to the depth of several feet. Whether the hollows are due to wear or to their having been so constructed to ease the gradient is an open question.

(4) Old maps of the county show that some roads now almost disused were formerly important highways. A

† "Roman Remains at Corinium," p. 5.
‡ "Roman Britain," p. 18.
map of Cheltenham and the vicinity a century ago, in the possession of our colleague Mr Vassar-Smith, notes two roads to London which even then had ceased to be so used. One was over Hewlett’s Hill, past the Hewlett’s Hill camp; the other was up Sandy-lane, on the eastern brow of Leckhampton Hill. Ogilby’s “Book of the Roads of England and Wales,” published in 1698, in describing the road from Gloucester to Coventry, tells the traveller, when he gets to Prestbury, to avoid the turning on the left to Southam, and to go “thro’ an irregular “Way over a Hill of 1M. by a Beacon on the Left, and “by Postlip on the Right”—to Winchcomb. Therefore two hundred years ago there was a regularly-used road over Cleeve Hill direct from Prestbury, instead of from Southam, and which crossed the common on the south side of the beacon or camp. These three roads, it is important to note, have for a considerable distance been worn into deep hollows.

(5) There are certain bye-roads which from construction or name or connection with ancient camps require to be connected with arterial highways. In addition to the roads from camps already mentioned, is a road running from Whittington past Cleeve Hill camp to Nottingham Hill camp, and another from Seven Springs past Norbury camp to Colesborne. There are also two short pieces of road which are somewhat remarkable. From Upper Dowdeswell to the village of Withington, there is a road nearly two miles long, which from its straightness and breadth is almost certain to be of Roman construction. A similar road, nearly three miles long, joins Eubury camp with the Cheltenham and Stow road two miles west of Stow-on-the-Wold.

If these camps and bye-roads are marked upon a map of the Middle Cotteswolds, it will readily be seen that three additional lengths of highway are required to bring them into common communication.
First, we want a road extending from the Ermine-street at Birdlip to the Foss Way at Stow-on-the-Wold. If we suppose the existing highway between these places to have been a British road, we may by following its course see that a number of bye-roads and camps are connected with it.

(a) The British town on Crickley Hill.
(b) The Greenway, from Churchdown, which crosses the Leckhampton-Birdlip road and runs through the grounds of Ullen Wood.
(c) Sandy-lane, from Cheltenham, and road from Norbury Camp (Colesborne).
(d) Two camps at Dowdeswell.
(e) The bye-road from Nottingham Hill and Cleeve camps.
(f) A small camp at Salperton.
(g) What, judging from its barrows, must in prehistoric times have been a populous district around Upper and Lower Swell.
(h) What is apparently a Roman road from Withington to Upper Dowdeswell.
(i) A probable Roman road from Eubury camp.

The last two roads should be specially noted. If they are of Roman construction, as they appear to be, the pre-existence of the Birdlip-Stow road is proved. Indeed, the only possible conclusion seems to be that one road was made by the Romans to connect the villas at Withington and Chedworth and the White Way with a British track-way at Andoversford; and that the other road was made to bring into connection with the same track-way the important camp at Eubury.

Secondly, we want a road crossing the valley from Leckhampton Hill to Cleeve Hill via Sandford Bridge, Cheltenham; for the Romans would assuredly have connected the camps on Leckhampton and Cleeve by a direct valley route as well as by the circuitous road past
Andoversford. Such a road we have in the disused Sandy-lane and a line of road (the Old Bath road, Hale's road, and Cemetery road) to Prestbury, which until recently was the boundary between Cheltenham and Charlton Kings; and from Prestbury to Cleeve Cloud there is the road described in Ogilby's book. Allusion has already been made to the probability that Sandy-lane and Sandford Bridge indicate a Roman way. To this evidence for place-names may be added that not only are there, as already mentioned, paving-stones in the bed of the stream at Sandford Bridge but that in the road climbing the Cleeve escarpment the edgings of a stone pavement may still be seen. From Sandford Bridge only a short length of road would be required for a connection with Greenway-lane and the track-way over Hewlett's Hill to Andoversford.

In connection with these two valley roads, reference should be made to a camp on the summit of Battledown. It is somewhat singular that this camp has never been included in the printed lists of Cotteswold camps. What its age may be is doubtful; but considering its size (about ten acres), the strength of its embankments, and its short distance from the camp on Hewlett's Hill, it was in all probability occupied in Roman times if not earlier. Commanding as it did two important track-ways at its base, it was not likely that the Romans would have left such a position open for occupation by their enemies.

Lastly, we want a road extending from the Seven Springs to Cirencester. There is an old track-way, a continuation of Sandy-lane, which runs past Norbury camp to Colesborne. From that village, and west of the present high road, which is quite a modern one, an old track-way passes Combend Roman villa, North Cerney camp, and the remarkable entrenchments at Bagendon, whence it continued to Cirencester along the valley of the Churn through Baunton and Stratton.
In his Annual Address to the Cotteswold Club just twenty years ago, Sir William Guise said: "The fact "forces itself upon us more and more every year, that we "are gradually ransacking every cranny and corner of the "district which is within our reach by road or rail within "the compass of a day's journey. It becomes, therefore, "increasingly difficult to arouse interest in mere locality, "and we must rely more and more upon the efforts of "members to work out minute facts of scientific interest "in their different localities.”*

It is in the spirit which ought to prompt a response to the appeal of our departed President that I venture to offer these notes “On the pre-Saxon occupation of the Middle Cotteswolds.” In the same spirit, may I ask for the co-operation of members of the Club in an endeavour to make a complete map of the old by-roads of the county, many of which were in constant use by drovers before the abolition of turnpikes, and are now practically discarded.

Map
To illustrate Paper
"On the Pre-Saxon Occupation of the Middle Cottewolds.

Scale—Half-inch to the Mile.
PROCEEDINGS
OF THE
Cotteswold Naturalists' FIELD CLUB
For 1896—1897

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The council of the club wish it to be distinctly understood that the authors alone are responsible for the facts and opinions contained in their respective papers.

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The President's Address at the Annual Meeting at Cheltenham, 1897.
Notes on the Geology and Glaciation of Norway. By CHARLES UPTON.
On the Archaeology of the Cowl Valley and Notes on the Welsh Way and Foss Way. By JOHN SAWYER.
The Manner in which the Domestic Animals and Plants have aided Civilization. By WINNINGTON-INGRAM.
Gloucestershire Rainfall. By A. S. HELPS, Hon. Sec.
Notes on the Earthquake of December 17th, 1896. By H. H. WINWOOD.
PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS'

FIELD CLUB

For 1896—1897

PRESIDENT

M. W. COLCHESTER-WEMYSS

HONORARY SECRETARY

A. S. HELPS

Vol. XII. Part II.

1897
The Annual Meeting of the Club was held on Monday, April 27th, at Cheltenham, in consequence of the serious outbreak of small-pox at Gloucester.

The Treasurer presented his financial statement and the following

RULES

were adopted for the Club:

1. — The Objects of the Club are to study the Natural History and Antiquities of the County and the adjacent districts.

2. — The Club shall consist of a President, Vice-Presidents (not exceeding seven in number), an Honorary Secretary and an Honorary Treasurer, and Honorary, Ordinary and Ex-officio Members. The number of Ordinary Members shall be limited to one hundred.

3. — Before anyone can be elected a Member he must be duly proposed and seconded at an Ordinary Meeting, and come up for ballot at a subsequent meeting; one black ball in ten to disqualify.

4. — The Entrance Fee shall be £1. The Annual Subscription of Ordinary Members shall be Fifteen Shillings, due in advance on the first day of January.
5.—Any Member in arrear with his subscription for the year is liable to removal from the list of members.

6.—No Member shall be entitled to a copy of the proceedings whose subscription is one year in arrear.

7.—The Club may admit a limited number of Honorary Members (see Rule 2), whose scientific work entitles them to the distinction, and who must be elected at the Annual Meeting.

8.—The Executive Council for the management of the Club shall consist of the President, Vice-Presidents, the Honorary Secretary and the Honorary Treasurer, all of whom shall retire at the Annual Meeting, but are eligible for re-election.

9.—The Annual Meeting shall be held in the early part of each year, at which meeting the President's Address shall be read, the financial statement of the Honorary Treasurer shall be presented, and the President, Vice-Presidents, Honorary Secretary and Honorary Treasurer shall be elected, and the dates and places of the Field Meetings be fixed; but the arrangements for the Winter Meetings shall be left to the Executive Council.

10.—The Club shall usually hold yearly four Field Meetings, and also four Winter Meetings for the reading and discussion of Papers. At the Field Meetings any Member may introduce one Visitor, and at the Winter Meetings more than one; and at the Winter Meetings the term "Visitor" may include ladies. Members must give due notice to the Honorary Secretary of their intention to be present at any Field Meeting, and should any Member, having given such notice fail to attend, he will be liable for his share of the expenses.

11.—The Council may at any time call a Special General Meeting of the Members. Upon the requisition of any eight Members being sent to the Honorary Secretary, a Special General Meeting shall be convened,
and any proposition to be submitted shall be stated in the notice. Not less than seven days' notice of any such General Meeting shall be given.

12. — The Club shall use its influence to promote the preservation of all antiquities and to prevent, as far as possible, the removal of scarce plants and the extermination of rare species of flora or fauna.

It will interest the members to know that on the 10th November last the Royal Geological Society of Cornwall awarded to Professor Etheridge, an honorary member of our Club, the Bolitho Medal. The honour was all the greater, as Professor Etheridge is the first recipient of the distinction.

Another member of our Club has recently been honoured by the Geological Society, Mr S. S. Buckman having received the award of the Murchison Fund for this year, chiefly in recognition of his researches in the Geology of the Cotteswolds.

This year being the Jubilee of the Club, it was decided to repeat, as far as possible, the programme of the first meeting of the Club, which was held at Birdlip on July 7th, 1846.

It was arranged that the Field Meetings of the year should be held at:

- Oxford
- Birdlip
- Awre and Westbury
- Bibury

During the winter papers were read by:

- Mr Chas. Upton on "Geological Notes on Norway."
- Mr John Sawyer on "The Archaeology of the Coln Valley and Notes on the Welsh Way and Foss Way."
- Mr Winnington-Ingram on "The Manner in which Domestic Animals and Plants have aided Civilization."
Mr Helps on "Gloucestershire Rainfall."
Mr Winwood on "Notes on the Earthquake of December 17th, 1896."

These papers, which all possess great interest, will be published in the forthcoming volume of Proceedings.

The first Field Meeting was held at Oxford on Thursday, 4th June, when the members assembled at the Oxford Station at noon. They were here met by Professor Green, who had kindly agreed to act as guide, thus materially contributing to the success and interest of the excursion. During the drive through Cowley to Wheatley several quarries were examined and their geology explained by Professor Green. After luncheon the members inspected some excellent photographs by Mr H. W. Taunt of Saxon skulls, complete skeletons, and various articles of Saxon handicraft which had been found on the site of a Saxon settlement about a mile to the east of the village. Two or three exposures of Kimmeridge Clay and a quarry of Coralline Oolite were inspected, and during a walk over Shotover Hill, strata of Iron Sand, White Quartz, Portland Sands, Kimmeridge Clay, and Coralline Oolite were successively examined.

A portion of the party then visited the Bodleian Library, where Mr F. Madan, the sub-librarian, kindly called attention to some of its treasures. The members then proceeded to Queen's College, where the College Plate was shown, many excellent examples of the silversmiths' art being the property of the College, including a curious silver trumpet of the time of Henry VIII., which was formerly used to summon the members to dinner, a custom still retained. Mr H. G. Madan most hospitably entertained the members with tea, and a most instructive and agreeable day was thus brought to a close.

The Jubilee Meeting of the Club was held on July 7th, and I am very much indebted to the Editor of the
“Cheltenham Examiner” for his kind permission to reproduce the following most admirable article entitled, “A Fifty Years’ Retrospect,” which was printed in that paper in giving a description of this meeting.

A FIFTY YEARS’ RETROSPECT

It was on Tuesday, the 7th July, 1846, that a few gentlemen met at the Black Horse Inn, at Birdlip, and founded the Cotteswold Naturalists’ Field Club. Yesterday week was the Jubilee of the Club, and to celebrate the auspicious event the Club again met at the Black Horse Inn, Birdlip. In one thing, at least, the half a hundred gentlemen who assembled did not follow the example of the founders of the Club. “They met for breakfast at eight o’clock,” says the minute book which records the first meeting. Most of those who attended the Jubilee meeting were content to meet at the G.W.R. station, Cheltenham, at 9.45, and be driven to Birdlip, via Leckhampton Hill and Crickley. En route, they visited the camp on Crickley Hill, and descended the precipitous escarpment to the “Devil’s Table,” and then they went to an exceedingly interesting quarry near the Air Balloon Inn, where some of the geological controversialists fully maintained the reputation of the Club for ding-dong argument upon knotty geological problems. Thence the party drove to Birdlip, where a luncheon fit for the veriest epicure fully satisfied appetites made keen by Cotteswold air. While at Birdlip Mr Wethered gave an excellent address on the chief geological features of the Cotteswold Club area, Mr S. S. Buckman discussed some of the problems yet awaiting solution, and Mr John Bellows dilated on the Roman occupation of Gloucestershire as typified by what could be seen in the far-reaching landscape spread around. From Birdlip the party drove to
the long barrow in West Wood, which Mr G. B. Witts had thoughtfully had partly uncovered, and of which he gave a lucid description. Thence to Buckholt, where the breaks were again left, for the party to descend the hill to the Roman Villa at Witcombe, to which the Rev W. Bazeley acted as guide. Thus in the day's programme three of the chief subjects discussed by the Club were kept in view—geological, prehistoric, and Roman remains. And as the Jubilee of the Club offers a fitting opportunity, it may be of interest if we take a retrospect of the progress made in the subjects alluded to during the fifty years that the Club has been in existence.

GEOLOGICAL

When the Club met for the first time the interest taken in geology was increasing. The geological survey of the United Kingdom had just been formed into a separate department of the Civil Service, and the Geological Society, which was formed in 1807, was just beginning a record of great advance in geological research. In those days there were few professional geologists, and the work of tracing out the history of our planet from the record of the rocks was chiefly done by amateurs, for whom the study had a great fascination. Among the geologists who have from time to time done excellent geological work are several members of the Cotteswold Club who have attained considerable eminence, and whose works will live in the annals of geology. Lycett, Wright, Buckman (father and son), Witchell, Lucy, Guise, Etheridge, Smithe, John Jones, Strickland, Brodie, Tomes, Symonds, Wethered, and others, have done work which has made their names famous far beyond the circles of the Cottswold Club.

Early in the present century William Smith, the “Father of Geology,” astonished the world by showing
that rocks may be identified by the fossils they contain, and on this basis he, in 1815, published a map of the strata of England and Wales. The correctness of his system of classification has never been shaken, and is now adopted throughout the world. For twenty years after Smith's work was published, the rocks of May Hill, a well-known Gloucestershire landmark, were given the vague name of "Transition Rocks," the belief being that they represented a period of the world's history which was transitional between the time when rocks were laid down all over the globe by chemical precipitation (a theory, however, now proved to be in error), from a hot ocean, and a time when conditions more like the present existed. Sir R. Murchison had doubts about this so-called "transition period," and he undertook, with the help of Professor Sedgwick, to examine this great mass of rocks with a view to their classification. In this he was entirely successful, and he added another clearly defined epoch to the geological succession of strata, and one, too, especially interesting because of its great antiquity. As a name for these rocks, Murchison selected the word Silurian, after the name of the brave tribe which at one time occupied the whole area of Gloucestershire, Monmouthshire and South Wales lying to the west of the Severn; and the name is now adopted for all rocks of similar age the world over. Little did Caractacus imagine that the name of his tribe would be handed down to posterity by the name given to some of the rocks of the land over which they contested with such determination the advance of the Romans. Though the Silurian rocks were named before the Cotteswold Club was formed, yet the working out of details of the various sub-divisions has been chiefly done since, and many have been the interesting days spent by the Cotteswold Club in the study of the Silurian rocks at May Hill and other parts of the county.
During the last fifty years there has been considerable discussion as to the origin of coal, and several papers on this subject have appeared in the Club's Proceedings. The vegetable origin of coal is, of course, established without doubt, but the nature of this vegetation is not even now accurately ascertained. For some years coal seams were supposed to have originated from the submergence of forests, but more recent research seems to point to aquatic vegetation, more in the nature of bogs than forests.

With the Coal Period the Palæozoic series of rocks come to an end, and this end was brought about by physical disturbance on a very grand scale. Instead of there being a continuous series of horizontal beds deposited one over the other in regular sequence, the Palæozoic system of rocks became tilted up, and it was not till after a long lapse of time that these forces subsided and the process of rock building continued. The débris which formed the Permian and Trias systems was then deposited over the upturned edges of the Palæozoic rocks. As to what went on during this great interval we are but little better informed than we were 50 years ago. All we know is that when the forces of disturbance ceased a new order of things was introduced with the advent of the Secondary Period. Most of the life of Palæozoic days had disappeared, and new forms appeared in the Permian and Trias rocks, which lie at the base of the Secondary series, this life including Marsupials, Mammalia, and numerous Reptilia, and among the latter is the Thecodonto-saurus discovered in the Keuper beds near Bristol.

Resting on the uppermost beds of the Trias are a very interesting series of strata which have been the subject of much discussion at the Club meetings, the question in dispute being to define where the Trias system ends and
the Lias begins. These beds are now included under the term Rhætic, as they are doubtless the representation in time of strata in the Rhætic Alps of Lombardy. The determination of these beds in this country is mostly due to the researches of four members of the Cotteswold Club—Dr Wright, Mr C. Moore, Mr Etheridge, and the Rev P. B. Brodie. In England these rocks may be regarded as representing a period of transition, during which the fauna of the Trias died out, and that of the Lias came into existence, and in this sense they are passage beds.

At the top of the Upper Lias we come to beds which are still in dispute, the problem being to determine where the Lias ends and the Oolites begin. After a discussion for 50 years, the advocates of drawing a hard and fast line between these systems appear to be still at variance as to where this line should be drawn. Probably it is impossible to do so, for, as Professor Phillips has well observed, "before the Liassic life had come to an end, the Oolitic had begun." This question of passage beds is a question of more than local interest, owing to strata of this character becoming generally recognised between most systems of rocks.

This passage of life from one system of rocks to the one above was a subject of controversy when the Club was inaugurated, the dispute being between the advocates of Catastrophism and Uniformity. The former taught that at the close of each geological formation a catastrophe occurred which put an end to the living creatures and vegetation, and that in the succeeding formation there was a fresh creation. The doctrine of Uniformity, with which the name of Sir Charles Lyell will ever be associated, taught the principle that there had been a regular and uninterrupted sequence of geological phenomena, and that the vast changes which have taken place in former
periods have been the result of the slow and ceaseless working of ordinary physical forces; further, that the life of one period was the progenitor of the life which appeared in the succeeding formation. Within the last fifty years the theory of Catastrophy has been shown to be erroneous, and that of Uniformity generally accepted.

One of the greatest geological discoveries of the last fifty years is associated with the name of Mr. E. Wethered, a vice-president of the Club and a former secretary. The Oolitic rocks were until a few years ago looked upon as of mineral origin, the small grains being supposed to have been formed by layers of lime gathering round a tiny nucleus. By microscopic examination, Mr. Wethered has demonstrated that instead of being of mineral origin, the Oolitic grains are organic in structure, and were formed by the tubules of a very low form of life, to which the name "Girvanella" has been given. Had the Cotteswold Club done nothing else of importance, it might rest its geological fame upon the work of Mr. Wethered. But the work also done by Mr. Lucy in connection with the Glacial Epoch as it affected the Cotteswolds, by Professor Etheridge and Mr. Taunton relative to the hydrology of the Cotteswold area, by Mr. Hoskold upon the coal-bearing strata of Dean Forest, and by other members on other branches of geological science, have placed the Cotteswold Club in the front rank of scientific societies in the kingdom.

PREHISTORIC MEN

The progress made in our knowledge of our prehistoric ancestors since the Cotteswold Club was founded has been enormous. Fifty years ago, indeed, scarcely any attempt had been made to classify the evidences of prehistoric occupation afforded by burial mounds, flint and stone implements scattered over the surface of the soil,
worked flints beneath stalagmitic floors in caves, and signs of man’s handiwork buried beneath accumulations of gravel. To-day the chaotic mass has been reduced to order, and ethnologists have from it written the story of early men in Britain. When the Romans landed on our shores they were opposed by natives who apparently for a long time had used weapons and domestic articles made of iron and bronze. The Cotteswold dwellers were a Celtic tribe called the Boduni (Bo, to dwell; dun, a hill—literally, “hill-dwellers”). They belonged to the great Celtic race which, in two swarms—the earlier the Goidelic, the later the Brythonic—started from their home in the East, swept across the southern part of the Continent, seized upon land in Spain and Gaul, and then landed in Britain. Their voice is no longer heard in the land; but, as Professor Rhys, author of “Celtic Britain,” says, “skulls are harder than consonants, and races lurk behind when languages slink away;” and in circular burial mounds like those at Leckhampton, Crickley, Birdlip, and elsewhere are the bones of the race which had occupied Gloucestershire long before they had to bend to the stern yoke of their Roman conquerers. But other burial mounds tell of an earlier race than the Celts. Tall, square-built, muscular, not pleasant in face, were the people whose skeletons are found in the circular-shaped tumuli, and the shape of their burial places was very nearly the shape of their heads. In the long “tumps,” on the other hand, barrows like those in West Wood and on Shurdington Hill, and, best preserved of all, that which crowns the height of Uley Bury, we have the remains of an Iberian race, short of stature, long in head, and pleasant of countenance. Metal was to them unknown, save that they may have recognised that bits of stone with glistening grains or surface were particularly useful, because heavy, when with sling and stone they
hunted their prey or defended their homes. Arrowheads, knives, scrapers, saws, borers were made of flint, beautifully shaped adzes and hammers were of stone, and lighter articles such as needles and pins were constructed of bone. For how long these men dwelt in Gloucestershire no man knows. Whence they came and whither they went no man can tell.

But early as these Iberian stone and flint-using folk were, investigations made during the last fifty years, and particularly during the last twenty years, show that there were other races far earlier. In two caves on the banks of the Wye, and in a cavern near Lydney, remains of man have been found covered by beds of earth, gravel and stalagmite. The thickness of the beds of stalagmite indicates the dropping of lime-charged water from the cavern roof during a very long period, and it is difficult to avoid the conclusion that the beds of earth and gravel were swept in by streams which once flowed at the same level as the cavern floor—a level far above that at which the nearest streams now flow. In many caves the bones of extinct animals are associated with human remains, thus placing the great antiquity of the cave dwellers beyond any reasonable doubt. Even cave men, however, were not the earliest Gloucestershire men. It is now about fifty years since a French scientist found some worked flints in a gravel bed many feet below the surface of the soil. His theory that these flints were the remains of men who lived when the gravel was deposited was at first received with incredulity. In the course of a few years worked flints were found under similar conditions in other parts of Europe, and then men began to search for them in England. The gravels in the valley of the Thames speedily revealed evidence of man's existence when the gravels were laid down, and similar evidence is forthcoming from the valley of the Severn. The general
conclusion from these discoveries is that men roamed over Gloucestershire, hunting for animals now extinct, with weapons of flint and stone, at a time when the Severn Valley as we know it had not been scooped out, and the North Sea and English Channel did not exist. Following them came the men whose remains are found in caves, then the Iberians who were buried in long barrows, and then the Celtic race, whose remains are interred in round barrows, and who peopled Britain when Julius Caesar landed upon our shores.

In the working out of these problems of the prehistoric period, the Cotteswold Club has taken a prominent part. To the late Rev W. S. Symonds, rector of Pendock, belongs the honour of having discovered undoubted relics of man in King Arthur's Cave and Bannerman's Hole, on the banks of the Wye, and thus made a valuable and corroborative contribution to our knowledge of men of the Cave period. The well-preserved long barrow near Birdlip was found by Mr G. B. Witts, and in opening and describing it he had the invaluable help and guidance of Professor Rolleston, one of the greatest authorities on the subject. A long barrow at Nymphsfield was opened by the late Professor Buckman, and the Club also undertook the cost of opening barrows in other parts of the county. The ancient camps on the Cotteswolds were carefully surveyed and mapped by Mr G. F. Playne, who also was the first to discover pit-dwellings on the commons above Stroud, and the value of which Professor Rolleston was one of the first to recognise.

THE ROMAN OCCUPATION

When the complete story of the Roman occupation of Gloucestershire is written, the work done and recorded by members of the Cotteswold Club will occupy a large space. Fifty years ago our knowledge of the Romans in
this county was confined to a few arterial roads and villas, and some remains brought to light at Gloucester and Cirencester. Thanks to the researches of the last twenty or thirty years, and the vast amount of Roman relics brought to light, we can now in imagination see the march of Vespasian and his followers over the Cotswolds, the capture and occupation of Cirencester, the construction—mainly by adaptation of existing defences—of a series of camps along the Cotswold escarpment, the settlement all over the plateau, and then the building of a camp (which afterwards became a colony) at Gloucester as part of the forward movement against the Silures on the Western side of the Severn. Evidence has come to light, too, which shows the dates and other details of much of the Roman work. We know that it was in the first century that the Roman engineers constructed the splendid fortress of Gloucester, and made the road which, straight as an arrow flies, connects the city with the Roman posting station at Birdlip. We know that, advancing from Gloucester, they made a road, known as the Via Julia, through Dean Forest to beyond Chepstow, where tall, strong, green-covered walls still mark the site of the Roman camp at Caerwent. We know that, still advancing, the Roman road was carried to near Newport, and that at Caerleon a camp was constructed which was an exact replica of Gloucester. We know that the engineers and soldiers who did all this work belonged to the Second Augustan legion. We know that the villas at Chedworth, Witcombe, and Wycombe (Andoversford) were Government farms for the breeding of horses for the Government service, and the details given by Roman historians as to the civil and military administration enable us to draw a fairly complete and accurate picture of what Gloucestershire was during the first four centuries of the Christian era.
Several members of the Cotteswold Club have done much to increase our knowledge of the Roman occupation, but head and shoulders above all is Mr John Bellows, of Gloucester. He it was who not only discovered but completely traced the walls of Glevum; it was he who found and tracked the road from Gloucester to Caerwent and Caerleon; and no man, hardly excepting Prebendary Scarth, knows more than he does of the details of the coming, the stay, and the going of the Power which for nearly four centuries ruled the island of Britain.

In a short address the President of the Club glanced at the general character of the work it had done, and expressed a hope that the next fifty years will see the Club maintain its present high position. If the spirit of enquiry after truth which has animated its members be continued, a solid record of progress will mark the centenary of the Cotteswold Naturalists' Field Club.

The third field meeting was held on August 7th, when the party assembled at Newnham, and drove thence to Awre, where the architectural features of the church were explained by Mr Waller. The members examined the curious old muniment chest, on the top of which in old days the bodies of those found drowned in the Severn were placed; and the Register, complete from the year 1538. The tide was too high to allow of an inspection of the interesting Liassic beds which are exposed at low water in the bed of the river. The drive was then resumed through Blakeney to Soudley, where there exists in good preservation a small Roman Camp in a commanding position close to the Via Julia. Most of the members then climbed the Hill to the Blaize Bailey and walked thence to Littledean, enjoying one of the most lovely and extended views in the Forest of Dean. They passed an old house called the "Temple," about which Mr John Bellows made some remarks, saying that he was of opinion that the Severn at Newnham was the scene of the most important battle the Romans ever fought in Britain; that the site of "the Temple" commands this battle field from the summit of the hill above, and that no less than four Roman roads are known to cross at the same spot. After luncheon at Littledean, the members proceeded to Gunns Mills along the Roman road, on which the bordering stones can still be very clearly traced, passed Flaxley Abbey, examined, close to the schools, an interesting Upper Ludlow Quarry, and thence drove to Westbury, where the Vicar kindly acted as guide to the church. A visit was then paid to the celebrated Garden Cliff, the geological features of which were explained by Mr Wethered. The party then honoured the President with a visit to Westbury Court, and returned thence in the carriages to Newnham.
The last Field Meeting of the season was held on Thursday, September 3rd, when for the first time the Club paid a visit to Bibury. Driving from Cirencester past the junction of the Foss Way and Ikenild Street, the Quarry of Forest Marble at Barnsley was examined and described by Mr Buckman and Mr Wethered. The interesting Camp at Ablington was visited, which has an area of some nine acres, and was probably the site of a permanent settlement in very ancient times. Hence a member of the Club led the party over Lady Hill, pointing out a long low mound with a shallow ditch outside it, which is believed to be the vestige of an ancient Rampart. Near Bibury Court Mr Sawyer pointed out the site of a Roman villa which was accidentally discovered some years ago, and which has never yet been excavated. Since the Club visited this spot I have been informed that the chief obstacle which hitherto has interfered with the exploration of this villa has been removed, and I should like to suggest that we communicate with the Bristol and Gloucester Archaeological Society with a view to jointly carrying out a complete examination of the site. A visit was paid to Bibury Court, by kind permission of the occupier, Mr Cooper. Mr Waller then conducted the party to the church, which, he explained, contained wo. 1 which, if not Saxon, is very early Norman. After an excellent luncheon at the Swan Hotel, the famous Bibury spring was examined, from which perpetually flows an immense volume of beautifully clear water.

During the afternoon three objects of special archaeological interest were examined. On the edge of Lambrough Bank Covert is a long barrow, which Mr G. B. Witts, in his Archaeological Handbook of Gloucestershire, says differs from other barrows in the county in being surrounded by a double wall of masonry, each having a face outwards, the space between the walls being filled
with rubble. It was opened about forty years ago, and found to have the horned end so characteristic of long barrows all over the kingdom, and in the middle of the curve between the ends stood a stone about 6 feet square. At the north end was a chamber made of rough stones, in which human bones were found.

Another structure visited by the Club is of great interest. It is an underground chamber, constructed entirely of stone with dome-shaped roof. The diameter of the chamber is about six feet, and it has an entrance about two feet wide. A few stones on the crown have been removed, but otherwise the structure is in an excellent state of preservation. Locally it is known as a shepherd's hut, but whatever it was it can never have been built by or for shepherds. Canon Greenwell has described two very similar structures, both at Nether Swell. As to their antiquity he has no doubt whatever, and he inclines to the belief that they were used for interments, and belonged to a transition period, when the long-chambered barrow was being replaced by the round tumulus for purposes of burial.

About half a mile away is a barrow about 100 feet long and 40 feet wide, which has the appearance of a round barrow 40 feet in diameter, with a low mound some 60 feet long extending on its northern side. This extended mound had been dug into, but the loftier circular portion had not been disturbed until it was recently opened by Mr Sawyer. Digging downwards from the highest part of the mound, he found that its central portion, about 10 feet in diameter, was composed entirely of stones, arranged carefully from the centre, from which they had a slight tilt. All the rest of the mound is of rubble. About two feet east of the centre, and on the natural surface of the ground, was a cist about 2 feet square and 9 inches deep, containing phosphate of lime and dirt. The inference is
that a body had been cremated, the bones and dust placed in the cist, and then the huge mound built over it.

Returning to the village of Ablington, a short visit was paid to the Manor House, where Mrs Gibbs kindly invited the party to afternoon tea. The house is a good specimen of sixteenth century architecture.

Appended is a short report on the Society's Library:—
It will be within the recollection of the members that an arrangement was authorised at the last General Meeting, under which a large and very suitable and convenient room on the premises of Mr J. Bellows in Eastgate street, Gloucester, was rented jointly by the Cotteswold Club and the Bristol and Gloucestershire Archaeological Society, for the purposes of a library, reading room, and meeting room for committees.

The tenancy commenced in June, 1896, and a bookcase was then placed in the room for the reception of the "literature" of the Club. This, which consists chiefly of periodicals and reports sent by other societies and institutions in exchange for copies of the Proceedings of the Club, had hitherto been very kindly kept by Mr Lucy at his office in the Docks. The whole of it, including a large number of surplus copies of the "Proceedings," has been transferred to the new bookcase, and a careful inventory has been made of it. About 30 copies of each of the first three volumes of the "Proceedings" have been collected from the loose sheets and stitched in paper covers, ready for issue to any members who desire to have them or other back volumes.

A few articles of furniture, the cost of which has been shared by the Bristol and Gloucestershire Archaeological Society, have been purchased for the room, which has, since September last, been open every Tuesday afternoon for the convenience of members, very few of whom, however, have availed themselves of it.
It is proposed to continue the same arrangement, in conjunction with the Bristol and Gloucestershire Archaeological Society, at any rate, for another year, viz., until June, 1898.

It may be as well to mention that the rent of the room, viz., £12 per annum, and the other expenses of maintenance, have for the past year been divided equally between the two Societies; but since it is found that the Archaeological Society takes the largest share both of space in, and use of, the room, it is proposed that for the coming year the Society should pay two-thirds, and the Cotteswold Club one-third of the expenses. There is every reason to believe that this arrangement will be accepted as a fair one by the Archaeological Society.
NOTES ON THE GEOLOGY AND
GLACIATION OF NORWAY

BY
CHARLES UPTON

One of the first things which strikes a stranger with geological instincts on first visiting Norway, is the almost entire absence of plains and gently undulating country such as we are accustomed to see in England. There are no Secondary Rocks such as give rise to our rolling chalk downs, our rounded Cotteswolds, or our level stretches of country occupied by clays of the Lias and Trias.

Metamorphic Rocks—Gneiss, Mica-schist and the like—occupy the greater part of the country, and these (as is usually the case) are very much dislocated and contorted. The pressure to which the Rocks have been subjected has been so extreme that the included "eyes" have in many cases been drawn out into mere threads and laminae.

As one steams along the coast from South to North, one sees nothing but an almost continuous succession of rugged cliffs, sometimes of stupendous height, as in the case of Hornelen, a sheer cliff of about 3000 feet in height, rising straight up from the water's edge.

From Stavanger northwards to about the Nordfjord, the rocks have the massive rounded appearance of granite: they are, however, a very highly metamorphosed Gneiss, as a rule of no very great elevation. From thence right
up to the North Cape, and for some distance to the Eastward of that point, the mountains which fringe the coast are, generally speaking, loftier and of more rugged outline, almost the only breaks in the line of cliffs being the entrances to the numerous Fjords and the lesser valleys at the mouths of the rivers.

To the north of Trondhjem the rocks appear to be somewhat less altered, consisting mainly of Schists, frequently showing the original lines of stratification very plainly. About three hours steam north of the entrance to the Trondhjem Fjord, is a magnificent range of cliffs of all shades of red, yellow and brown, with occasional white bands. Lit up by the evening sun, as I saw them, these cliffs are a truly gorgeous spectacle, the recollection of which is not easily effaced. These Red Rocks have been referred to the old Red Sandstone, but this suggestion is, I believe, not generally accepted, and in the absence of fossil evidence their age must be considered not proven.

Further north the rocks are for the most part of Schistose character, gradually getting finer in texture until at the North Cape itself they are more of the nature of a dark grey clay slate than true Schists.

From Bodø northwards, to some 40 to 50 miles beyond Tromsø, the disturbance and dislocation has been tremendous, and this, together with the action of the frost on the splinterly Schists, has given rise to some of the grandest scenery possible. For some 200 miles or more the Lofoten Islands, the islands of Hindö and Senjen, the islands in the neighbourhood of Tromsø, and the peninsula behind which lies the Lyngen Fjord, present one continuous succession of lofty mountains with sharp jagged tops and equally sharp valleys between, many of the valleys and mountain sides being occupied by glaciers of no mean dimensions, affording
altogether, in my opinion, the grandest scenery of the whole Norwegian Coast.

Eastwards, from the North Cape, the character of the rocks changes, gradually growing less rugged and stern until at Vadsö, on the North shore of the Varanger Fjord, the shore line consists of low level cliffs composed of black muddy shales. Here, too, the general appearance of the country is very different. Instead of lofty rugged mountains we have comparatively low ridge-like hills, with smooth outlines, rising one behind the other.

On the South shore of the Varanger Fjord the mountains, which consist of Gneiss, are considerably more rugged in outline than the stratified rocks of the Northern shore, but not so lofty as those further south. So far as could be judged from a distant view, these rocks were highly metamorphosed.

In one or two places rocks of Silurian Age have been detected along the West Coast, but the area occupied by them is comparatively insignificant.

Such is a very brief outline of the physical geology of the country as seen from the deck of a steamer.

It is stated in all text Books on Geology that the southern portion of Scandinavia is sinking, whilst the northern portion is being elevated, and, naturally, I was on the look out for evidence in confirmation of that assertion. Such evidence I found in plenty. From the Romsdal northwards, almost without exception, every Fjord and sheltered cove is occupied by raised beaches or terraces, occasionally of very considerable extent. All the towns and villages are built upon them, and, indeed, were it not for such terraces it would be almost impossible for the inhabitants to exist, as they constitute almost the only land capable of cultivation. All along the shores for scores of miles, from the Lofoten Islands until the open sea is again reached north of Tromsö, terraces are most
apparent, as level as the sea itself, looking very like railway embankments, while in many of the Fjords terrace rises behind terrace to a height in many instances of several hundred feet.

The materials of which the terraces are formed varies, as it might naturally be supposed, according to the materials which the sea had to act upon, and the circumstances under which they were deposited, in some instances consisting of pebbles and shingle, ranging from huge boulders weighing many cwts. each, down to fine gravel; in others, as in the Romsdal, being composed almost entirely of sand; again, in other places being mainly constituted of clayey material, and not infrequently of shells and shell sand. Where the shore is steep and exposed to the open sea, usually there is but little evidence of terracing, but occasionally more or less obscure notchings in the cliffs could be seen. Two reasons may be assigned for this—1st. the violent action of the water would tend to keep all portable material below high tide mark, and, as the elevation of the land, though relatively rapid at times, was nevertheless very gradual, the sea had ample time to work upon the incoherent material which in more sheltered spots would have been left where it was deposited; 2nd, the accumulation of débris from the crumbling of the cliffs would obscure any such narrow terraces as the sea might have left. On the other hand, in the Fjords and sheltered coves terraces are almost invariably found.

The city of Trondhjem stands on a terrace of sand far up in the Fjord of the same name, formed, so far as one could judge from a very hasty survey, in the manner indicated, but moulded, so to speak, by the river which winds around the city.

In the Romsdal the terraces could be plainly seen for many miles up the valley, extending right up to and beyond
the very base of the mighty Romsdalshorn itself. The terraces here are composed almost exclusively of sand. I do not know the height to which they extend, but it must be very considerable, as the road ascends almost continuously from Andalsnaes. The number of perfectly well defined terraces is very great, too many to be easily counted, and as they extend entirely across the valley, the quantity of sand accumulated is prodigious.

The town of Bodø stands on a raised beach of an entirely different character. The valley in which the town is situated is of considerable size. Behind the town, and between it and the mountains which rise inland, there lies a level plain, the greater portion of which is at the present day occupied by a peat bog resting upon a substratum of stiff dark blue clay. All along the sea margin there is a ridge having an elevation of about 80 to 90 feet, composed of similar blue clay, with a considerable number of well rounded boulders embedded in it, and upon the top of this there rests a bed of regularly stratified shell sand, varying in thickness from one up to several feet, containing vast numbers of the shells of Mya truncata. Most of the shells are entire, and in very many instances the pairs were lying in contact. It appears probable, however, that the shells were washed up, as none were observed in crypts, and all were lying on their sides, although from their perfect condition they could only have been transported a very short distance, and by comparatively tranquil water. Overlying the shell bed is a bed of peat of about 9 inches in thickness. The width of this ridge was variable, probably a quarter of a mile at its widest part, and upon it the town stands. Circumstances favoured observation, as extensive drainage works were in progress, and consequently a number of excellent sections were open for inspection. In this connection a feature of some interest observed at Bodø
may be mentioned. For a considerable distance along the foreshore on the sheltered side of the bay there runs a ridge of boulders just about the line of high tide mark at ordinary tides. Being somewhat conspicuous and unusual, one naturally desired to know how they came there. The action of the water alone is clearly insufficient to account for their presence, and there is no obvious reason why they should have been placed there by man. The only tenable hypothesis is that they were pushed up by the action of floating ice.

It is a well known fact that in severe winters ice forms along the shore in shallow places to a considerable thickness, picking up boulders from the bottom. On the ice breaking up, it drifts through the action of the wind and tide, into the more sheltered bays, where it becomes stranded and eventually deposits its burden of boulders. These in time are pushed up further and further by subsequently formed ice, and ultimately form a ridge at the highest point reached by the drift ice.

Amongst and on the land side of this row of boulders a blue clayey deposit is accumulating, very similar to that underlying the town and forming the substratum of the peat bog, and the inference is irresistible that the line of boulders seen along the foreshore is merely a repetition of the action which has been going on for a very considerable period; that the ridge is nothing less, in fact, than the commencement or foundation of another terrace.

Tromsö, like Bodö, is built upon a raised beach. It stands on the west side of a narrow channel, through which runs a very strong current. Owing to local causes, the swift portion of the stream is on the side of the strait farthest from the town, whilst near the shore on the town side there is practically no current. The subsoil consists of Blue Clay with a few boulders, not materially different in appearance from that underlying Bodö, and, as in that
case, capped by a bed of very fine shell sand, only of much greater extent and thickness. One section was observed where upwards of 5 feet of the shell gravel was exposed without showing the base. The species of shells are also much more numerous, and a very large proportion are entire. A similar deposit appears to be in course of formation along the shore at the present day.

Another instance of a town similarly situated is that of Hammerfest, but the circumstances here are somewhat different and peculiar. The town is built at the head of an almost circular bay, perfectly sheltered from the violence of the open sea, but having apparently a circular current which enters from the south-west, sweeping along the north shore, and which, but for the circumstance to be next noticed, would make the entire circuit of the bay. At the north-eastern extremity of the bay, and immediately to the north of the town, is a stream of sufficient volume to deflect the current, causing it to take a course towards the centre of the bay. Immediately to the south of where the two streams unite, there juts out into the water a somewhat triangular shaped terrace, and on this the main portion of the town stands, and it is doubtless owing to a very large extent to the joint action of the two streams that this terrace owes its existence.

Immediately behind the town to the north-east is a long narrow valley occupied by a lake of perhaps a mile in length. The waters of the lake are held up by a ridge of Glacial Boulder Drift extending right across the entrance to the valley, except for one small breach through which the river water escapes into the sea. This in itself would not appear very remarkable, but the feature which causes it to be of more than usual interest is that this particular dam has been levelled at the top by the same agency which deposited the material of the terrace just mentioned, and to exactly the same height as the uppermost
terrace on which part of the town stands, and it would appear that the moraine was formed beneath the waters of the bay before the land was elevated to its present position, being, in fact, a fine example of a subaqueous moraine. The top of the terrace and dam would be from 80 to 90 feet above the sea level.

The best opportunity of studying raised beaches in detail was afforded during the stay at Vadsø. The town itself, unlike most of those passed on the voyage thither, is not situated upon a raised beach. Stretching from the town eastwards is a range of low cliffs seldom more than 25 to 30 feet in height, consisting of black shales, looking very tempting to the hammer, but wofully disappointing on investigation, for although they were examined with very considerable care for some miles by two companions and myself, we were unable to discover the slightest vestige of an organism. The age is unknown, though probably of earlier date than the Trias. Towards the west the shale is obscured by recent shingle, and about two miles west of the harbour there stands out a promontory of Schistose or Gneissic Rock, against which abuts a series of raised beaches. This promontory, with a range of ancient cliffs extending inland from it, evidently once formed the shore line. Immediately behind the town is a ridge of old beach, the top being about 90 feet above sea level, then comes a bog of considerable extent, and beyond this a grand series of terraces. I cannot say how many distinct terraces might be counted, but probably not fewer than thirty. The height of several of the most important were noted, four of them being respectively 227, 232, 240 and 285 feet above sea level, the last being, so far as my observation went, the highest. The height of the first range of hills in the rear of Vadsø is about 400 feet, but I am disposed to think that an examination of the loftier hills further inland would disclose
2. RAISED BEACH AT VADSO WITH ICE BORNE Boulders AND ANCIENT CLIFFS (BEACH 240 FEET ABOVE PRESENT SEA LEVEL)
terraces of greater altitude. As, however, there are no roads except along the shore, and the natural features of the country making walking very laborious, I was unable to investigate the matter further in that direction. I was, however, fortunate enough to be able to extend my investigations up to the head of the Varanger Fjord, and from thence right across the low-lying country lying between it and the Tana River, altogether somewhere about 35 miles. Over the whole of that area the same series of terraces is persistent, and it is quite obvious that at no very great distance of time, geologically speaking, the peninsula lying to the eastward of the Tana River, and to the north of the Varanger Fjord, on which the towns of Vadsø and Vardø stand, was an island.

Just above the Lapp village of Karlbotn, which lies at the southern head of the Varanger Fjord, there exists a very interesting feature in connection with these terraces. To the left of the village, looking from the Fjord, is a magnificent array of terraces, looking, at a distance, like an enormous amphitheatre, with tier rising behind tier in the most perfect manner. On the opposite side is a corresponding series. The terraces for about the lower half of the series extend continuously from one side of the village to the other, but at about half way up, and almost immediately behind the village, there is a break in the continuity, and the breach gets gradually wider and wider with each succeeding terrace, until when the uppermost is reached the interval is very considerable. The appearance is very striking, looking somewhat like huge stairs.

Standing on the uppermost of a series of terraces forming a kind of promontory immediately behind the Lapp settlement of Bigganjargga, the view was very striking. Immediately in front lay a step-like arrangement of these old beaches, extending almost down to the water of
the Fjord, and on the opposite side of the Fjord, from
the extreme left of the range of vision, all along the shore,
passing Karlbotn and right away to the valley of the Tana
River for many miles, there is an almost continuous
range of terraces, broken only here and there by the more
precipitous mountain spurs, constituting probably as fine
a panorama of ancient beaches as it would be possible to
see.

In the neighbourhood of Vadsö each of the more
prominent terraces is bordered on the land side by a
range of low cliffs, having precisely the appearance of the
cliffs against which the sea now washes lower down, and
it is perfectly easy to estimate the force of the waves
which once played against them. In places where the
wave action was but slight, the shales are merely sub-
angular slabs, piled up precisely as may be seen on any
beach where the rocks are flaggy or shaly, whilst towards
the west of the town, where the water must have exerted
greater force, the pebbles are perfectly rounded, and the
rocks against which they lie smoothed and worn away by
the continuous pounding of the pebbles. There were
many small potholes or giants kettles in the rocks, in a
few instances having the original pebbles remaining in
them.

The 240 foot terrace was perhaps the most extensive,
having a width in places of 40 to 50 yards, and this was
remarkable in another way. All along for miles it was
strewn with thoroughly well-rounded boulders, many of
them of huge dimensions, much too large to have been
transported by water, except in the form of ice. Many of
the boulders were of material not found in the immediate
locality, and the only way to account for their presence is
to assume that they were brought there by drift ice. So
far as one could judge from an imperfect knowledge of
the country, they came from the eastward, beyond the
head of the Fjord.
Of equal importance and interest with the raised beaches is the evidence of the action of ice in the past and at the present day. Generally it may be stated that there is most unequivocal proof that in former ages the whole country, with the probable exception of the topmost points of the mountains, was covered by an enormous mass of ice. The sides of all the deep valleys, for, perhaps, from 2000 to 3000 feet up, are smoothed and polished as if they had been carefully worked by masons, and where the rocks are of a character to retain them, the striae are as clear as if they were made but yesterday. The direction of the flow was naturally seawards. The pressure of the ice must have been something inconceivable. In the valley above Odde, for miles the side of the mountain is almost vertical, and the face of the rock not merely rounded and scratched, but literally cut away as straight as a wall to a height of probably 1500 feet in places. In the Mundal Valley, between Mundal and Bojum, the same thing may be seen. The Nærodal and Romsdal again exhibit the same phenomena on perhaps a still more gigantic scale. The Romsdalshorn is about 6000 feet in height, and for certainly upwards of two-thirds of its height there is palpable evidence of ice rounding, whilst Jordalsnut, a conspicuous mountain upwards of 3000 feet in height, in the Nærodal, is ice rounded to the very summit.

The rocks along the actual coast line and the small islands which fringe the coast almost from one end of the country to the other, have their tops and sides similarly rounded and polished. This may, however, be due partly to the action of water, but it is probable that ice action accounts for a good deal of it.

I have already referred to the circumstance that the highest mountain tops do not appear to have been covered by ice. This is very noticeable in the Romsdal.
Further north, too, in the Lofoten Islands and in the neighbourhood of Tromsø, the pointed mountain tops stand out from the snow and ice which to a very large extent covers their flanks and fills up the higher valleys between them. Bare mountain peaks also stand out from the perpetual snows of the Jostedalsbræ and the Svartisen Glacier. Nansen noticed the same thing in Greenland, and most arctic navigators have given similar testimony. It is therefore safe to assume that even during the glacial periods the ice never completely covered the loftiest mountains.

The action of floating ice in pushing up the ridge of boulders along the shore at Bodø and in depositing the rounded boulders on the old beach at Vadsø, has already been alluded to, but I confess to a slight disappointment at not finding more evidences in this direction. The instances mentioned were not the only ones observed, but, generally speaking, the effects were not very conspicuous.

The usual phenomena connected with glaciers is, of course, very apparent wherever glaciers exist or have existed. At the foot of the Buarbæ and the Bojumsbæ (which were the only glaciers I visited) there were the usual moraines, and throughout the length of most of the valleys were huge masses of moraine matter, frequently extending completely across the valley and holding up considerable lakes. The Buar lake, just above Odde, is an instance of this kind, and another lake of similar character exists in the Romsdal. Each glacier, too, has its ice cave, out of which flows the stream caused by the melting of the ice. The ice cave at the Bojumsbæ is of very considerable dimensions. Near the Bojumsbæ is another glacier called the Suphellebæ, which is a good example of a re-cemented glacier. The peculiarity arises from the circumstance that masses of ice break off from
the end of the descending glacier and re-consolidate at the base of the mountain, forming a secondary glacier.

Before quitting the subject of ice and ice action, I must refer to a supremely interesting instance of palæozoic glaciation to which my attention was called by Mr A. Strahan, of the Geological Survey, and which it was my good fortune to visit in company with him. Near Biggan-jargga, at the head of the Varanger Fjord, the formation consists of sandstone altered into a quartzite. This quartzite rests unconformably on an eroded surface of Gneiss, and is regularly bedded. The surface of one of the beds of quartzite is very clearly scored with glacial strice. The grooves, which are very numerous and distinct, run in various directions, the three principal sets having the following directions, viz:—N. 30° W.; W. 20° N.; and N. 10° W. There was no doubt whatever about them. They were not mere casual scratches such as might be made by rocks tumbling upon and slipping over the surface, but perfectly well defined and unmistakable glacial strice, which could be traced up to and under the drift which rested upon the striated rock. Immediately upon this striated surface reposed a mass of consolidated glacial drift with embedded boulders, the included fragments ranging from sand up to two feet in diameter, the larger being for the most part of granitic character, the smaller of shale and other materials. The bed of conglomerate has a maximum visible thickness of about 9 feet, and a lateral extent of about 60 to 70 yards. How far it extends inland it is impossible to tell. The mass thins out northerly in about four yards from its thickest part, and against it the quartzite is unconformably bedded, and is continued in regular sequence over it for a considerable thickness. Just at the junction of the upper quartzites with the mass of drift, the rock consists of an intermixture of the drift and sandstone, or, to express it
more correctly, the quartzite encloses fragments of the
drift material, constituting a kind of secondary con-
glomerate. The quartzites have not yielded any fossils,
so their age is uncertain, but from extrinsic evidence it is
considered that they cannot be more recent than the
Trias, and are not unlikely to be of Silurian age.

I am informed that a somewhat parallel case is known
in Australia, but with that one single exception it is
believed to be unique.

Dr Hans Reusch was the discoverer of this remarkable
element of ancient glaciation, and he describes it at some
length in the “Norges Geologiske Undersøgelse” for
1892, with diagrams and reproductions from photographs.

It has been stated, on the strength of certain measure-
ments taken at intervals of some years, that the Scandi-
navian glaciers are gradually advancing down the valleys.
I am not prepared to deny this, nor, on the other hand,
am I quite able to accept it as a true proposition. The
evidence afforded by the moraines seems to point in the
other direction, for they are found in all the valleys
whether occupied at the present day by glaciers or not, at
frequent intervals from the sea upwards, and in the case
of existing glaciers the moranic matter for a distance of
some hundred yards from the actual ice foot, has a very
modern appearance. This looks very much as if the ice
was receding.

In connection with this glacial débris one feature which
astonished me was the enormous size of some of the
blocks of stone of which it consisted. At the foot of the
Bojumsbræ some of the blocks must have been of many
thousand tons in weight, large enough to have accommo-
dated a respectable quarry.

Although there is so much evidence of disturbance, such
crumplings and dislocations of the rocks of Norway,
and so much extreme metamorphism—by far the greater
portion of the surface rocks being metamorphic, I believe I am correct in saying that there are a few examples of igneous rock, properly so-called. Granitoid rocks there are in abundance, but most of them are only granitic in appearance, and are, in point of fact, sedimentary rocks which have undergone extreme metamorphosis. Nor is there any evidence of volcanic energy in mesozoic times, such as we have in the West of Scotland in the vast sheets of Basalt and kindred rocks which there overspread so large an extent of country.

The extent of the knowledge of the geology of a country like Norway which can be acquired in the course of a month, most of which was spent at sea, is necessarily very small, and that, together with the fact that my object in going to Norway was not primarily geological, must be my apology for the brevity and disconnected nature of this communication.

P.S.—Since the above paper was written, a paper by Col. H. W. Fielden, F.G.S., on “The Glacial Geology of Arctic Europe and Its Islands,” has appeared in the Quarterly Journal of the Geological Society, vol. lii., p. 721, and two others by A. Strahan, Esq., M.A., F.G.S. (whose name appears above), “On Glacial Phenomena of Palæozoic Age in the Varanger Fjord,” and on “The Raised Beaches and Glacial Deposits of the Varanger Fjord,” will also be found in the same journal, vol. liii., pp. 137 and 147. Some of the matters touched on in my paper are there dealt with in greater detail, and to those papers the reader is referred.

Chas. Upton
ON THE
ARCHÆOLOGY OF THE COLN VALLEY
AND
NOTES ON THE WELSH WAY AND
FOSS WAY
BY JOHN SAWYER

From Foss Bridge to its junction with the Thames at Lechlade, the river Coln flows through a district which has been occupied by man from very ancient times. The earliest monument of human occupation is a long barrow in the hamlet of Ablington, on the western edge of Lambrough Banks covert. In its general proportions and in its horned end it is similar to other long tumuli in the county, but it differs from them in the character of its masonry. Instead of, as is usual, being surrounded by a single wall, this tumulus has a double wall, each wall facing outwards, and the space between is filled with rubble. In another respect, also, it is unlike most of the Gloucestershire long barrows, for instead of the interior being a mere mound of débris, it was, says the late Canon Lysons, "built up of loose stones placed in a slanting position, converging to the centre, like a succession of roofs placed one upon the other, a kind of gutter apparently running down the centre through the whole course of the tumulus. A straight dry wall here and there at intervals intersected this sort of roof at right
angles, so as to strengthen the fabric, the whole covered with soil and turf at the northern or principal end."

Directly in the centre of the curve formed by the horned end, and between the two walls, was a stone six feet high by five feet wide. Wood ashes, a few flints, and several sling stones were found in the mound; and at the narrow end was a cist made of rough stones, containing one skeleton. The presence of wood ashes points to burial after cremation, and possibly small chambers containing human dust may have been overlooked. Unfortunately, when the barrow was opened in the summer of 1854, the art of tump excavation was in a rudimentary stage; but we have reason to be grateful to a distinguished member of our Club for placing on permanent record the character and contents of an exceedingly interesting barrow, so far as they were observed in an incomplete examination. Even now considerable portions of the mound are apparently undisturbed, but it is doubtful if further excavation would reveal anything of special interest.

About half-a-mile to the north-east of the long barrow just described, in a field near some farm buildings known as Oldwalls Sheds, is a tumulus not marked on the Ordnance map, to which my attention was last summer directed by Mr W. Mills, of Ablington, in whose field it stands. In appearance it is a circular mound, about forty or fifty feet in diameter, and eight or nine feet high, with a low mound about fifty feet long and ten or twelve feet wide on its northern side. By the kind permission of Mr Mills, and with the aid of a stalwart quarryman, I was able to examine its construction and contents, although I am afraid that in so doing it has been robbed of its interest for future antiquaries. We first of all dug into the low extension of the barrow by cutting a trench across it, and

making shallow excavations in other parts of its surface. Nowhere was there the slightest evidence of masonry. It seemed to be entirely made up of loose rubble, thrown, as an onlooker said, "all of a yep" (heap), or as loads of broken stone are tipped from carts along the margins of our roads.

Finding that the "crust" of the circular mound was of the same rubbly character as its extension, we decided to dig into its centre from its crown. Two trenches were made, intersecting at right angles; and a few inches below the surface the rubble was found to be resting upon a mass of stones which in size, shape, and setting were like the dry walling so common upon the Cotteswolds. As we went downwards we carefully extended the area of the excavation, and kept a sharp look out for any sign of a cist or other evidence of human burial. All the stones had a slight tilt from an imaginary central line, as though they had been built over a small object placed in the centre at the surface of the ground. But of such an object in that position no sign whatever did we find. East of the central line, however, there seemed to be indications of a small chamber, and every stone was carefully removed in approaching it. Our surmise proved to be correct. About two feet from the centre, on the original surface of the ground, was a cist, approximately two feet square, and nine inches deep, formed of rough, unshaped stone slabs. As a general rule, cists in round barrows contain human bones or other undoubted human relics. This one contained a few handfuls of phosphate of lime and dirt. So far as we could find, and we examined the mound very carefully, this chamber was the only evidence of the purpose for which the barrow was built. In round barrows in Gloucestershire, Canon Greenwell says, the prevailing practice was burial after cremation. The only inference in this case seems to be that a body had been
burnt, the bones and dust placed in a small cist, and then a huge mound built over it. A barrow similarly built was some years ago opened at Nether Swell, but the burnt bones were placed on the surface of the ground, and the stones placed directly upon them.

A third structure in the hamlet of Ablington is of a very remarkable character. This is an underground chamber, with a beehive roof. From its widest part, about six feet in diameter, the stones overlap inwards and make a dome. In the walls are three recesses, each about ten inches wide, fifteen inches high, and fifteen inches deep. A fourth opening in the wall, with a steep cutting in the surrounding soil, leads to the outside of the structure. Whether this was originally an entrance, or whether it was originally a recess and has been made an entrance, is uncertain. In similar structures elsewhere the entrance is sometimes through the crown, sometimes from the side. In this structure the crown has been disturbed, and it is impossible to determine whether the dome was originally perfect, or whether an opening was left in it which might have been covered with a slab.

For what purpose was this underground structure made? Locally it is known as a shepherd's hut. Amid much that is uncertain about it, we may be quite certain that it was never built by or for shepherds. A man who could build such a structure would find much more profitable employment than tending Cotteswold sheep; and a shepherd would require a much more convenient shelter than an underground chamber six feet across, into which he had to swing like a monkey or crawl like a mole. Canon Lysons says that in the immediate vicinity of the Ablington long barrow "there exists a round hut underground, formed of dry walling similar to that employed in the construction of this tumulus. There were formerly
more of them close at hand." I have reason to think that the hut to which Canon Lysons alludes is not the structure which I have described, but one much simpler in shape, now filled or covered in, and I cannot find evidence of any others in the neighbourhood. Canon Greenwell, however, describes two very similar structures in Nether Swell, where, singularly enough, as already stated, is a round barrow very much like that at Ablington.

For what purposes these underground chambers were made is to a large extent a matter of conjecture. Sir John Lubbock describes some whose object was the concealment of food or treasure. Dr Tylor, discussing the arts of life, speaks of beehive houses in the Hebrides, covered in with growing turf, which, he says, "remind antiquaries of Tacitus' account of the caves dug by the ancient Germans and heaped over with dirt, where they stored their grain and took refuge from the cold, and in time of war from the enemy." Mr Robert Damon, of Weymouth, records, among objects found in similar underground structures in the Isle of Portland, a celt, small flint flakes, corn crushers, blackened wheat, and skulls and bones of domestic animals; and some of the articles, he adds, do not differ from those found in the Swiss Lake dwellings. Canon Greenwell strongly inclines to the belief that the Nether Swell structures were places of sepulture for bodies that had not undergone cremation, and that they belong to a time of transition, when the older manner of burial (in long barrows) was being replaced by a later one (in round tumuli).

† "British Barrows," p. 447, et seq.
‡ "Prehistoric Times," 1869, chap. ii.
|| "Geology of Weymouth," p. 166.
When the Club visited Ablington in its Field Meeting last September, the structure had been, by the kind offices of Mr Garne, partially cleared of its accumulation of débris. A further clearance might, however, reveal objects of interest, and it is sincerely to be hoped that care will be taken to preserve intact this almost unique monument of our prehistoric Cotteswold ancestors.

The Valley of the Coln is intersected by two well-known Roman roads. The Foss Way crosses it at Foss Bridge, and Ikenild Street at Coln St. Aldwyns. Parallel with the Valley on its northern side, and running to, and probably through, the town of Lechlade, is the Salt Way. But these are not the only ancient highways in the district. On the Ordnance map the Welsh Way is the name given to a road running from Barnsley past Ready Token to Fairford and Lechlade. On old maps of the county a road bearing the same name goes in the other direction from Barnsley to Perrott’s Brook. Connecting with it at Perrott’s Brook is a short length of road, also known as the Welsh Way, which joins the Irmin Street about three miles north of Cirencester. In the days when Welsh cattle were driven from the Principality through Gloucester to the metropolis, this road was greatly used for that purpose, and a glance at the map shows that it is shorter than the ordinary route through Cirencester.

The probability that the road is an ancient one is very much strengthened by the name of a place upon it—Ready Token. In its present form the name is meaningless, and it is obviously a corruption of a name that had a meaning. For the original name we must look at the position and surroundings of Ready Token. It is a small area of high ground, and with its clumps of trees is
visible for some distance away, so that it is a useful landmark for travellers. Four miles east of it, along a wide road, is Fairford, with its "fair ford" over the river Coln, an important matter in the days when bridges were few and far between. It is therefore very probable that the place once bore a name indicating that it was the way to the easy passage across the river. If this be so, the origin of the name is not difficult to find. Rhydd, the Celtic name for a ford, may easily be corrupted into Ready, and Token is very likely to be a corruption of the Saxon word "tacen," an indication or sign. Ready Token would on this theory mean simply "The way to the ford," and would indicate an origin dating back to pre-Saxon times.

Whether this be the explanation of the name or not, the existence of the Welsh Way suggests an interesting enquiry. Commencing, as I have said, from the Irmin Street, it ends at Lechlade. Why does it end there? A second ancient road also runs to the town—the Salt Way, which some say ended at Lechlade, while others maintain that it passed through the town on its way south. A third road passing through Lechlade also merits some attention. If you follow the course of the Roman road from Winchester through Marlborough, you will see that from almost exactly opposite where it joins the Irmin Street an important highway runs northward through Lechlade to Stow-on-the-Wold, where it joins the Foss Way and also the Roman road through Alcester to the Watling Street.

Lechlade is therefore connected with the most important of the Roman roads in the South of England. Is this from accident or design?

In studying the means of communication used by the Romans in Britain, we have not, I think, sufficiently considered the extent to which they may have utilised inland
navigation. We know that on the Continent the rivers were in Roman times, as they have ever since been, great highways for military and commercial purposes. Mommsen records that a tombstone found near Tréves "has the form of a ship; in this sit six mariners plying the oars; the cargo consists of large casks, alongside of which the merry-looking steersman seems—one might imagine—to be rejoicing over the wine which they contain."* Mommsen also reminds us that immediately after the Romans crossed the Thames and took Colchester, the working of the British mines began, and "a stream of Roman merchants and artisans poured into the country, and London became the natural emporium of trading on a great scale."†

Now it is obvious that a great deal of the mineral wealth of the country was then, as now, in the south-west. In the Forest of Dean, as abundant evidence testifies, the Romans worked iron to an enormous extent, and even to-day the unexhausted "cinders" they left are worked to profit. Some, if not much, of the mineral resources of the Forest probably reached the Continent through the port of London. Was the conveyance to the metropolis the entire distance by road, or was part of the journey by water? There is no trustworthy evidence for an answer to either question. But three considerations point to the probability that the Thames was used for a considerable part of its course. (1) From Gloucester, the lowest point at which the Severn was crossed by a bridge, to London there was no direct road in Roman times; the great Roman road from Gloucester to the metropolis was through Silchester, a very roundabout and troublesome journey for commercial traffic. (2) The

† Ibid., p. 177.
Romans were perfectly well aware of the great advantage of water over land transport in labour and expense; they could see the help afforded by a current flowing towards their great emporium; and the vast importance they attached to the use of horses for military purposes would naturally lead them to avail themselves of any other means of communication for non-military objects. (3) The Thames was then, as now, navigable for a very considerable part of its course by boats which could carry many times the weight that could be drawn by horses. John Chamberlayne, F.R.S., whose work on Great Britain was published in 1708, says that much of the fuel used in London came down the Thames, and that from London "boats are drawn about 200 miles to Oxford, and higher many miles." This is sufficient proof that before the weirs, which now form an essential feature of Thames navigation, were erected, the river was navigable for boats as far as the town of Lechlade. Members of the Club scarcely need to be reminded that when a century ago the Thames and Severn Canal was constructed, it was at Lechlade that the junction with the Thames was made.

In the plan they adopted for the conquest of Britain, the Romans had two leading ideas. One, as Mr John Bellows has demonstrated so admirably, was to make rivers the boundaries of the subjected parts of the country; the second was, as Dr Hübner has shown, to advance northward in parallel lines from east to west. The first of these lines, as Dr Hübner and Mr Bellows prove, was from Gloucester to Colchester. The reason for selecting Gloucester as the western end of the line is obvious: it was the key to the Severn. Was Colchester selected for the eastern end simply because thereby the

line was made parallel, or was there another object in view? May it not also have been because it passed just north of Oxford and thereby secured complete command of the Thames from its source to its mouth?

The coming of the English into the Coln Valley may reasonably be assumed to have quickly followed the famous battle of Deorham, in 577. Dr Guest's* view is that when the Saxons first entered Gloucestershire they came from the Marlborough Downs across the Cottewolds to the Foss Way a few miles south of Cirencester, and then marched down the famous Roman highway in the direction of Bath. It is generally believed that after the battle they at once descended into the Severn Valley and marched northward. Is it not much more likely that they kept to the high ground of the Cottewolds? By doing so they would have protected their lines of communication with their base in Wiltshire, while a descent into the valley might have hemmed them in between fierce enemies on the one hand and the broad waters of the Severn on the other. By quickly retracing their steps they would be able to prevent their scattered foes from again collecting in dangerous force, and with the plateau conquered and reinforcements close at hand if required, the conquest of the lower part of the Severn Valley would be a comparatively easy task. The language of the Chronicle, too, bears out this theory, for after recording that Cuthwine and Ceawlin slew three Kings, it adds that “they took three cities, Gleawanceaster and Cirenceaster and Bathanceaster.” Clearly, therefore, the invaders went to Cirencester on their Northward march.

Some light is thrown upon the early Saxon occupation of the Cottewolds by an examination of the boundaries

* "Origines Celticæ," II., p. 182.
of parishes along the Foss Way. This is now made easy by the publication of county Ordnance maps which exhibit parish boundaries with lines of main roads. A study of the maps of Gloucestershire and Wiltshire reveals the remarkable fact that the Foss Way from Littleton Drew through Cirencester to Stow-on-the-Wold, a distance of about forty miles, is for almost its entire length a boundary of parishes. No other main road in the two counties, ancient or modern, is a parish boundary for more than a mile or two in length, and even this is of rare occurrence. The Irmin Street, which, next to the Foss Way, is the most important of the other Roman roads, is in its entire course across the two counties a parish boundary for only about half-a-dozen miles. It is further noteworthy that the southernmost point from which the Foss Way is a parish boundary is almost exactly where it is joined by the direct road from Dyrham.

Was this boundary originally parochial or tribal?

If the West Saxons, after their victory at Dyrham, marched over the Cotteswolds instead of up the Severn Valley, they probably did so along the Foss Way. In the settlement which quickly followed, its well-defined line would be of great service in the distribution of the land, and thus it may originally have been a parochial boundary.

On the other hand, the Foss Way may have been a tribal boundary. The Hwiccas were a tribe which, on the authority of Professor Freeman, occupied Gloucestershire, Worcestershire, and a part of Warwickshire. The western boundary of their land was probably the Severn, and the southern the Avon. What was the northern and eastern? The Foss Way, which runs near the border of Gloucestershire, may well have been the eastern boundary, and the Watling Street, from the point where it is intersected by the Foss Way, may have been the boundary on the north.
In the road map of England there is no such striking feature as the Foss Way, which runs in almost a straight line from Cornwall to the mouth of the Humber. Its importance in the Roman occupation of the country is obvious. It is probable that the historical interest which thus attaches to it is increased in our own part of the Kingdom by the part it played in determining the original settlements of our English forefathers.

Upon the Colin Valley and its neighbourhood the Danes have left a more lasting impress than upon any other district of like size in Gloucestershire. Elsewhere in the county, with two or three exceptions, the Danish invasions were mere plundering expeditions. In and around the Colin Valley the invasions resulted in permanent settlements.

The earliest record of a Danish connection with Gloucestershire is that in 855 Burhred, King of the Mercians, brother-in-law of Alfred the Great, granted to a Danish bishop Alhun and his family, at Worcester, certain property in Ablington and the surrounding parishes of Barnsley, Poulton and Eisey. Twenty-two years later the Danish army first planted their feet in the county, and, despite a desperate resistance from the citizens, successfully attacked Gloucester, and settled within its walls. At the beginning of the following year the Danish host, as the Chronicle says, “rode through the West Saxons’ land, and there sat down, and mickle of the folk over sea they drove, and of the others the most deal they rode over.” In the spring of the same year (878) Alfred defeated them in the great battle of Ethandun, near Trowbridge; in the following year the Danish army went from Chippenham to Cirencester, where they “sat” for a year, and in 880, under the treaty of Wedmore, the Danish army left Gloucestershire and never afterwards came within its borders.
By this agreement, which was renewed half a century later, the Danish district was divided from the English Kingdom by a line passing along the Thames, the Lea, and the Ouse, and then following the course of Watling Street to Chester. It is commonly believed that south of this line Danish names do not exist. It is true that tried by the most important of the characteristic Danish test-words, the suffix "by," the place-names fail to reveal a Danish origin. But take another useful test-word, "thorpe," "thorp," or "trop," a Danish suffix which means a village, and we find a number of Danish settlements south of the line indicated, and several in and contiguous to the Coln Valley. Adjoining the town of Lechlade is Bouthrop (or Eastleach Martin), and following up the valley of the Coln we have Southrop, Hatherop, Williamstrip (the suffix "trip" probably a corruption of "trop") and Cockrup, and adjoining the Foss Way at Foss Bridge is Pindrup. Dr Taylor holds that from the Danish word "baec," a brook, we have several place-names,* so that possibly Bibury, which in the Domesday Book is called "Bechberie," may also be a name of Danish origin. Coln St. Dennis is a name said to be derived from the fact that in Norman times its church belonged to the Abbey of St. Deny's, near Paris. But it is noteworthy that the natives of the village and of the neighbourhood invariably call it Coln Deans, and the rector of the parish (Rev Lewis B. Bubb), to whom I am indebted for some interesting information on the subject, tells me that in a document relating to church lands, dated 1683, the parish is twice described as "Coln St. Deny's alias Coln Deans," and that on the church plate the name is spelt in three different ways—Coln St. Dennis, Coln St. Denys, and Coln Deans. Everyone

acquainted with the Cotteswold dialect is familiar with the sound of “a” as “e,” so that it is easily understood that Coln Danes, or the Danes’ Coln, would be called Coln Deans. Of course, Deans is also a very possible corruption of Denys, and if the popular name were Coln Saint Deans, that might be the correct explanation. But the “Saint” is dropped, whereas Coln St. Aldwyns, three parishes south, is called by its right name, and never called Coln Aldwyns. Pindrup, although close to the Foss Way, and within a stone’s throw of Coln St. Dennis Church, is in the parish of Coln Rogers. At one time, Mr Bubb tells me, it must have been a place of some importance, and some remains of a moat around it still exist. Coln Rogers, therefore, was probably a Danish settlement, and it is significant, as well as curious, that amongst its inhabitants recorded in Domesday Book was “one foreigner.”

If, then, we admit the place-name Bibury to be of Danish origin, the whole of the Coln Valley from the Foss Way to the Thames bears an unmistakable impress of occupation by the only foreign enemies our English forefathers had to fight against in England until they had to bow their necks under the iron heels of the Norman.
THE MANNER IN WHICH
THE DOMESTIC ANIMALS AND PLANTS
HAVE AIDED CIVILIZATION

BY
WINNINGTON-INGRAM

There can be no doubt that Man has not suddenly reached his present position on the earth, but has only attained it after vast ages of development and progress.

Man, though weak in body compared with the other animals, has struggled upwards through the gloom of ages to hold the supreme command. Many circumstances assisted his rise, and perhaps, indeed, the very consciousness of his weakness was one chief help in his upward course, for that consciousness made him seek the aid of other forms, and he pressed into his service those animals and plants which seemed best adapted to his needs. This practice was begun many thousands of years ago, and for a long time little advantage was gained. By degrees, however, some races who were more enterprising than others domesticated the wild animals, and so obtained flocks and herds and added to their own strength by using various animals as assistants in the chase as beasts of burden and for food and clothing.

The dog, the horse, the ox and the sheep are those animals which have been most useful to the primitive savage in raising his condition and in promoting his civilization.

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Throughout the world the dog was the first possession of man and his earliest companion beyond his own race, and the dog has been so long separated from the primitive species that we cannot trace with any certainty the stock from which he originally sprang. No animal has been so thoroughly or so universally domesticated as the dog, in none have the moral and intellectual faculties been so largely developed. Wherever man of any degree of civilization is found, there also is the dog found. The dog took his origin at a very remote period, for we find undoubted evidence in the very earliest records of his existence and regular domestication. Among the early Hebrews he seems to have been known, or rather despised, and it seems very remarkable that such an astute nation of shepherds should not have domesticated and used so valuable an assistant. Possibly this was partly owing to the prejudice of the Hebrews against an animal which was venerated as a symbol of the Divine Being by the idolatrous Egyptians. Yet this objection cannot go for much, as the Hebrews kept oxen, which were also worshipped by the Egyptians. But it must be remembered that in the East dogs were, and are, filthy and savage creatures, which act as scavengers in the towns. The only instance in the Bible where the dog is mentioned as a domestic animal is in Job, chapter 30, verse 1, where, speaking of the greatness of his former prosperity, he says, "But now they that are younger than I have me in derision, whose fathers I would have disdained to have set with the dogs of my flock." This passage is extremely remarkable as showing at what an early period of the world's history the dog was sufficiently domesticated to be capable of the arduous task of guarding sheep—a task, the proper performance of which necessitates a total suspension of the true canine instinct, which is not to guard sheep but to worry and devour them.
There is, however, another allusion in the Sacred Writings to the domesticated dog. I mean in the Apocrypha, where in the Book of Tobit, chapter 5, verse 16, we are told that when Tobias and the angel were setting out on their journey, "They went forth both, and the young man's dog with them."

It is certain that the Egyptians selected their dogs so as to produce well-marked varieties, for there are to be seen on the Egyptian temples representations of dogs with long ears and broad muzzles. The Assyrians, too, had considerably advanced in the breeding of dogs, for mastiffs and a kind of greyhound are found represented on their tombs. The ancient Greeks and Romans, as is well known, possessed dogs. Homer frequently alludes to them.

But more ancient than any of these records are the evidences which prove the existence of the domestic dog among the prehistoric savages of Northern Europe.

In the Danish "Kitchen middens" or heaps of household refuse piled up by men of the newer stone period, are found bone cuttings belonging to some species of the genus Canis. Together with these remains are some of the long bones of birds, all the other bones of the said birds being absent. Now it is known that the bird bones here found are the very ones which dogs cannot well devour, while the absent ones are those which they can bolt with ease, and it has been ingeniously argued from this that the remains in question really belong to the domesticated dog, as if the animals to which they appertained had been wolves, they would have made short work of the long bones of the birds as well as of the others. Other dog bones are found in Denmark belonging to later periods. At the time when flint knives were succeeded by bronze a large dog existed, and at the time when iron was used a larger one still. In Switzerland during the
newer stone period a dog existed, probably the oldest of which we have any record. It partook of the character of our hounds and setters or spaniels, and in the formation of its scull was equally remote from the wolf and from the jackal. This dog, too, like its Danish contemporary, was succeeded in the bronze period by a larger variety. Thus we see that when our ancestors were living in the dens and caves of the earth the dog was systematically kept and selected, that is, any good varieties which appeared were noted and kept up.

When the savage was driven to feed upon his dogs in times of dearth he was naturally more willing to sacrifice the least intelligent and affectionate of them, and would delay killing the best dogs as long as possible. In this way for ages a careful, though unintended, process of selection was applied to those animals, and to this we may attribute the great intellectual and physical development which has taken place among them.

The dog has contributed in various ways to the civilization of man; he has done so by calling forth sympathy and kindness towards the lower animals, the dog being the first creature which was domesticated and made the captive and friend of man for the sake of companionship rather than profit. As time went on, however, the dog was serviceable to man by helping him in the chase, and so enabling him to procure a larger quantity of game in a shorter time than by himself: and so man had more leisure for other pursuits. Also the dog was useful as a guard over the dwelling and property of his master, and later on, when man acquired flocks and herds, the dog protected them; and in some countries he was used to draw sledges.

The opportunity to advance beyond the state of the early savages depends very much upon men possessing animals which can be domesticated and used as beasts of
burden and of draught; and where men had such means of supplementing their own strength they made great advances. In Asia, in Europe, and in North Africa where the country afforded the horse, the ass, the ox, the buffalo, the camel and the elephant, men soon advanced in civilization. But in North America the natives, though they were ingenious people, remained savages; and also in Southern and in Central Africa, though there were plenty of large mammalia, yet as they were not such as could be domesticated and used as beasts of burden, the savages remained in their barbarism. The immediate result of the possession of beasts of burden and of draught is to increase the productiveness of the soil, to save men the labour of digging, to promote trade by producing a surplus of food and distributing it; and also to develop the arts of war by enabling swift marches to be made, by furnishing an army with cavalry as its eyes and ears, and to bear down the enemy by a furious charge; and to facilitate the transport of war materials.

The chief of these beasts of burden and of draught is certainly the horse.

In the early Pliocene and late Miocene Ages the family of the horses was represented by the hipparion, a small, slender and graceful animal possessed of three well-defined toes on each limb bearing hoofs, one strong and large in the middle, while the two lateral toes were so small that they did not extend below the fetlock, but might be compared to dew claws. The next step above the hipparion was the anchitherium.

It is very remarkable that occasionally horses have been born with tridactyl feet similar to the ancestral type. The tarpon and the wild horse of Tartary are the nearest examples of the stock from which the domestic horses are derived. It was in the Polished Stone Age that domestic horses were introduced into Europe. Their remains are
found in the ruins of Swiss Lake dwellings, but it is supposed that at this time they were chiefly used as food.

The horse was universally used for food by man before the historic period. During the Roman occupation of Britain it formed a large part of the diet of the inhabitants. It was eaten by the Scandinavians in honour of Odin. As Christianity prevailed over the heathen worship, it was banished from the table. It was, however, used in this country as late as 787 A.D., after it had been prohibited in Eastern Europe. The ecclesiastical rule, however, was not always strictly obeyed, for the monks of St. Gall, in Switzerland, not only ate horseflesh in the XIth century, but returned thanks for it in a beautiful metrical grace. During the Bronze Age horses were used for riding, as may be seen from the bronze bits which are dug up in France and in Italy.

As the horse came into use in war, those nations which used horses conquered those which were without them, and pressing forward from their own lands they over rode the tribes which were unmounted. So imposing is the effect of cavalry on all peoples who have no previous knowledge of the horse, that it always produces fear, for to such people the horse and his rider appear a single terrible being, and the Greeks have left a token of their appreciation of the strength derived from the union of the man and horse in the myth of the Centaur. And the ease with which the Spaniards conquered Mexico and Peru is to be attributed to the awe which they struck into the ranks of the savage footmen by their mail-clad horses.

Until the invention of gunpowder the success of an attack depended chiefly on the charge, and the army which possessed cavalry was able to overwhelm a host consisting only of infantry. Since the introduction of firearms, and more especially since the invention of the breech-loading rifle, the manner of employing cavalry has
been altered; but, nevertheless, horses are more useful than ever in war. They are used as chargers for field officers and aides-de-camps, and artillery, on which the success of a modern battle chiefly depends, could not be managed without horses. And they are necessary to bring up stores. Cavalry are still of great use as scouts and to pursue fugitives. So the strength of a country in war depends very much on its supply of horses.

Although at one time the horse was chiefly used in war, yet, perhaps, it is in peaceful pursuits that he has most contributed to the civilization of man. As a pack horse, as a plough horse, and as a coach horse he has distributed goods, increased the food supply, and conveyed passengers, letters, and merchandise throughout the country. An hundred years ago, if the horses had been exterminated in England, famine and depopulation would have been the result. But since steam engines are coming into such general use, horses are not so necessary to man as they were, and it is possible that before long the use of horses will be chiefly confined to luxury and sport, to farm work and to war. But it is worthy of remark that even in this age of machinery the force of engines is still calculated in horse power, horse power being the force which will raise 33,000 lbs. one foot in one minute.

And this fact bears strong testimony to the great services which the horse has rendered to mankind.

The earliest use of animals to assist the strength of man appears to have been brought about by the taming of wild cattle. Several varieties of wild bulls were distributed throughout Europe and Asia, such as the Bos Primigenius, Bison Europeus, and Bos Longifrons, and were chased by the primitive hunters. The full grown animals were ferocious, but when the young were caught and brought up by hand they soon became tame and continued about the dwellings of their masters. And
thus men became possessed of domestic cattle, whose tameness increased and whose shape and colour changed after passing through successive generations in subjection. By domesticating horned cattle man gained the use of creatures well suited to promote his advancement from savagery to civilization. The first use to which domesticated cattle were put was probably that of carrying packs and of moving tents and such like from place to place. Then some ingenious savage was seized with the idea of harnessing one of his tame bulls to the forked branch of a tree and making him draw it up and down a field, tearing up the ground, and so produced a great improvement in agriculture by thus originating the plough. Then, having experienced the beneficial effects of making the strength of the bull assist his own, the primitive farmer proceeded to put cattle to other occupations and made them draw carts and wagons.

The next advantage which man derived from horned cattle after their use as working animals was from their milk, which is the most perfect and complete form of food; and those nations which drink milk and use its products, cheese and butter, are the strongest and most enduring. With regard to the moral aspect of the owning of cattle, nothing has been found more civilizing than the possession of property, with its sympathies, its responsibilities, and its independence. And among primitive men cattle were the earliest forms of property.

The clever and astute Jesuit missionaries who evangelized South America made much use of this means of civilization, and by introducing property in cattle they raised the natives above the state of mere hunters, and by improving their worldly condition they were able also to promote their spiritual welfare. Asia is the headquarters of the genus Ovis, and the domestic sheep is said to be derived from the different
wild forms which are found in that Continent. The fleece of the wild sheep is composed of hair with wool at its roots. But in the domestic species, by continued care and selection, the hair has been reduced to a minimum, so that wool is the only coat. In Great Britain the breeds of domestic sheep are very numerous, and have been greatly improved of late, and have been brought by judicious breeding to a high state of perfection in the valuable qualities of early maturity, aptness to fatten, smallness of bone, and gentleness of disposition. And the length of the wool and its quantity has been improved till a single fleece will now generally weigh from 5 or 6 to 12 lbs., the latter being, of course, an unusual weight.

As flesh-producers in a barren country, sheep are much more valuable than horned cattle. They mature more rapidly, and are reproductive in less than two years, so that in many parts of the world it is possible to obtain a larger quantity of flesh from poor pasturages with sheep than with any other domesticated animal. But the chief contribution of the sheep towards civilization is in providing material for warm clothing for men inhabiting cold countries. Before the domestication of sheep, men who were exposed to severe winters dressed in the skins of wild beasts, but such garments were rough, uncleanly, and not always procurable in sufficient quantities. But by the introduction of sheep, which can be shorn year by year, abundance of wool is obtained, which, when made into cloth, forms the strongest and warmest clothing that can be devised; and if we consider only such an item as cloth for the uniforms of our army, navy, and police we shall see how much we depend upon the sheep for our modern costume.

Did time permit, I might go on to point out how the goat has contributed to civilization by its milk and flesh and by providing material for tents; the ass and mule,
by acting as handy beasts of burden in rough countries and over rocky mountain paths, and the pig by its abundant food supply. How the camel has acted as the ship of the desert by conveying men and merchandise across the sandy wastes. And how the intelligent Asiatic elephant has been enlisted into the service of civilization as a mighty bearer of burdens both in peace and in war.

As I have mentioned the elephant, I will at this point of my paper read a note which I have recently made concerning that animal.

At the present time Mr Hagenbeck, a German, is engaged in a scheme for re-domesticating the African elephant for use in German East Africa. I say re-domesticating, for the African elephant was trained and successfully employed by Pyrrhus and by Hannibal in their wars, but of late it has only been regarded as a wild beast and shot down for its ivory. But if the African elephant could be re-domesticated and used as a beast of burden in the districts where the tsetse fly stops all animal carriage, and where for generations human transport has been the only means of conveying goods from the interior to the coast, it would be of vast service to civilization. The African elephant is hard to tame, and is deficient in memory, and is said to be descended from the mastodon. The teeth of the African elephant correspond with those of the mastodon, and it may be that it has inherited the mental qualities of its huge ancestor.

With regard to the Asiatic elephant, it is easily domesticated and has a good memory, and it is possible that it owes these qualities to its descent from the mammoth. The teeth of the Asiatic elephant are analogous to those of the mammoth.

But were I to enter into a full description of the manner in which these and other animals have contributed
towards civilization, I should weary both you and myself. I will, therefore, now turn to the domesticated plants.

As the pastoral life was an advance from the existence of the hunter, so agriculture was a step in civilization above the pastoral life. But in order to live by agriculture it was necessary that certain plants should be domesticated, so that man, instead of ranging the forests for game or wandering about with his cattle in search of pasturage, should be able to settle in one spot and by means of these plants be able to keep himself, his family, and his animals in plenty and comfort.

Of these domesticated plants the various kinds of corn are undoubtedly the chief. The original plant from which wheat has been developed is said to be the ægilops, a wild grass which still grows on the French and Italian shores of the Mediterranean. If the seed of this grass be transplanted to good soil and well tended, after a few years of cultivation it develops into perfect and productive wheat. This transmutation of grass into a cereal was effected by M. Favre, who found that by selecting the most perfectly developed plants of each generation and thus making each crop an advance on the preceding, in 12 generations wheat was evolved. From other plants originally wild like this have come our oats and barley, rye and maize and other varieties. Corn has been used by man for a vast number of years. Many bushels of wheat and some ears of six-rowed barley have been discovered in the pile works of the Stone Age at Wooseedorf and Wangen, in Switzerland. Egypt since historic times has been a great corn-producing country, and was also remarkable for its early advance in civilization, the extreme fertility of the soil enabling a comparatively small number of men to raise abundance of corn for the food of the rest of the population, and so leaving a large number of people to engage in literary
pursuits, to erect magnificent buildings and pyramids, and to invent elaborate systems of religion.

Theophrastus and Pliny make frequent mention of wheat, for it was used among the Greeks and Romans. When Cæsar landed in Britain he found wheat growing in the island, which, possessing a temperate climate, is well suited to its cultivation. In early times in this country corn was grown for several years running on the same ground, and then the land was allowed to fall down to grass, which was after a time ploughed up again for corn. But in process of time the system of seeding with clover and artificial grasses was introduced. The clover, by means of its broad leaves, attracts the nitrogen from the atmosphere and stores it up in the nodules on its roots to the great benefit of the succeeding corn crop. And, moreover, the clover itself provides an abundant supply of green food and of dry fodder for live stock.

Another domesticated plant which has produced an important effect upon civilization is the turnip, which is not a truly British plant, but was introduced by the Romans, having been previously evolved by years of cultivation from a wild plant with a slender and worthless root. The culture of the turnip was discontinued in this country for a time, but in the 16th century the Flemings brought in several vegetables, and it is supposed the turnip among them. But for many years after it was chiefly used as human food, being sometimes mixed with flour and made into bread. This was notably the case in 1629 and 1630, which were years of dearth.

But in the 18th century Lord Townsend, who was Secretary of State to Kings George 1st and George 2nd greatly promoted the growth of the turnip as a regular farm crop as food for animals, and turnips have for some time taken their place in the four course system of agriculture—wheat, turnips, barley, clover.
Root crops, including the turnip, Swedish turnip, and a root of the chenapodeæ tribe, the mangel wurzel, have been of great service by providing material for feeding sheep in folds and cattle in stalls during the winter, thus enabling animals to be made fat just at the season when such meat is required, and abolishing the necessity for the old plan of feeding animals fat in the autumn and then killing and salting them for consumption during the winter and spring, a plan which was productive of scurvy and other cutaneous diseases, which were also accelerated by the dearth of green vegetables of the brassica group of the cruciferæ, which are now in general use.

The potato is a domesticated plant of the solanum tribe, which has been, and is, of great service to civilization.

The early explorers of America discovered a plant of the solanum tribe with a small, bitter root, growing on the sea shore, which plant, having been brought to these islands and carefully cultivated, has developed into the large and palatable potato.

Besides the fact that the potato produces a large quantity of wholesome food, without much skill or expense being necessary on the part of the grower, there is another advantage connected with the potato which is not, I think, generally appreciated, and that is that the potato crop could not be burnt nor easily destroyed in other ways in war time. I will give an illustration of this from events in the history of Ireland.

During the Cromwellian wars Coote, Inshiquin, and other parliamentary officers invariably caused the lighted torch to be applied to corn, hay and all combustible food for man and beast. Depopulation therefore ensued, and the country was reduced to a desert. But some fifty years or so later, during the war of the Revolution, when King William's soldiers killed and wasted without control,
the population of Ireland nevertheless kept increasing. This was owing to the potato, which about this time was spreading into cultivation and afforded the Irish and their animals an abundance of food, almost beyond the power of the enemy to destroy, for the potato field cannot be fired like a cornfield, nor when the root is out of the ground can it be destroyed with much facility.

It would not be proper for me to conclude my remarks upon domesticated plants without some reference to the flowers which have been artificially reared in our gardens, for they, too, have their bearing on civilization. Among the poor it is well that they should aim at something more than bare existence, and the few bright flowers which adorn the cottage garden in addition to the vegetables, are an advance beyond the mere necessities of life and are good both on account of the refining influence which flowers exercise even over the roughest natures, and because any nation which keeps too near the line of want soon feels the pinch of poverty in seasons of dearth, since the people have nothing which they can abandon without actual distress.

Ireland in 1847 and India at the present time are instances of what I mean.

Among the richer classes there is no purer or more healthy and civilizing pleasure than that which is derived from seeing the various flowers springing up in their seasons, refreshing the eye with their lovely hues and gratifying the senses by their fragrance. Some of these flowers bring us acquainted with the flora of foreign lands, while others are monuments of the patient ingenuity and attention with which skilful gardeners have developed their gay forms.

Modern civilization is fast filling this country with unsightly rows of brick houses and the din and fumes of steam engines. Such uninteresting sights and sounds
grow wearying and monotonous, and there is nothing more refreshing to the spirit than to turn away from them to the sweet forms which the skill of man, co-operating with nature, has developed and domesticated, and has brought into close communion with himself.

But in regarding both the domesticated animals and plants as contributors to civilization, we must not forget that there is a yet Higher Power which has been working through all the ages by means of the lower forms for the physical and moral progress of mankind.
GLOUCESTERSHIRE RAINFALL

BY A. S. HELPS

The widespread attention which is now given to the interesting subject of rainfall statistics may be said to be entirely due to the labours of Mr G. J. Symons, who, since the year 1860, has published a yearly record for the British Isles; and the success which has attended his devotion to the work is manifested by the striking increase in the number of observers making returns dealt with by him. In the year 1895 these observers were over 3000, the number having been only 1000 in the year 1865.

I have long thought that the collection and publication of the earliest known rainfall returns for the County of Gloucester, which, as far as I am aware, have not yet been brought together in an easily available shape, would be of sufficient interest to form a part of the proceedings of the Cotteswold Naturalists’ Field Club, and this more especially as it is the fact that some of the earliest and longest and, consequently the most valuable registers have been kept by past members of the Club.

I have, therefore, endeavoured to make such a collection of rainfall returns for the county as will form at least the basis for a complete record of all such information as is now in existence, and, although I am quite aware that this collection is not as yet an exhaustive one, sufficient materials have come to my hand to warrant a beginning.
Rainfall records in the British Isles are known to be in existence which go back complete for over 170 years, and, with intervals, for about 50 years more, or over 220 years altogether.

The earliest known records for Gloucestershire date back to the years 1774 to 1778: these were taken in Bristol.

Records for the six years 1833 to 1839 were taken by Mr Moss, of Cheltenham, and then come returns which will be found below, kept by Mr T. C. Brown, F.G.S., who was a member of the Cotteswold Club, at Further Barton, near Cirencester, commenced in 1844 and continued by his daughter, Miss E. Brown, F.M.S., to the present date, and another kept by the late Mr J. Curtis Hayward, at Qedgeley, from the year 1844, and continued by his son, Colonel Curtis Hayward, and Mr W. G. Robinson, to the present time.

These two registers and that of the late Mr Clegram and the Rev C. J. Jones, at Westbury-on-Severn, are good representative returns from the Hill and Vale; the Forest is not so well represented, the best record which I have as yet discovered being that from Edgehill House, Mitcheldean, kept by the late Mr Phillips.

The late Dr Burder, who was also a member of the Cotteswold Club, kept a return at Clifton for the years 1853 to 1865. This register I give, and then follows the return kept by Mr W. B. Clegram, C.E., another member of the Cotteswold Club, at Saul Lodge, which dates from the year 1858, and which has been continued since Mr Clegram's death by Mr F. A. Jones, C.E., to the present time.

Among the other registers given are those for the Witcombe Water Works, Heath Lodge, Cheltenham, Witcombe Court, Bowden Hall, Westbury Vicarage, Newnham, Edgehill House, Mitcheldean, and Gloucester.
There are now no less than 75 observers in Gloucestershire whose returns are yearly published in "Symons's British Rainfall," but, in the main, I confine this paper to some of the older and more continuous returns, illustrative, as far as possible, of the three natural divisions of the County: Hill, Vale, and Forest.

For all or most of these records I have calculated the means both of the monthly and yearly falls, and have distinguished by a red line all those figures which exceed the average; thus, I hope, adding to the interest of the information recorded.

It may be thought that a register of rainfall such as is here printed is, after all, rather a dry statement, but let us see what may be gathered from one, by analysis and comparison.

I take my own register, with which I am most familiar. First of all it should be noted that 14 years, which is my total of observation, is obviously too short a record to give a true average. This is shown by the fact that the first seven years show an average fall of 30'03, and the last seven of only 25'90: and by a comparison with the fall at Witcombe Waterworks.

The recognised standard for calculation is, that the amount of rain increases in ordinary hill districts (not mountains) 2½ per cent. per 100 feet of increased elevation. Witcombe Water Works for 34 years gives an average of 29'52.

My gauge is over 400 feet higher, and should, therefore, show 10 per cent. more, or 32'67, but the 14 years only give 28'02. Witcombe, for the same 14 years, gives 27'67, thus proving an increase in the higher station.

One point comes out very strongly, viz., the remarkable correction afforded by a continuous record. The proverb is quite true—"There is no debt so justly paid as that
from the sky to the earth." In my own return it will be found that the monthly returns have varied as follows:—

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<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>69</td>
<td>01</td>
<td>20</td>
<td>02</td>
<td>28</td>
<td>91</td>
<td>30</td>
<td>89</td>
<td>76</td>
<td>60</td>
<td>92</td>
<td>46</td>
</tr>
<tr>
<td>Range</td>
<td>from 4'76</td>
<td>to 5'10</td>
<td>from 5'60</td>
<td>to 5'85</td>
<td>from 5'10</td>
<td>to 5'10</td>
<td>from 5'10</td>
<td>to 5'10</td>
<td>from 5'10</td>
<td>to 5'10</td>
<td>from 5'10</td>
<td>to 5'10</td>
</tr>
</tbody>
</table>

Showing an average range of as much as from 1 to 10, and considerably more in individual months. July, for instance, 30 to 5'10, or as 1 to 17; while the yearly returns have only varied from 20 inches to 36 inches, or as from 1 to 1\(\frac{1}{4}\).

It will be noted, also, that February is the driest month of the year, and that the last six months of the year average 16'07 inches, as against 11'91 for the first six; hence, when February has any heavy fall of rain its effect following on the six wetter months, at a time when evaporation and vegetation are at their lowest, is so apparent in the larger amount of rain finding its way into watercourses as to have given rise to its "fill-dyke" name.

Another fact not perhaps recognised, and which can only be shown by daily returns, is that a fall of one inch in 24 hours is not by any means common even to every year. The last which I had was on 12th November, 1894, and there were none in 1892-3, so that four years out of 14 did not have any fall of one inch; in the other 10 years the falls of one inch were rather more than two for each year. A rainfall of three inches in two days has only once fallen within my experience, and the result of this, in the consequent flooding of the road between Gloucester and Birdlip, and the lower parts of Gloucester at the Spa, Wagon Works, &c., is such as to make one thankful that in our temperate climate we have not to contend with the
enormous rainfall with which some parts of the world are regularly visited. In a severe thunderstorm, as much as 15 to 20 will fall in as many minutes, or at the rate of 0.01 per minute. A fall of from 0.10 to 0.15, between 9 a.m. and 9 p.m., will make quite a wet day.

Since writing this, I note in the "Times" of 8th February, the results of a fall of less than three inches in five days following upon a wet January, where, speaking of the district round Lincoln, it is stated that "Thousands of acres of land are flooded in Lincolnshire, and the loss to agriculturists will be incalculable. . . . Many houses in Lincoln are flooded, and at three of the large engineering establishments work had to be stopped. . . . The bank of the Fossdyke Canal, at a point seven miles west of Lincoln, gave way just as a barge was passing, and the vessel was carried by the sudden rush of water partly over the bank. It would have been taken right into the adjoining field had not the captain realised the position, and dropped anchor."

What would be the effect on the Severn Valley of a fall of 40 inches in one night, as reported to me last year by the Rev Canon Parker through a relative in the Mauritius? But without contemplating any such a visitation, it is clear that the Severn Valley would become largely uninhabitable with a rainfall of 80 inches per annum, such as is common to the N.W. Coast of Scotland, and that but for the marvellous adaptations of nature, if the rainfall at Clifton were common to Tewkesbury, its Severn meadows would be very prejudicially affected. Eleven inches more per annum fall at Clifton than at Tewkesbury.

An interesting and practical point is apparent from the return (when given) of the number of days with rain in a year. This on my register for 14 years averages 172, but it must be remembered that a rainfall day is 24 hours.
Some observers are enthusiastic enough to take their return both at 9 a.m. and 9 p.m., but the majority, of which I form one, are content to take it every morning for the previous 24 hours.

I have, however, made a compromise by declining to label a fine day as a day with rain, when the gauge showed a fall during the night, and have roughly used a distinguishing mark for such cases, from which I conclude that from 30 to 40, or even more, days from 9 a.m. to 9 p.m. may be deducted as rainless, thus showing that on the average 230 days out of the 365, or nearly two days out of every three, may be expected to be absolutely without any fall of rain to interfere with either business or pleasure.

The relation of the number of days rain to the total also presents noticeable features.

In the driest year 166 days give 19'19, or '11 for each day of 24 hours; while the wettest year, with 198 days, shows '18 for each day; the mean figures are 172 days with '16 for each day, so that the more days rain there are the more rain you get on each day, and the less days the less rain each day.

It is obvious that a rainfall of 80 or 90 inches must involve much heavier falls than we ever experience in this county, or there would be no fine days at all, and accordingly at Fort William, the station at the base of Ben Nevis, 78'81 falls on 222 days, showing an average for each day of over '35, while an east coast station, Lincoln, gives 22'73 on 170 days, or '13 per diem.

The observer who lives in a town does so under great disadvantages in respect to rainfall. He can, on a rainy day see only a wet pavement and roof, and a glimpse of open sky, with perhaps a weather cock stuck in the wrong direction, and one rain is very like another; he cannot enjoy or take any interest in a rainfall, or see where it comes from, or goes to. Now on a hill station how
different it all is! You go outside the front door and hear a S.E. wind drawing down through the trees on the edge of the hill, and you hardly need to look at the barometer to know that it is falling for the passage of a cyclonic depression. You may see from the windows the "badgers brewing in the wood," a local expression referring to an indication, which requires some explanation. At certain states of the distribution of pressures a warm, or comparatively warm, and saturated current comes over from the south and east and condenses on the colder banks of the Witcombe valley, which faces N., and parts of which never get any warm sun, presenting the appearance of a continuous formation of cloud which seems to rise out of the hill side, and which is similar to that, to compare small things with great, observed to advantage on such places as, for instance, the peak of the Matterhorn, or Noss Head, Shetlands, when a warm and moist wind passing a cold headland forms a continuous stream of cloud. When, therefore, the "badgers are brewing," rain is not far off; these floating clouds are visible until a large amount of rain has fallen, but when the balance of temperature is restored "the brewing is done."

With the advance of the depression the regular succession of weather may be watched—from halo, gloom, muggy weather, drizzly rain S.E. to S., driving rain, passage of trough S. to S.W. Squall or showers W. to N.W., when the sky clears with cumulus clouds and blue sky, and the Forest Hills, the Black Mountains, and Brecon Beacons become visible. This is a clearness of distant views not forecasting rain.

At another time the rain storms may be seen on the Forest side working up the valley, obscuring, and again leaving clear, the Forest Hills, May Hill, more distant hills in Herefordshire, and the range of the Malverns, and sometimes, though only to a partial extent, striking across the Severn Valley.
If you see a moon with a greasy ring of halo at about twice the distance of its apparent size you may expect half an inch of rain in the night.

It has been noted that rainfall observers are generally long-lived; probably the regular habits acquired by a daily visit to a rain gauge, with the consequent distraction from other cares, may have something to do with this.

In 52 years 18,980 rainfall observations will have been taken, and if to this be added, as is very common, the readings of a barometer, dry and wet, maximum and minimum, and ground thermometers, the number is no less than 113,880.

The amount of rainfall is most important with reference to water supply—a question which is yearly attaining greater prominence, and which will some day, for England with its dense population, present one of the problems of the age, even if this time may not be said to have already arrived.

In considering this aspect of returns, attention should be paid to the area of woodland which, especially when at a good elevation, has a large influence over and above that produced by the tendency of a thickly-wooded district to attract and detain low-lying clouds, and so increase the recorded rainfall. I am disposed to think that this influence is perhaps insignificant in comparison with the precipitation induced by trees at a time when rain does not actually fall.

When the air is saturated with moisture short of the formation of rain, you may see under a large beech tree in the winter quite a stream of water coursing down the bark, and a heavy shower of rain falling from the branches, so much so that, on a light, oolite soil, a large area round each tree will be found to be saturated with moisture and, even, standing in puddles of water. I am not aware that the amount of this precipitation, as distinguished from
rainfall, has been measured and recorded, but it must be very considerable, especially when a large area of woodland is present.

In a severe frost the same effect is continued by the formation of ice, every twig bearing at times an inch, or even two inches, of frozen moisture extracted from the air. When this is dislodged and falls under the influence of the morning sun a very beautiful effect is produced, and one which, once seen, is not easily forgotten. In connection with this it is very noticeable how far from any town smoke products are present in the air, which now become visible by a black deposit in the ice. The same deposit is found to be present on the leaves of trees, for instance, in shooting through a cover of young larch which, even on the top of the Cotteswold Hills above Cheltenham, will quite blacken the hands and clothes.

By the kindness of Mr J. G. Symons, I am able to show you a rainfall map for the British Isles. This was constructed 30 years ago, and was published with the sixth report of the Rivers Pollution Committee, and is the one which is reduced in Huxley’s "Physiography." Mr Symons, in sending it to me, writes that of course he could do a better now, but that he cannot get the time. You will see that the only details given for this county are a rainfall from 25 to 30 inches over the whole county, except the Cotteswold district, &c., where it is given as 30 to 40 inches. On such a small scale map, further niceties cannot perhaps be easily shown, but bearing in mind that the key to the amount of rainfall is the physical configuration of the land in relation to the direction of the rain-bearing winds, you will see that the mountains of Ireland, Cornwall, Wales and Scotland, dispose of all the heavier rains; and that not more than from 35 to 40 inches reaches our coast, if I may use the expression (the S.W. boundary of the county). This maximum gradually thins
out up the Central Severn Valley, as shown by the following figures:—

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Years</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clifton (Dr Burder)</td>
<td>39</td>
<td>34'11</td>
</tr>
<tr>
<td>Ditto, R. F. Sturje (to 1889)</td>
<td>34</td>
<td>35'51</td>
</tr>
<tr>
<td>Berkeley</td>
<td>32</td>
<td>28'80</td>
</tr>
<tr>
<td>Saul</td>
<td>39</td>
<td>27'50</td>
</tr>
<tr>
<td>Quedgeley</td>
<td>47</td>
<td>29'83</td>
</tr>
<tr>
<td>Tuffley</td>
<td>26</td>
<td>28'34</td>
</tr>
<tr>
<td>Gloucester</td>
<td>13</td>
<td>24'34</td>
</tr>
<tr>
<td>Tewkesbury, Upper Lode</td>
<td>16</td>
<td>24'79</td>
</tr>
<tr>
<td>Beckford</td>
<td>12</td>
<td>23'59</td>
</tr>
</tbody>
</table>

The same thinning out is continued in a N.E. direction over Warwickshire and Leicestershire into South Lincolnshire, where the rainfall is as small as any in the British Isles.

On the Forest side, with its high land, the fall at places runs up to 34'63—

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Years</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staunton Rectory</td>
<td>8</td>
<td>34'54</td>
</tr>
<tr>
<td>Newnham</td>
<td>19</td>
<td>33'34</td>
</tr>
<tr>
<td>Westbury</td>
<td>14</td>
<td>27'66</td>
</tr>
<tr>
<td>Mitcheldean, Edge Hill House</td>
<td>17</td>
<td>34'63</td>
</tr>
</tbody>
</table>

And on the Cotteswold side, the same features, with more variation, are presented—

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Years</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroud (Upfield)</td>
<td>21</td>
<td>30'80</td>
</tr>
<tr>
<td>Cirencester</td>
<td>52</td>
<td>31'42</td>
</tr>
<tr>
<td>Hatherop Rectory</td>
<td>20</td>
<td>29'34</td>
</tr>
<tr>
<td>Bowden Hall</td>
<td>14</td>
<td>23'47</td>
</tr>
<tr>
<td>Birdlip</td>
<td>14</td>
<td>28'02</td>
</tr>
<tr>
<td>Witcombe Water Works</td>
<td>34</td>
<td>29'52</td>
</tr>
<tr>
<td>Witcombe Court</td>
<td>16</td>
<td>28'30</td>
</tr>
<tr>
<td>Cheltenham, Heath Lodge (to 1887)</td>
<td>21</td>
<td>29'30</td>
</tr>
</tbody>
</table>
I hope some day or another to construct a complete rainfall map for our county, which, with its striking physical features, will present for rainfall registry an amount of variation perhaps not to be equalled by any other county in England.

In conclusion, I must acknowledge my indebtedness to numerous correspondents for all of the information which I have endeavoured to present to you in an interesting light.
RAINFALL AT CLIFTON, 1853-91

G. F. BURDER, M.D.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>JAN.</th>
<th>FEB.</th>
<th>MAR.</th>
<th>APRIL</th>
<th>MAY</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUG.</th>
<th>SEPT.</th>
<th>OCT.</th>
<th>NOV.</th>
<th>DEC.</th>
<th>TOTAL</th>
<th>NO. OF DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1853</td>
<td>2.99</td>
<td>0.73</td>
<td>0.54</td>
<td>3.12</td>
<td>2.33</td>
<td>4.38</td>
<td>4.78</td>
<td>4.48</td>
<td>3.32</td>
<td>3.93</td>
<td>2.94</td>
<td>0.60</td>
<td>34.20</td>
<td></td>
</tr>
<tr>
<td>1854</td>
<td>3.20</td>
<td>1.01</td>
<td>0.67</td>
<td>0.02</td>
<td>3.39</td>
<td>3.06</td>
<td>2.53</td>
<td>3.33</td>
<td>1.08</td>
<td>3.34</td>
<td>1.98</td>
<td>1.99</td>
<td>23.66</td>
<td></td>
</tr>
<tr>
<td>1855</td>
<td>0.31</td>
<td>1.46</td>
<td>2.16</td>
<td>0.42</td>
<td>2.18</td>
<td>3.62</td>
<td>3.49</td>
<td>2.78</td>
<td>0.84</td>
<td>6.06</td>
<td>0.54</td>
<td>0.99</td>
<td>24.90</td>
<td></td>
</tr>
<tr>
<td>1856</td>
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<td>1.19</td>
<td>3.66</td>
<td>3.14</td>
<td>1.66</td>
<td>1.73</td>
<td>4.69</td>
<td>5.24</td>
<td>2.73</td>
<td>0.72</td>
<td>2.46</td>
<td>32.57</td>
<td></td>
</tr>
<tr>
<td>1857</td>
<td>2.70</td>
<td>1.55</td>
<td>1.88</td>
<td>2.85</td>
<td>2.07</td>
<td>2.10</td>
<td>2.50</td>
<td>3.96</td>
<td>2.21</td>
<td>3.27</td>
<td>1.66</td>
<td>1.07</td>
<td>27.87</td>
<td></td>
</tr>
<tr>
<td>1858</td>
<td>1.20</td>
<td>1.16</td>
<td>1.07</td>
<td>2.90</td>
<td>2.46</td>
<td>2.00</td>
<td>1.91</td>
<td>2.06</td>
<td>3.27</td>
<td>2.67</td>
<td>1.50</td>
<td>2.88</td>
<td>25.12</td>
<td></td>
</tr>
<tr>
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<td>1.99</td>
<td>1.65</td>
<td>4.74</td>
<td>2.95</td>
<td>2.39</td>
<td>1.92</td>
<td>3.93</td>
<td>3.95</td>
<td>4.18</td>
<td>2.22</td>
<td>3.04</td>
<td>3.86</td>
<td>36.87</td>
<td></td>
</tr>
<tr>
<td>1860</td>
<td>4.94</td>
<td>0.99</td>
<td>2.91</td>
<td>1.68</td>
<td>3.53</td>
<td>7.10</td>
<td>1.86</td>
<td>5.68</td>
<td>2.43</td>
<td>3.02</td>
<td>2.82</td>
<td>3.77</td>
<td>40.79</td>
<td></td>
</tr>
<tr>
<td>1861</td>
<td>1.03</td>
<td>2.75</td>
<td>2.93</td>
<td>0.30</td>
<td>1.38</td>
<td>3.33</td>
<td>4.53</td>
<td>2.56</td>
<td>3.86</td>
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**DOUGLAS J. WINTLE**

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**W. G. ROBINSON, ESQ.**

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STAUNTON RECTORY
REGISTER KEPT BY MRS C. J. JONES

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Kept by

W. Piffe Brown, F.R. Met. Soc.

5-inch gauge, 12 inches above ground, and 65 feet above sea level.

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PROCEEDINGS OF THE COTTESWOLD CLUB

179
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Average for 14 years, 23.47.
# Rainfall at the Knaf, Great Witcombe, near Gloucester

Latitude 51° 50' N. Longitude 2° 17' W. 5-inch gauge, 1 foot above ground. 800 feet above sea level.

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Latitude 51° 54' 57" N.; Longitude 2° 3' 21" W. Height above sea level 206 ft.; above ground 1 foot.

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Kindly assisted by

REV. H. KYNASTON, D.D.
MR. H. D. HUMPHRIS

# WITCOMBE COURT, ANTHONY BUBB, ESO.

Height above sea, 290 feet.

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RAINFALL AT SAUL LODGE (W. B. CLEGRAM, Esq., C.E.)

51° 16'. 18" North Latitude, and 2° 22'. 16" West Longitude, on the North-east bank of the broad part of the River Severn between Frampton and Purton, and about mid-way in the valley of the Severn, bounded by the Cotteswold Hills on the East, and on the West by those of the Forest of Dean, about 9 miles apart. The rain gauge is 42 feet above mean sea level (ordnance datum) 5 inches in diameter, and 3'. 6" above the ground.

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Average for 39 years: 2'49

The monthly averages in the last line of the table show that September has had the greatest, and March the least quantity of rain; and that the last six months of the year has had nearly 24 per cent. more rain than the first six months of the year.

The mean annual rainfall for thirty years being 27'96 inches. The rain in the last year is 22'4 per cent. less than this average; but in the 30 years there have been four years with less rain than 1887, namely:

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NOTES MADE BY MR CLEGRAM, JANUARY, 1888

The quinquennial averages show a remarkable increase in the quantity of rain in this locality in the first five periods, and a decrease in the last period, namely:

| In the 5 years ending 1862—23'84 |
| " 1867—24'18 |
| " 1872—23'77 |
| " 1877—29'32 |
| " 1882—34'37 |
| " 1887—27'62 |

The monthly averages in the last line of the table show that September has had the greatest, and March the least quantity of rain; and that the last six months of the year has had nearly 24 per cent. more rain than the first six months of the year.

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Average for 15 years, 1860 to 1875, 32.80 inches; for 31 years from 1845, 31.40 inches.
Diameter of gauge from 1864 to 1882, 9 inches; following years 5 inches. Average for 16 years from 1876 to 1891, 32.62 inches.

Note.—Figures underlined in red are above the average for 52 years.
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NOTES AND
OBSERVATIONS ON THE EARTHQUAKE
OF DECEMBER THE 17TH, 1896
CONTRIBUTED BY MEMBERS OF THE
COTTESWOLD CLUB, AND EDITED BY THE
REV. H. H. WINWOOD, VICE-PRESIDENT

The earthquake which occurred with especial severity
in the Cotteswold and neighbouring districts on the
morning of Thursday, the 17th of December, 1896, has
not unjustly been characterised by Mr Symons as the
greatest English earthquake (except the Essex one, in
1884) of modern times. It was therefore thought that a
permanent record of the occurrence would find an appro-
priate place in the Proceedings of the Cotteswold Club,
and a circular was sent by the Secretary to all the
members, requesting those who had made any definite
and noteworthy observations of the phenomenon, or who
had heard any really trustworthy accounts of the details
of it from others, to commit them to paper and send
them in; for the purpose of forming the basis of a short
report on the subject.

As an indication of the kind of information which
would be most useful, the following series of questions,
formulated by Dr C. Davison, F.G.S., who has made
seismology his special study, was sent with the circular,
and members were asked to arrange their replies under the heads given. It is to be feared that this request was taken too literally by some, at any rate; for many of the replies are severely tabular, and hardly take the form of a continuous, succinct narrative, such as would be best suited for transference verbatim to the pages of the Proceedings.

THE CHIEF POINTS ON WHICH
INFORMATION RESPECTING THE EARTHQUAKE
IS DESIRED
(FORMULATED BY DR C. DAVISON, F.G.S.)

1.—Name of the place where the shock was felt.

2.—Situation of the observer. (a) Whether indoors (and on which floor of the house) or in open air; (b) How occupied at the moment of the shock.

3.—Time at which the shock was felt; if possible, to the nearest minute.

4.—Nature of the shock: (a) Was any tremulous motion felt before the principal vibrations, and for how many seconds? (b) How many principal or prominent vibrations were felt, and for how many seconds did they last? (c) Was any tremulous motion felt after the principal vibrations, and for how many seconds? (d) Did the movement gradually increase in intensity and then die away, or were there two or more maxima of intensity or series of vibrations; and, if so, what was the interval between them, and the order of their intensity? (e) Were the principal vibrations strongest near the beginning, the middle, or the end of the series? (f) Was any vertical motion perceptible, and, if so, was the movement first upward and then downward, or vice versa?

5.—Duration of the shock in seconds, not including that of the accompanying sound.
6.—Intensity of shock: Was it strong enough (a) To make windows, doors, fire-irons, &c., rattle; (b) To cause the chair or bed on which the observer was resting to be perceptibly raised or moved; (c) To make chandeliers, pictures, &c., swing, or to stop clocks; (d) To overthrow ornaments, vases, &c., or cause plaster to fall from the ceiling; (e) To throw down chimneys, or make cracks in the walls of buildings?

7.—Sound phenomena: (a) Was any unusual rumbling sound heard at the time of the shock, and, if so, what did it resemble? (b) Did the beginning of the sound precede, coincide with, or follow, the beginning of the shock, and by how many seconds? (c) Did the end of the sound precede, coincide with, or follow, the end of the shock, and by how many seconds? (d) Did the sound become gradually louder and then die away? (e) Did the instant when the sound was loudest precede, coincide with, or follow, the instant when the vibrations were strongest, and by how many seconds? (f) Did the sound change in character at or about the time when the vibrations were strongest?

8.—If any slight shocks were felt before or after the principal shock, a list of them with their times of occurrence would be most useful, together with answers for each shock to any of the above questions, especially to Nos. 4, 6, and 7, the notes relating to each shock being kept separate.

The following thirteen members (a rather small proportion out of a total of about a hundred) responded to the appeal:—

Mr M. W. Colchester-Wemyss (President)  
(Westbury-on-Severn)  
Sir Brook Kay (Cheltenham)  
Rev. E. Cornford (Secretary) (Cheltenham)  
Sir J. E. Dorington (Stroud)  
Mr A. S. Helps (Birdlip)  
Mr W. Leigh (Woodchester)  
Mr G. E. Lloyd Baker (Hardwicke)
Mr H. G. Madan (Gloucester)
Mr W. H. Mellersh (Cheltenham)
Mr W. L. Meredith (Gloucester)
Dr T. Ringer (Cheltenham)
Mr C. H. Stanton (Stroud)
Rev. H. H. Winwood (Vice-President) (Bath)

In giving a general summary of the information supplied, it is proposed to adhere to the order of Dr Davison's series of questions, and to preserve, as far as possible, the individuality of the replies.

1.—THE LOCALITY OF THE OBSERVATION

It will be seen from the above list that the records come from places situated on or near the line of the Cotteswold escarpment—from Cheltenham on the north, to Bath on the south—the majority coming from Cheltenham and Gloucester.

2.—THE POSITION AND OCCUPATION OF THE OBSERVERS

With two exceptions—Mr Meredith and Mr Mellersh—all were (as they should be) asleep in their bedrooms, the latter being, in all cases except two, on the first floor of the house.

3.—THE TIME AT WHICH THE SHOCK WAS FELT

Here discrepancies occur in the accounts which would be remarkable and almost inexplicable but for the fact that nearly all the observers were aroused from a state of sleep and took an indeterminate time to collect their senses and consult their watches.

Probably the most reliable statements are those of the two observers who happened (I suppose I must say fortunately) to be awake at the time, viz., Mr Meredith, who dates the commencement of the shock at "5h. 33m. a.m., Greenwich time," and Mr Mellersh, who gives
5h. 34m. a.m. Mr Madan estimates that the whole occurrence was comprised within the limits of 5h. 32m. and 5h. 32m. 45s. a.m. Other records vary from 5h. 29m. to 5h. 40m. a.m., a difference of 11 minutes. This may partly be accounted for by inaccuracies of clocks, certainly not by the progressive movement of the earthquake wave past the places of observation, for these tremors are calculated to have travelled at the rate of thirty miles per minute.

4 a.—THE NATURE OF THE SHOCK

The bulk of the evidence appears to show that the principal vibrations were not preceded by any tremulous motion, at least, the latter was not noticed, owing possibly to the fact of its not being sufficiently strong to arouse the sleepers. One observer, however, Mr Mellersh, who was awake at the time, states that "the shock began with a distinct tremulous motion, which merged into prominent vibrations, increasing in intensity and then dying away."

Neither is there any record of such tremulous motion having been felt after the principal shock, though there is a general agreement as to the gradual increase in the intensity of the shock. Mr Helps states that "the shocks increased to a maximum, the final vibrations being shorter, and hardly, if at all, less intense than the maximum."

Dr Ringer says that "the movement gradually increased in intensity and then died away, the principal vibrations being strongest near the middle of the series."

Sir Brook Kay considers that "they were more violent towards the end."

Mr Madan states that "there were at least two maxima of vibration, one dying away and followed almost immediately by another, which latter was the most violent of the two."
Mr Meredith's report (which, from his long experience as an engineer, and from the fact of his being fully awake at the time, is worthy of especial attention) includes the following details:—"My attention (being awake) was drawn to a rattling and vibration of the whole house, too strong to be entirely accounted for by the disturbance due to a train which was passing near my house at the time. Thinking that the train had left the rails I jumped up in bed and noted the time, 5h. 33m. a.m. Instantly a second shock occurred, which I at once recognised as an earthquake, and noted all the subsequent incidents. Including the first shock, observations of which were rendered doubtful by the passing train, there were three distinct series of vibrations, separated by intervals of about one or two seconds. The second of these consisted of five lateral oscillations, equal to at least one inch horizontal movement, and lasted between two and three seconds. The third shock consisted of seven distinct vibrations, of which the first three were the most severe, and about equal to those of the previous shock. It lasted about four seconds, and all tremulous motion ceased within about two seconds after the distinctly-counted seven of the third shock."

4b.—THE DIRECTION OF THE OSCILLATIONS

It seems to be the opinion of all the observers that the vibratory movement of the earth was entirely horizontal, and not vertical, and that it took place in a plane lying approximately north and south. (Mr Meredith, however, considers it to be N.N.E. and S.S.W.) The following notes by Mr Madan may be quoted in confirmation of this. He says—"I have a barograph (Richard Frère's pattern) in which the changes in atmospheric pressure are continuously recorded by an ink trace upon a band of paper wrapped round a brass cylinder which is rotated on
a vertical axis by clock work. The instrument is screwed firmly to a bracket attached to one of the internal walls of the house. The long arm, or lever, which carries the recording pen is so sensitive to changes of vertical pressure that the mere employment of a housemaid's brush near the instrument is enough to cause a vertical displacement of 1/12th of an inch in the ink trace. If, then, there was any vertical movement of the wall during the shock, there would undoubtedly be a straight vertical line observable in the ink trace. If the movement was purely horizontal the pen would be simply jerked away from the paper and would fall back to its former position. I examined the register shortly after the shock and could find no trace whatever of any vertical irregularity in the barometric line."

Mr Madan goes on to say—"I have seen here (at Gloucester) one interesting piece of evidence respecting the direction of the earthquake wave. A large iron ornamental vase, weighing at least 3 or 4 cwt., with square pedestal, stands in the middle of a lawn on a square block of stone sunk in the ground. A few hours after the earthquake this vase was found to have been moved sideways on its stone foundation through a space of about an inch, or rather more. I laid a long straight lath close to it, and adjusted the lath so as to lie as nearly as possible in the direction of displacement. I then took compass readings near each end of the lath (to eliminate any deflexion due to the mass of iron). The mean of the readings gives (magnetic) N. 18° 30' E. as the direction in which the vase had been shifted by the movement of the earth underneath it. Since the magnetic declination at Gloucester is now approximately 18° W., this would show that the oscillations took place in a plane lying very nearly due (geographical) north and south."
Sir J. Dorington mentions a fact which seems confirmatory of the above estimate of the direction of the wave. He says—"A pane of glass in a mullion window in my house (near Stroud) was cracked from top to bottom by the earthquake. This window lies in a plane nearly north and south, which perhaps indicates that the vibration passed from N. to S. or vice versa. If the pane had been broken by an E. and W. oscillation, it would have cracked horizontally and not vertically."

5.—THE DURATION OF THE SHOCK

This is variously stated. Only five attempts to estimate it were made, and these range from 3 seconds to 45 seconds. Mr Meredith says—"The whole earthquake did not last more than 10 or 11 seconds from beginning to end."

6.—THE INTENSITY OF THE SHOCK

This seems to have varied very much in different localities, but in no case is any serious structural damage recorded by the observers (except in one or two instances at Gloucester). All agree in reporting that the vibrations were sufficient to make doors, windows, jugs, &c., rattle, and to ring bells on shutters. The minimum of disturbance seems to have occurred at Cheltenham and Stroud, where no permanent displacement of things was observed. Mr Colchester-Wemyss (Westbury) mentions that china was thrown off shelves into the middle of the room. Mr Lloyd Baker (Hardwicke) says that a bottle on his dressing table was upset, and that two or three vases and ornaments about the house were thrown down or broken. At Gloucester, besides the displacement of the massive iron vase already alluded to, several chimneys were partly or wholly shaken down, and a fair amount of damage was done to glass and crockery.
7.—THE CHARACTER AND INTENSITY OF THE SOUND ACCOMPANYING THE QUAKE

Here the usual and obvious difficulty of distinguishing between the sound of shaking doors, windows, furniture, &c., and the true earth sound-wave is felt by many of the observers. At least two were not conscious of having heard any sound either preceding, accompanying, or following the vibrations. The others describe the sound phenomena in various ways. Mr Colchester-Wemyss compares the noise to "that which a traction engine would make." Mr Lloyd-Baker heard "a rumbling sound as if a wagon had run against the house." Mr Helps, on the edge of the oolitic formations, likens the noise in its intensity to "that of Niagara Falls." Mr Winwood, to "the roaring and rumbling of wind in a chimney." Mr Madan speaks of it as a "rattling and grinding sound like that of a load of bricks emptied out of a cart." Mr Meredith thinks it was similar to "the sound of an underground explosion as heard by a person on the surface." Most of those who noticed the sound and its character consider it as coincident with the vibrations, increasing in intensity with them and dying away as they ceased. Mr Madan, however, is pretty sure that the greatest oscillation of the bed occurred a second or two later than the maximum of sound, and this is likely to have been the case, since sound waves are known to travel through rocks faster than vibrations of the whole mass.

8.—SUBSIDIARY SHOCKS

No one appears to have noticed any minor shocks or noises during the hours preceding or following the occurrence of the principal sets of vibrations above described.

A few remarks may be offered, in conclusion, respecting the area affected. Mr Symons (Meteorological Magazine, Jan. 1897, p. 178) considers that this earthquake
was one of a series which have occurred at various times during the last 600 years over approximately the same area. The damage done (which is, of course, a rough measure of the intensity of the shocks) seems to have been chiefly confined to a district included within lines drawn through Worcester, Hereford, Ross, Dursley, and Gloucester, a space about 30 miles in length and about half that amount in breadth. This district Dr Davison (in a letter to "Nature" of Dec. 24th, 1896) considers to contain the epicentre, though the exact position of the latter is not yet definitely ascertained. The total area, however, over which the seismic disturbance was felt, was very much greater than the district above mentioned, and includes nearly the whole of England and Wales—a space nearly ten times as great as that of the Essex earthquake of 1884, though the intensity of the latter was much greater. Mr Symons, in the article above referred to, estimates the rate of progress of the disturbance at about 30 miles per minute, from Hereford as a centre.

Perceptible shocks, according to Mr Lowe (Proc. British Meteor. Society, vol. 1863-65, p. 59), are much more frequent than is generally supposed; and it is believed that a shock occurs on an average every six days somewhere in the British Isles, and that they are more frequent in winter than in summer.
PROCEEDINGS
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Cotteswold Naturalists'
FIELD CLUB
For 1897—1898

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THE COUNCIL OF THE CLUB WISH IT TO BE DISTINCTLY UNDERSTOOD THAT THE AUTHORS
ALONE ARE RESPONSIBLE FOR THE FACTS AND OPINIONS CONTAINED
IN THEIR RESPECTIVE PAPERS.

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The President's Address at the Annual Meeting at Gloucester, 1898.
Chalk under the Microscope. By CHARLES UPTON, with Plate A.
Observations of a Cycle Tour. By S. S. BUCKMAN, F.G.S.
Recent Discoveries in the Geology of the Malvern Hills. By C. Callaway, D.Sc., F.G.S.
Beverstone Church and Castle, and Malmesbury Abbey. By F. W. WALLER.

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It is open every Tuesday afternoon from 2.30—4.30, when books may be examined, or borrowed.

Books, Pamphlets, etc., presented to the Club should be addressed to The Cotteswold Club, The Library, Eastgate, Gloucester.
PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

For 1897—1898

PRESIDENT

M. W. COLCHESTER-WEMYSS

HONORARY SECRETARY

S. S. BUCKMAN, F.G.S.

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ANNUAL ADDRESS

TO THE

COTTESWOLD NATURALISTS' FIELD CLUB,

MAY 16th, 1898,

BY

M. W. COLCHESTER-WEMYSS, PRESIDENT.

During the year the Club has sustained a severe loss by the death of its late Honorary Secretary, the Rev. E. Cornford. With the exception of two years spent in South Africa, when he was first ordained, his whole career was passed in Gloucestershire, until the last few months of his life, when he accepted the living of Shipton Bellinger, near Andover, where he died on New Year's day last. A resident for many years in Cheltenham, he took an active part in public life, and his leisure hours were devoted to natural science, of which he was an ardent student, and a keen observer. On the death of Professor Harker he was appointed Honorary Secretary of our Club, and on resigning that office he was elected a Vice-President. Since his death, Mrs Cornford has presented the Club with his collection of fossils, the result of the devotion of many years to the study of geology. This gift will be highly appreciated; it will form a fitting and lasting memorial of a most regular attendant at the Club Meetings, who will be greatly missed by the members, to nearly all of whom he was intimately known.

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Since this address was penned there has occurred the death of another officer whose loss will be long and severely felt: William Charles Lucy, lately our President, one of our oldest and ablest members, has passed away, full of years, honoured and respected by everyone. It is most desirable that some record of his life should appear in our Proceedings. No one is better able to write this record than his old friend, John Bellows. To him I telegraphed a request to render the Club this service. He most kindly and promptly responded with the following letter:

"It will be the desire of every member of the Cotteswold Club that some expression should be given to the sorrow we all feel at the loss of our most valued member, and late President, William Charles Lucy.

"All through the most vigorous period of our history as a society, his name has been associated with it as the most active of its workers, not only from the material he has left in permanent record in our Proceedings, but from the aid he has given us, verbally, in our summer excursions, and in our winter meetings, as well as by his individual study at other times, of areas both at home and abroad, which offered features of geological interest.

"For a large part of his life William Lucy held a leading position as a merchant of Gloucester: a position won by a unison of ability and uprightness such as is not very common, even where these qualities are separately present. In using the word 'ability,' I do not mean that he was a brilliant, or a remarkably original man. He was not: but he possessed an insight into the broad bearings of whatever he had to decide upon, and a prudence that made his judgment valued, and sought after.

"This led to his being weighted with an amount of work under which a less patient and methodical man would have failed hopelessly. Not only as a merchant carrying
on a large foreign business, as a director of the Bank, "and of the Canal Company, as chairman of the Severn "Bridge Railway Company, as a Magistrate, and as a "member of I know not how many local committees, was "the estimate shown in which he was held by the busi- "ness men of the community; but he was continually "appealed to by unbusinesslike people to help them in "their dilemmas, some of which must sorely have tested "his patience. I recollect an occasion when I had "accidentally become aware of such a task that had been "unreasonably laid upon him; I asked why he should be "expected, busy as he already was, to give his time to it; "he said, with his wonted quiet smile, 'they come to me "because I am a busy man; for if you want a thing done, "you are more likely to get it attended to by a busy man "than by an idle one: he must get it out of the way; "but the man of leisure puts it off till some other time, "and perhaps never does it at all.'

"The real motive for his undertaking so much extrane- "ous work was his sympathy with others—especially "with those least able to help themselves. He gave "the same painstaking and interested attention to secur- "ing the savings of a poor needlewoman, so as to "make her lonely old age comfortable, that he did to the "management of the thousands invested by his wealthier "friends in the bank, or in the Severn Bridge. Apropos "of the Bridge, I know that at one period he would gladly, "have retired from the Chairmanship, to take more rest; "but he told me that as he had been the means of "some persons placing their money in it, he felt they "would be easier if the management were in his hands "than if it were intrusted to anyone else—'and so for "'their sakes,' he added, 'I am keeping on.'

"Not personal gain, but the happiness of others; not "self first, but duty first, was the continuous motive of
William Lucy's daily life. He was very reticent, even to an intimate friend, of speaking of his own inner state, but his conduct and his spirit manifested it more clearly than words.

Wisely foreseeing the danger of confining his circle of ideas too exclusively to business matters, he chose the study of geology as a relaxation from the cares of bread-winning. This enforced a little leisure on him, and gave interest to his country walks, which as we all know was shared by many of his friends: and more especially by the members of this Club. How excellent a leader he was to us, as our President, every one of us will testify. It was my own lot, besides so often accompanying the Club under his guidance in our field excursions, to share his walks for hundreds of miles, both in England and on the Continent; and as I look back on these journeys I am reminded of some of those little acts of self-denial, and of consideration for others, that so endeared him to those who knew him. I have said 'little acts': but they were little only in the sense that the ruby or the diamond are so: for it is precisely such acts that build up the ultimate character. For forty years I knew William Lucy very intimately. I have seen him lifted on the wave of prosperity without losing his balance of simplicity and humility in the smallest degree. I have seen him plunged into disappointment, and trial, and sorrow, and yet bear himself with the same quietude and sweetness of spirit that he had shown in his happier days. Age, that for some men is dark and unlovely, was not so with him; and now that it, too, is closed we have seen in it the fitting end of a life spent in the patient endeavour to do justly, to love mercy, and to walk humbly with God. We know not what there is beyond our sight, or in another state of existence; but we do know that a life so spent cannot fail of its reward.
During the year there has also passed away one of the last, if not the last, link between the Cotteswold Club of to-day and of fifty years ago. The Rev. P. B. Brodie, F.G.S., who died in November last, was one of the earliest members of the Club, for he was elected in 1849; and as President of the Warwickshire Field Club he was an ex-officio honorary member of our Club at the time of his death. While curate of Down Hatherley, from 1840-1853, he was an earnest student of geology, and contributed some valuable papers to the Club's Proceedings. After leaving Gloucestershire he continued his geological investigations with great zeal, chiefly devoting himself to a study of insects and vertebrates. The collections he made in these two branches of Palæontology, in the course of half-a-century, were unique. About three years ago the British Museum acquired many of his specimens of fossil vertebrates, and it has now purchased the rarer and unique examples from his collection of fossil insects. The name of Brodie ranks with those of Wright, Lycett, Buckman, Lucy, Jones, Witchell and other early members whose contributions to geological science have shed great lustre upon the Cotteswold Club.

During the year four Field Excursions have been made: one to the Forest of Dean, the next to Beverstone and Malmesbury, the third to the neighbourhood of Cheltenham, the last to Thornbury and Aust Cliff.

The day's programme in the Forest of Dean (May 24th) included a descent of the Trafalgar Colliery, an inspection of an Electrical Fuse Factory, and a visit to some stalactite caves near Symond's Yat.

In the prosecution of these scientific objects, some very lovely parts of the Forest of Dean were passed through, especially lovely at the time as many of the enclosures were seen to be literally carpeted with masses of
the beautiful flowers of wild hyacinth. Fortunately times have altered since the publication of an ancient book on Forest Laws, called "the Book of Denys," which informs us that "noe stranger of what degree soever hee be but onely that beeene borne and abideing within the "Castle of St Brevills and the bounds of the Forest as is "aforesaid shall come within the mine to see and to know "ye privities." No penalties however were incurred by the members of the Club who, thanks to the courtesy of Mr. Frank Brain, were enabled to descend some hundred fathom at the Trafalgar Pit, to see something of the method of winning the coal in one of the largest and best appointed mines in the County of Gloucester. One interesting feature at Trafalgar is the extent to which electricity is, and for a long time has been used as a motive power. The whole of the haulage on one of the main roads in the Pit, with a gradient of about 1 in 5 (up which the loaded trucks have to be pulled), is done by electric motors supplied by dynamos above ground. Electrical energy is also extensively used for lighting both above and below ground; and there are many pumps in different parts of the Pit which are worked by the same power. Its ready capacity for transmission renders it peculiarly applicable for this special work.

After luncheon at Symond's Yat, the afternoon was spent by some members in exploring the Coldwell Rocks, by others in visiting the interesting stalactite caves at the Elysian Fields, by the remainder in a placid contemplation of the beautiful work of nature so lavishly displayed on woodland, cliff, and river, in one of the most lovely valleys in the kingdom.

The second excursion of the season was to Beverstone and Malmesbury, on June 19th. The members assembled at Nailsworth Station, thence they drove over the Cotteswold Hills to Beverstone, where they spent some time in
the examination of this most picturesque and interesting village. The remains of the Castle are extensive enough to show that it must have been a place of considerable importance; and the old farm house, partly built out of, and partly embedded in the ruins of the Castle, is very quaint and attractive. From Beverstone a pleasant drive over the hills brought the party to Tetbury, where a halt was made for luncheon, and to allow of a ramble through the streets of this old-world Cotteswold Town. A short distance beyond Tetbury the boundary of the County of Gloucester was passed, and journeying for a few miles through Wiltshire, the party arrived at Malmesbury. The rest of the day was devoted to an examination of the Church and other remains of the ancient Abbey of this Town.

I have to tender my hearty thanks to Mr. Waller, who acted as guide during the day, for his great kindness in furnishing me with some valuable and interesting notes on the Church and Castle of Beverstone, and on the Abbey of Malmesbury. They will be found printed as a separate communication in the body of the Proceedings, p. 249.

On July 23rd, the Club spent a most enjoyable day in the neighbourhood of Cheltenham. For its success the members are largely indebted to Mr. Sawyer for his careful explanations of the archaeological items on the programme, and to Mr. Buckman for his interesting remarks on geological features.

The earlier part of the day’s programme was chiefly of antiquarian interest, and related to the Roman occupation of the bay in which the town of Cheltenham stands. Rapidity of transport being an essential feature of the Roman military system, it is obvious that the camps at Leckhampton and Cleeve were connected by a road across
the valley as well as by viæ over the crown of the hills. This valley road, it is now clear, ran from Leckhampton by Sandy Lane, the Old Bath Road, Hale's Road, and Cemetery Road; and from Prestbury it ascended to Cleeve Cloud by a now disused trackway, which, two centuries ago, was the main road to Winchcombe. Stone paving of possible Roman date may in places still be seen; and the names Sandy Lane and Sandford (on the Old Bath Road), judging from their roots and associations, indicate the line of a Roman highway. In view of these facts, there was an interesting discussion as to the date of the camp on Battledown. Mr. Witts omits it from the list of camps in his "Archæological Handbook of Gloucestershire." He did so, he told the members, on the advice of the late Mr. S. H. Gael, an eminent local antiquary, who held that the entrenchments were made during the war between Charles I. and the Parliament. Against this theory of the origin of the camp, it may be urged that there is no evidence, in the very full journals of the war, that Battledown was visited for more than a few hours by the combatants of either side; while it is only reasonable to suppose that the Romans would have occupied a height which commanded one of their important lines of communication.

At Whittington the members of the Club saw ample evidence of Roman occupation. Nearly forty years ago, excavations in a field known as Wycombe, near the Andoversford Hotel, revealed the foundations of Roman buildings of considerable size. Amongst the embedded remains were a very large quantity of pottery (including plain and figured Samian), several hundred coins (extending from the earlier emperors to Areadus), some sculptured stones, fibulae, &c., and a beautifully preserved bronze statuette, believed to be of Mars. The late Mr. C. W. Laurence made a careful record of the discovery
which was published in the 'Gentleman's Magazine.' The present owner of the relics, Mr. C. W. Laurence, of Sandywell Park, kindly exhibited them to the members. The site on which they were found was undoubtedly that of a Roman posting station; and, at the Garrick's Head Inn, the members of the Club saw what an important position it occupied. A road of Roman, and possibly pre-Roman, date runs through Andoversford from the Ermine Street at Birdlip to the Foss Way at Stow. Connected with it were the camp of Crickley Hill, the Greenway Lane past Ullen Wood, Sandy Lane, three camps at Dowdeswell, the White Way from Cirencester past Withington Villa, a trackway over Ham Hill, Nottingham Hill and Cleeve camps, Salperton camp, and the Eubury camp, near Stow. Withington and Eubury are connected with this arterial highway by roads whose remarkable straightness testifies to their Roman construction; and the little village of Foxcote is in Domesday, and by every villager called 'Foscote,' or the 'wood by the fosse.' Two of the camps at Dowdeswell—one of which was visited—are marked on the ordnance map as Roman. One has ramparts on two sides, and the other on three sides; so that possibly they may have been haiae, or places into which cattle were driven and kept: this theory receives some support from a neighbouring place-name—Heylens farm. The third camp covers a large area, and was undoubtedly a British village.

At Whittington the party visited the church and the court. Like most Cotteswold churches the former dates back to Norman times; but it has been much altered. The south aisle was formerly much wider; and in a recent restoration its eastern arch and west window were exposed. Two knightly effigies are of the de Crupet family, whom the late Mr. John Jones, an erudite member of the Club, identified as the owners of The Crippets: hence the latter
name. The Rector, the Rev. A. C. Lawrence, a courteous and capable guide to the edifice, showed the well-preserved parish register, which dates from 1539: it contains curious entries of persons being touched for king's evil, bodies buried in wool, and of the marriage of Sir Walter Raleigh’s grandson. Of the Court, now occupied by Mr. C. Faulkner Dobell, one of the most interesting points is the size and character of the arches, which the late Professor Middleton considered were the remains of a destroyed castle, whose moat and walls still exist. On the old staircase is a good example of a dog-gate; and two of the bedrooms have interesting oak entrance-lobbies. Of another style of architecture is the fine old manor house and buildings at Upper Doweswell, occupied by Mr. J. Arkell.

Doddle's Hole, at Whittington, is of special interest, because here, for generations, the Lower Freestone has been worked underground. It is a massive bed, overlying the Pea Grit, and yields the best building stone in the district: its good qualities are apparent in Whittington Church and Court. From Cleeve Hill to Colesbourne a special feature of the geology is the persistence of the Upper Trigonia-Grit upon beds which were denuded before its deposition. At Cleeve Hill there are, between the Upper Trigonia-Grit and the Notgrove Freestone, beds about twenty-five feet thick; at Cold Comfort only four feet; but in the Hilcot Valley the upper bed rests directly on the lower; and at Colesbourne, the Notgrove Freestone has entirely disappeared—the bed immediately below it has the Upper Trigonia-Grit resting on its surface. The explanation of this interesting feature of the district is that there had been a considerable amount of denudation of the beds below the Upper Trigonia-Grit, before that bed was deposited. Some of the details of this geological feature the members were able to study,
visiting sections on the route from Dowdeswell to Colesbourne down the Hilcot valley: which, by the way, is a remarkable piece of river excavation. On the return journey from Colesbourne, a brief visit to Seven Springs gave Mr. Buckman an opportunity to explain the changes which have taken place in the configuration of the district since the Chalk spread not only over the Cotteswolds, but also over what is now the Severn Vale.

The last Field Meeting of the Club was held on Tuesday, the 31st August, when the members present were most ably chaperoned by Mr. Winwood, who has kindly written the following geological notes of the day's excursion.

On leaving Charfield Station the attention of the members was invited to an exposure of vesicular basalt at the side of the road west of the station. It was difficult however to recognise the section now as the excavation has been filled up with refuse. On the top of Hammerley Down a halt was made, and an old quarry of Lower Limestone Shales, on the left-hand side of the road, inspected.

At the bottom of the hill a fine quarry, worked in the Lower Limestone, was seen, the beds dipping rapidly to the south, some of the upper beds being oolitic. Passing through Bibstone and Cromhall—the northern apex of the Bristol and Gloucestershire coal-basin—the members crossed the Old Red Sandstone of Milbury Heath, and, after luncheon and a long drive, found themselves beneath the Rhætic Cliffs of Aust. A shelter having been sought in vain from the high wind, Mr. Winwood described the section to the few energetic members who braved the gusts, under difficulties. Having on a geological map shown the day's route, and that they had crossed from the eastern edge of the coal-basin to the western, he said that every member of the Cotteswold Club ought to be
familiar with the admirable section made by their old and valued member, Mr. Etheridge, to be found in the Proceedings, vol. IV., 1866. In the 150 odd feet of sandstone, marls, and limestones they had one of the finest successions of beds from the Triassic Marls, resting upon the upturned edges of the Mountain Limestone, to the Rhætic Beds and White Lias above, that exists anywhere, rendered classical by the many eminent geologists who had described them. Notwithstanding this there was still something left for Cotteswold geologists to do, namely, to accurately measure and describe some 13 feet of the top beds which Etheridge had omitted from his section: they were very difficult of access. The shortness of the time, as usual, only allowed a hasty traverse along the shore; but many fossils were collected, e.g. fish scales and teeth, saurian vertebrae and bones, *Pecten valoniensis*, slabs covered with *Pullastrea arenicola*, blocks of Gotham marble and the iron-pyritised bone-bed, the result of falls from the cliff above. But no teeth of *Ceratodi* were obtained—local collectors probably having carefully watched the opportunity of securing these notable teeth after violent gales had brought them down from the cliff.

After entraining at Thornbury, the entire succession of the Carboniferous Limestone beds was passed through, from the Lower Limestone shales, through the Lower and Middle, to the Upper Limestones, so well exposed in the Tytherington quarry, of which a section is given in the Proceedings, Vol. IX, p. 325.

During the winter three afternoon meetings were held, when papers were read, which will be found printed in the forthcoming portion of the Proceedings.
In the early days of Geology chalk was thought to be a chemical precipitate of carbonate of lime. The microscope, however, long ago proved this a mistake: it is almost entirely composed of the remains of minute organisms.

Of these microzoa the Foraminifera are by far the most important, numerically; in fact it may safely be asserted that our chalk hills are composed of countless millions of the shells of these minute creatures. Ehrenberg endeavoured to form an estimate of the number of their shells in a given mass: he came to the conclusion that a cubic foot of the material contains something like 200 millions. Dr. M. C. Cooke also experimented on several samples: and his conclusions were similar to those of Ehrenberg.

These investigators only estimated the number of the shells of Foraminifera. I venture to assert that the coccoliths (which are usually taken to be organic bodies) outnumber the Foraminifera by a million to one. The number of Foraminifera which can occupy the space of a drop of water can be counted with some approximation to truth, but the coccoliths which may be taken up in a drop of water are absolutely beyond computation.
Both divisions of the Foraminifera, i.e., the Imperforata and the Perforata, are found in chalk. The most numerous forms belong to the latter division: Globigerina, Rotalia, Textularia (Plate A, figs. 8, 9, 15), and Cristellaria may be mentioned as exceptionally plentiful. Trochammina, Quinqueloculina, and one or two others, belong to the Imperforata.

Altogether about 40 genera of Foraminifera have been detected in the Chalk. Many of the forms, such as Globigerina, Rotalia, Bulimina (Plate A, figs. 3-5), Cristellaria, Truncatulina, Textularia, Quinqueloculina, etc., are not to be distinguished from their living analogues: this was one of the reasons which led Sir Wyville Thompson and Dr. Carpenter to promulgate their theory of the continuity of the Chalk. Occasionally I have found among the other forms portions of shells which appear to be composed of grains of sand, or other granular matter, agglutinated together: they would seem to belong to the arenaceous Foraminifera. Further I may mention one singular form to which I am unable to assign a place. It consists of a spherical cell covered with spines of considerable length, as compared with the size of the organism; and, from what I take to be the base of the cell, a long, slightly curved stem proceeds—its extremity appears to be broken off. The mouth is at the apex, upon the summit of an obtuse, conical elevation. The whole very much resembles an apple with a long stalk, covered with spines, the mouth taking the place of the apple’s eye (see Plate A, fig. 1.)

The next in importance of the microscopic organisms of the chalk are the sponge spicules, which are both

* The Foraminifera are placed in the divisions Imperforata and Perforata on account of the structure of their shells: those of the former are white, opaque and not traversed by canals, or tubules; while those of the latter are more or less transparent, or more correctly translucent, and traversed by canals or tubules, through which the pseudopodia are protruded.
numerous and varied in shape. The sponges of the chalk are very numerous; some authorities, in fact, consider that the flints are formed solely from the silex derived from silicious sponges by a process of dissolution and re-solidification. Other authorities hold different views; but, as I do not propose to enter upon a discussion as to the origin of flints, suffice it to say that a very considerable percentage of flints contain well-preserved sponge spicules, and spicular network, and in some cases entire sponges, enclosed in their masses.

All the chalk sponges appear to belong to the silicious class—at least I am not aware of any calcareous form having been found—and comprise the orders Tetractinellidae and Hexactinellidae. To the former belong the spicules which have 4 rays proceeding from a centre, the stellar forms, such as occur in Tethya, and probably all the acicular spicules. The latter order comprises the Ventriculites and their allies, which have a continuous spicular skeleton forming a beautiful though complex network. The structure of the spicular network of the Hexactinellids is best seen in sections of flint, although in the majority of specimens the finer structure is so completely obscured by iron oxide that the elegant lantern nodes at the points of intersection cannot be made out.

In some localities the chalk contains great numbers of ostracoda belonging to the genera Cytherella, Cythere, Cythereis and Bairdia. In a small piece of chalk taken from the hollow of a flint at Caterham Junction, I found no fewer than 5 different species, comprising all the above-named genera, except Cytherella.

Coccoliths, as I have stated above, occur in chalk in immense numbers: I have never yet examined a piece without finding them. These bodies are exceedingly minute, and require a magnification of 800 to 1000 diameters. Even then, to see them at all satisfactorily, it
is necessary to use an achromatic condenser with an angular aperture, adjusted for the angle of the objective, and very carefully centred. The coccoliths are of various forms, mostly consisting of an elliptical ring, either plain or marked by transverse lines, giving the ring a jointed appearance; and in many cases the space inside the ring is occupied by a granular film. Ehrenberg, Huxley, Wallich, and others have theorised about these organisms; but by a later authority they are believed to belong to the Algae. The best method (at least, according to my own experience) to obtain coccoliths for mounting is to take a small quantity of whiting, well mix it up with water to the consistency of cream, and then let it stand in a small beaker or large test tube until the heavier portions of the whiting have settled, leaving the water at the top apparently clear. Upon the surface of the water will be found a kind of scum, which should be avoided. With a rather fine-pointed pipette take up some of the water, taking care not to disturb the sediment; put a cork in the upper end of the pipette, and stand it, with the open point downwards, upon a clean cover glass, upon which a drop of distilled water has been placed. After about a quarter of an hour the coccoliths will have settled to the bottom, and will be found in the drop of distilled water. This drop should be spread evenly over the covering glass, evaporated very slowly, the residue moistened with benzole or turpentine, and mounted in pure Canada balsam.

Diatoms of several kinds are present in chalk—not abundantly, I believe; but still they are to be found. I have never searched specially for these organisms, and cannot say how many genera and species occur. Two species of Fragillaria are mentioned in the Micrographic Dictionary as having been found by Ehrenberg; and Dr. Carpenter figures a Navicula in his work on the microscope. Upon a slide which I mounted for coccoliths
I have one diatom which most resembles *Bacillaria*. It is quite worth while, however, to bear in mind, when examining chalk, that diatoms do occur in it.

The Polyzoa of the Chalk are numerous and interesting, and, as a rule, are in a splendid state of preservation. They all appear to belong to the order Infundibulata, sub-order Cyclostomata, i.e., those in which the cells have a simple, round mouth. I have a good many forms mounted; but as I have not been able to get access to any work upon the Chalk Polyzoa, I have not been able to gather much information respecting them. Beautiful specimens of *Diastopora*, *Alecto*, and other parasitic forms may frequently be found incrusting the shells of the commoner Echinoderms, such as *Micraster* and *Ananchytes*; and by washing the soft chalk which is found in the external hollows of flints many fragments of the erect-growing forms may be secured. Of the many specimens of Polyzoa which I have procured from the Chalk, not a single one has any appearance of having possessed the peculiar appendage called the "avicularia," or bird's-head process; and only one solitary example has vibracula. This is a somewhat singular circumstance, as in the Polyzoa of the Crag, and in the majority of living species, either avicularia or vibracula are present, and in some both occur. In most of the Chalk Polyzoa a few of the cells are found to be almost closed by a calcareous diaphragm, or extra growth extending inwards from the edge of the mouth of the cell, and having a very small opening in the centre. This appears to be in some way connected with the process of sexual reproduction.

I have already referred to flint in speaking of the sponges; but sponge spicules are not the only interesting objects to be found therein. In some specimens very perfect casts of the interior of the shells of the Foraminifera may be found, showing in the most complete manner the
connections between the several chambers, being, in fact, perfect pseudomorphs of the animals which formed and inhabited them. Again, scarcely a piece of flint can be taken which does not contain Zanthidia. In some specimens they are extremely numerous. The Zanthidia are said to be the sporangia of the Desmidiaceæ. Some 5 or 6 different forms occur in flint. Some flints also contain immense numbers of globular bodies which have been erroneously called Pyxidicula; they do not however belong to the Diatomaceæ, and it is far from certain what they really are: possibly they are sponge gemmules. I have in my cabinet a section of flint which is literally crowded with them.

Chalcedony is frequently found on the inside of hollow spongy flints, sections of which are lovely objects for the polariscope.

Polycistina are occasionally found in the chalk, but it has never been my fortune to meet with any.

The ordinary fossils of the chalk, such as the Brachiopoda, Conchifera, and Echinoidea, are not exactly microscopic objects; but sections of the tests, especially those of the Brachiopods, are very interesting; and so are sections of the plates and spines of Echinoderms. Fragments of bones which are occasionally found in the Chalk should also be submitted to microscopical examination, as by this means it may be determined whether the bone under examination belongs to the Mammalia, Aves, or Reptilia; and the microscope may also be applied to fragments of wood which are occasionally met with.

Echinodermata are plentifully represented in the chalk by the Echinidea or sea-urchins, and the Asteridea or star-fishes; but hitherto no remains of the Holothuria, or sea-slugs, have been recorded. Upon examining some washed chalk some time since, which I obtained at Caterham Junction, I was considerably delighted to find
a single wheel of *Chirodota*: it has 6 rays, and is \(0.0425\) in. in diameter (See Plate A, fig. 16).

Various methods are recommended in the Micrographic Dictionary and other works for the preparation of the Chalk Microzoa for examination with the microscope; but in my hands no process has been so successful as the following:—For Foraminifera, Ostracoda, Polyzoa, and such sponge spicules as are free in the chalk, my plan is to procure the very soft chalk from the deep hollow cavities on the exterior of freshly extracted flints: while damp this has somewhat the consistency of putty, or clay, and contains the most perfect and the largest organisms, and a greater number of spicules than chalk taken from a distance from flints. This soft chalk, upon being placed in water, immediately breaks up and falls to the bottom of the vessel in a kind of mud, without the need of any brushing or other pulverising process. The chalk and water should be shaken and allowed to settle, and the water poured away a good many times, regard being had to whether the smaller forms are required or not, and as a rule this will be found sufficient; if, however, the organisms are not found to be perfectly clean, a good boil in strong soda, and decantation, will invariably be found sufficient. Care should be taken in the soda-process to keep the test tube continually in rapid motion, otherwise it is apt to spurt and so eject the organisms.

The soft chalky material from the interior of hollow spongeous flints frequently contains good specimens of sponge spicules. This can be treated with acid, as the spicules are silicious. The preparation and mounting of sections of Flint and Chalcedony is, of course, best left to the lapidary; but sections of test, Echinid spines, and stems of Crinoids are easily made by grinding down upon a hone in the usual way: they should be mounted in Canada
balsam. Foraminifera, Ostracoda, and Polyzoa are best, I think, when mounted dry as opaque objects; but if it is desired to mount the Foraminifera in balsam, I consider the best process to be, to put some of the material, which must be perfectly dry, into a small test tube with some spirit of turpentine, and boil it until all the air has been expelled from the interior. Very little turpentine suffices. When the air has been expelled, drop in some pure balsam, and keep at a considerable heat for a short time in order to evaporate the turpentine, stirring the material so as to disseminate the organisms equally throughout the mass. The balsam with its contained forms may then be taken up with glass rod or a piece of wire, and placed upon covering glasses. The organisms may then be mounted without the slightest difficulty, and without any air bubbles.

The annexed Plate A illustrates certain of the organisms to which reference has been made in the text, as well as other noticeable forms. It will give some idea of the interesting and varied microzoa, whose remains, as the microscope reveals, make up the substance of what is known as chalk.

EXPLANATION OF PLATE A.

Fig. 1. Foraminifer, Genus? × 95.
Fig. 2. Gaudryina sp., × 120.
Figs. 3-5. Bulimina sp. var., × 58.
Figs. 6, 7. Frondicularia sp. var., × 58.
Figs. 8, 9. Textularia cretacea, × 76.
Figs. 10, 11. Pullenia sp., × 58.
Fig. 12. Glaudulina sp., × 38.
Figs. 13, 14. Rotula sp., × 40.
Fig. 15. Textularia sp., × 40.
Fig. 16. Wheel of Chirodota, × 200.

All the specimens are from the Upper Chalk, Purley, Surrey.
OBSERVATIONS OF A CYCLE TOUR,

BY

S. S. BUCKMAN, F.G.S.

(Read March 21st, 1898.)

In the summer of last year my wife accompanied me on a short cycle tour through some of the counties of West and Central England. The observations which I made during the journey have a general connection with lessons learnt in our own neighbourhood, wherefore they may not be unsuitable for placing before the members of the Club.

We started one morning from Charlton Kings, on the road to Coomb Hill. The route lies over a Lower Lias plain, and the changes by which this broad, flat vale has been produced are certainly remarkable. The sea of the early Jurassic Period, of course, once covered this area, because the Lias is now beneath the road; but the non-geological mind does not at once grasp the idea that the sea of the post-Liassic period also covered it, depositing strata like those of Leckhampton and Cleeve Hills. Yet the outliers seen on both sides during the ride—Bredon and Churchdown—are relics of such strata. Still less is it generally understood that the Cretaceous rocks must also have overspread all this district. Yet the sea, which deposited
those rocks in Wiltshire and in the North of Ireland, must have been continuous, unless it was interrupted by any Palæozoic land-area. And there was no such possible land-area in the Severn vale this side of the Malverns.

So to commence the story of the Severn Valley, it is necessary, in imagination, to refill that valley with its lost Jurassic and Cretaceous strata, and then to tell the tale of its excavation out of a great Cretaceous plain—like the Wiltshire Downs—raised, perhaps, 3000 feet above the present level of the road to Coomb Hill.

At Coomb Hill we turned to the right towards Tewkesbury, running along a ridge. And this ridge is not easy to account for. I have surmised the possibility that it is the relic of one side of an old river-valley: that the Avon flowed east of this ridge, past Tredington, into the present course of the Chelt, to join the Severn where the Chelt does now; and that subsequently the Avon obtained connection with the Severn at Tewkesbury. The right-angle turn of the Chelt below Boddington, and the alluvium in which the old canal to Coomb Hill is cut, seem to support this idea.

We turned off from the Tewkesbury road, took the way to the Haw Bridge, crossed the Severn there, and followed the road to Ledbury. On this journey there is a fine south-end view of the Malverns. They are grand merely as scenery; they are far more remarkable in their geological aspect.

For the Malverns stood up as a shore line—a huge bluff of cliffs—against which beat the waves of the Jurassic sea. They are the merest relic now of what they must have been then. For just as it is necessary to continue the strata from east to west in order to picture the Severn Valley before its excavation, so it is necessary to continue the strata from west to east, in order to restore the Malvern Hills.
Strickland made such a restoration of the Malverns, shewing a “great fault” of some 12,500 feet.* Though the details of his diagram may be open to criticism, yet it forms a good basis upon which to start in the reconstruction of what may be called the lost strata of our own country. Thus on the east he shows about 11,000 feet of Palaeozoic rocks above the present level of the Malverns. On the west we may place, above sea-level, Trias rocks about 4000, Lias 1800, Oolites 2000, and Cretaceous 1200 feet. The given thicknesses are only approximate: they probably understate the case; for near a shore line would be expected a greater accumulation of strata than at a distance.

The Cretaceous strata would be unconformable to the Jurassic rocks. And by the time the Cretaceous strata were laid down the degradation of the Malvern land-area by denudation during Jurassic times would have sufficiently lowered it to permit of its submergence beneath Cretaceous deposits.

Since it is evident that the Malverns must have stood up as land while the sea was depositing the rocks of the Cotteswold Hills, and since it is thus possible to map the relative areas of land and sea in this district, it is not uninteresting to study a map of the world constructed from similar data, showing the distribution of land and water during the Jurassic Period. Three rather remarkable points then demand attention. First, all the great mountain ranges of the world—the Andes, the Rocky Mountains, the Himalayas, the Alps, the Caucasus—were, like our Cotteswold Hills, being slowly formed in the bed of the sea during Jurassic times: they have all been raised to their present positions by subsequent earth movements.

* 'On the Elevatory Forces which Raised the Malvern Hills;' Phil. Mag., 4th ser. vol. ii., p. 11, pl. 1. 1851. (Reprint in "Scientific Writings," p. 192.)
Second, South America and Africa are supposed to have been joined together as a great continent; North America stretches over beyond Iceland, but is separated from the southern continent by a comparatively narrow sea, wherefore the Atlantic, as an ocean, is of comparatively late geological date. Third, Europe is mostly under the sea: it is the area of an archipelago of which Wales, Brittany and Ireland joined together formed a principal island.* Of this island the range of the Malverns, May Hill, and so forth formed the eastern coast line; and this ancient Jurassic coast line can be observed at many places in our district with often a great stratal unconformity.

Further about the Malverns: the noticeable serrated edge and the dry valleys leading down from the hill tops —some of them, as for instance that at the Holly Bush, very conspicuous on the route taken—are due to denudation; but it is a denudation largely accomplished at a time when the Jurassic strata were level with or even above the present height of the Malverns, when such strata were contiguous to the older rocks, just as is the case with the Mendips to-day, and when the drainage passed equally over newer and older strata, before the existence of the Severn Valley.

Our route was continued to Ledbury. A noticeable point in the scenery of that district is the valley excavation. Taking into consideration the full width across from the highest ground on the one side to the highest ground on the other side of such a valley as that of the Leadon, two points become of interest—the height at which the river must once have flowed, the width and depth of the valley it has excavated.

There is a quaint legend attached to Ledbury. It has a geological origin, for it relates to certain hollows excavated

* The map is given by Emile Haug in his article, 'Jurassique,' in "La Grande Encyclopedie," Paris, 1894, p. 325.
in the Old Red Sandstone rock. Most satisfactorily, of course, the legend accounts for them. It is as follows:—

"A person, said to be a girl with a pair of pattens on, having stolen St. Catharine's mare and colt, and led them down several brooks to avoid detection, the saint, upon being informed of her loss, prayed that wherever the animals and thief trod the marks of their feet might be left, and that in answer to this prayer the prints of the animals' feet and also of the patten rings, were deeply indented, not only in the earth, but also in the stones whereon they trod, and thereby they were traced to and found at Ledbury."*

A worthy Worcestershire antiquary is said to have been dissatisfied with the saintly part of this explanation. He argued in a valuable pamphlet that the marks were really made by antediluvian mares and colts.

Beyond Ledbury is some interesting Old Red Sandstone country. It is fertile and suited to the growth of hops. Irish labourers come over for the hop picking.

Some miles beyond Ledbury, on the Leominster road, is a place called England's Gate, suggestive of a former boundary between English and Welsh. The influence of the latter was also brought home to us in another way. We took a wrong road here, and were informed that it would lead us over Dinmore Hill. The name shows very little alteration from the original Welsh *Din mawr*, the big hill. In our own district the Welsh origin of place-names is generally more involved: they have taken an English form. As an instance may be cited Garrick's Head, a well-known place on the Gloucester to Stow road—its first word is *Garreg*, a common Welsh place-name connected with *careg*, a stone. The whole is possibly an Anglicised version of *Garreg sad*, firm stone. So, too,

such place-names as Toadsmoor, Tudmoor, Todmore, to be found in our district, received more or less of an English dress to make sense—Anglo-Saxon Tāde, a toad, mere, a pool; the British original was Taωdd, wetness, mawr, great. But some of our place-names have been little changed: Maisemore, near Gloucester, is maes, mawr, big field; Wycombe, near Andoversford, is Gwy cwm, water valley.

We passed on through Leominster, and bore away for Mortimer's Cross. Noticeable on the journey was the escarpment-cutting by the river Lug. Such escarpment-cutting where the river is still engaged in doing the work, gives an interesting clue to the origin of our Cotteswold escarpments, at the base of which no river now flows. For instance may be cited the escarpment at Puckham Wood, near Cheltenham. It is plain that a river once flowed at the foot of that, but the action of denudation in decreasing the drainage area, coupled probably with a greatly diminished rainfall, has caused the complete disappearance of the river. But the escarpment remains as evidence of its former existence.

Escarpment-cutting is only another phase of valley-formation; but the difference may be noted. When the river cuts through inclined strata in the direction of their dip, a valley is formed with, approximately, equally sloping sides: the width of the valley and the steepness of the slope depend in a large measure on the rapidity of the river's fall. When a river cuts through inclined strata at right angles to their dip, then the feature of escarpment-cutting is produced: that is to say, a valley is formed with very unequally-sloped sides. The side with strata dipping towards the river has a long gentle slope; it has lost more material because of the facility given by the dip for the transport of its rocks to the river; but the side which dips from the river has a steep slope, and however
much the river cuts it back, it still, on account of the dip, tends to retain a cliff-like face. The extreme difference in unequally sloping sides of a valley is produced when the river runs at right angles to the dip, but obviously the difference lessens as the river takes more and more of a course in the direction of the dip. If the equal-sided valley be represented by $V$, and the extreme unequal-sided by $L$, all the gradations between $V$ and $L$ may be obtained as the river takes intermediate courses in regard to the dip of the strata-courses between that with the dip and that at right angles thereto. So all the varying features in the sloping sides of our valleys, and the scenery thereby produced will be found to have connection with the direction of rivers in relation to the dip of strata they cut through; and the depth of the valleys has relation to the rapidity of the fall of the stream, among other factors.

And speaking of valleys, the opportunity may be taken to point out that our district shows three kinds—1st, those which a stream is now engaged in excavating; 2nd, those which a stream has excavated, but where there is no stream now; 3rd, those which may be called duplicate valleys, like the Chelt valley and the Winchcombe valley. Their upper portions have been cut out by a stream flowing in one direction. When this stream was tapped they became dry valleys, then their lower part has been cut again by a stream flowing in the opposite direction. So they are really composed of one valley beneath another valley.

Again, these types of valleys might be subdivided according to the general directions of the excavating streams in regard to the dip of the strata.

We passed on to Mortimer's Cross, famous in the Wars of the Roses. As it was about 50 miles from our starting place, we were more interested in tea, and we
were glad to find suitable accommodation in the hotel of
Mortimer's Cross, not far from where the cross itself is
situated.

This hotel seems to be a convenient stopping place for
cyclists from the Midlands on their way to the Welsh
coast, say, to Aberystwith. Those who journey from our
district may, perhaps, like the hint as to its suitability, its
historical associations, and other interesting features.

However, we could not stop; we had to go another 10
miles to our friend's house, situated near Leintwardine, in
Shropshire. This is the Roman station Bravinium,
which is presumably a careless Latinization of wardine—
the Latin 'v being properly w. There is a street in the
village called Watling Street, and the Roman road runs
northwards from the village over the hill to Craven Arms.

There are really in the neighbourhood two Roman
roads known as Watling Street—an east and west road
from London to Shrewsbury, and a north and south road
from below Hereford up to Manchester. This Watling
Street is a part of the latter.

Leintwardine is an obvious Welsh name, and there are
several place-names in the neighbourhood ending in
wardine, for instance, Pedwardine, Lugwardine, etc. In
this case Leint is the Welsh Lliant, a stream, war is
\( g\var \), meaning 'water,' from the same root as Sanskrit
\( \var \), water, Greek \( \varepsilon\varpsilon\nu\varrho \), Latin ur\( i\)na, and Welsh \( gwern \),
a swamp, \( gweren \), a sauce: but dine demands special
notice.

Isaac Taylor* finds a somewhat similar river name in
"the Tyne in Northumberland and Haddington, the
"Teign in Devon, the Tian in the Isle of Jura, the Teane
"in Stafford, the Teyn in Derbyshire, and the Tynet in
"Banff." He connects it with Don or Dan in Danube,
Don, Dneiper, etc., or with Celtic Tian, running water.

I feel doubtful about his association of *tyne* and *don*; the latter presumably has reference to colour. And possibly the *dine* in the compound words ought not to be associated with *tyne*—it may have an adjectival force, and be derivable from the Aryan root *tan*, to stretch, and so denote a narrow stream. Some of the names in our own district—of places situated on small streams—seem to contain the same word as in the Shropshire instances, but in a median position; for examples, Boddington (Botintune), Cheltenham (Chinteneham), Withington (Windentune)—the names in brackets are those given in the Domesday Book.

Having got so far towards the etymology of Cheltenham, further suggestions may be made. The ending *cham* may be a corruption of Welsh *y cwm*, the valley. The difficult part is *Chin*. This may be a corruption of a river name *Sin*, found in Shannon, called by the Romans *Sena*, or *Seenna flumen*, and in the name of India, *Sindhu*.

The neighbourhood of Leintwardine is very rich from an antiquarian point of view. My host wrote to me:—

"Within less than a 10-mile radius we have Brandon "Camp, the Watling Street, the British Camp on Coxhill "Knoll, Caer Caradoc, Hopton Castle, Warfield Bank, "Norton Camp, Stokesay Castle, etc." And Offa’s dyke is at no great distance.

Of these interesting places we chose Caer Caradoc for the next day’s excursion. It is said to be the camp where Caractacus made his last stand against the Romans. To reach the camp we proceeded up a river-valley, where is a place called Redlake. Legend says that the origin of the name is connected with the slaughter of the British in this last stand: the stream became a lake of blood in consequence. But a more prosaic interpretation may be suggested: in Welsh *Rhydd* is a ford, *llaca* is mud, or
llech, a flat stone; and the name has reference to the character of a crossing of the stream at this point.

The Shropshire valleys seen on this day's excursion differ appreciably from most of those in the Cotteswolds. They are deep and narrow, and are not, as is so often the case in the latter, out of all proportion to the width of the contained stream. These differences tell much in regard to their history and development.

The hills also differ much from those of the Cotteswolds. They have a peculiarly rounded appearance, and there are not the angular cliff-like outlines such as are found in our district.

Occupying one of this rounded, isolated hills is Caer Caradoc. The hill is enclosed by the ramparts. The defence of the entrance is very different from what may be called the L shaped gateway, found in such perfection at Crickley Hill. At Caer Caradoc the inner ramparts are turned back towards the inside of the camp, so that the defenders could take the attacking force in both flanks as they assailed the gate.

The camp is very well situated to resist an attack: the steepness of the hill, on all sides defended by double, and, in certain places, treble ramparts, should have made an assault an extremely hazardous undertaking.

A visit to an oblong barrow—of a type between long and round—situated close to the banks of the river Clun, and to a large, circular, low elevation a little distance from it, occupied the next morning. The latter object may be compared to certain mounds in Standish Park, near Stonehouse, which the Club might profitably investigate.

The Clun valley where the remains are found is of a different character to the valleys traversed on the previous day. It is of considerable width, with broad belts of flattish land. The distance from the hill summit on one
side to that on the other shows that the amount of excavated material removed by denudation has been enormous.

In the afternoon we continued our journey—the destination Buildwas, about 25 miles distant. For the first part of our journey we purposely travelled along the Watling Street into Craven Arms. Thence our road seemed to be a constant succession of inclines for miles, till we reached the edge of the Severn valley, above Much Wenlock, when descent was rapid.

On the right, as we journeyed, Clee Hill stood out as a fine object, interesting to all cyclists as the source of the best roadstone. It is a fine example of the resistance which a hard rock, such as this basalt, offers to denudation. The geological history of this hill was ably sketched by the late Prof. Harker on the occasion of the Club's visit.*

Above Much Wenlock I observed pebbles, similar to what we know in this district as northern drift, heaped up by the roadside for use as road metal. I should like to have extended this observation, for there is little doubt that the pebbles are obtained from local deposits. In that case these deposits would be a continuation of the drift spread over the Cheshire Plain and the high ground north of the Severn, which would indicate that the Severn has cut the gorge at Coalbrookdale since the deposition of this northern drift debris.†

We know in our own district that very much denudation has been accomplished in the Severn valley since this drift was deposited. For the drift occupies the tops of hills in the Severn valley; and at Sedbury Park, near

* Proc., vol. xi., p. 239, 1895.
† At Ironbridge, near Coalbrookdale, the drift is 200 feet thick—H. B. Woodward, Geology of England and Wales, 2nd Ed., p. 492.
Chepstow, it is on the top of the cliff, high above the river. Wherefore the division of the cliff at Sedbury Park from its opposite counterpart at Aust, has presumably been accomplished since the deposition of the northern drift.

The neighbourhood of Much Wenlock and Buildwas is famous for Silurian fossils, and in the course of our descent to the Severn valley we passed several places where they are obtainable in abundance. It was from this district that George Maw procured such a large series for Thomas Davidson. The latter described to me how Maw used to work. He washed something like 11 tons of the shale, and the debris, sorted out by sieves, was spread on tables for women to look over, so that they might pick out the fossils. By this means thousands of specimens were obtained, and all the Brachiopods were sent to Davidson for the purposes of his monograph. There were as many as 10,000 specimens of \textit{Orthis biloba}. I asked Davidson how he accomplished the labour of sorting, and with a chuckle he replied that he engaged the services of some Brighton parsons for the rough sorting of the species, "because they had nothing to do six days in the week."

We duly reached the inn at Buildwas, and while a meal was being prepared we visited the famous Buildwas Abbey, a fine Norman ruin.

The next morning we proceeded down the Severn valley to Coalbrookdale. It is a fine gorge, with steep, well-wooded sides. In proportion to the stream it is very much narrower than the valley in Gloucestershire, and in any history of the development of the Severn valley such noticeable differences of width would have to be accounted for. If this Shropshire Severn was once a Thames tributary, as suggested by an American, Prof.
Davis, of Harvard College, and if it was comparatively recently tapped by a northern working back of the Gloucestershire Severn, then the resulting lowering of the level would produce a narrow gorge-like valley.

At Coalbrookdale we turned northwards, and climbing the Severn valley found ourselves on somewhat high ground—a wide, level plateau, the southward continuation of the great Cheshire plain. It is all Trias, though considerably overlaid with northern drift. Practically all the Jurassic strata have been removed from a great area many square miles in extent; but their former extension over the district is shown by the presence of one or two patches of Lower Lias, according to the evidence of geological maps.

The whole of the day’s journey—about 60 miles to beyond Knutsford—was, after the rise out of the Severn valley, practically over a level country. I do not remember noticing a hill on the route; but one thing we remarked, the excellence of the Cheshire sign-posts, a point wherein our county is behind hand. Our way was through Wellington, Hodnet, Market Drayton, Audlem, Nantwich, and Middlewich.

Our stay in Cheshire continued for several days, during which I took the opportunity to visit places of interest. Knutsford is noteworthy as the scene of ‘Cranford’ in Mrs Gaskell’s novel of that name, and several of her characters are taken from members of my wife’s

* H. J. Osborne White, ‘On the Origin of the High-Level Gravel with Triassic Debris adjoining the Valley of the Upper Thames,’ Proc. Geol. Association, vol. xv., Pt. iv., August, 1897, p. 157. This is a most interesting paper. To it and to its quotations from the writings of Prof. Davis I am indebted for what I may call a very rapid enlargement of ideas that I was forming as to the westward extension of Thames streams. My views will be found in ‘Cheltenham as a Holiday Resort,’ 1897, p. 50 and ‘Deposits, Bajocian Age: The Cleeve Hill Plateau,’ Quart. Journ, Geol. Soc., vol. liii. (1897), p. 607.
family—the Holland’s. It also boasts a dragon legend, which is thus detailed:

“The story is about a Thomas Venables, son of that Sir Gilbert Venables, who was cousin-german to King William the Conqueror. In the time of this Thomas Venables, says the old chronicle—’Ye chaunced a terrible dragon to remayne and make his abode in the lordehippe of Moston, in the sayde countye of Chester, where he devoured all suche p'sons as he laid hold on, which ye said Thomas Venables heringe tell of, consideringe the pytyfull and dayly dystruction of the people, w'tliowte recov'ie, who in followinge th' example of the Valiante Romaines, etc., etc., dyd in his awne p'son valiantlie and courragiouslie set on the said dragon, where firste he shotte him throwe with an arrowe, and afterward with other weapons manfullie slew him, at which instant tyme the sayd dragon was devouringe of a childe’.”

Wherewith the author compares the quaint “Legend of Wantley,” published in the Percy Reliques:

“This dragon had two furious wings,
   Each one upon each shoulder.
   With a sting in his tail, as big as a flayl,
   Which made him bolder and bolder,
He had long claws, and in his jaws
   Four-and-forty teeth of iron.
   With a hide as tough as any buff,
   Which did him round environ.

Have you not heard of the Trojan horse—
   Held seventy men inside;
This dragon was not quite so big,
   But very near betide;
Devoured he poor children three
   That could not with him grapple,
And at one sup he eat them up,
   As one would eat an apple.”

To explain the Knutsford dragon legend, the author gives a tale about a child, a minor, in danger from his guardian, who wished to seize the estate. But the dragon legend is too widely spread for such an explanation. It is related in regard to the parish of Deerhurst.† It is

* ‘Knutsford: Its Traditions and History,’ by Henry Green, 1869, p. 90.
† E. S. Hartland, ‘Folklore of Gloucestershire,’ 1892, p. 23.
brought forward in Revelations, where a red dragon is ready to devour a child,* and persecutes women; † there is the tale of Perseus and Andromeda; and many other stories might be cited.

Natural history will furnish the readiest interpretation of this wide-spread legend—an origin in the devouring propensities of beasts of prey generally—the characters of dragons being furnished by a bringing together in the form of one animal of all the special attributes of death-dealing animals, not omitting the wings of birds. To these are further added such man-slaying elements as fire and iron, to make a more terrible picture of the monster.

Knutsford is also famous for the meres in its vicinity—Rostherne Mere, Tatton Mere, Mere Merc. With the name reduplication in the latter case, our Cotteswold “Snowshill Hill” may be compared.

I visited Rostherne Mere. It is a grand sheet of deep-blue water, in a large basin-like depression, said, of course, to be unfathomable. It has a legend, which was told me as follows:—“That when the men were hanging the bells in the parish church, which stands on the edge of a bank sloping towards the mere, the biggest bell fell down and rolled almost to the edge of the mere. The men tried to haul it back, but it was so heavy that three times it broke away from them. Then one of the men swore—some wish that Old Nick had the bell at the bottom of the mere. Then the bell broke away, crushed the man who had sworn, rolled to the bottom of the mere, where it now lies. And at certain times, especially on the approach of rain, the mournful sounds of the bell may still be heard coming from the depths of the mere.”

I suppose that under certain conditions the surface of the water reflects sounds from a distance.

* Ch. xii., v. 4. † Ch. xii., v. 3.
The meres are stated to owe their origin to two causes, some to the one and some to the other. One cause is the dissolution by springs of the salt in the Trias strata: as a result a subsidence occurs. The other cause is Glacial action, which produced hollows in the drift.

Of Glacial action I obtained good evidence in a section of drift near a small stream by Mobberley, which is not far from Knutsford.* I brought away some well-scratched stones from a deposit of boulders and gravel embedded in a reddish clay. The scratches are very definite, and the whole surface of the stones has undergone much attrition. But something has happened to the stones since the wearing processes were in action, and before the time of embedding in the clay. Certain pieces have been broken off, leaving rough surfaces. They do not seem to have been knocked off by blows, and it is difficult to suggest what the agency has been.

From the position of this drift near the stream, certain inferences may be drawn. The denudation of the plain of Cheshire had been accomplished before the deposition of this drift. The somewhat shallow valley of the stream has been cut out subsequently.

Drift of another character, presumably formed of materials, removed by a stream during valley excavation, partly through drift, partly through Trias rocks, and redeposited as river gravel, was found in another section not far distant. Here I did not obtain any evidence of ice-action, though I cannot say the search was prolonged or exhaustive. But the interest of this gravel section was the finding of rounded pebbles by the side of sub-angular rock fragments, which had only their edges abraded. The

* Other Glacial evidence at Mobberly was furnished by large boulders by the road-sides. To one of these was attached a legend about a white lady who sits thereon and combs her hair. Dire consequences were to overtake anyone daring enough to attempt to move the stone.
rounded pebbles had been shaped by marine action, the sub-angular fragments by river water. But the marine action had had no share in the making of the gravel deposit: the pebbles had been rounded before they were enclosed in the strata from whence the river had derived them, namely, the Trias rocks. The lessons are that the least abraded fragments in a gravel pit indicate the agency, and that the finding of marine-rounded pebbles in a gravel is no evidence that the sea formed that particular deposit.

A lesson similar to the last was learnt at Alderley Edge. This is a fine Red Sandstone escarpment overhanging the Cheshire plain as a bold cliff. In the sandstone are numerous very rounded quartz pebbles. Where the sandstone had become disintegrated the pebbles were collected as a kind of gravel. But the rounding of the pebbles was anterior to the formation of the sandstone. Sitting on the cliff near these pebbles I wondered if, in propounding the theory of the "Straits of Malvern," the authors thereof might not have been led astray by finding in our local gravels sea-worn pebbles, whose date of abrasion was not that of the formation of the gravels, but of a period anterior to the deposition of the rocks whence they had been derived.

Rocks of such a character we saw in several exposures of Bunter Conglomerate during the first day of our return journey. A road section near Leek, in Staffordshire, was particularly fine, some of the embedded pebbles being as large as cricket balls.

The country about Leek is very hilly; it is, in fact, a southern portion of the Pennine range. From a geological point of view, perhaps, the true Pennine range might be confined to the area of the Palæozoic rocks; but the hilly country extends southwards to the Mesozoic strata. And the sculpturing of the strata of both Eras has been comparatively recent.
If the drainage of the Welsh hills formed the north-western tributaries of the original Thames river-system, then presumably the drainage of the Pennine range yielded the northern streams thereof. And among such streams a continuation of one would have flowed down the valley of the Evenlode. The westward working back of the Trent would have tapped these streams successively, giving them a shorter distance to a much lower level. In consequence they would have rapidly cut their valleys much deeper; and so would be produced the hilly country around, and south of Leek, by stream denudation.

From Leek we proceeded to Uttoxeter, the Roman station *Utocetum castra*. In asking our way we were told to enquire for Utchetur, if we wished to be understood. This reminds one of the story in Akerman's Wiltshire Tales—of the man who enquired of a native for Cirencester. The native knew no such place. "The next town!" "Oh, Zizitur, you mean, about two mile off."

By the road-side, south of Uttoxeter, there was evidence of much northern drift. I seemed to follow this drift all the way into the Severn valley, and on another occasion into the Thames valley, by Oxford. The importance of the distribution of this drift, and its connection with ancient river drainage has been pointed out by H. J. Osborne White.*

Owing to tyre troubles, the rain, and the hilly country we were not able to accomplish more than some 55 miles on our first day's homeward journey. It was necessary to halt for the night at a little village called Abbots Bromley.

The peculiarity and the similarity of features in a group-photograph attracted my attention here. Nearly all the faces possessed a broad, somewhat bulbous nose, with

wide nostrils. The character was so noticeable and so similar in all cases that I asked if it was a family group; but it was not, it was a group of school children with their teachers. So this facial character seems to be a racial peculiarity of the district.

The next day our joint tour was brought to a sudden termination. Owing to a collision with poultry, my wife had a severe fall, which necessitated her conveyance to the house of the friends we were travelling to visit.

Their house is situated near Lichfield, in the valley of the Tame, not far from its junction with the Trent. The width and remarkable flatness of this valley is noticeable; the latter feature seems to be due to a filling up with redeposited material. I gather from H. B. Woodward's 'Geology of England and Wales,' that the redeposited material in the Trent valley can be divided into eight beds, laid down during three periods of the Pleistocene; that Boulder clay is a great feature connected with Glaciers from the Pennine range; also that there is much chalky material in the Boulder clay derived from Glacial denudation of the Yorkshire wolds.

However, I had no time for exploration. In order to attend the meeting of the Club, near Cheltenham, on July 23rd, it was necessary for me to start the day after our arrival, July 22nd, leaving my wife to the kind nursing of our friends.

I passed through Tamworth, Coleshill, Kenilworth, Warwick, Stratford-on-Avon, and Evesham to Cheltenham—a ride of about 75 miles. A feature of this ride was that though I passed over the watershed of central England—between the basins of the Trent and Severn—yet I did not traverse any particularly high ground. This would mean that the drainage equilibrium between the Trent and the Severn is more nearly established than between the Severn and the Thames.
If the main drainage of England and Wales was originally Thamesward, and if the westward working back of the Trent, and the northward working back of the Severn has successively tapped the upper Thames tributaries, diverting them to the building up of their own respective river-systems, it is obvious that, in their contests with the Thames, the Trent and the Severn have both had the immense advantage of working at lower levels; they have, as it were, been able to undermine the Thames tributaries, and to give them a shorter and more expeditious outlet seawards. But, when they came into contest with each other, neither would have so marked an advantage; though that river, which had any such advantage, should ultimately gain on the other, until complete equilibrium was established.

In its contest with the Thames the Severn still has an immense advantage, as we may see anywhere along the line of our Cotteswolds; and it will retain this advantage until it has eaten its way far into the Cotteswold country, and until the degradation of that country has been carried immensely further than at present.

Another feature of this day's ride was the persistent evidence of northern drift apparently throughout the whole journey. There is a very fine section of this drift in the Avon valley at Bengeworth, near Evesham. I did not stop for its examination that day, as I had seen it on other occasions. The collection of materials is remarkable. There are pebbles and boulders of granite and similar rocks,* of quartz and quartzites, of Jurassic limestones; and there are broken up flints. All are mixed

* Some of the pebbles indicate much history. For instance, one is made up of angular fragments which must have been derived from the waste of an older rock. These fragments were cemented together to form a newer bed. That completed, the sea broke that newer bed into fragments, rounded this pebble, and laid it down as part of a newer conglomerate. Out of that it was taken by some agency and carried along to be a constituent of the drift in the Avon valley.
with a reddish sand, and deposited on an irregular surface of the Lias clay. Some of the blocks are as large as the hand can grasp, or bigger: one quartz block measured 5 in. by 4½ in. Many of the blocks are very rounded, others of all kinds are sub-angular. The Jurassic blocks are sub-angular. The flints are very little water-worn.

The great difficulty is to account for the presence of the flints. H. J. Osborne White wrote to me—"The presence of flints at Moreton [in-the-Marsh] and other places still more remote from any existing occurrence of the Upper Chalk is very hard to explain satisfactorily on any theory with which I am acquainted."*

The subject is one of much interest; but I wish to examine more of these exposures—for instance, those near Moreton—before I say much.

[In connection with the subject it may be mentioned that in a deposit of river gravel near Frampton-on-Severn, mostly composed of local materials, I found a lump of chalk. Writing from recollection and from where Mr. Lucy's paper† is not available, I think that this agrees with his experience. But whence came this chalk, and how?]

While in the neighbourhood of Evesham and the Avon, I may remark on the possibility of travelling from the Avon valley at this point into the Thames basin, and yet be in a valley all the time. From Evesham, the route is up the valley of the Isborne, past Winchcombe, to Charlton Abbots. Then there is a rise to higher ground, but it is only low ground in comparison with the surrounding hills. It is, however, the watershed of the Severn and Thames river-systems. And the valley of the Coln is entered just by Charlton Abbots.

* Letter, March 4, 1898.
This is a case of a duplicate valley. The upper valley was cut out by a stream which flowed past Evesham, along the course of the Isborne, and past Charlton Abbots into the Coln: it was a Thames tributary.

And yet this stream was probably not an original one. The more original stream took a course from north-west to south-east: an indication of a part of its course may be seen in the valley by Hailes, Pinnock, and Guiting. This valley is a fine example of a breach of the Oolite escarpment caused by an old river. A north-westerly extension of the Windrush was this river, reaching back towards the Malverns. This was the more original stream. It was tapped by the northward extension of the Sevenhampton branch of the Coln, when the main stream of the Coln came from beyond Cheltenham.

Time did not permit this matter being touched upon when the paper was read; but Dr. T. S. Ellis noticed in the discussion, that from the Severn at Tewkesbury up the course of the Swillgate into the Chelt valley by Dowdeswell, and so into the Coln valley, was all a following of comparatively low ground. And it seems that he had many years ago first enunciated the idea of this part of the Severn having taken this course into the Thames, and of the westward rising of Thames tributaries on the west side of the Severn valley, when that valley was not in existence, and when there was no Severn as a river in the present sense. I gladly take this opportunity to draw attention to his paper; for, if I may say so, it contains the germ of some remarkable ideas with regard to ancient river-courses which we are now beginning to understand.*

So I conclude the account of a tour expressly undertaken to a country where there are no Jurassic rocks, in order to give me a needed rest from geological work. How exactly it fulfilled its object may be gathered from this account.

* 'On some Features in the Formation of the Severn Valley as seen near Gloucester,' Gloucester Philosophical Society, 1882.
The crystalline rocks forming the chief mass of the Malvern Hills have received considerable attention from geologists. The following are the most important conclusions at which they have arrived.

Prof. John Phillips * regarded the crystalline schists as altered sediments of Pre-cambrian date, and the massive rocks, granites and diorites, as eruptive and posterior. He says distinctly of the schists, that "they were stratified, the traces of stratification remain."

Dr. Holl † pushed the views of metamorphism then current even further than Phillips, and assigned a metamorphic origin to some of the diorites. He referred these so-called metamorphic rocks to the "Laurentian" system. He described the mass forming the eastern spurs of the Herefordshire Beacon as being composed of "baked rocks," probably of Cambrian age, the alteration being regarded as due to the intrusion of trap dykes.

Sir R. J. Murchison* opposed the "Laurentian" hypothesis of Dr. Holl, and contended that the gneisses and schists are metamorphosed Cambrian strata.

Much more recently, Mr. F. Rutley† has suggested a modification of the views of Phillips and Holl, and has attempted to construct a succession amongst the foliated rocks. He thinks that the structural planes "sometimes certainly, at others possibly, indicate planes of stratification."

My attention was first attracted to the Malvern region by Holl's "baked rocks," which, from his descriptions, I suspected to be something very different. In 1878, I visited the ground, and was at once able to identify the rocks with our Salopian Pre-cambrian volcanic series,‡ which is now known as the Uriconian system. Both lavas and ashes were to be recognised in the craggy outcrops, but nothing approaching a succession could be made out. Happily, the local authorities of Malvern, with unconscious benevolence, have come to the aid of science by excavating a reservoir for water in the heart of these volcanic rocks, thus exposing to view excellent sections of the anatomy of the formation. It is now seen that the lavas and ashes clearly alternate with each other in bands which display definite dips and strikes. Mr. H. D. Acland, President of the Malvern Field Club, has published§ a short account of the rocks exposed in the cuttings; and it is to be hoped that he will work out the details of this interesting formation.

We now come to the crystalline rocks which form the core of the Malvern ridge from end to end. The main

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problem to be solved was the origin of the parallel structure which they so frequently display. Were the older geologists right in concluding that the gneisses and schists were once sedimentary strata, mere beds of clay and sand, which, under the influence of heat and pressure, had been transformed into the likeness of bedded granites and diorites?

In the year 1884, while studying the crystalline rocks of Donegal, I was struck with the fact that in one locality the massive granite of that region was distinctly foliated and bedded, as if it had been formed in layers; yet within a few yards of this foliation, the granite sent out veins into adjacent rocks. It was therefore evident that an apparent bedding was no proof of an original sedimentary condition.*

In the following year,† I found a similar phenomenon in County Galway. In addition, I ascertained that different kinds of igneous rocks, intruded into each other and, subjected to pressure, assumed a banded appearance. The different bands were therefore merely compressed veins, and not igneous sediments.

These studies led me to undertake an investigation of the Malvern crystallines, which I commenced in 1886, and continued for five years. The results were embodied in a series of three papers to the Geological Society of London,‡ the last of which appeared in the Journal for 1893. I propose in the present paper to sketch, in untechnical form, the chief conclusions to which I have been led.

All the crystalline rocks of the Malvern chain, excepting the volcanic mass at the Herefordshire Beacon, are in

† Ibid., Aug., 1887, p. 517.
‡ Ibid., 1887, p. 525; 1889, p. 475; 1893, p. 398.
their origin igneous and plutonic, not igneous and sedimentary. The apparent stratification is due to pressure, not to deposit under water. The crystalline condition is not superinduced upon an original fragmental structure, but is itself either original or a recrystallization under new conditions. To make the theory clear, a few details are necessary.

The Malvern crystallines were once an igneous complex, that is to say, they were a mass of igneous rocks, chiefly a granite, and two or three varieties of diorite, which were intruded into each other in veins, dykes, and masses. The diorites form by far the largest part of the range, and may be well seen in the quarries at North Malvern, in a large quarry in the Hollybush Pass, and indeed almost wherever rock is exposed. The granite is easily distinguished from the dark-green diorites by its pink or reddish colour. It usually forms veins in the diorite, but at the northern end of Swinyard's Hill, and at several other localities, it appears in considerable masses. The veins vary in thickness from several yards to a scarcely perceptible line. Sometimes they occur in great numbers very close together, and give the rock a distinctly banded appearance.

After the rocks of the complex had consolidated—or the greater part of them—the whole mass was subjected to enormous pressures, acting for the most part along a north-east and south-west line, which caused the rock here and there to give way, and flow along planes at right angles to the direction of the compressing force. I say "flow," but it will be readily understood that the flow of a solid differs from that of a liquid. A solid body yields to the pressure by fracturing; it can give way to the new stresses only by breaking into fragments, and these, as the crushing continues, are forced to shear and slide over each other. They take the form of lenses, thickest in the middle, and thinning towards the edge.
These lenses or lenticles are of all sizes, from the dimensions of a sofa-cushion down to the minuteness of a wafer. In the granite, which is a very coarse rock, they are much thicker in the middle than they are in the finer-grained varieties of diorite, where they are almost like uniform sheets, though of course they thin out towards the margin.

The bands of rock within which shearing and sliding have taken place, I have called "shear-zones." These zones vary in breadth between a few lines, or inches, and several yards, or hundreds of yards. They usually strike obliquely across the axis of the hills, and their laminated structure gave rise to the belief that they were composed of aqueous sediments subsequently metamorphosed by heat. This hypothesis, I may remark, was at the time, a very natural one, since deposition under water was the only cause known to the older geologists which was capable of producing a laminated or banded structure.

I need hardly point out that all this crushing and shearing must have been attended with the evolution of heat. The rubbing of two sticks against each other will cause heat enough to kindle the wood. What then must have been the result of the friction between flakes of solid rock, forced to slide over each other under inconceivable earth-pressures? An illustration taken from modern engineering will throw some light on the problem.

Dr. J. W. Redway, of Mount Vernon, New York, writing in "Science," in 1894,* describes a remarkable accident that happened to some machinery. A cone-shaped bearing was found to be too large for the cylindrical box in which it was supposed to revolve. Dr. Redway goes on to say: "A speculative workman thought it might "wear down to shape, and started the machinery. The "experiment, though of doubtful success from a mechanical

* Feb. 9, p. 79.
"standpoint, was brilliantly successful in another light. "The bearing and box, both of drop-forged steel, were "welded to each other, and broke into a dozen pieces. The "interesting point, however, was the fact that two forgings "of laminated steel under the agency of heat were con- "verted to a metamorphic form. At the surface of welding, "the laminated steel became crystalline, and even the parts "at some distance became semi-crystalline. It was a fair "illustration of what is now called 'dynamo-metamorph- "ism.'" The writer then goes on to compare the metamorphism of the steel under the influence of pressure and heat, with the metamorphism of the Malvern rocks as described in my memoirs, and he concludes that "in essential principles" the metamorphism in both cases is of the same kind. With this view I agree, and I point the moral of Dr. Redway's illustration by asking: If the forces developed in a steam-engine can do so much in such a substance as steel, how much more may be effected by enormous earth-pressures acting upon stone, which, compared with steel, is soft and friable?

That heat was generated during the metamorphism of the Malvern crystallines, can be demonstrated by the direct observation of microscopic slides. The fragments produced by the crushing are seen in an advanced stage of the schist-making to lose their angularity, and to be flattened out into minute cakes. These are often cement- ed together to form larger cakes or lenticles. In the completed gneiss, the fragmental structure is often entirely lost, but sometimes there remain a few crushed crystals of felspar to indicate, like an ill-cooked potato in Irish stew, the origin of the rock.

There will be little difficulty in understanding that all this crushing and shearing has been attended by great chemical changes. In the earlier stages, decomposition sets in; in a later stage, reconstruction occurs. Complex
minerals are at first broken up into simpler compounds, and these products often form new combinations. Take for example, the change frequently undergone by potash-felspar. This is a silicate of alumina and potash. In the metamorphism, a portion of the silica separates as quartz, and the remainder, in union with the alumina and potash, forms white mica. Apply this change to the metamorphism of the Malvern granite. This granite is a coarse crystalline compound of quartz and a reddish potash-felspar. The quartz remains unchanged. A part of the felspar breaks up into quartz and white mica; and the rest is reconstructed in granules, or in small crystals. Thus a binary granite, consisting of quartz and felspar confusedly intermixed, is transformed under pressure into a rock made up of quartz, felspar, and mica, with these minerals arranged in lenticular layers, so as to form a mica-gneiss.

Sometimes in the crushing process a portion of the rock proves too tough for the earth-mill, and remains unaffected. Owing to the shearing motion of the surrounding mass, this core is made to assume a lenticular form, while the planes of sliding curve round it, just as the current in a rivulet is divided by a boulder in mid-stream, and bends round it on each side. These lenticular cores are called "eyes," and the rock containing them is known as "augen-gneiss."

The activity of the chemical forces in the rock will obviously be greatly increased by its crushed condition. A crushed granite is almost as porous as a sponge. The products of the decomposition of a diorite, such as iron-oxide and chlorite, can often be traced into an adjoining sheared granite for many yards, passing between lenticular flakes and filling microscopic cracks. In this way, heated waters containing in solution alkalis, alkaline carbonates, and other chemical re-agents, can pass from place to place, and take an active part in the production of new mineral compounds.
The change from a massive igneous rock to a well-foliated gneiss or schist sometimes produces in an intermediate stage a curious mimicry of a sedimentary grit. The large quarry at the hamlet of White-leafed Oak exhibits this phenomenon. A coarse-grained diorite is intensely crushed. The felspar is broken up into angular fragments, the hornblende being decomposed into chlorite, iron-oxide, and other compounds. As the pressure increased, the fragments were rolled out into thin layers, with the soft green chlorite and the dirty-looking iron-oxide lying between the layers, and among the fragments. The resemblance of this rock to a laminated grit is remarkably close. In a further stage of metamorphism, this grit is converted into a well-foliated micaceous schist.

I must not enter into further details of the new theory of metamorphism. They may be seen in the papers to which I have referred.

In conclusion, I will indicate the great variety of gneisses and schists which have been formed out of the few varieties of igneous rocks contained in the Malvern range.

One of the most striking effects of the metamorphism is the production of mica. Three varieties of this well-known mineral have been generated in the Malvern rocks, white mica or muscovite, brown mica or biotite, and a silky white mica called sericite. One or more of these micas will be found in all the gneisses and schists in which the metamorphism has proceeded to an advanced stage; yet in the granites and diorites which have been the raw material of the metamorphism, not a scrap of mica occurs. All the varieties of mica which are found in the Malvern crystallines must therefore be regarded as of secondary origin.

These micas are formed in several ways. Potash-felspar, as we have seen, breaks up into quartz and white mica. Soda-lime-felspar may also be a source of mica. But the
most remarkable change that takes place in the Malvern metamorphism is the generation of mica out of hornblende. The hornblende yields, as a product of decomposition, the soft green mineral called chlorite, a silicate of magnesia combined chemically with water. In a further stage of metamorphism, this chlorite loses water and takes up potash, thus becoming a brown mica. It would seem then that all the principal minerals in the Malvern igneous rocks, except, of course, quartz, may be a source of mica.

Granite alone is converted into muscovite-gneiss, as we have already seen. Diorite, a compound of hornblende and soda-lime-felspar, is changed to a hornblende-gneiss, and in a further stage into biotite-gneiss. Sericite-gneiss also may be formed out of diorite. Some of the most interesting gneisses are produced by the interveining of diorite and granite. The contact of the granite with the diorite assists in the production of brown mica, and when the veins are numerous and near together, the intervening diorite becomes charged with the mica, and a beautiful gneiss results, in which the bands of red granite alternate with dark seams glittering with the mica.

These illustrations will perhaps suffice to explain the general theory of the metamorphism of the Malvern crystallines. A similar theory has been found to apply to the old gneissic rocks of the Highlands of Scotland, of Scandinavia, and of many other parts of Continental Europe, as well as to the so-called Laurentian gneisses of North America. Indeed, it is now generally admitted that all the older Archaean rocks of the globe are of igneous origin.
BEVERSTONE CHURCH AND CASTLE,
AND MALMESBURY ABBEY,

BY

F. W. WALLER.

(Read at the Annual Meeting, May 16th, 1898.)

BEVERSTONE CHURCH

The Church, dedicated to St Mary, was no doubt originally a Norman structure. It now consists of a nave, 40 ft. 10 in. by 19 ft., a narrow south aisle only 6 ft. wide, and the whole length of the nave, a chancel, 28 ft. 8 in. by 14 ft., a chapel on the north side known as the Berkeley Chapel 10 ft. 6 in. by 11 ft. 6 in., and a western tower.

The arcade between the nave and south aisle is an interesting example of transitional Norman work. This, the doorway under the porch, and the figure which has been inserted in the south wall of the tower are probably about the same date. Lord Berkeley is said to have rebuilt the Church (1331), not destroying, however, the whole work of his predecessors: probably a great part of the existing fabric belongs to that date, but the building appears to have been very badly treated when last restored, and it is difficult to understand some portions: for instances, the stone coffin-covers built into the south wall
of the nave, and the west wall of the Berkeley Chapel in the 14th century; also the arched canopy under the window in the south aisle, which probably covered a recumbent figure; also the skew passage or large squint in the Berkeley Chapel, and the rood stair. Bigland says: "In the great window of the Church are the arms of Berkeley, which was probably built by Thomas, Lord Berkeley in the Reign of Edward III."

There is an angle piscina at the south-east corner of the chancel very similar to that in the chapel at the Castle.

There is a good Edwardian pulpit on a modern stone base.

There is no arch or other opening from the Church, though I am told that a small doorway existed previous to the last restoration.

The jambs of the chancel arch have been cased on the front apparently, thus much injuring the effect of the responds of the inner arch.

Was the floor of the Church formerly lower than at present? See the part by the tomb. I understand that some very interesting mural paintings were destroyed at the last restoration, by being covered up with cement.

Some traces of decorative work still remain round the north door.

The roof and fittings are all modern.

BEVERSTONE CASTLE.

I feel very great diffidence in venturing upon any remarks on the subject of this Castle. The building and its history are most interesting, but I have not had either the time or opportunity for such study as I should have wished in such an exceptional case.

Unfortunately no plan of the building exists, either old or new, so far as I have been able to ascertain, and a good plan is an invaluable aid to investigations.
Had time permitted, I would have taken a plan myself; but to plot such a structure as this with fair accuracy, and to lay down the probable lines of the parts which have wholly or partially disappeared is a considerable undertaking, and one needing much careful research. I have only a rough sketch plan for reference.

For the following notes I am mainly indebted to Bigland and other known authorities.

The place does not appear to have been known in history until "Earl Godwine and his patriot host," marched from here to Gloucester to meet Eustace of Boulogne "in the autumn of 1051." Godwin did not actually reach Gloucester, so it is said, and the difficulty was got over, and Godwin reinstated in his position; but Sweyne, his son, was outlawed, and died at Beverstone, which they are stated to have seized: it appears in Domesday Book in 1086 as crown property.

There seems to be a doubt as to whether any Castle actually existed here in 1051, though Rudder says "some accounts expressly say that they (the Godwine’s) seized upon the Castle of Beverstone;" but he does not state whence this information comes.

It seems probable that there may have been a stronghold here before the present one; and Blunt calls attention to the fact that "the base of a circular tower of solid rubble masonry, 24 feet in diameter, was discovered in 1873 in the Rectory kitchen garden, opposite the west face of the great tower of the Castle, and 37 yards distant from it . . . . and some large chamfered stones were also found under the Rectory lawn, and their position seemed to indicate the presence of a gate of similar age."

Could these have been the remains of an earlier building, or were they outlying defences of the present structure?
Beverstone formed part of the Royal Manor of Berkeley which was Crown land at the Conquest, and was granted by the Conqueror to Roger de Berkeley of Dursley.

The Berkeleys having got into trouble in the wars between Stephen and Matilda, the property was granted by Henry II. on his accession, in 1154, to one Robert Fitzhardinge, son of a Bristol worthy; and Robert was born in Bristol.

The Manor passed to the 3rd son of Robert Fitzhardinge, who took the name of de Wearr, from a manor he held in Somersetshire, and then to his son Maurice, who assumed his mother's name of de Gaunt, and to him is ascribed the building of the Castle of Beverstone in 1225. There would appear, however, to have been great doubts as to his loyalty and intentions; and he was taken to "task" for having fortified his Castle without Royal permission.

He seems to have overcome the difficulty, and to have been allowed to complete the work; and Bigland says: "it "then became a military fortress, and was probably much "dilapidated during the Barons' wars." Blunt says: "the "lower parts of the Castle are all of this date, massive "Norman piers and groining still remaining in a perfect "condition, with external walls many feet in thickness." But nearly all appears to me to be of later date.

Maurice de Gaunt was succeeded by his nephew, de Gournay, and he again by his son, Anselm, and the latter by his son, John, whose daughter and heiress married John Ap Adam: and their son, Thomas, sold Beverstone to the 8th Lord Berkeley, in 1331, who is said to have reconstructed the Castle, without however destroying all the work of his predecessors.

The necessity for reconstruction is explained by Bigland's note as to the dilapidations during the Barons' wars.

There is a curious point connected with this reconstruction: the funds are said to have come from the
ransom of prisoners taken by Lord Berkeley, at Poictiers, (1356) but Lord Berkeley's eldest son, Maurice, was taken prisoner there by the French. Why was it that Lord Berkeley did not first ransom his son—was he an unnatural parent, or the son an unsatisfactory person?

The Manor next passed to Sir John Berkeley, and remained in that family for over 200 years. It was sold by another Sir John, the last of the Berkeleys of Beverstone, to Sir John Pointz, in 1579, and successively to Henry Fleetwood, Sir Thomas Earstfield, Sir Michael Hicks, and in 1842 to Mr Holford, whose son, Captain Holford, is the present owner.

During the early part of the 17th century, Smyth says that the Castle was kept in good repair, and was "often "inhabited by the Lord thereof;" but by 1840 it had become a farm house, for Nicholas Shipway (farmer) of the Castle was buried on August 27th, 1640. Subsequently, during the Civil Wars, the Castle was a point of contention between the opposing forces, its position being important for strategic reasons. It was held first by the Royalists in 1643-4, but Colonel Massey determined, if possible, to take it.

There is an interesting and somewhat amusing account of his first endeavour in this direction:—

"Colonel Massey brought up his men and two sakers against Beverstone Castle, when having surrounded it he "planted his guns within pistol shot of the gate and gave "fire several times."

"Fifty musketeers ran up to the gates at noonday and "fixed a petard, which nevertheless failed in execution."

"Those from within threw grenades amongst our men, "but hurt none, who, although thereby forced from the "gate, ran up a second time, being open to the full shoot "of a secure enemy, and brought of the petard with much "gallantry."
The attempt to take the Castle was abandoned for the time, but a second effort was more successful. The Governor, Oglethorpe, while away from his duties, as some say courting a fair lady in the neighbourhood, paid for his temporary aberration by being taken prisoner; and Massey, suddenly appearing before the Castle, and demanding its surrender, it was yielded to him, and from thence held by the Puritans.

According to Bigland, the Castle was burnt down soon after the siege, and a large dwelling house built within its walls; that house was also burnt in 1691, and replaced by the present farm house. But this hardly seems probable, it is more likely that the Castle was dismantled, and the old Hall turned into a farm house, as suggested by Blunt, and that this old hall, adapted as a farm house, was the house which was burnt previous to the erection of the present one.

Next, with regard to the building itself, of which I must regret there was no time to make a good plan. As before suggested, it is possible that an earlier stronghold may have existed, and that the remains found in the Rectory garden were part of it; and there may be remains of the Castle of 1225 in the lower portions and foundations of the present building, but it appears to me to be for the most part Edwardian.

Blunt gives the following general description:—“The reconstruction of the Castle by Lord Berkeley left it a fine quadrangular structure, with—so tradition states—four towers (though only two now remain) a Barbican, a large Banqueting hall on the site now occupied by the dwelling house of the Castle Farm, and a moat immediately under the walls of the Towers and Curtains.”

“The western face of this Edwardian Castle still remains, consisting of a large square Tower, 34 ft. by 30 ft., at the southern end, a smaller one, 24 ft. square, set
"angularly at the northern end, and a curtain between
"them containing roomy galleries, the whole side extend-
"ing to 123 ft. The distance from the outside of this
"face to the outside of the Barbican is 165 ft.; the whole
"area of the Castle within the moat may thus be reckoned
"at 2255 sq. yards, and the Court Yard must have been
"of small dimensions."

"The great tower at the southern end of the west side
"consists of three storeys, and is 60 ft. in height. The
"lower storey formed an entry and a guard room, the
"latter being lighted by a beautiful ogee leaded window,
"which remains extremely perfect, as may be seen from
"the bank of the moat."

"The ascent from the entry is by a newell staircase in
"an octagonal turret, which seems to have been added on
"to the main tower in a very insecure manner."

"The large chamber above the guard room and entry
"was probably appropriated originally to domestic use,
"but turned into a Chapel early in the 15th century, two
"sedilia and a piscina having been added, which are
"elaborately carved in a shallow and rather debased style
"of art."

"Another large chamber occupies the tower above this,
"forming the third storey; and northward of this is the
"more ancient Chapel, which is situated in the curtain,
"and beyond which is another chamber nearly as large as
"that in the tower."

"There are double slits or squints on both sides of this
"Chapel, so that although it is not large enough to hold a
"dozen persons, more than a hundred could be accommo-
"dated in the chambers on either side, most of whom
"could obtain a view of the altar through these squints,
"and all could distinctly hear the service which was going
"on there."
"The only trace of the Great Hall is the mark of the weather table, on the inner wall of the table adjoining the Great Tower."

"Below this is the roof of the present dwelling house, which preceded this, and which was burnt down, was the great hall itself, divided by floors and partitions."

"A noble gallery which, with the narrow passage between its western wall, and the exterior wall of the Castle, occupied the second storey of the curtain, is now roughly divided, and used as store rooms for farm produce."

"A handsome stone chimney piece of 18th century workmanship, shows how recently it was used."

"Beneath it, on the level of the courtyard, are vaulted offices, which are now used as dairy and brewhouse."

"Lower still, is the only underground portion of the Castle, a gloomy 'dungeon,' which lies immediately under the west end of the upper Chapel."

"This vault, whatever its use may really have been, is entered by a door near the guard room."

"The northern, or angular tower, has nothing remaining of its interior dimensions except the vaulting of the floor chamber, which is used as a coal cellar."

"Above the vaulting the tower is gutted to the roof, which itself is modern."

"If there was ever a curtain on the northern side of the Castle not a trace of it remains, nor is there any of the other two towers, which are said to have completed the square of the fortress."

MALMESBURY ABBEY CHURCH

In placing these notes before you I can lay no claim to original research: I fully acknowledge my indebtedness to a most valuable paper by the late Mr. E. A. Freeman,
and to an article, with a plan, which appeared in the "Builder," in March, 1895.

I do not propose to enter into any detailed account of the early history and foundation of the Monastery: this has already been dealt with in various able papers.

The generally received account of the original foundation is that Maeldulph built a cell at Malmesbury; that Aldhelm, a disciple of his, enlarged, in the 7th century, upon Maeldulph's work, founded the Monastery, and dedicated it to the Holy Saviour and St Peter and St Paul.

Mention is also made of two smaller Churches dedicated respectively to St Mary and St Michael. Aldhelm was transferred to Sherborne, but was subsequently buried at Malmesbury.

The Monastery received many grants of land and other benefactions from various donors, particularly from King Athelstan, who is said to have been buried before the altar in 941.

Passing over the interval between the original foundation of the Monastery and the rebuilding of the Church on its present grand scale, we find that this building is said to have been commenced by Roger, Bishop of Salisbury, about the year 1135, but the character of work would hardly bear out this view. Freeman says on this point: "It appears to be generally believed that the present Church was begun by Roger, Bishop of Salisbury, about the year 1135."

"This tradition seems confirmed by two passages of William of Malmesbury, neither of which directly "assert it."
"Certainly the architecture of even the earliest portions "of the Church is remarkably advanced for that date, but "this is no more than we might reasonably expect in the "works of a prelate so renowned for his architectural
"skill, and whom we might therefore naturally expect to "find at the head of the artistic developments of his age."
"If, then, we accept this date we may recognise in the "foundation of this Church one of the most memorable "epochs in the history of architecture in this island, for "we may safely set it down as exhibiting the first English "example, not indeed of the incidental use of the pointed "arch, when any special necessity rendered it desirable, "but, what is a very different matter, the first instance of "its distinct preference on æsthetical grounds in the main "arcades of a great Church."
"When this point had been gained, the battle between "Romanesque and Gothic was really won by the latter: "every Gothic detail now followed as a natural develop- "ment in its natural order."
"Malmesbury, however, happily exhibits the style just "after this first and greatest change had been accomplish- "ed, and no other commenced; every other feature is "still Romanesque."
"In short, while in a history of English architecture, "we ought to speak of Malmesbury as the earliest of "Transitional examples, it will, in practically describing "the building itself, be far more convenient, and indeed "far more accurate, to speak of its earliest portions as a "specimen of the pure Norman style."
"One remark, however, I must make. I mentioned "1135 as the date assigned to the commencement of the "Church. We must on the one hand remember that "great churches were not, least of all in the reign of "Stephen, finished in a year or two, and that the west end "would probably be the last part finished; consequently "Malmesbury nave may well be twenty or thirty years "later than 1135."
This is such an important point in the architectural history of this Church that I venture to quote the words of so great an authority in full.
PLAN. On reference to the plan it will be seen that the whole of the main walls are Norman, everything in fact to the clerestory level except some minor details, and the building consisted of the usual parts of a great Norman Church, the four arms of the cross and a central tower, and the dimensions, so far as they can be ascertained, were as follows: the nave, 150 ft. by 32 ft.; north and south aisles, each 12 ft. by 150 ft.; the central tower, 28 ft. by 28 ft. within the walls; he south transept, 39 ft., internal projection beyond the aisle, the width probably 30 ft. The size of the north transept cannot be determined, nor yet the sizes of the presbytery, and the eastern chapel which is said to have existed.

William of Worcester mentions some dimensions (gresons snos) from which it might be inferred that the length of the presbytery was 110 ft. east of the crossing, that is, a presbytery of six bays, with an eastern ambulatory supposing the bays were the same size as those of the nave (see plan in blue); but Freeman thinks that the presbytery was "a short Norman structure of 3 or 4 bays, as at Peterboro' or Romsey," (see plan in red.)

The large south porch is 14 ft. by 12 ft.

The cloisters and other buildings were to the north of the Church, as at Gloucester, and in their main features no doubt followed the usual Benedictine arrangement.

NAVE. The nave is divided into 9 bays, with arcades of slightly pointed arches resting on circular columns about 5 ft. in diameter. Above them is a triforium, with the somewhat unusual arrangement of an arcade of 4 arches enclosed in one semi-circular arch, all being Norman; above this again is a clerestory and vaulting of entirely decorated work, except at the eastern end where the 3-light decorated windows have been inserted in the Norman walls.

The unusual height of the clerestory (which appears to have been about the same in the Norman work) has a
particularly fine effect, and is far more satisfactory in design than that at Gloucester. Freeman says of it: "this "whole elevation must have been one of the very grand- "est in England; it has all the solemn majesty of a "Romanesque building, combined with somewhat of "Gothic inspiration."

There is, however, an unpleasing effect in the awkward lines of the long ribs of the quadripartite groining where they join the wall and pass down it.

Note the roof shafts rising off the caps of the columns, the elaborate mouldings of the arches, and the increased richness eastward, the arch labels and their terminations.

AISLES. These were lighted by single round-headed windows, with arcades beneath them, many of these remain with later perpendicular tracery inserted, and some have been entirely replaced with large decorated windows.

Note the treatment of that on north side—those on the north side are higher than those on the south, being above the cloisters. The vaulting is quadripartite.

WEST FRONT. The treatment of this was unusual in Norman work, at each angle was a large staircase turret, oblong on plan, with a wall connecting it with the west end of the nave, thus forming a façade which screened the terminations of the roofs westward. This façade was richly arcaded and divided into four storeys horizontally.

Freeman calls this façade "simply a sham," "the pro- type of that at Salisbury."

Lincoln and Wells were similarly treated, there was a fine Norman west doorway, which has now a perpendicular insertion within it, and above is a window of similar date.

A great western tower was added in the perpendicular period.

The construction of this appears to have been alto- gether exceptional and reckless: instead of being built on to the west end of the Church, as was the usual plan, it
was actually built over the last two bays of the nave, the western wall of the tower resting on the western wall of the nave.

Leland speaks of it as a "great square" tower, and Freeman suggests that such towers were to carry bells—the central towers acting as internal lanterns—and that the arrangement adopted at Malmesbury may have arisen from a desire not to injure the fine west front already existing, and because the form of that front would not have harmonised with a tower built out in the ordinary manner.

In carrying out this tower, so completely was it supported on the existing work that even the clerestory and cornice on the south side were not disturbed, nor the decorated clerestory and vault interfered with internally, an arch being thrown across above the vaults between the second piers westward, on which the east wall of the tower rested, and some additional support being obtained by strengthening the wall and pier, and by flying buttresses outwards: thus a fine west front was obtained, and no material alteration effected internally.

But this piece of reckless construction, though standing in Leland's time, fell subsequently, and in its fall destroyed the west end of the nave and north aisle.

SOUTH PORCH. This is a magnificent specimen of Norman work, with a subsequent casing in the decorated period. Possibly this is the most remarkable feature of Malmesbury, and, as such, merits a paper all to itself, especially as so much of the interest would naturally centre in the sculptures.

Professor Cockwell has treated of these in his work on the sculptures of Wells Cathedral.

There is a Norman doorway in the north aisle which gave access to the cloisters. This has a perpendicular insertion with groining of the same date over.
Central Tower and Lantern. The north and west arches of the central tower still remain, the latter being blocked by the later masonry. The effect of these great arches is extremely fine, and when complete, this lantern and tower must have been grand indeed. The tower is said to have been surmounted by a lofty spire—these fell previous to the Dissolution, and were not rebuilt.

Freeman says: "the character of the central tower which these arches supported we can only conjecture—perhaps we shall be nearest the truth in imagining a rich "Norman tower crowned with a timber spire of later date."

The Ritual Choir, as may be seen by the inner faces of the eastern and western arch of the tower piers, was under the crossing—as these faces have no projection, whereas those north and south have, and the arches above are stilted to compensate for the difference in width, and bring the arches level.

A perpendicular vault was subsequently introduced and cut off the lantern—the springing of this can still be seen.

Leland speaks, in 1540, of two steeples, one having a "mighty high pyramis," and which stood in the middle of the Church, and fell dangerously, within the memory of man.

Transepts. Of these a great part of the west wall of the south transept remains, and a small piece on the north side—they had no western aisles—and that on the south projected two bays beyond the aisles of the nave.

Presbytery. Of this only sufficient remains to show that the general character of the work was similar to that of the nave, but richer.

Externally. Of the external changes from the Norman work now apparent are the pinnacles and flying buttresses, which the decorated stone vaults over the nave, rendered necessary by the new clerestory with stone vaulting, and the parapets of the same date.
INTERNALLY. There are some points of interest which should be noted. The perpendicular rood screen still remains within the present church, and forms an altar screen; and stone screens of the same date, but with decorated tracery, exist at the ends of the aisles.

The tomb of Athelstan, so called, is now placed on the south side of the altar.

There is a curious projecting gallery on the bays of the south triforium, and Freeman suggests that this may have been a watching place of some kind.

As before pointed out, the cloisters and buildings were on the north side, and the ground here slopes rapidly down to the river. The effect of the whole group of buildings from this side must have been very fine. Some remains of the old buildings may be seen forming a basement to the old house to the north-east of the Church.

There is one point to which I should particularly like to direct attention, and that is the wonderful similarity in much of this Church with that of certain of the Romanesque Churches of the South of France.

The decoration on top of the abacus of some of the nave columns closely resembles that on a string at the Chapel of St Croix de Montmajour. At the Cloister at the same place are arcades of four arches beneath one.

The $T+$ is on an abacus in the Chapel of St Gabrielle, and at St Trophime (Arles).

The ornament over the north door is similar to that on the capitals of the columns in the cloisters of Vaison, and also at Montmajour.

(END OF VOL. XII.)

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15 JUL. 1901
PROCEEDINGS

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VOLUME XIII.

Parts I, II, 1899. Part III, 1900. Part IV, 1901

GLOUCESTER: 1899—1901
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HONORARY SECRETARY
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Vol. XIII. Part I.

JUNE, 1899
ANNUAL ADDRESS

TO THE

COTTESWOLD NATURALISTS' FIELD CLUB,

(Read at Gloucester, May 2, 1899)

BY

M. W. COLCHESTER-WEMYSS, PRESIDENT.

PART I.—FORMAL RECORD.

During the year members of the Club have not been idle: they have added to scientific and other literature. For instance, in the Quarterly Journal of the Geological Society are the following contributions:—

By Mr C. J. Gardiner, "On the Bala Beds and Associated Igneous Rocks of Lambay Island."

By Mr H. G. Madan, "On an Ebbing and Flowing Well at Newton Nottage, Glamorganshire."

By Dr C. Callaway, "On Metamorphism of a series of Grits and Shales in Northern Anglesea."

By Mr S. S. Buckman, "On the Grouping of some Divisions of so-called 'Jurassic Time.'"

By Mr H. D. Acland (an ex-officio member as President of the Malvern Field Club), "On a Volcanic Series near the Herefordshire Beacon."

A 2
The Palæontographical Society has published Part X. of the “Monograph on Inferior Oolite Ammonites,” by Mr S. S. Buckman, wherein many of our local fossils are figured and described.

Mr Arthur Gibbs has written an interesting work, entitled, “A Cotswold Village,” which is published by John Murray; and I would call particular attention to a paper, full of local references, by Mr S. S. Buckman, “On the Development of Rivers; and particularly the Genesis of the Severn.” It is published in Natural Science, vol. xiv., April, 1899.

It is evident, therefore, that we can congratulate ourselves. Our members are doing their best to maintain the prestige of the Club.

Concerning what has been accomplished by the Club in the way of meetings and scientific work during the past season, I give the following formal account.

The Annual Meeting was held at the School of Science, Gloucester, on May 16, 1898. The President read his Address, which is printed in Vol. XII., p. 197. The Treasurer read his financial statement. The President and the Vice-Presidents were re-elected. Mr A. S. Helps, who resigned the office of Secretary, was appointed Treasurer, and Mr S. S. Buckman was elected to the Secretaryship. Mr J. H. Jones, the late Hon. Treasurer, and Mr C. Bowly were elected Vice-Presidents.

The places selected for the summer meetings were—
Chepstow and Tintern;
The vicinity of Bath;
Silchester;
Woodchester and Avening.

A vote of condolence with the family of Mr W. C. Lucy was proposed by Mr William Leigh and seconded by Mr W. Stanton, and carried; as also was a vote of thanks to Mrs Cornford for the gift to the Club of the cabinet of fossils collected by her late husband.
For the first Field Meeting, held on June 6, 1898, the lower part of the Wye Valley was selected, and the members assembled at Chepstow station.

Starting from Chepstow, with Mr H. Saunders as local guide, the party soon halted to examine a quarry in the Mountain Limestone, when Mr Wethered gave an explanation of the genesis of these beds of rock, pointing out the important part played by microscopic organisms in the building of such beds of limestone.

The journey was then continued to the Windcliff, and when the party had ascended to the summit the beautiful view was much enjoyed. Here Mr Wethered sketched the estuarine conditions under which the Old Red Sandstone was formed. A gradual deepening of the water led to the deep sea deposit of the Carboniferous Limestone, which is mainly made up of remains of microscopic life. Shallower water conditions then again prevailed, and considerable sandy sediment brought down by rivers formed the Millstone Grit; and still greater shallowing brought the lagoon conditions of the Coal Measures.

Following up the geological record from the point at which Mr Wethered left it, Mr Buckman gave an account of the making of the Wye Valley, pointing out the inferences to be drawn from its configuration. (This paper is printed in the present volume of Proceedings, p. 25.)

From the Windcliff the party went to Tintern, and after lunch at the Beaufort Arms, Mr John Bellows read a paper, in which, taking Tintern Abbey as an object lesson, he traced the evolution of monasticism in this country, submitting evidence that the suppression of the monasteries was a just and necessary act. (This paper will be found in the Proceedings, p. 33.) The members then visited the abbey, under the guidance of Mr Saunders.

Returning to Chepstow, through Piercefield Park, the party went over the Castle. Here Mr Bellows discoursed
to his audience about the Roman occupation of the district. (A short summary of his remarks will be found at p. 45).

To finish the day a visit was paid to the residence of Sir William Marling, Bart., at Sedbury Park. Here, acting under instructions from Sir William and Lady Marling, the agent entertained the party to tea, and afterwards accompanied them to a portion of Offa's Dyke, which is on the border of the park. Only sufficient time now remained to drive to the station, from which point the return journey was commenced shortly after seven o'clock.

The second Field Meeting was held at Bath on Monday, June 27, 1898.

Nearly thirty members assembled at the Bath railway station, and followed the Vice-President (Rev. H. H. Winwood) to the famous Roman baths. A paper upon them and upon the Roman occupation of the city was read by Mr John Bellows in the concert room, which adjoins the Pump Room. (This paper is printed in the Proceedings, p. 47.)

Returning to the main bath, Mr Winwood and Mr Bellows conducted the party from point to point, throwing much valuable light on the architecture, the methods used in constructing lead pipes, the excavations, &c. In one corner the workmen found a teal's egg, which, said Mr Winwood, was a proof that after the retirement of the Romans there must have been a period of desolation, as such a wild bird would not lay its egg near the dwellings of human beings. Mr Bellows remarked, that the Romans paid a rental for the use of water, and it was based on the size of the pipe connected with the aqueduct. A man might draw as much as he liked through the pipe, but woe-betide him if he was caught tampering with it. Many thousands of tons of lead were exported from the
Mendip Hills to Rome, where it was used during the days of imperial greatness; and now some of it might be found on the roofs of modern Italian churches.

After thanking the Corporation of Bath for their kindness in allowing a free inspection of the ruins, and Dr Collins, their genial and attentive representative, the party lunched at Fisher's.

After luncheon, carriages were taken for Midford, to see the house of William Smith, the father of English geology, and also the sections in the neighbourhood.

In this journey the Foss Way was crossed, and then the Wansdyke; about the latter there was a discussion, which a passing shower cut short.

The Wansdyke is an earth rampart which, it is probable, originally crossed the country from the Thames, near Reading, to the Severn, at Portishead. In Savernake Forest and on Marlborough Downs it is a prominent landmark, and south of Bath its course is in places also clearly marked, sometimes, as at Hampton Down and Maes Knoll, by forming a boundary of camps. Eminent antiquaries have long held that the Wansdyke marks the boundary line of the last conquest of the Belgæ. But is the Wansdyke old enough to have been the boundary of the Belgæ? That prince of excavators, General Pitt-Rivers, has opened a part of the Wansdyke, in Wiltshire, and at the base of the mound he discovered some Roman nails. At that point, therefore, the Wansdyke, instead of being prehistoric, is post-Roman.

On arrival at Midford the party inspected the famous cutting of Midford Sands, and Mr S. S. Buckman pointed out how they are of later date than the Cotteswold Sands—the former being post-striatulus, and the latter pre-striatulus in the matter of date of deposition: striatulus is the name of a distinctive ammonite which marks a very definite horizon across England and on the Continent.
He also drew attention to the remarkable non-sequence—the Upper Trigonia-grit resting directly upon the Midford Sands, so that there is no representative at Midford of something like 200 feet of the strata of Leckhampton Hill.

A visit to the house of William Smith, and to the Fullers' Earth Works in the neighbourhood, brought the day's excursion to a close.

The third Field Meeting, held on July 20, 1898, had the Museum at Reading, and the excavations of Silchester for its objectives.

On arrival at Reading, the party proceeded to the Museum, a fine building with well-arranged collections under the care of Dr Joseph Stevens, as honorary curator. In his absence, the members were received by the assistant-curator, Mr Colyer, who courteously explained the very interesting collection of Roman relics obtained from Silchester.

After a well-served luncheon at the Great Western Hotel, the party drove to Silchester, the Roman city, Calleva Atrebatium.

On arrival at Silchester, the party were met by Mr Herbert Jones, one of the superintendents of the explorations, who courteously gave as much information as he could concerning the uncovered portions of the Roman city. The time at his disposal, owing to the exigencies of the train service at Reading, was all too short—for a visit to the museum and to the excavations in one day, so far from home, is really too much; but Mr Jones made the most of his opportunities.

The fourth Field Meeting was held at Nailsworth and Minchinhampton on Wednesday, September 21, 1898.

The party assembled at Nailsworth station, and proceeded to the High Beeches, where Mr A. E. Smith had made a small excavation, exposing a fossiliferous band of yellow sands, resting on blue clay. Two or three hundred
yards away, in excavating for a new church, a bed of yellow sand was exposed, containing ammonites of a different type from those at the High Beeches, and Mr Smith supposed that they might belong to beds above those in his garden, because the latter rest on blue clay. Mr Buckman, however, pointed out that in all the sections he has examined the ammonites from the church exposure occupy a lower position than those from the garden bed; and his experience is that the colour of beds is not to be relied upon as a test of horizon, even in a few yards. Indeed, when excavations were made for a gasometer, at Nailsworth, he found ammonites of exactly the same type as those at the church, not in a yellow matrix, but in a bed of blue colour; while at Chalford he had obtained ammonites of a blue colour but of a similar type to those in Mr Smith's garden. To call these beds, as is generally done, "Upper Lias" or "Cotteswold Sands," only leads to confusion in Mr Buckman's opinion. Mr Upton supported this view, having examined several of the sections mentioned by Mr Buckman. About 60 feet higher up the garden the well-known Cephalophoda bed is exposed, and Mr Buckman gave a description of its contents and its relation with other parts of England. Before leaving the High Beeches the archaeologists of the party, at the invitation of Mr Smith, jun., inspected an interesting little collection of antiquities found in the neighbourhood, the most noticeable of which was a hand-quern—a stone mortar with a handle.

A large gravel pit was next visited, in which there is evidence of deposition of gravel that had undergone little rolling; and running through the pit is a clay bed containing fresh-water shells, showing that the Nailsworth Valley has occasionally been turned into a lake.

Another object of interest was the remains of the 14th century church, formerly a chapel-of-ease to Avening,
which is supposed to have been destroyed at the dissolution of the monasteries. A portion of the edifice is now used as a schoolroom by Miss Tabram, who welcomed the party and read some notes on the building, made by her father. The piscina is now built into one of the walls, with the under part of the drain separated from the upper part, in order to show its use. Inside the building is an Anglo-Saxon bell, made of plates of iron, rivetted together in the shape of an inverted wedge. A somewhat similar bell was dug up at Gloucester a few years ago.

On the journey towards Avening a halt was made at Longfords, where various roadside sections were examined, concerning which Mr. C. Upton and Mr. S. S. Buckman gave explanations.

At Avening the party were met by the Rev. E. Edwards and Mr. Erskine Pollock at the entrance to the Rectory grounds, where the removed and re-erected remains of some long barrows were seen—noticable as an instance of mistaken archaeological zeal.

Then the Rector conducted the party over the interesting Norman church, and gave details concerning it. Three of the original Norman windows remain, two above the north and south arches of the tower, and one on the north side of the chancel; and the eastern arch of the tower, the tower groining, and some groining in the western bay of the chancel are also Norman. On the western jamb of the north-west tower-piers are what are supposed to be remains of a recluse’s cell. The porch and south part of the north transept are of thirteenth century date, and some of the windows in the nave and north transept were inserted a century later. Formerly there was a chapel on the north side of the chancel, and its piscina (partly formed out of a Norman window-head) still exists in the outside north wall of the chancel; and the presence of ancient tiles, a piece of melted gold, and
other relics within the area, suggest the possibility that the building was destroyed by fire. Since its destruction, an eastern bay, of considerable artistic merit, has been added to the chancel.

By the time the church had been inspected it was nearly two o'clock, and the members gladly responded to Mr Erskine Pollock’s invitation—an invitation entirely unsolicited—to luncheon at Avening Court. The kindness of the host and Mrs Pollock was gracefully acknowledged by Mr W. Leigh, of Woodchester Park, who was the acting president for the day.

From Avening the party went towards Minchinhampton, passing the large tumulus at Gatcombe, described by the late Mr G. F. Playne, and in the one chamber of which he found a long-headed skeleton in a sitting position. Near to it is the well-known Long Stone. Minchinhampton Church, with its monument to Bradley, the celebrated Astronomer-Royal, was hurriedly looked at; and then a move was made for the Common, where entrenchments, pit-dwellings, and worked flints indicate early occupation by man. Concerning the entrenchments, Mr Northam Witchell read a paper, which will be found in the Proceedings, p. 53. He also exhibited a series of worked flints from the neighbourhood; while the Hon. Secretary produced and described some other specimens from various localities, the series illustrating the different uses for which the implements were made.

Four Winter Meetings have been held during the past session, and we have been fortunate in securing an unusual number of papers on interesting subjects. They show how much there is to be done by members of the Club, not only in the immediate neighbourhood, but also further a-field. They will be found printed in the Proceedings, so that the first part of our thirteenth volume promises to fully maintain the Club’s reputation.
Part II.—A Gold-Bearing River in California.

Last autumn it fell to my lot to visit in California a property almost entirely owned by two friends of mine. The property comprises all the gold, timber, and water rights on a stream, called the Coffee Creek, some 40 miles long, a tributary of the Trinity River.

My journey there was rapid: in just a fortnight to a day after starting from Westbury I reached San Francisco. Yet I had time to see something of New York, including the great demonstration in the harbour in honour of the war fleet returning from Cuba; and I also made a short stay at Chicago, where I had the opportunity of examining Armour's marvellous establishment, with its many and varied subsidiary industries, mainly created for the purpose of dealing with some form or other of refuse from the parent undertaking.

After a few days at San Francisco, where, among other things, I visited the United States Government Agricultural College, at Berkeley, I took the train for Redding, a place some 150 miles north of San Francisco. Thence I travelled by coaches, of sorts, about another 80 miles to Trinity Centre, a small mining town on the Trinity River. Here I was met by horses and mules from the camp at Coffee Creek, and I started off for my friends' property.

The Cañon down which Coffee Creek flows enters the Trinity Valley some 10 miles from Trinity Centre. The Creek is a mountain stream of considerable volume in the spring and early summer; and it rushes tumultuously through a most romantic wild and rocky glen, the mountains rising thousands of feet above it on either side. From the Divide at the head of the valley to its mouth is a distance of about 40 miles, and the stream falls
altogether about 3000 feet. Nothing can exceed the wild beauty of the scenery. In most places rocky, and often precipitous, cliffs press right over the Creek; but here and there, as you ascend, you come across level plateaux formed by deposits of gravel of unknown thickness.

Wherever they can find foothold, and where they have not been destroyed by fires, groves of magnificent pines raise their tall crests hundreds of feet towards the sky, clothing the mountain sides almost up to the snow line. Wherever there is water, ferns, lilies, a very curious plant, Darlingtonia californica, and many varied forms of vegetable life flourish luxuriantly. In the lower parts of the valley there is a fairly dense undergrowth of Manzaneta, of tallow shrub, and several varieties of oak: at the higher elevations this is almost replaced by Azalea. Here and there on either side small Caños enter the gorge, each one seemingly more wild and lovely than its predecessor. As the Divide is approached, the valley widens out, and the forests become less dense.

There are not many varieties of Pine in the valley. Among them are the Sugar Pine, Pinus lambertiana; the Bull Pine, Pinus ponderosa; the Douglas Spruce, Pseudotsuga taxifolia; and a variety of Cedar, Thuja plicata. These trees grow to an enormous size. I measured many which had a girth of from 25 feet to 30 feet at 6 feet from the ground; up to that height there is a good big bole, but after that, up to 60 feet or 70 feet, the tapering is but slight, and they are usually straight as an arrow. Several that I measured, lying on the ground blown down by tempests, were 200 feet and over in length; and I must have seen thousands of such trees during my visit. Countless numbers are annually destroyed by fires which ravage the forests disastrously. The trees are generally covered, more or less, with a lichen of a lovely pale
yellow colour: and it is most curious to see a flash of fire run up a tree when the flame has once caught the lichen at the base. But it gives one a feeling of sadness to see these giants of the woodlands, with their foliage and vitality destroyed, still standing with blackened stem and withered branches, or lying prostrate, half burnt, and rapidly decaying.

The special "big trees" of California, the Sequoia sempervirens, and Sequoia gigantea are only found in the southern parts of the State; and I think the latter is practically confined to the Yosemite valley: the former, always known as "Redwood," covers thousands of square miles of land in the State, growing everywhere south of San Francisco within the limits of a certain zone of altitude above the sea.

Such is briefly a general description of the valley, wild and rugged among the mountains, sombre and mysterious in the silent shadows of the mighty pine forests; lively and enchanting where the Creek hurls its waters madly downwards over a never-ending series of glistening cascades. It is far removed from the busy throb of civilisation, but surpassingly lovely, and bathed in an atmosphere redolent with the odour of the pine forests, and so translucent as completely to deceive the stranger who unwarily judges the distance of a remote object by any ordinary standard.

There are few signs of life; as far as mankind is concerned they are almost non-existent, except that here and there you notice by the side of the trail a rough box fastened to a stake, which indicates that "John Webb," or someone, is prospecting for gold far away, perhaps, up some side Cañon, and will be glad for anyone descending the valley to carry away and post any letter he may find in the box; or, that the postman riding up the valley twice a week may drop into the box the missive from the
States, or, may be, from far away England, or Ireland. There are but few birds, chiefly, perhaps, because there is not much insect life, no end of rattle snakes, a few bears, but plenty of deer, who do not show themselves much by daytime. And the Creek is full of excellent trout, which are as yet sufficiently unsophisticated to allow themselves to fall easy victims; though I must confess that the baskets secured by the miners, with a stick, a bit of cord, and a grasshopper, put to shame my European rod, fine tackle, and artificial flies.

About half way up the valley the mining camp has been fixed, and there I spent several days of unalloyed happiness. I lived with the manager, who is brother to one of the chief owners of the property, a most charming man with a wonderful experience of life in many climes, and under varied conditions. He has a little wooden house of his own; but we lived entirely with the men, who are all catered for in one large mess room, the kitchen department being presided over by a couple of Chinamen, one of whom woke up the camp every morning by making a most fiendish row on a sort of gong formed of a steel bar bent into triangle form. Three real square meals a day forms the rations; and as tea and coffee are drunk at all three, and the pièce de résistance is always beef or venison, with the unlimited cakes, pies, and waffles that gladden the heart of the American miner, it is not easy to tell from outward signs whether the meal is breakfast, dinner, or supper; and the same keen appetite is invariably ready to form the sauce to all of them.

Besides the mess room and kitchen, there are large dormitories for the men, workshops, and store rooms. There is also the Store, which is kept up not only for the use of the camp, but to supply the needs of the scattered population of a very large district; and, as the Store is
also the Post Office, on every mail day purchasers are sure to arrive with horse or mule to carry off their necessaries. It is curious, too, that practically there is no current money; everything is paid for in gold dust or nuggets. Then there is the Saw Mill, the most important adjunct of the Camp, where some fine saws, driven by water power, are constantly at work cutting up the lumber, which is used for the bulk-heads, sluices, and flumes, by means of which the water is controlled and utilised. Of course, every building is made entirely of wood, for every single thing that comes to the Camp, except timber, has to be carried on mule back, over most difficult trails, for a distance of nearly 80 miles, where the nearest point on the railway is struck. There is a train of about 24 mules, led, as is usual in California, by a grey mare, kept constantly at work for the use of the Camp and Store.

About a quarter of a mile below the Camp the stream makes a somewhat wide detour to pass round a huge mass of stone which obstructs the valley, and through this mass a tunnel has been constructed, by means of which placer-working has been rendered possible for the whole length of the stream above it. Down every valley through which a stream runs there are beds of gravel, certainly in the existing course of the current, and probably also in many places now high and dry, but where the stream flowed at some former time. In Coffee Creek and in many another Californian stream and river, these deposits are all more or less gold-bearing, and the problem of placer-working is to extract this gold from the gravel. This can only be done where hydraulicking, or sluicing is possible.

In order to explain the position, I had better describe what placer-working is, as applied to a stream such as Coffee Creek.
In this case, as in many others whereof we have examples at home, the real bed of the stream is many feet below the channel of the flowing water. In Coffee Creek the valley has been filled up with several feet of gravel. The annexed diagram, which represents a cross-section of the stream, its gravel deposits, and its original valley, will explain my meaning.

![Diagram of a stream and its valley](image)

In this diagram a, a, a mark the solid rock called "Bedrock;" b, b, b are beds of gravel which may be of very great thickness; c, c indicate the actual channel of water.

Consequently the bed of gravel or sand below the running stream is saturated with water, and the bulk of any gold gravitates to the bottom of the mass of gravel to become lodged in the crevices of the bed-rock. It is almost certain that the whole body of gravel glides slowly, very slowly, down stream with a movement similar to that of a glacier, and, as it moves, all the particles of gold it contains will tend downward in the mass.

Since the gravel is permeated with water, directly a hole is made in it by boring, drifting, or open-cut, it is immediately filled with water, and endless are the contrivances invented by man's ingenuity to enable him to get rid of the water and follow down the bed-rock. But in a stream of the volume of Coffee Creek all contrivances...
are unavailing, and it is only the circumstance that rendered possible the construction of a tunnel that has virtually opened the way for dealing with the whole bed of the ravine above its level.

The process of working is this:—Gravel is forced into the current of the river either by hydraulicking, sluicing, or simple manual labour, and so carried on through the tunnel; and all, or nearly all, the gold it contains is arrested in its passage along the bottom of the tunnel-flume. This flume is specially constructed for this purpose, and figures 2, 3, 4 show its elevation, plan, and section. It is built of great strength, but not in the least too strong, when it is considered that all the material treated—sand, gravel, and boulders, many of the latter weighing much over a ton, must be hurled along the flume with enormous force and thrown out into the stream at the lower outfall. The framework of the flume is constructed in exactly the same way as any ordinary
flume, except that inside the tunnel the frame timbers are connected overhead and boarded over. In the sills of the frames, cuts (1 in. × 4 in.) are made (a a); into these are let strips of a similar section, flush with the top of the sills and running the whole length of the flume. Planks are then laid lengthways down the flume, with their joints immediately over the centre of the strips a a. There are then nailed against the sides of the flume for its entire length, 1½ in. boards, rising some 4 feet up its sides. Blocks of wood (c, c, c, c), 12 ins. deep, 28 ins. wide, are laid across the bottom of the flume; when a rank of these has been laid, a so-called "riffle-stick" (d, d, d), 1½ in. × 3 in. is placed on the bottom of the flume and nailed up tight against the rank of blocks; a few nails are left projecting from the opposite side of the "riffle-stick," and another set of blocks is then laid and driven tight up against it. Another "riffle-stick" is then
fixed, and the same process is repeated right down the flume. Side pieces (e, e, e) of 1½ in. board are then nailed along the sides of the flume, resting on the blocks.

It will, therefore, be seen that above the "riffle-sticks," and between each rank of blocks, there is a cavity 3 in. × 10½ in. Directly work commences, these fill loosely with gravel, which the water keeps constantly in motion, and as pieces of gold pass down, they are arrested in the cavities and gradually gravitate to the bottom of them. In a partial "clean-up" the contents of these cavities are roughly scraped out, but a complete "clean up" can only be made when the whole of the "riffle-sticks" and blocks are taken up; they need taking up and replacing about once a year.

There is a strong bulkhead about 100 yards above the tunnel, and from there the river is flumed for the greater part of the detour it makes round the rock through which the tunnel passes. By means of suitable gates at the bulkhead, the water can be sent at will either through the tunnel or along the flume of the detour. At the head of the tunnel-flume, where it strikes bed-rock, a piece of open-cut is left towards the bulkhead, with the bed-rock exposed. On this some little gold collects and is easily gathered. For this gathering of gold in placer-working a set of simple tools is used. One (Fig. 5) is usually an

![Fig. 5.—The Scraper.](image_url)

old file, one end ground to an edge and turned over and downwards, the point end being also bent at about right angles. With this tool the miner scrapes out all the contents of the cavities, gathering them in the scoop
(Fig. 6), from which he passes them into the ordinary gold-washing pan (Fig. 7). By washing in the pan, with skilful manipulation, he is able to reject the sand and gravel and save the gold. Where men are just placer-working on their own account, they will generally put up

![Fig. 6.—The Scoop.](image)

by the side of the stream some rocker arrangement, or some contrivances such as very small wooden flumes with strips nailed across the bottom to arrest the gold: they lead the water from the stream into this arrangement, and feed in the gravel.

![Fig. 7.—Gold-Washing Pan.](image)

The Camp at Coffee Creek is just at the fork where another stream, the Union Creek, joins the main stream; and a few hundred yards up Union Creek, two Frenchmen took up a location about 25 years ago. They built themselves a log hut of the rudest description, and here they lived ever since, all the year round— their hut buried in the winter under 20 feet of snow— just working along the edge of the stream as far down as the water would allow them; and many thousand dollars worth of gold they got out. A few days before I came to the Camp one of them died, and all the miners from the Camp turned out and gave him quite a distinguished
funeral. His grave was dug about a hundred yards from his hut in a grove of enormous sugar pines, and marked by a rough erection of planks. The survivor was so utterly miserable, that he came into the Camp one morning when I was there, said he could stand the solitude no longer, and that he had made up his mind to leave his location for ever. Poor old man, he seemed quite broken and shattered, and utterly unable to take any fresh interest in life, too miserable to remain and yet miserable to go, though he had a good bit of money laid down in San Francisco.

It may be of interest to describe the difference between sluicing and hydraulicking. In sluicing, the water in the stream is simply diverted and led along flumes in such a way as either to drain the water off some bed of gravel, or to make the water by its own force wash away banks, or beds of gravel.

Hydraulicking is using water under pressure. Water is taken from the stream far away up the valley, and led along, with as slight a fall as possible, either in an open ditch or a flume, until a height of some hundreds of feet above the valley is attained. The water is then conveyed straight down into the valley in an iron pipe of considerable dimensions. At the end is a peculiar nozzle, commonly called a “giant,” which is so arranged that by means of levers it can be pointed in any direction when the water is turned on.

The force of the water is almost inconceivable. A jet is thrown for hundreds of feet, and whole hill sides can by this means be washed down into and along the stream, leaving the gold deposited in the crevices of bed-rock, or in the “riffle-stick” cavities of the flume. It is used either for clearing away the gravel in the bed of the stream, where often the deposits of gold on the bed-rock are very rich, or for moving great masses of ancient
gravel beds; and so economical is the process that a yield of a very few grains of gold to the ton will pay; for the cost of moving a ton of ordinary material rarely exceeds 2d or 3d. It is marvellous to see how the force of the water will cut right into a hill side and bring great boulders of rock rolling down into the stream. I once saw a railway cutting being made by hydraulicking, and the process seemed to answer most admirably.

How the gold has got into the bed of these streams is a very interesting subject for investigation.

Of course it has all come out of veins, or "ledges" as they are usually called in California, which during countless ages have been gradually washed away with the rocks that enclosed them. There are two distinct theories on the subject:—One, that the gold has been dissolved out of the ledges, carried down to the cañons in solution, and there again deposited in the stream as fragments of gold; the other, that the process has been purely mechanical, that bit by bit the "ledges" have been washed away, pounded up by the action of torrents, the particles of gold have been separated out, and have gradually gravitated on to the bed-rock in the streams.

The facts urged in support of the precipitation theory are as follows:—

1. The rarity of nuggets or gold masses of any considerable size in quartz veins.
2. The greater purity of the gold contained in placers than that in the neighbouring ledges or veins.
3. The frosted character of the surface of some gold nuggets.
4. Instances of deposition of gold in organic substances buried in the gold placers.
5. The solubility of gold as proved by laboratory experiments.
Against which the following facts are urged in favour of the mechanical theory:—

1. Deposits of placer-gold are always found adjacent to and lying below districts traversed by auriferous veins, and nowhere else.

2. The areas where the quartz veins occur have certainly suffered great erosion, and great mechanical forces have undoubtedly been for countless ages in action.

3. The conditions in which the placer gold is found, mingled with rolled fragments of quartz and in the irregularities of the surface of the bed-rock, prove the accumulations of gold to be mechanical. A deposit from chemical solution would not be thus circumstanced and localized.

4. The nuggets and coarsest gold are always found nearest the outcrops of the quartz veins.

5. Pebbles and fragments of gold-bearing quartz are found in the placers which must have been derived from the neighbouring veins, and often nuggets have fragments of quartz still adhering to them.

6. The surfaces of nuggets bear almost incontestable evidence of the battering they have sustained. They are generally rolled and rounded, and the surface is such as could be produced only by blows and friction; whereas, if the gold were deposited from solution, much of it would be found crystallized and forming strings and sheets running through the porous matter.

Such are the arguments that can be adduced, and I leave it to the members of the Club to determine which may be considered to have the greater weight.
THE VALLEY OF THE LOWER WYE,

BY

S. S. BUCKMAN, F.G.S.

(Read at the Windcliff, Chepstow Meeting, June 6th, 1898)

The valley of the Lower Wye is as interesting as it is picturesque. And although all the principles of river development which it illustrates cannot be fully considered in a short paper, yet some of its chief features deserve notice.

North of Tintern the river passes through an Old Red Sandstone district, and maintains therein a fairly straight course. From Tintern to Chepstow it has scooped out a deep gorge-like valley through hard rocks of Carboniferous Limestone, and its course is remarkably sinuous. The question is, why it should have developed these features—why it shows the combination of remarkable meanders and a steep-sided, deep valley. For the Wye is a somewhat swift river, and the tendency of such a river is to cut a straight course. A meandering course is only developed by a river which is flowing sluggishly over a somewhat flat district. It is obvious, then, that the meandering course of the Wye is something which does not accord with the present river, and consequently it must be an
inheritance from some earlier period of its development—an inheritance which the power of the swift-flowing river has not had time to efface in the part of its course where it traverses hard Carboniferous Limestone, although it has accomplished this effacement where it runs through the softer Old Red Sandstone to the north of Tintern.

To understand the past history of the river, a slight geological sketch is necessary. In post-Carboniferous times the Palæozoic rocks of the district were elevated from the sea-bottom to form land; but about two miles to the east of the Windeliff they were beneath the sea, which was depositing Triassic rocks. And in the neighbourhood of Chepstow the old Triassic shore line can be easily traced. But as the accumulation of Mesozoic rocks continued, necessitating a gradual subsidence of the whole area, and as at the same time there would be denudation of the western land-area, it may be concluded that, before the deposition of the Mesozoic strata ended, the whole of the district of the Lower Wye Valley had been buried beneath overlapping Secondary rocks.

It was after the deposition of the Cretaceous strata that the country was again elevated, and the river system, of which the Wye forms a part, was commenced. In the development of that river system, with its accompanying denudation, all the Mesozoic strata which formerly covered the Lower Wye district have been completely swept away. Once more the Palæozoic rocks have been bared, and in their turn they have suffered much from sub-aerial denudation.

But before the covering of Mesozoic strata had been removed, there was a time when it is supposable that no Severn Valley existed. The rivers of this Wye district drained into the Thames system. The Usk and neighbouring streams formed the head waters of a southern branch of the Thames—a westward extension of the
Kennet; and to this river system belonged a stream occupying somewhat the course of the present Lower Wye. It was a river which had developed in an area of Mesozoic strata.

Later this river system was broken into by the growth of the Severn from the (present) Bristol Channel north-eastwards. Working its way back, it cut into these Thames-flowing rivers, and, tapping them, diverted their head waters to itself. It could give them so much quicker fall to the sea than if they travelled all the way to East England.

This will account well enough for the steep, gorge-like valley of the Lower Wye. For when the Wye was flowing at a level high enough to carry it over the Cotteswold escarpment at Bath, and the growing Severn was working back in a channel 200 or 300 feet lower, as soon as the Wye was tapped by the Severn it would be enabled to lower its bed by the difference between them. And in thus rapidly lowering its bed it would cut a gorge-like steep-sided channel.

The Cotteswold Hills, relatively to the Severn Vale, furnish many parallels to this presumed state of affairs, before the Wye had been tapped by the Severn. Thus, near Andoversford, the Coln is flowing in a bed 500 feet above sea-level. The bed of the Chelt, at Cheltenham, some five miles distant, is 300 feet lower, and that level the Coln does not reach till it has travelled some 40 miles, not counting windings. So when in time the Chelt taps the Upper Coln, the latter will be able to deepen its bed very rapidly, and will make a gorge-like valley. Such has happened with the upper waters of the Stroud stream, the Frome, and its wonderful valley at Sapperton.*

* The views upon this and other river developments have since been put forward in a paper in "Natural Science," vol. xiv., p. 273, 1899, to which the reader is referred.
The horse-shoe curves of the Lower Wye Valley are still unaccounted for. It is difficult to imagine that they were made when the river was flowing at a high level as a Thames tributary, because it would have then been flowing over Mesozoic rocks. That supposition, that the curves initiated in Mesozoic rocks would be continued into the harder Carboniferous beneath, would not be easy to contend for.

Another theory may be put forward. The horse-shoe curves of the Wye were formed while the Mesozoic strata were being deposited. This Lower Wye area was low-lying land, and its river drained on a gentle slope into a Mesozoic sea on the east. On that low-lying area it would meander to form big curves. The channel of this river was subsequently drowned out, submerged beneath the encroaching sea, and it became filled with Mesozoic rocks. When the new river system was started it was roughly on the line of the present river. When that was tapped by the Severn and given a very quick fall, it naturally sought the easiest erodable channel, and that was along the line of the old filled-up meandering channel. It re-excavated that channel in preference to the hard Carboniferous rocks, and then, being established therein, it had to follow its sinuosities as it subsequently deepened its bed. This much is certain, the horse-shoe curves were developed first, and the gorge was developed later. The sinuous course of the gorge is on account of the previous existence of the meanders.

This theory may seem elaborate; and yet the late Edward Wilson pointed out to me that the Bristol Avon, flowing through a similar Carboniferous Limestone gorge, has found, or adapted itself to, a pre-Jurassic channel. For there is, in the Clifton gorge of the Avon, Dolomitic Conglomerate of the Trias, showing that a channel had been already formed in Triassic time. But, as there is
Lias on the high ground above, that channel must have been subsequently filled with Mesozoic strata, and must then have been re-excavated by the present river Avon.

Something further may be said concerning the meanders of the Lower Wye, their manner of development in a river valley, and their possible effacement by an accelerated stream. I have made some addition to the following remarks since the paper was read, and have to acknowledge my indebtedness to the written and verbal communications of Prof. W. M. Davis.

The appended Figs. 1, 2, 3 show the development of a stream from slight curves into pronounced meanders, which become greater as the river impinges more first on the one bank and then on the other. In these figures A A' are the sides of the valley, B is the curving stream, and C C are the "spurs" of the convex portions of the valley. These spurs tend to become more and more worn away with the development of the meanders, on account of lateral encroachment of the stream—encroachment, that is, on the sides of the spurs; and it is the up-stream sides of the spurs which are most worn away.
In time, when the curvature of the meanders becomes very great, the river straightens its course by cutting through the narrow neck of the meander at D, as shown in Fig. 4. This phenomenon is well known in the case

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**Fig. 4.** The meander neck severed

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**Fig. 5.** Supposed earlier, more tortuous course of the Wye, when it flowed at a higher level. Meander neck at D

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**Fig. 6.** Present course of the Wye
of the Mississippi.* Now, in soft rocks this process would go on much more quickly than in the hard Carboniferous Limestone. And it is possible that this process of straightening out may have gone on considerably in the Old Red Sandstone area north of Tintern, thus accounting for the straighter course of the river in that portion.

Quite possibly, however, the same process has been accomplished in certain cases in the Carboniferous Limestone part of the valley. In Fig. 5 is shown what may have been a previous, more meandering course of the Wye just north of the Windcliff. It will be seen that it represents the river in a somewhat analogous stage of development to that represented in Fig. 3. Then the river is supposed to have straightened its course by cutting through the neck D, and so has produced the present day contour shown in Fig. 6, which is a copy of the Ordnance Survey 1-inch map.

This supposition will explain the greater width of the valley just north of the Windcliff, and why the river is now far away from the cliff which it must once have been cutting at.

Between Tintern and Tintern Parva there is a noticeable horse-shoe bend. On the east is a spur of Carboniferous Limestone still remaining; and this rock may be said to have contributed to the preservation of the bend. But at the foot of this spur is a jutting-out piece of Old Red Sandstone, and it will be seen that the river is working away on both sides of this strip to narrow the neck. Now that the Carboniferous Limestone has been worn away sufficiently to leave this neck of comparatively soft rock to the mercy of the river, it can only be a question

* While this paper was in the press I have found an interesting example of a pronounced meander on the point of extinction—one corresponding to Fig. 3, with a very narrow neck. It is on the Upper Coln, just south of Withington.
of time before the neck is cut through and the river straightens itself.

One more future speculation may be indulged in. The Carboniferous Limestone between Tintern and Chepstow acts as a kind of check to the outflow of the Wye—the river cannot cut its bed down rapidly. Now the Usk, on the west, has no such impediment to contend with: it can lower its valley and drain the surrounding country effectually. As it is, a tributary of the Usk rises at Trellech, within a couple of miles of the Wye; and as the Old Red Sandstone will be denuded faster than the Carboniferous Limestone, in time the Wye may find prepared for it an easier course into the Usk than down its own channel, a course which it will hasten to make use of in flood time.

Then it will soon make use of it regularly; so that the gorge of Carboniferous Limestone between Tintern and Chepstow will be left like that at Cheddar, a dry, or nearly dry, valley—the relic of a once existing river.
ARCHAEOLOGY, as a science, must include something more than the observation of isolated facts. It should co-ordinate such facts and put them in their true place in their relationship to history; and thus help us to a clearer estimate of the evolution which is the underlying law of history. With this in mind, Tintern Abbey is not only an object of beauty in its architecture and environment, but presents a series of endeavours, often renewed, and yet as often failing to accomplish the aim of the earnest men who founded the several monastic orders. The family tie, which is a basis of society, is the greatest of the natural forces that conduce to order: a fact which Confucius had in view when he laid down the principle that the whole government of an Empire should be an evolution from it. The monastic system springs from the opposite theory, being founded on the assumption that there is something inherently imperfect in the family relationship, which hinders the highest development of the soul; and the several monastic orders are so many variations, or modifications, of an ideal which would make the world better by superseding the family, that is, by isolating certain individuals, or communities.
under a pledge to abstain from entering into the family bond, as a means to their perfection.

Beginning in the retirement of single individuals to the solitude of an African desert in times of persecution, monachism has preserved a reminder of its origin in the first portion of its name, from the Greek μόνος; * but the experience that it was "not good for man to be alone," led to a modification of this alone-ness, or isolation, by the grouping of a certain number of the hermits into a community; and the head of this community, the Abba, or father, exercised rule in the artificial family, as the parent does in the real one. This monastic régime was taken up and systematised by Basil, in the East; and, as modelled by him, passed into Europe in the fourth century. Before the middle of the sixth, however, it had so far ceased to fulfil the requirements of the most earnest adherents of monachism, that a new order was evolved out of it by Benedict. But the unattainable was still unattained; and the practical working of the Benedictine monasteries was found so far short of the ideal, that by the end of the eleventh century, and during the twelfth, a reform was again made by the establishment of stricter rules in a Benedictine house near Dijon. The new order, named in France from its founder, "Bernardins," and known in England as "Cistercians," from Bernard's monastery at Citeaux, built this Abbey of Tintern, shortly after his death. Tintern, therefore, marks a period of endeavour after the reformation by the Benedictines: how strong an endeavour anyone may see who examines the Bernardine rules which forbad all unnecessary ornaments; all pictures in the monastery, except that of Christ; the use of stained glass in the windows, and so

* That is the beginning of Western monachism. The system had been devised long previously among Oriental peoples.
on. But every attempt to purify the monastic system by a return to simplicity and severity in discipline, is like the effort to tighten a screw with overworn threads: the result, in the one case as in the other, is a momentary firmness, followed by a further slipping back. In respect of the Cistercian reformation itself, I would quote the words of a writer of reputation, a warm eulogist of the services rendered to scholarship by many of the Benedictines, notwithstanding the degeneracy of the mass of their members:

In the "Dictionnaire d'Histoire" of M. N. Bouillet, Inspector-General of Public Instruction in France, the article on "Cîteaux" closes thus: "Les Bernardins dé-générèrent bientôt, et leurs désordres nécessitèrent de fréquentes réformes."

Of these "frequently reformed" Cistercians, the order most celebrated for its strictness is that of La Trappe. It had already been organized before Tintern was completed (that is as early as 1140); but of it again we read in the work just cited (Dict. Bouillet, article La Trappe) "Cet ordre, qui s'était relâché, fut réformé en 1662."

Here we see that an evolution had been going on for more than a thousand years, in the development of the theory that a greater degree of purity is attainable in the convent, than that which is compatible with the family relationships; for as men of piety, who often brought their piety with them into the cloister, in a character already formed at the mother's knee, and in the environment of the home, were disappointed with the practical outcome of the monastic rules, they naturally tried to amend those rules as the remedy for all shortcomings.

The discipline of the cloister life tended to bring everything to routine, and to the imitation of fixed standards, rather than to develop originality. In agriculture this had some advantages, and the intercourse between members of

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the same order, but of different nationalities, was calculated to diffuse knowledge of new or improved plants, and methods of cultivation: thus resuming a process that had been carried on everywhere under the Roman Empire. To the out-door pursuits that occupied the earlier monks, the Benedictines added more work of the pen and pencil; until they attained a high degree of excellence in the copying and illumination of manuscripts, in painting on glass, etc. But above all they were successful in ecclesiastical architecture: evolving by a continuous gradation from the cruder forms of Roman and Byzantine building the most beautiful designs to which stone and lime can lend themselves; and nowhere perhaps were these brought to greater perfection than in the building of Tintern Abbey.

It is sometimes remarked that the times which produced such architecture, and during which the copyist preserved to us the great treasures of Hebrew and of classical antiquity, ought not to be styled "the dark ages:" but those who make the remark seem never to have reflected that the earlier "dark ages" of classical Greece and Rome not only produced marvels of architecture, but those more enduring marvels of writing, which they also preserved as effectually as did the monks who afterwards came into possession of them.

It is clear that while the monks worked out this remarkable evolution in architecture, they did not accomplish a commensurate progress in literature. The horizon of the cloister was too restricted for that freedom of thought which is indispensable to such an expansion; and its narrowing influence is apparent even in the most valuable of the works for which we are indebted to them: such for instance as the several mediaeval Chronicles. Even the best of their compilations will not bear comparison with works of the same class of an earlier period. For
example, who would place Bede's "Ecclesiastical History" on a level with the works of Tacitus or Pliny? Had the development of European literature during a thousand years of the monastic régime been on a par with that of architecture in the same period, we should not only have had a greater abundance and variety of authorship, but at least a few authors of the very highest power to reflect lustre on the cloister. Dante was unquestionably the most powerful and original of the mediæval writers; and his work was not the outcome of monastic seclusion; but, like that of Tasso and Chaucer, was accomplished in the busy outside world. All through the ages of monachism we seek in vain, all over Europe, for any one work produced by it, which is read to-day everywhere. To find such a book we must go back to an earlier, or come forward to a later time; for the golden day of English literature did not dawn till after that of the monasteries had set.

The principal aim, however, of good men, in establishing the monastic orders, was not so much the development of the arts or of literature, as of a higher morality than prevailed in the world at large; for no grandeur of building, and no beauty in writing tends to make men good. On the contrary they often comport with the greatest moral debasement, both in the individual, and in the masses: as is shewn by the corruption that reigned universally in the days that produced the most splendid architecture of Greece and Rome, and by the wickedness that had its home in the shadow of the temple at Jerusalem.

If a foot-bridge is built for the passage of a multitude, it is idle to insist upon its strength because some men have crossed it in safety. And the crucial point in the history of the monastic system, is not whether at some time some men have come up to its several respective
ideals; but whether as a whole, both as to time and place, it has set an example to the masses of the people, such as tended to their enlightenment and moral well-being.

The several efforts at reformation of the orders at which we have glanced, show that in the opinion of such men as Benedict, Bernard, Dominic, and Francis of Assisi, it has repeatedly failed to do this. If, for example, Bernard had not believed that the ornamentation and the stained glass, of which some of the monasteries were so proud, hindered instead of aiding the soul in its effort after Divine communion, he would not have forbidden the use of them: since his object in founding a new order was that it might maintain that communion more perfectly than the one previously existing, and that it might set the world a purer example. And if, again, the daily round of the cloister monk were compatible with the essential missionary work of preaching the gospel, what need could there be of a new order whose specialty it was to abandon the cloister routine in order that it might effectually preach the gospel? It would be in vain to argue that the new order was created to meet a new necessity of the times; for if the whole of Europe had been for ages in a lawless condition, with turbulence and violence everywhere rampant outside the cloister, then the necessity for the preaching was not new, but had existed for ages, and the monastic system had failed to meet it.

The very grandeur and beauty for which Tintern is so admired are evidence of the failure of its builders to carry out the rules of their founder. Two centuries earlier the Cluniac Order had inaugurated a system based on the theory that nothing could be too magnificent in a building dedicated to the service of God. Bernard's rules shew clearly that he regarded this as a fallacy; for, so far from basing worship upon an indulgence of the
senses, or a stimulating of the imagination, he called his followers to simplicity and self-denial, not merely in their personal habits, but in all their surroundings, especially including the buildings in which they assembled for worship.

As we are considering more particularly the period of the foundation of the Cistercian order, and of the Abbey of Tintern, it is worth our while to examine as to how far the reform was needed, which Robert of Molesme began at Citeaux in 1098, and Bernard carried on in the next century.

Arnulf, the Bishop of Lisieux (1159—81) petitioned the Pope, Alexander III., to dissolve a Benedictine monastery in his diocese on the ground of the evil lives of the monks: no fewer than three of whom had committed murder—the Abbot, an absentee, living a debauched life in England, while these disorders were going on.

Two hundred years later we find a book published by one of the foremost leaders of education in Europe, the Rector of the University of Paris, to call attention to the general condition of the monasteries, whose inmates he states were guilty of idleness, drunkenness, gluttony, and debauchery. He uses even stronger language than this: but the title of his book may suffice: De Corrupto Ecclesiae Statu.

A local history, such as that of Gloucester, shews a state of things not much more satisfactory in the century following that dealt with by the University rector; and, as Gloucester was proverbial for the number of its monastic houses, there is no reason to suppose that their condition differed materially from that of similar establishments in other places.

More important, however, than the question whether the monasteries ever did, in their earlier history, come up to the expectations of the earnest men who founded them,
is that of their actual state at the period of their dissolution in England. School-books for the most part tell us that although there were "irregularities" among them, their dissolution was an irreparable loss to the country, being due to the caprice and greed of Henry VIII.: some of the "Extension" lecturers incline to the same view.* The truth is that both the school-books and the lecturers are so taken up with the misdeeds of Henry VIII. that they have no time to touch upon certain facts with which Henry had nothing to do. But these facts are of great interest and value for forming a right judgment on one of the most important events in our national history. Much exception, for example, is taken to the bias of the commission appointed by Henry's government to enquire into the state of the monasteries. But this was not the only commission appointed; nor was England the only country in which the enquiry was made. Pope Paul III. cannot be accused of bias against the monasteries; yet complaints against them reached him, in such force and from such a variety of sources, that he appointed a commission to enquire into their condition generally. Its members were exclusively Cardinals: among them were Reginald Pole, who can hardly be suspected of playing into the hands of Henry VIII., and Cardinal Caraffa, afterwards Pope Paul IV. No writer, or lecturer, who deals even briefly with the dissolution of the monasteries, has any right to omit mentioning this commission, and the substance of its official report to the Papal See, delivered in 1538, at the very period of the dissolution in this country, which was from 1536 to 1539. It says:—

* It is due to the Extension lecturers to mention that some of them do not consider that the cloister produced the purest and most perfect of the characters of the Tudor time. They award this distinction to Thomas More, the active statesman, the father of a family, and the writer of the remarkable letter which is given a few pages further on
Another abuse needing correction is the religious orders, because they have so deteriorated that they are a serious scandal to the laity, and do the greatest harm by their example. * * * We are of opinion that they should all be abolished"—etc.

If it was the opinion of the cardinals of the Roman Church that the monasteries did "the greatest harm by their example," and that "they should all be abolished," then it is evident that all the endeavours, to set up a standard of purity higher than that of the family circle, had failed utterly. More than a thousand years of evolution in one experiment after another, had ended in this verdict of the very guardians of the institution, that it had so "deteriorated" that the only thing to be done with it was to "abolish" it.

This has nothing to do with Henry VIII. or his misdeeds. If he had never been born it would evidently have been the duty of the English parliament to abolish the monasteries, if they were in the condition which the Pope and his counsellors seriously averred they were in, all over Europe. There were no fewer than thirty heads of monasteries in the House of Lords that passed the Act of Dissolution, and when the Commissioners' Report of the abuses in the various houses was read, Lingard states that not one of these 28 Abbots and 2 Priors opened his lips in refutation of it. Yet even if the charges made had been untrue, it was not much like Englishmen to sit still under them, no matter what the risk of speaking might be. There was great indignation against the betrayal of the trust of which the bulk of the monks had been guilty,* but amidst all the indignation there was an

* What the condition of the English monks was, twenty years before the Cardinals' Report here mentioned, may be seen from a letter by Thomas More in reply to one of their number who had expressed a fear that he would be corrupted by the "new learning" of his friend Erasmus. It was written in 1519: He, certainly, is above suspicion of bias against monachism; yet this is what he says:
endeavour to do justly in dealing with the vested interests involved, notwithstanding the unworthiness of so many of the participants in them. The Cardinals, in their

"Into what factions—into how many sects is the order cut up! Then, what tumults, what tragedies arise about little differences in the colour or mode of girding the monastic habit, or some matter of ceremony which, if not altogether despicable, is at all events not so important as to warrant the banishment of all charity. How many, too, are there (and this is surely worst of all) who, relying on the assurances of their monastic profession, inwardly raise their crests so high that they seem to themselves to move in the heavens, and reeling among the solar rays, to look down from on high upon the people creeping on the ground like ants, looking down thus, not only on the ungodly, but also upon all who are without the circle of the enclosure of their order, so that for the most part nothing is holy but what they do themselves. . . . They make more of things which appertain specially to the religious order, than of those valueless and very humble things which are in no way peculiar to them but entirely common to all Christian people, such as the vulgar virtues—faith, hope, charity, the fear of God, humility, and others of the kind. Nor, indeed, is this a new thing. Nay, it is what Christ long ago denounced to his chosen people, 'Ye make the word of God of none effect through your traditions.' . . .

"There are multitudes enough who would be afraid that the devil would come upon them and take them alive to hell, if, forsooth, they were to set aside their usual garb, whom nothing can move when they are grasping at money.

"Are there only a few, think you, who would deem it a crime to be expiated with many tears, if they were to omit a line in their hourly prayers, and yet have no fearful scruple at all, when they profane themselves by the worst and most infamous lies?" . . .

[He goes on to speak of an Abbot who, he says, had "committed the most horrible crimes I ever heard of"; and he concludes thus.]

"Now, I have not mentioned this with the view either to defame the religion of the monks with these crimes, since the same soil may bring forth useful herbs and pestiferous weeds, or to condemn the rites of those who occasionally salute the sacred Virgin, than which nothing is more beneficial; but because people trust so much in such things that under the very security which they thus feel they give themselves up to crime.

"From reflections such as these you may learn the lesson which the occasion suggests. That you should not grow too proud of your own sect—nothing could be more fatal. Nor trust in private observances. That you should place your hopes rather in the Christian faith than in your own and not trust in those things which you can do for yourself, but in those which you cannot do without God's help. You can fast by yourself, you can keep vigils by yourself, you can say prayers by yourself—and you can do these things by the devil! But verily, Christian faith, which Christ Jesus truly said to be in the spirit; Christian hope, which, despairing of its own merits, confides only in the mercy of God; Christian charity, which is not puffed up, is not made angry, does not seek its own glory—none, indeed, can attain these except by the grace and gracious help of God alone.

"But how much the more you place your trust in those virtues which are common to Christendom, by so much the less will you have faith in private ceremonies, whether those of your order or your own; and by how much the less you trust in them by so much the more will they be useful. For then at last God will esteem you a faithful servant, when you shall count yourself good for nothing."
report already alluded to, in order to guard existing interests, recommended that the older monks should be allowed to continue for the rest of their lives, while all the younger postulants should be sent to their homes. The English government acted in the spirit of this, and gave to every monk and nun who was under twenty-four years of age at the dissolution the option of remaining under the vow of celibacy, and receiving a pension for life; or, of being released from it, and receiving one year's pension and a suit of clothes.

Those who imagine that the object of the government, or of the King, in dissolving the monasteries, was to obtain their revenues, have probably never endeavoured to reconcile this theory with the fact that no monk or nun of over the age of twenty-four was allowed to go free with the one year's salary, although many entreated permission to do so; for in every case without exception such persons were compelled to keep under the celibate vow for the rest of life, although it involved the payment to them of the annual pension. The amount of this pension varied with the rank of the recipient: that is, more for abbots and other dignitaries, but for the monks themselves the usual income of a parish curate,* and for the nuns one-half as much.

If spoliation was the aim it was clumsily managed. That favoritism affected the allotment of the estates thrown into the market by the nation, is probable. It affects many things now; but if the allottees paid 20 years' purchase for the lands and 15 years' for the buildings, the terms, on the whole, do not appear very different from those which would be secured at the present day, if a twentieth part of all the land in the country were suddenly

* Several years before this, a number of priests waited on Wolsey to remonstrate against a tax laid on them. They stated that “twenty nobles a year” was a bare income, that would not stand such a tax. A noble was six and eightpence.
offered for sale. As the total revenues confiscated amounted to under £170,000 a-year,* and out of the proceeds of the sales the debts of every monastery were cleared off, and the pensions provided for the thousands of monks and nuns for life, as well as the incomes of half-a-dozen new bishops, and the cost of fortifying places on the south coast, with that of building ships for a navy, it is not easy to suppose any very large balance left either for the king, or anyone else.

The dissolution of the monasteries was the snapping of the chain of endeavour to make a system perfect which, on the testimony of the commission of Paul III., was inherently incapable of being perfected. We are sometimes told that the nation suffered great loss by the change. It is not easy to see where the loss comes in. It could not have been in respect of learning or of the general diffusion of knowledge, as is shown by the rise of the Elizabethan era of the national literature, after the monasteries were closed. It certainly was not in respect of the moral example set by the monks; for on this point the language of Cardinal Pole and of More leaves nothing to be said.

* Some authorities give under £143,000. Possibly one figure may represent the gross, and the other the net amount. [See Cox's "Monmouthshire:" chapter on Tintern Abbey.]

There is a very full article on the History of Monachism in the ninth edition of the "Encyclopædia Britannica." It is from the pen of Dr. Littledale, and will be read with interest not only by those who believe, as he does, that the monastic system is founded on aspirations inherent in human nature, but by those who do not agree with him.
ROMAN WORK AT CHEPSTOW

BY

JOHN BELLOWS

(Read at Chepstow, June 6th, 1898)

The great number of Roman tiles in the Castle walls evidence the Roman occupation of the site (which has been doubted by some); and the finding of Roman coins in Chepstow is further proof of it, as is also the local name, “Port wall,” as applied to the town wall. This has nothing to do with “port” in the sense of “harbour,” but is a corruption of the Latin parietes, which became in Cornish and south-east Welsh, “poruit,” and finally “port,” a wall, and a walled town. The head officer of such a town was known till recent times as the Portreeve. The word “port,” for wall, still lingers on in four towns—Bristol, Chepstow, Caerwent, and Caerleon—just the corner most affected by the Second Roman Legion. Another curious fact is that while Monmouthshire was officially reckoned as belonging to Wales down till the time of Henry VIII., the Castle of Chepstow is classed in Domesday as belonging to Gloucestershire; and this singular exclusion of it from the rest of Monmouthshire is explained by the Roman occupation: it formed the necessary tête de pont to the bridge crossing the Wye from the Gloucestershire shore. It was on the great line of Roman road from London to South Wales, generally known as the Via Julia; and as Chepstow was the most important point on this road so far as it linked Gloucester with Caerleon, it was impossible the Romans
could have neglected to guard it, with its passage over the Wye. In Coxe's "Monmouthshire" a drawing is given of the bridge over the Wye, at Chepstow, as it stood at the end of the last century; as well as a plan of the piers. I took a tracing from this plan of the angle of a pier, and on laying it down upon a similar plan of a pier of the Roman bridge at Newcastle-on-Tyne, as given by Dr. Bruce, the angle of the cutwater in both (83 degrees) was found to be identical. That is, the engineer who built the pier at Chepstow (which there is good reason to believe is Roman) made it of precisely the same degree in the angle as that of the bridge at Newcastle, which is known to be Roman. It must be remembered that all the engineering of such work in the south-west of Britain was done by the Second Legion, which had its headquarters first at Gloucester, and afterwards at Caerleon; and that the same Second Legion was employed on Hadrian's Wall. Evidently the angle was a standard one adopted in building their bridges.

Further, these piers, which are hexagonal in plan, like a bee's cell, but somewhat more acute at the points, were only built to about the water's edge, the superstructure consisting of tall trestles of timber, twelve feet asunder. On these timber frames, or piers, the floor of the bridge was laid in loose planks.* The intention of this was, of course, that the planks might be taken away at a moment's notice in case of the approach of an enemy; and, according to Coxe, the bridges both at Caerleon and at Chepstow were of this construction. It is therefore evident that Chepstow was Roman.

* A carpenter in Caerleon told Coxe that the planks used to be nailed down, but that this was discontinued because the nails split the oak planks! He evidently invented this to account for what he had no real knowledge of: for Pliny, in his "Natural History," says it was an article of religious faith with the Romans never to nail down the planks of a bridge.
ROMAN REMAINS AT BATH

BY

JOHN BELLOWS

(Read at the Bath Meeting, June 27, 1898)

It is interesting to compare the points of similarity and of difference between Gloucester and Bath. Both date from the earliest occupation of Britain by the army of Claudius; but while Gloucester, from all its lines, shows that it was meant for a fortress of extreme strength, Bath owed its importance then, as it does now, to its hot springs, not to its strategic position. The first thing that strikes one, in comparing the ground plans of the two cities, is the much more perfect preservation of the minor or sub-dividing streets, in Gloucester than in Bath; and the next is the greater regularity of Gloucester in its outline: it approaches very clearly to a square, while Bath, in its southern portion, is irregular—approaching more to the form of Silchester, or of Kenchester (the Roman *Magna*). That is, the last two cities were British modified by Roman occupation: they were not originally founded by the Roman invaders, like Gloucester, Chester, and some other fortresses. Some of the Roman lines in Bath are, however, well preserved. There is the main cross, formed by Union and Stall streets, traversed by Westgate street and Cheap street; while in the north-west quarter the sub-division into three blocks, which is so general a
feature in the earlier Roman camps,* has survived all the changes the place has undergone. The two small streets between the Westgate street and Borough Walls do not run straight across Westgate street on the southern side; where, as in other Roman towns, the opposite quarter was divided in the same way. But while the upper, or northern half of the Roman city makes a tolerable approach to the right angles of the standard type, the southern walls are deflected so greatly from this square standard, that we are driven to one of two conclusions:— Either the Roman wall was originally built square, and after some destruction of the city has been rebuilt, so as to leave the outline what the streets now show; or else Bath was a British town before the invasion of Claudius, and the Romans partly preserved its outline on the southern side, while they carried out their own plans by measuring off as much as they required on the side of the hot baths—thus producing the same effect as at Silchester, where at the East gate the regular Roman wall runs in a straight line, while the rest of the enceinte is polygonal. It is impossible to suppose that no town existed here in the pre-Roman time. The Britons were in a fairly advanced state of civilization in many points, and it is not likely that they would neglect these remarkable curative waters. Indeed, the British name Sul implies a knowledge of the waters; and the clever way in which the Romans combined this name with that of their own Minerva (Sul-Minerva) shows that they regarded such a compromise as inevitable. The existence, therefore, of baths and a temple at the time of the Claudian invasion would be a strong reason for the Romans making their plan of this

* The two quarters cut off by the shorter end of the cross were those occupied by the officers and used for the stores. These were each divided into three blocks of building, separated by two minor streets. The other two quarters, parted from the short end of the camp by the via principia, were each composed of four blocks divided by three streets.
part of the city subordinate to the existing buildings; so that they would simply arrange their cross streets in the centre of the city in such a manner as to get the baths and the temple close to the cross. The Roman temple of Sul-Minerva stood on the site of the present Pump Room, and this determined the site of the Abbey, which was built as close to the temple as possible.

The street leading to the East gate of the city is not now called Eastgate street, as is the case in Gloucester, but Cheap street. The explanation is that the position of the river Avon made the East gate merely a water gate, not a roadway equal in importance to the West gate; so that the fact of its being east ceased to impress itself so much on the mind as the fact that the market was in it, and it therefore got to be known as Cheap street (or Market street). That Bath was the great market of the district, and was known to the country folk outside as the Forum, is shown by this name having lasted till the present day in the name of the Hundred of which it is the head borough, for the Hundred still bears the name of Bath-Forum.

There is good reason to conclude that in the erection of the Abbey the builders made a compromise, as the Romans had done before them: that is, they found the position of Sul-Minerva too strong to permit of the demolition of the temple, for a portion of the latter was standing till comparatively recent times.

Two other traditions have come down from the Roman times, and leave their mark on Bath of the present day. One is that while many of the streets are macadamised, there are still others in which the Roman method of paving with squared sets is continued: not necessarily old streets, for some of them are quite recent. The other tradition is the Roman system of building pillared porticos along the streets, for that system has been
adopted from generation to generation until the present day, as, for instance, Bath street and the entrance to the Abbey Close, the latter being simply a modern representation of the ancient court of the temple.

The common idea that the name of Bath occurring in the Saxon Chronicle as “Acemannes ceastre,” meant “Sick men’s city,” will not stand examination. The Saxon word for “sick man” was then practically what it is now *seoc man*, for although *ace* was used for “ache,” no such form as “Ace-man” existed. It is simply an unintelligent attempt to account for a name which was probably the result of the abrasion which is so marked in Celtic speech. Even down to our own time the Cornish people, for example, clip many words till they are scarcely recognisable. Miners say, instead of “Yes, I believe,” “Iss, bleh!” and so on. This abbreviation was carried on excessively with words adopted from Latin: as *Cathedra*, which the Welsh make *Cadr*; *socius*, which the Cornishman make *soce*, &c. There was also a tendency in adopted words to bring forward the accent to the first syllable (like the Italians sound O’tranto, Brin’disi). But for this it is not easy to see why the Englishman of the present day pronounces the name of the eighth month as “Au’gust,” or why he says sec’ond, where a Frenchman says “sgōhnd.” This would lead the Britons to make *aqua*, or *aqua*, a single syllable, just as we know the Gauls did, for the French pronounce *Aig’ Mort*, and *Aix* (that is, the exact sound of the English “aches”). Then accenting the word Min’erva, and dropping, in turn, the terminal syllables, as already shown in Cath’edra, *Aqua Minerva* becomes *A’ca min’er*, and then Ac’min (ceaster). In the Chronicle of Florence of Worcester we get a glance at the intermediate form, for he says the coronation of Edgar took place in 973, “in civitate Acamanni.” “Aca” had nothing to do with
"ache." It is the abbreviation of _aqua_ or _aqua_. In the same way, in the Riviera we find the five syllables of _Forum Julii_ clipped down to two in the modern name of Fréjus.

In the remarkable map known as Peutinger's, which comes down to us from about the third century, there is a peculiarity which throws light upon the architecture of the Baths. This map is really a series of road-plans, marking the stations in Gaul, &c.; and wherever there is a thermal station (similar to Bath) it is depicted as a sheet of water surrounded on three sides by rooms, but with the centre left unroofed or open to the sky. The entrance is indicated as a pillared portico, with no building over it, and there seems no reason to doubt that the present pillared entrance to the Abbey Yard and Pump Room, at Bath, is a simple evolution from the style so clearly shown as that of a thermal station by Peutinger; that is, that each succeeding architect has copied the work he has replaced, with but unimportant modifications, since the Roman time. In the same way "Bath street" (opposite this portico), the present houses in which date from last century, preserves the Roman tradition of the pillared walks for the foot passengers on both sides of the way. We have examples of this in many other Roman towns in Britain and on the Continent.
THE CAMPS AT MINCHINHAMPTON,

BY

E. NORTHAM WITCHELL.

(Read at the Nailsworth Meeting, September 21st, 1898)

(I.) THE BRITISH CAMP.

This Camp consists of an entrenchment from 3 to 4 feet in height, with a ditch on the outside. It extends from near the May-pole, at Amberley, to the Reservoir of the Stroud Water Company, and thence turns to the south-west to the escarpment.

The Camp measures in length, from north to south, 760 yards; and in width, from west to east, 366 yards.

The north-west end of the Camp is divided from the remainder by a mound and ditch. The ditch is on the south-east, or outward, side of the mound, and the height of the latter from the bottom of the ditch is, from 10 ft. to 14 ft. This fortification runs diagonally across the Camp from the escarpment on the south-west to the entrenchment on the north-east, and measures 283 yards in length.

I am of opinion that this is Roman work, and that the British Camp was thus utilized as an occasional camping ground. The only evidence I have obtained in support of this theory is a copper coin found in the Camp, kindly
described for me by Mrs Bagnall-Oakley, who states that it is a coin of Constantius, son of Constantine the Great, struck at the second Mint of Irens.

There is a never-failing spring of water below the escarpment, to which the old path from the Camp can still be traced.

The remains of hundreds of pit-dwellings are in and around the Camp.

I have opened several, and found in them, burnt stones, and charcoal, also foreign pebbles, and pieces of stone known locally as "holy stone."* In one pit-dwelling I found an upright stone placed across it as a division. We dug to about 18 in. below the surface of the ground, and found burnt stones only on one side of it. Pit-dwellings similarly divided have been found in Wiltshire.

A considerable number of flint implements, and fragments of pottery, have been found in, and near, the camp. They consist of scrapers, knives, leaf-shaped arrow points, borers, &c.

I also found a small lead weight, shown in Fig. 1; and Mr Reed, of the British Museum, says it was used by the Britons for weighting their drag-nets.

Fig. 1.—Lead Weight, from Minchinhampton. Natural size.

The pebbles found in the pit-dwellings were probably used in the manufacture of flint implements, and the larger specimens as pestles for grinding purposes.

Some of the pottery is of a very rude and early type, and was apparently baked in the sun. Other pieces have been baked by fire, and are Romano-British in character.

* [Equivalent to the Dagham Stone of the Cirencester Great Oolite, Ed.]
(II.) The Danish Camp.

This is the largest Camp in Gloucestershire, and covers an area of about 300 acres. It consists of a high mound with a ditch on the inside. The mound runs from near "The Box" across the Common to Minchinhampton Park, and formerly extended round the site of the town, as there are remains of the fortifications about a mile to the eastward.

I consider it to be of Danish origin for the following reasons:

1.—There are few, if any, pit-dwellings in or around the Camp.

2.—Only one fragment of a flint implement has been found by me after careful search in the arable fields in the Camp.

3.—The mound is outside the ditch, instead of inside as in the Amberley Camp.

4.—Local tradition, and also the entry in the Saxon Chronicle, point to a great battle with the Danes having been fought here.

5.—The soil of a great portion of the Camp is of clay, which would not be so healthy for a people who lived in pit-dwellings as a dry porous soil, such as one finds in the sites of other British Camps.

6.—The great size of the Camp, which measures roughly one mile in length by half-a-mile in breadth: it would have required a large army to defend it.

In Prof. Ingram's translation of the Saxon Chronicle appears the following:

"A.D. 837. This year Alderman Wulfherd fought at Hampton with thirty-three Pirates and after great slaughter obtained the Victory."

Local tradition points to a great battle with the Danes having been fought here.
There is a stone called the "Lang Stone" situated on the far side of the Camp, which tradition states was placed with two other similar stones (since removed) to mark the spots where three Danish Chieftains were killed. The hollow to the south is called "Woeful Dane Bottom": tradition says that the blood at that spot was over the fetlocks of the horses, and that the stream in the valley below was red with it.

The ancient name of Minchinhampton was Hamton or Hanton: the word "Minchin," a religious House of Mercy, having been added later.

There is also an old road running nearly due east called Daneway.

The lack of pit-dwellings and the other characteristics mentioned, the local tradition, and names, and the entry in the Chronicle, are, I think, sufficient evidence to warrant a conclusion that this is a Danish Camp, and that the great battle of A.D. 837 was fought at this spot.

The term "pirates" was often used in the Chronicle to designate Danes, and it doubtless refers to 33 Pirate Chiefs, or Earls, and their following.

In another part of the Chronicle, in a description of the Danish army, it is stated that the average following of a Danish Earl, or Chief, was 500 men. Supposing that these Pirate Chiefs had the same average following, the Danish army, which was defeated at Hamton, would have numbered about 16,500 men, which would have been sufficient to man this Camp.
THE CARRARA MARBLE QUARRIES

BY

REV. H. H. WINWOOD, M.A., VICE-PRES. GEOL. SOC.

(Read February 21st, 1899)

These notes are the result of a visit to the marble quarries of Carrara last year, with a genial companion, no mean authority in geological matters, Prof. Boyd Dawkins. Leaving behind us that city of palaces, Genoa la Superba, in the glorious sunshine of an autumn morning, we took the train to Avenza, the junction for Carrara. Much has been written about the beauties of the road between Genoa and Pisa—the far-famed Riviera di Levante; and lucky are those travellers who, before the days of the iron way, followed the devious but picturesque route along the carriage road, for the railway line is the most disagreeable of all I have travelled. On this lovely coast it is reasonable to expect seascapes and landscapes far surpassing those pretty peeps on the Exeter and Torquay line; but nothing of the sort. Landwards a glimpse is caught of the wooded heights with a picturesque Italian villa embosomed amidst tropical foliage. You try to remember what tree or shrub it is growing so luxuriantly and to such a height, familiar to you in a dwarfed greenhouse or hothouse form, when you are shot into a tunnel. You take the other side of the carriage, and think you must certainly be rewarded by a sight of the blue waters of the Mediterranean, just catch a peep of the wavelets gently laving the sunny shore, when another tunnel, and into the darkness you go. Well, in any case the gulf of Spezzia, the Portus Lunense, must be seen. If you are very quick you may just catch the glinting of the waters of that celebrated bay.
capable of containing all the navies of Europe, and that is all. But after passing Spezzia, troubles cease. The country is more open, those 70 tunnels in 80 miles come nearly to an end. You can open the window again and breathe freely, without being stifled by the heat or suffocated by the black sulphurous smoke of the engine.

At last Avenza, in the Duchies of Massa and Carrara, is reached, and the mighty range of the Apennines, with their worn and rifted summits rising more than 5000 feet, opens out on the left. White streaks run down their sides from the summits, which may easily be mistaken for snow. They are the debris of the marble quarries—records of the wasteful method of working for thousands of years.

CARRARA

A branch line from Avenza, three miles in length, following the course of the now dry torrent bed of the Carrione, lands us finally at the town of Carrara, or rather just outside its barrier gate. Two Italian friends, Messrs Robson and Pelliccia, who met us at the station, passed us quickly by the sentinel on guard, giving the assurance that we had nothing contraband, and conducted us to the comfortable Hotel de la Poste, where our plans for the morrow's visit to the quarries were matured. A short walk in the evening through the town and up the valley of the Torano* on the west, gave sufficient proof of the industry carried on. Everywhere was marble—white, glaring white, houses, road-metal, road-dust, workmen's clothes, all was as marble in some form or other, consolidated in large blocks, or trituated into fine impalpable powder.

* The Torano Valley, on the west, seems to be the boundary line of the true marble, as the strata which we examined with our hammers, much to the curiosity of the women, were apparently Triassic beds very crumpled up.
The town of Carrara itself is most picturesquely situated at the foot of the Apennines, whose various summits form a fine background. The buildings are of a superior class, as might be expected from the excellent material so close at hand, especially the public buildings, Duomo, theatre, schools, &c. Two fine statues of Garibaldi and Mazzini adorn the piazzas, and the west end of the Duomo has a beautiful "Rota window," what we should call a rose window. From the weathered appearance of the outside one would not recognise its material, until told that the box of the wheel and the spokes were cut out of white marble. The inside, which was dimly lighted at the time of our visit, was a mass of marble of various colours.

**The Apennines**

It may be well to give a short description of the range of the Apennines. It is a continuation of the Maritime Alps, striking off E.S.E. from Genoa towards the Adriatic Sea. Trending then S.S.E., it runs down nearly through the centre of Italy, terminating in Italy's toe. Forming the southern boundary of the great plain of North Italy, the range is a watershed, the drainage flowing on the one side into the Adriatic, and on the other into the Mediterranean Sea. The summits of this range reach from 5000 to 6000 feet, so well described by Virgil—

"Gaudet (que) nivali
"Vertice, se attollens pater Apenninus ad auras."

(Æneid XII, 703.)

Deep valleys and rugged ravines cut into the heart of the mountains, thus making detached ranges and spurs, especially on their southern slopes. One of these spurs, dividing the valleys of the Macra and Serchio (Auser), contains the celebrated marble quarries of Massa and
Carrara. A railway, specially constructed for the purpose, runs right to the foot of the quarries, connecting them with the port of Avenza, about six miles distant from Carrara.

**The Quarries**

An early start in the morning enabled us to catch the first workmen's train, which, zigzagging up the steep incline, depositing sand and men at the various levels, finally reached its terminus at the station of Ravaccione (1110 feet). Here we left the train and found ourselves surrounded by a mountainous semi-circle of white marble. High above were the "cave," or quarries, with their streams, or rather *torrents*, of white debris extending to our feet, so well shown in the picture which forms Fig. 1.
And just below is the scene shown in Fig. 2—the patient meek-eyed, dun-coloured oxen, waiting for the wains to be loaded with the large blocks for transport to the sawing houses below—a busy and most interesting scene. Prof. Boyd Dawkins considers that the Italian large-horned, fawn-coloured, patient oxen are different from the large English domestic breed (Chartley, Chillingham, &c.) in every respect—colour, horns, and shape, and are not their ancestors. He considers Mr Arthur Evans' suggestion, that they have been derived originally from Egypt, very likely to be true.

We had our work cut out for the rest of the day. It was no easy matter climbing under the hot sun over debris composed of loose angular blocks of white marble. Here a staircase of steps rudely put together led straight up to a level, whence a zigzag path, scarcely discernible from the white mass around, and only known to the workmen, led up to the various workings. Some of
these quarries can only be approached by the skilled mountaineers who work them. A steep climb of another 500 feet brought us to Derville’s *cava.* This produces the ordinary clear white Carrara marble, called “Marmo Siciliano,” used for common statuary and architecture, its fine grain resisting the action of the weather. On the left is a valley containing the *Cava del Polvacco,* whence came the marble for Trajan’s Column at Rome, and for the Pantheon (temp. Agrippa, B.C. 26). The fineness of the grain, its purity and slight opaqueness adapt it for statuary purposes. Here Michael Angelo, who explored the Versiglia district in 1565, is reported often to have turned his steps. And the marble for his masterpiece, the statue of Moses, well known to visitors in Rome from its position before the Church of St. Peter, is said to have been brought hence.

After lunching at Ravaccione, we returned to the Stazione Torano, and walked up the Piastra valley, visiting the quarries on either side. A feature here was very noticeable, one which we afterwards saw in the other valleys: the road had been cut through a mass of drift. Large and small rounded pebbles and boulders, consisting principally of angular blocks of thin-bedded limestone, were mixed up here and there with some of a different kind, in one case a large green schistose boulder resting on a bluish, dense, crystalline rock, with occasional white bands approaching the marble structure. This drift stretched across the valley, but has since been cut through by the stream, now a mere rivulet, dry in the summer, which must formerly have descended in much greater volume from the watershed above, cutting out the valleys and bearing with it the various materials through which it ran its course.

* The quarries belong to different owners, and are called after their names.
A steep ascent on the opposite side took us to *Cava di Betogli*, whence comes the *Marmo statuario*. Resting on a huge block of ordinary statuary marble,* we were content to feast our eyes upon the fine view, to be told that the best was in a quarry still higher up, and to learn from the description that it was noted for its translucency when first excavated, losing that character when exposed to the air for some time. Hence it is more suitable for indoor work and the artist's studio. It also possesses a certain elasticity, for when sawn into thin slabs and placed against a wall, a slight curvature is plainly perceptible.

Descending the valley to Torano, we passed a section showing the "Dove Marble" *in situ*, called *Bardiglio marmo*,† blue in colour, and generally found at the base or on the lower slopes of the hills. Having done as much as we could in the Piastra valley, we retraced our steps to Carrara.

The next day, after an early start, we were landed at the small station of Miseglia, and thence backed to Torano and up a steep incline to Tornone, 820 feet above Carrara. Our object was to examine the quarries to the south-east on the opposite side to those seen the preceding day, and situated in the *Canal Grande*‡ and *Canal Colonata*, two valleys leading down to the Bedizzano valley. The deep valley called *Canal Grande* has its origin in Monte Sagro (1749 m.).

A short distance from *Cava dei Ravaccione*, and on the right hand, is the celebrated *Cava dei Fantiscritti*, or "quarry of the soldiers," so called from certain figures

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* The statuary marble is the most highly crystallised, and difficult to get without flaws.

† *Bardiglio unito*, quite plain; *Bardiglio scuro*, dark; *Bardiglio fiorito*, blue with black veins. The "Lion" and the "River," of the Vatican (temp. Antonius) were sculptured in Serravezzan Bardiglio.

‡ *Canale*, a narrow valley.
cut in the marble, supposed to be those of three Roman soldiers, but really the figures of Jupiter between Hercules and Bacchus (temp. Septimus Severus, 193-211. A.D.) These, with other Roman sculptures, have been deposited in the Academy of Fine Arts at Carrara.

It would be tedious to enumerate all the quarries that we visited, suffice it to mention that in passing to the Fossa cava the marks of Roman working were plainly visible where a way had been cut from one quarry to another in the slate-coloured marble; their tool marks also remaining on a face of blue marble just above a modern reservoir. Leaving Fossa Cava, belonging to our guide, Signor Pelliccia, we crossed to a quarry belonging to a Signor Catani, where some magnificent blocks of Siciliano Clara had just been cut out, one weighing 200 tons. Near at hand a Roman column was just peering out of the debris, having been left behind by the workmen, probably for some imperfection which disclosed itself in the finishing. A Roman pick, similar to those in present use, and recently found not far off, possibly the very one used in shaping this column, was presented to us and is now in the Owen's College Museum. Crossing a causeway which carried the road over one of the numerous fissures in the marble, some semi-circular worn cavities, coloured reddish from the infiltration of the red soil above, indicated where water had once found its way and formed swallet holes. Near here we observed a curious method of quarrying. A tall scaffolding of three stages was erected against the face of the quarry over the block required. Each stage was of sufficient height to allow three or four men to stand upright and work an iron bar (some 20 feet in length) up and down, time being kept to the tune of a wild Italian song, whilst the hole was being bored for blasting.
Descending to the Colonata valley, we were glad to take a short rest in a dirty *albergo* kept by one Josepho, who gave us an excellent repast of Salami, eggs, and chopped up fowl stewed in wine sauce, a most savoury dish, our thirst being allayed by some *vino di Carrara bianco*, the common wine of the country and very good. Refreshed, we made our last ascent to La Gioija (579 m.), Signor Pelliccia’s quarry, whence we had a fine view of the village of Colonata (450 m.), below us on the right. The height of the Campanile, seen on the ridge to the left, was 500 m. In the distance, Monte Sagro reared its pointed top. Descending, and leaving on our left hand five quarries on the mountain side which divides the territory of Carrara from Massa, we entered the valley of Bedizzano, passing over the whole series of strata down to the many coloured *Breccie pavonazze*, with fragments and pebbles of white crystalline marble, compacted by a ferruginous red or purple cement, hence called *Marmi pavonazzi* or *Mischi*. The following diagram of the strata in the Colonnata valley, copied from a rough section lent me by Prof. Boyd Dawkins, will give a general idea of the succession.

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*The columns of the Campo Santo at Pisa are made of Mischi.*
GEOLOGY

After this lengthy description of the quarries, it is time to give some notice of the geology.

The Apuan Alps, considered as a continuation of those of Switzerland, have been described as an elevated ellipse or dome-shaped structure, with Secondary beds and schists on either side of a central crystalline nucleus. To what age the latter belongs has been, and is, the *vexata questio*. That this marble nucleus is altered limestone admits of no doubt; but how altered and to what series it belongs, has been much disputed. The south-western flanks of the mountains in the Torano valley near Carrara are of Secondary age, as the Museum at Carrara contains fossils from these beds characteristic of the Lower Lias, and Rhaetic, *e.g.*, Lower Lias Ammonites, and *Avicula contorta* from the schists at Graguana farther up the valley, north of Torano. The Italian geologists generally, with Stefani at their head, trace an orderly succession from the Lias through the Rhaetic and Triassic beds downwards to the marble series, which they consider to be altered Triassic beds. M. Coquand, in his communication to the Comptes rendus,*" On the Age and Position of the White Statuary Marble of the Pyrenees and the Apuan Alps, in Tuscany," considers them to be of Carboniferous age, contemporaneous with the saccharoid marble of St. Béat, in the Pyrenees: he gives the order of succession as Lias, Rhaetic, Permian, and Carboniferous, its base being Carrara marble.

It is unnecessary to give a longer list of the various opinions as to the position of these rocks, ranging from the Mesozoic to the Palæozoic series. Since these views

* Compt. rend. t. lxxix., p. 411, 1875.
were held, a great advance has taken place in our knowledge as to the position and formation of crystalline rocks. Crushing, faulting, over-thrusts and shearing have been accepted as explanatory of much that has been hitherto in dispute. That a great crush and strain has taken place no one can doubt. There is evidence, too, of faulting, the extent of which, however, requires more time than we had at our disposal to work out. From the diagrammatic section there is an apparent dip of the various beds at a high angle—in some instances observed they were nearly perpendicular—but it is difficult to ascertain in these crystalline rocks whether this was the true dip or the result of cleavage. M. Jervis, in his "I tesori sotterranei dell' Italia" vol. iv., 1889, p. 261, 8vo., Turin, evidently thinks that this shows stratification, which, he writes, is sometimes well marked, sometimes completely obliterated. He considers the marble to be Pre-palæozoic. In one quarry (Ravaccione), where the crush was especially remarked, the crushed planes measured from a few inches in thickness to even a thin thread. A specimen taken from this spot measures half-inch in thickness, the faces of the thin slabs being stained a brownish hue from downward percolation of iron oxide.

In any case, whether that section shows dip or cleavage planes, it is clear evidence of great disturbance. And notwithstanding the opinion of the Italian geologists that these are planes of stratification following in orderly succession the Cainozoic and Mesozoic beds which are highly inclined on the flanks of this range, yet, comparing the structure of the Alps, where similar earth movements have taken place, and considering the analogy of this marble with the white crystalline Palæozoic marble of that range, the more recent view supported by Professors Bonney and Boyd Dawkins seems to be the more likely one—that this marble is of the same age as the schists
which flank it on either side and forms part of the massif of the Apennines, altered as that central nucleus has been in the Alps.

The fact, however, remains that whether the schists are of Carboniferous, Palæozoic or Archæan age, they are so much altered that as yet undoubted evidence of their position in the geological series is still wanting. And if any Cotteswold geologist would visit this interesting district and carefully map down the faults, note the great crushes, and follow up the strata from the flanks on either side to the central nucleus, he would pass a pleasant and profitable time amongst the picturesque valleys and glorious scenery of these marble mountains.

As to the alteration of the limestones, of whatever date, into their present crystalline form, here, again, opinions differ. That a metamorphosis has taken place all agree; some attribute this to igneous action, but there is no evidence of this in the Carrara district. The yellow, streaky, veined Sienna marble may have been formed by the intrusion of igneous rocks, as veins of Serpentine are not uncommon there; but in our visit we saw no indication of any intrusive dykes, and M. Jervis says that evidence of igneous action in the Carrara mountains, consisting of marble 3000 feet high, is singularly wanting. An intrusion of Serpentine does, however, appear near Spezzia, I have since ascertained.

The crystalline, granular, saccharoidal structure of the marble requires, according to the best authorities, heat and pressure, aided by moisture. Geikie writes: "The conversion of wide areas of limestones into marble is a regional metamorphism associated usually with the alteration of other sedimentary masses into schists, &c." (Text Book, 1882, p. 304.) M. Jervis thinks that metamorphism of sedimentary rocks, without the intervention of intense heat from the redistribution of the
mineral molecules under the influence of chemical decomposition, might account for this alteration. Stefani does not agree with the view that the formation of the marbles is due to compression, but attributes the alteration to slow molecular changes, brought about by circulating waters and by the ordinary metamorphic surroundings. (Geol. Mag., 1890, p. 373.)*

It might be interesting to give an analysis† of the marble, which is almost pure Carbonate of Lime:

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<tr>
<td>Lime</td>
<td>55.4</td>
<td>Carb. of Lime</td>
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<tr>
<td>Magnesia</td>
<td>0.4</td>
<td>Do. Magnesia</td>
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<td>Carbonic acid</td>
<td>43.2</td>
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There are crystals of calcite, iron pyrites, gypsum, sulphur, and pure white rhombohedral crystals of dolomite. In the cavities of the best marble clear quartz crystals called “Madre macchie” and “Carrara diamonds,” sometimes one inch long and pointed at both ends, occur, and are much sought after.

**METHOD OF WORKING**

In conclusion, a few words may be written on the methods of working and conveying the blocks from the different quarries. The way in which the vast mass of debris is shot from one slope to another at the discretion of the many proprietors, without any organised system, is

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* We need not go far to see an alteration in limestone rocks obliterating their ordinary lithic features. A visit either to the fields around Castle Comfort, on the Mendips, or to Shepton Mallet, will afford very good instances. Scientists have not yet succeeded in showing cause for this metamorphism, neither do they agree as to that of the limestone of the Apuan Alps.

† Berthier (T. des essais, tom. 1, p. 614).
most wasteful. It conceals much of the workable marble beneath its thick coating, and renders the lowering of the blocks over its irregular surface most hazardous. The way in which this work is done is shown in Fig. 4; the manner thereof has probably not varied from the earliest times. The large blocks are placed on wooden sleighs, with large cables attached. A rough upright block of wood, the limb or body of some small tree is let into a solid mass of marble enclosed in the debris above. Round this two or three men wind the end of the cable, and gradually slack off as the sleigh below slowly grinds its way over the rough and uneven surface of the angular debris. Two men, one on each side of the sleigh, place wooden rollers beneath the runners, and, whenever a stoppage occurs, start it off again by the aid of iron crowbars. The danger of this process can easily be seen; many accidents happen daily, and there are often deaths. Michael Angelo, commissioned by the Medici (Cosmo I.) to visit the quarries,
especially the Cava del Polvaccio, speaking of his difficulties, says, "the countrymen are excessively ignorant of the duties required of them; great patience and a long time will be requisite before the mountains have been made accessible \((\text{ad} \text{domesticat} \text{e})\) and the men trained for their work \((\text{am} \text{nestrat} \text{e})\). The peculiar grating noise of these primitive windlasses, accompanied by signals from the men to each other as they worked them, filled the air with a weird sound as it reverberated from one side of the valley to the other.

A syndicate has been formed for the purpose of working most of the principal quarries at Carrara and Massa. As most primitive methods have hitherto been employed, the marble being extracted near the surface and often much injured in blasting, it is thought that a great saving will be effected by modern appliances and machinery; the cost of "getting" the marble will be materially reduced, its purity better preserved, and the waste much lessened by cavern working. The supply is practically inexhaustible. The chief difficulty will arise probably from the disinclination of the Italian workmen, numbering about 5000, and physically, a remarkably fine body of men, to accept any improvement on their conservative ways of working, unless they can be persuaded that their earnings will not be diminished thereby. Like all mountaineers, they form a very independent and masterful community.
The Earliest Known Forms of Life.  By C. Callaway, M.A.  page 73
Human Babies.  By S. S. Buckman, F.G.S.  Plates I.  II.  "  89
Some Cotteswold Brachiopoda.  By Charles Upton.  Plate III.  "  121
Brachiopoda: Types and Figured Specimens.  By S. S. Buckman, F.G.S.  "  133
The Library of the Club is at Mr John Bellows', Eastgate, Gloucester.

It is open every Tuesday afternoon from 2.30 to 4.30, when books may be examined, or borrowed.

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PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

PRESIDENT
M. W. COLCHESTER-WEMYSS

HONORARY SECRETARY
S. S. BUCKMAN, F.G.S.

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The Secretary very much regrets that, although this (the second) part of the yearly Proceedings was kept back for the sake of Mr John Bellows' important paper on the "Evolution of Public Buildings," Mr Bellows' very numerous engagements have prevented his preparing the paper for the press. It is hoped, however, that the paper will appear in the next part of the Proceedings, which may be issued next June.

S. S. B.
THE EARLIEST KNOWN FORMS OF LIFE

ON THE GLOBE,

BY

C. CALLAWAY, M.A., D.Sc., F.G.S.

(Read March 21st, 1899)

Our Hon. Secretary, in a paper read before the Club on January 24th, called attention to a very recent phase of the process of evolution. He described some of the evidence which leads to the belief that Man is derived from the lower animals. He sketched the probable line of descent from the Ascidian or Sea-squirt. But the Ascidian is itself an animal of some complexity of organisation, possessing distinct organs of respiration and circulation, and being furnished with a granule of nervous matter, answering the purpose of a brain. When the Ascidian first came into being we probably shall never know, for the tissue of the animal is entirely perishable, and it is hardly likely that its sac-like body has left any traces of itself in the earth's crust. It seems, however, fairly certain that this ancestor of our race flourished in Pre-Cambrian times, for the lowest Cambrian strata contain the remains of several animal types of much higher organisation. This leads me to the main topic of my paper.
As we follow the succession of life downwards through Tertiary, Mesozoic, and Palæozoic formations, we find the higher types gradually disappearing. Man we lose almost at the start. He may be found below the Post-Pleiocene rocks, but we have not identified him yet with certainty in older strata. A corresponding qualification will apply to the first appearance of all animals and plants. We know where we first find them, we do not know how much older they may really be. The Mammalia disappear in the Upper Trias, birds in the Jurassic, reptiles in the Permian, Amphibia in the Carboniferous, and fishes in the Ordovician. The Vertebrata had therefore been evolved at least as early as the Ordovician, and it is not improbable that they commenced their existence as simple worm-like fishes, even in Cambrian times.

In the Cambrian rocks, from the top right down to the base, we find an abundant fauna. Even in the lowest Cambrian strata we have proof that nearly all the chief types of life below the Vertebrata had been evolved. We can detect sponges, Crustacea, Brachiopoda, Gasteropoda, and conical shells which were formerly thought to be Pteropoda, but are now regarded as the ancestors of the Kephalopoda, the highest of all the molluscs. These are but the relics of worlds of life that peopled the earliest Cambrian seas, for the occurrence of these animals implies the co-existence of numerous types which had no bone, or shell, or crust to perpetuate their memory.

But in the Pre-Cambrian rocks the traces of the life of the globe are meagre in the extreme. The abundance of the Cambrian period suddenly sinks almost to zero. It is as if, in tracing back the history of England, we passed in a moment from the varied life of the Elizabethan epoch to the poverty and emptiness of the Age of Bronze.

Yet we are sure that the seas of the Pre-Cambrian ages were teeming with living creatures. We believe it
on theoretical grounds, and we know it in some degree by actual indications furnished by the rocks themselves. I will take these two lines of evidence in their order.

I assume that the types of life found in the Cambrian rocks are the descendants of preceding species. I assume this as a deduction from the theory of evolution, which may now be taken for granted as safely as the law of gravity or the doctrine of the conservation of energy. Before the Cambrian fauna can have commenced to evolve the succession of life which culminates in Man, it must itself have been evolved. It is the result of a series of evolutions extending through vast periods of time. Think what the plastic material of life must have gone through before a brachiopod or a trilobite was born! Some of the Cambrian trilobites are furnished with compound eyes. Yet we regard an eye as one of the most elaborate of all organs. The brachiopod possessed complex apparatus for respiration and a digestive system of a comparatively high type, and the gastropod was more elaborately formed. The conical shells of the Cambrian probably contained creatures of still higher organisation.

In estimating the time required to evolve Pre-Cambrian life, we must keep in mind the fact that the lower forms change less rapidly than the higher. This law is well seen if we compare the mollusca of the Tertiary epochs with the mammalia. Existing species of molluscs began to appear in the oldest Tertiary strata, but no living mammal is found even so low as the Pleiocene. Since the beginning of the Eocene period the Molluscan fauna has varied but slightly, very few new genera having been produced; but the mammalia have varied fundamentally, nearly all the existing orders, to say nothing of families and genera, having come into existence. In the Eocene period, we find the primæval stock from which all the higher mammals have descended, but the differences
between the Eocene mammals and their modern representatives are enormous. To take one example. The Eocene horses were about as large as a fox, each front foot was furnished with four toes and a thumb, while the hind feet had three toes, each of them terminating in hoofs.

We have next to compare the amount of differentiation in Pre-Cambrian times with the differentiation of life in subsequent epochs. We know that at the opening of the Cambrian epoch all, or nearly all, of the existing animal sub-kingdoms had been evolved. These ancient types, as we have seen, must have been differentiated much more slowly than the higher forms. The differentiation before the Cambrian epoch was therefore much greater than since, and it was much less rapid. We are therefore driven to conclude that Pre-Cambrian life took much longer in developing than all the faunas of succeeding epochs. Some authorities make the difference at least nine to one. I will assume it to be one to one. In other words, we may conclude with reasonable certainty that the sedimentary formations—the only ones that are fitted to contain the remains of life—below the Cambrian represent time at least equal to the long succession of epochs represented by the Palæozoic, Mesozoic, and Kainozoic systems.

The result at which we have just arrived will appear the more surprising when we reflect upon the paucity of the formations which represent Archæan (Pre-Cambrian) time. Thirty years ago we knew next to nothing of these rocks. The Laurentian and the Huronian had been described in America; and the Laurentian had been correlated by British geologists with the crystalline rocks of the Malvern Hills and North-Western Scotland. But since that time the enormous gap between these ancient gneisses and the base of the Cambrian has been partly bridged over by two great formations. First of all, Dr Hicks
discovered a volcanic series below the Cambrian of St. David's, and this he called "Pebidian." These rocks have also been identified in Shropshire, the Malverns, Charnwood Forest, and other Midland localities; but here we name them "Uriconian," though I have always conceded that Hicks' term has priority. More recently, a third Archaean group has been established in Western Shropshire. The vast series of slates, sandstones, and conglomerates composing the hill range of the Longmynd, originally identified by Murchison and the Survey as Lower Cambrian, underlies the lowest Cambrian unconformably, and the present Director of the Geological Survey now admits its Pre-Cambrian age. I have called this formation the Longmyndian. Rocks of probably the same age have been found underlying the basal Cambrian of the Scottish Highlands. In America, also, more than one series of strata have been found to lie between the Huronian and the Cambrian. The name "Algonkian" has been given to the most prominent of these formations in the United States. The rocks immediately underlying the Cambrian, on Lake Superior, are called "Keweenawan." Whether these formations, or either of them, were formed contemporaneously with our Longmyndian it is impossible to determine on the present evidence; but in a general way we may regard them as occupying the corresponding position in the geological series.

It would not be difficult to speculate on the succession of life in Archaean time; but I wish at present to confine your attention to bare facts. Much has been written on the life of the Laurentian (Malvernian) epoch. The famous Eozoon (Dawn-animal) has done duty in text books as long as I can remember. It fitted so neatly into the evolutionary scheme that it seemed as if it must be real. But regretfully we must come to the conclusion that this supposed ancestor to all the forms of animal life
is a mere mineral mimicry of an organic structure. It has also been contended, it is still contended by some authorities, that the occurrence of limestones in these ancient rocks is a proof of the agency of living beings. I have elsewhere* given reasons for treating this opinion with extreme scepticism, and in the same paper I have pointed out the insufficiency of the arguments based upon the presence of iron ores, graphite, apatite, and metallic sulphides. I do not consider that the chemical evidence for the existence of animals or plants in the Lower Archaean formations is of any decisive value. I will go even further. I hold that these rocks never can furnish any evidence for the existence of living beings. For these gneisses and schists are of plutonic origin. They are igneous masses, formed at great depths in the earth's crusts, under enormous pressures, and at temperatures which sometimes caused absolute fusion. This conclusion has been proved for the Malvernian masses of Malvern and the Highlands; and American geologists are applying the same interpretation to most of the Laurentian rocks of the Western Continent.

The older Archaean formations being thus excluded from our purview, we turn to the newer rock-groups. I will first notice the evidence furnished by foreign localities.

In Southern Brittany is found a graphitic quartzite which has yielded numerous minute fossils. The rock forms part of the series of Saint-Lô, which is the probable equivalent of our Pebidian, but at least is certainly Pre-Cambrian. The fossils have been referred by some of the highest authorities to the Radiolaria, unicellular gelatinous bodies enclosed in a siliceous test, which is usually spherical in form, but sometimes ellipsoidal, and often bell-shaped. The wall of the test is perforated, but

not so minutely as in the Foraminifera. One or more radial spines occur in some of the species; and in two or three of them an inner wall has been detected, connected by rays with the outer shell. One objection to the organic origin of these forms is their extreme minuteness, their average diameter being only one-seventeenth of that of one of the Palæozoic Radiolaria. For this and other reasons we are unable to accept these specimens as undoubted proofs of the co-existence of living beings. If we could do so, we should have to regard them as the oldest known forms of life.

The Algonkian rocks of North America have yielded Brachiopoda not unlike some of the Cambrian forms, and obscure fragments of trilobites. The conical shells which have been referred to the Pteropoda, have also been detected. These types are so similar to the Lower Cambrian fauna as to indicate that we are still very far from the base of the great life-succession. Associated with these highly organised forms is Cryptozoon, which, if organic, is a compound structure allied to the Foraminifera, and somewhat resembling the Stromatopora of the Silurian.

We will now return to our British Upper Archæan formations. Of the Uriconian there is little to be said. It is usually of volcanic origin, consisting of lavas and tuffs. No fossils could occur in the former, save under very exceptional circumstances; but organic remains are sometimes found in volcanic rocks. However, the tuffs of the Uriconian have not yielded fossil remains in any of the localities in which the rocks have been studied. In some localities the Uriconian is composed of ordinary sedimentary strata; but hitherto they have proved entirely barren of life.

There remains only the Longmyndian series, and it is here, if anywhere, that we should expect to find some of
the ancestors of the world's inhabitants. I have been searching these rocks at intervals for the last 20 years; and I have been in the habit of urging upon younger workers that a fortunate discovery of fossils in these strata might be of the very first importance in the history of geological and biological science. Hitherto, however, our researches have been tantalising in the extreme; for, though we have obtained evidence that the life of the Longmyndian period was by no means meagre, we know very little of its nature.

The Longmyndian series in the typical area consists of conglomerates, purple and green sandstones, and fine-grained shaly and slaty rocks. Their thickness was calculated by the Government Surveyors at not less than five miles. Making allowance for probable repetitions, we may adopt a minimum estimate of three miles, whereof at least one-third is composed of strata which were once a fine mud, a material above all others most favourable for receiving and retaining impressions made upon it. It is in such rocks as these that we find the exquisite plant remains of the Coal Measures and the exceptionally perfect ammonites of the Middle Oolite. Nor have these shales undergone any material change. They are indurated and somewhat slightly cleaved, but they usually split along the planes of lamination, and readily reveal such traces of fossil remains as they contain.

When the Geological Survey first studied the Longmynd rocks, they described them as "unfossiliferous." Subsequently, Mr Salter discovered what he regarded as the pygidium of a trilobite which he named *Palaeopyge Ramsayi*. This marking must, however, be relegated to the limbo where *Eozoon Canadense* is already peacefully reposing. Salter's discovery of *Arenicolites* is, however, abundantly confirmed. It occurs in the form of small pits, which Salter supposed to be the orifices of borings
made by a sea-worm; and as they are sometimes found in pairs, he gave them the specific name of *didyma*. He presumably thought that the animal ascended by one of the apertures and descended by the other. My own experience is that these pairs are extremely rare, while single pits occur in vast numbers. That the single and double pits belong to different species may be considered probable. I have also detected the traces of a fossil of larger size, about one-eighth inch in diameter. It is in the form of an annular depression surrounding a raised ring, in the centre of which is a minute pit. This structure would also seem to be connected with the movements of worms on a sea-shore; and in this opinion I am confirmed by the high authority of Mr E. T. Newton, F.R.S. On some of the slabs of shale there appear linear elevations, which sometimes bifurcate like the veins of a fern-leaf, and are aggregated in clusters so as to suggest a *Dictyonema*, or a Polyzoan. I have one specimen which looks as if it were an impression of a leaf with parallel venation, but I incline to think that it is merely the weathered outcrop of thin laminae of sediment. The absence of any trace of carbonaceous or chitinous matter in these rocks somewhat militates against the belief that either of the last two forms is really of organic origin. My last fossils are in the form of oval depressions, the largest of which are about half-an-inch in length, and are well marked, with sharply defined edges. Others are smaller and less distinct, and some are so minute as to be scarcely visible. They can hardly be footprints, for they do not occur in pairs; but they certainly suggest the action of living creatures.

The evidence I have adduced clearly points to the abundance of animal life in Longmyndian times. The traces of organisms are often extremely obscure, but that wormlike animals abounded on the shores of the seas is
fairly certain. But the question still presses upon us—what preceded these annelids? We know of nothing which is certainly organic and certainly older. We are apparently not much lower down in the scale of living beings than we were in the Lower Cambrian; and we have still beyond us a vast gulf of time which has to be occupied by fossiliferous formations, if our knowledge of the earliest forms of life is to advance beyond the speculative stage. Why is it that the required evidence has not been forthcoming?

There is one reply to this question which will cover a part of the ground. There can be little doubt that the earliest plants and animals were composed entirely of perishable tissue. The first forms of life were probably unicellular marine plants. These could exist in the absence of an organic environment, since they were able to elaborate their protoplasm out of inorganic materials. Their tissue would provide food for the earliest animals. Long ages must have passed before the organisms that tenanted the Archaean seas came to be protected by a shell or test of any kind. The need of such protection could not have arisen until the ocean began to teem with living beings, and the struggle for life grew intense and forceful. It is probable that the open ocean was the habitat of the earliest animals; but, as competition grew fierce, some of the species would be driven to take refuge from their fellow-creatures amidst the dangers of the shore. Here protection would be needed against the attacks of the waves as it had been required against the living tyrants of the deep.

Another cause of the scarcity of fossils in Pre-Cambrian rocks is the fragmentary state of the Archaean succession. This is the natural result of the extreme antiquity of these formations. They have, of course, been exposed to the forces of denudation much more frequently than other
rocks, and the probability of their destruction is much greater.

As denudation destroys, metamorphism obliterates. Sedimentary Archæan rocks have been metamorphosed oftener than newer formations. They have more frequently sunk down to deeper and more heated zones of the crust, and been exposed to the pressures which so profoundly modify original structure. It is rare indeed for fossil remains to survive the complete metamorphism of the strata in which they were imbedded.

Of one thing we may be certain. The earliest forms of life were the lowest. If we wish to people the Archæan seas with their original inhabitants we must supply them with sea-weeds, Foraminifera, sponges, Radiolaria, jelly-fishes, annelids, simple forms of Crustacea and Molluscoidea, and probably many of the Mollusca proper. But we cannot doubt that a large proportion of the Archæan faunas consisted of animals the very types of which have no modern counterparts. Just as amongst the Mesozoic vertebrates creatures lived which were neither birds nor reptiles, but were the ancestors of both, so in Archæan times there probably existed animals of generalised types, which by gradual differentiation gave rise to the forms now called annelid, or crustacean, or mollusc. A blind dull life they must have lived, these Archæan tenants of the deep; but let us not despise them, for without them we could not have been.
TWO BRONZE SPEAR-HEADS
FROM RODBOROUGH, NEAR STROUD,
BY
MAJOR C. H. FISHER, F.R.A.S.
(Read February 21, 1899)

The two spear-heads depicted in the accompanying Figs. 1, 2, are in my possession. They were given to me long ago by Mr Pinfold, the last of a very old family of that name, who inhabited a house called the Woodhouse, in the Parish of Rodborough, near Stroud, and possessed much land around there. He informed me that these old weapon-heads were ploughed, or dug up when the site of a very ancient beech wood, on the edge and fringe of Rodborough Common (unenclosed fortunately and unenclosable, from its proximity to the populous town of Stroud) was converted into arable land, and finally into hill pasture. This was not much less than fifty years ago. He only added that there was not, he thought, any appearance of an interment (though oddly enough the two spear-heads were found near one another), and that nothing else of the kind was discovered. They were not very deep in the ground, some 18 inches, he believed, only.
In an interesting and well illustrated work by Waring called "Rude Stone Monuments, Tumuli, and Ornaments of Remote Ages," London, John B. Day, 1870, Plate 77 contains engravings of many bronze Implements. In this
plate the spear-heads depicted in Figs. 1 and 2 are strikingly like mine. They have the same shallowness of socket for the reception of the handle, and two loops (sulci) one on each side of the socket for further securing the head to the helve, or handle: a very rough and unsatisfactory form of attachment, instead of the vastly longer socket adopted for modern boar spears, and the lances of all lance-armed cavalry. Waring says (p. 62) "Fig. 1 is a bronze spear-head 7½ inches long, with the sulci, or side loops, usual in Irish specimens, for attaching it more strongly to the handle: these loops Sir William Wilde believes gradually rose towards the head till they were formed in the spear-head itself, as seen in Fig. 5. The length of Fig. 2 is 7¼ inches." My spear-heads are shorter than those figured by Waring; one is 5 inches, and the other only 4 inches long.

These memorials of the Celtic folk who dwelt in the Cotteswolds in what is known as the Bronze Period are interesting from their local associations. They show very good workmanship. They are depicted in the accompanying illustrations, Figs. 1, 2, of natural size.
HUMAN BABIES: SOME OF THEIR CHARACTERS.

BY

S. S. BUCKMAN, F.G.S.

[PLATES I., II.]

(Read January 24th, 1899)

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I. INTRODUCTION

In the Introduction to his “Descent of Man” Darwin says: “The conclusion that man is the co-descendant with other species of some ancient, lower, and extinct form, is not in any degree new. Lamarck long ago came to this conclusion, which has lately been maintained by G
several eminent naturalists and philosophers; for instance, by Wallace, Huxley, Lyell, Vogt, Lubbock, Büchner, Rolle, and especially by Haeckel."

In the General Summary of his conclusions which he advances in the same work, Darwin remarks: "By considering the embryological structure of man,—the homologies which he presents with the lower animals, the rudiments which he retains, and the reversions to which he is liable—we can partly recall in imagination the former condition of our early progenitors; and can approximately place them in their proper place in the zoological series. We thus learn that man is descended from a hairy, tailed quadruped, probably arboreal in its habits. This creature, if its whole structure had been examined by a naturalist, would have been classed among the Quadrupedae, as surely as the still more ancient progenitors of the Old and New World monkeys. The Quadrupedae and all the higher mammals are probably derived from an ancient marsupial animal, and this through a long line of diversified forms, from some amphibian-like creature, and this again from some fish-like animal. In the dim obscurity of the past we can see that the early progenitor of the Vertebrata must have been an aquatic animal, provided with branchiæ, with the sexes united in the same individual, and with the most important organs of the body (such as the brain and heart) imperfectly or not at all developed. This animal seems to have been more like the larvæ of the existing marine Ascidians than any other known form."

It is only with the last chapter of this history that the present communication is concerned, and only very partially with that; for the subject is of such wide scope that it is impossible in this case to treat it exhaustively. But the object is to call attention to certain characters of human babies, and to point out that in the main they are totally foreign to characters which would have arisen in
Man if he had never been anything else but Man; while on the other hand, they are such as would be shown if Man's immediate ancestors had been, as Darwin states, "hairy, tailed quadrupeds, probably arboreal in their habits."

Putting aside, however, for the moment, the question of the development of the race, it cannot be said that Man is always Man in his individual history. The ovum from which he proceeds "is about 1/15 of an inch in diameter, and might be described in the same terms as that of the dog; it is very long before the body of the young human being can be readily discriminated from that of the young puppy;" then for a period of foetal development it resembles that of an ape; and "it is only quite in the later stages of development that the young human being presents marked differences from the young ape."*

Man is not truly Man, then, until he has passed these stages in his individual history. That such stages have to be passed through in the development of every human being is inexplicable if Man has always been Man: in such case he should commence life as Man, with every organ, brain, heart, limbs, etc., complete, though minute.

On the other hand, it is what would be expected if Man has only lately become Man, and if his ancestors, starting from a unicellular organism, have gradually developed to become Man in successive generations.

A short reference may now be made to a paper read before this Club some seven years ago, and published in its Proceedings (Vol. X. p. 258, 1892). Therein was dealt with the Law of Earlier Inheritance—that if an organism with a character, say, $A$ throughout the greater part of life, develops a character $b$ in maturity, then in successive generations the character $b$ will tend to appear

earlier and earlier. Circumstances being favourable to character b, it will elaborate and pass through stages B to B. Then circumstances favour the growth of a character c, which similarly develops to become C and C, the while that b, B and B appear respectively earlier in life. Thus the life-history—youth, adolescence, maturity—of a given species may be stated as all A. In its descendants such life-history may be represented as youth and adolescence A, maturity incipient b. In later descendants, youth may be A, adolescence and maturity increasing degrees of b—B; and, in still later descendants, youth may be A, adolescence the stages of b—B rapidly developed, maturity c increasing, and so forth.

Such a symbol as b may denote any given character—for instance, the growth of ribs by a smooth Ammonite, or the ability of Man to walk upright.

This is only a short and partial summary of what was more fully considered in the paper referred to; but it is sufficient for the present purpose. It is desired to point out that, in accordance with this law of earlier inheritance, the characters of adult and adolescent monkeys should become characters retained by youthful Man. Or the argument may be put the other way—if in youthful Man are found special characters such as would be developed in an arboreal quadruped, while they are unfitted or unsuitable for a biped, then it is reasonable to infer that Man had an arboreal quadruped for his immediate ancestor.*

It is now proposed to consider some of the characters of youthful Man.

* Immediate in an evolution sense—say, some million years ago—in a line of ancestors whose developmental history would extend back some 100 to 500 million years.
II. Characters

a. Quadrupedal Progression

It is unusual for the babies of civilized races to adopt a truly quadrupedal method of progression. Their method of movement is fittingly called crawling, because they progress on hands and knees. Or, in other cases, sitting on the buttocks, they progress in a spasmodic manner by putting one hand to the ground and then dragging the body up to it.

The human baby, as the descendant of four-footed animals, should be able to progress on its four limbs directly it is born. That it does not do so is the result of excessive maternal solicitude for a great number of generations, so that it has been unnecessary for the young human being to develop its powers of progression as early as it should do. The more the mother protects her offspring, the more helpless does the offspring become in successive generations, development being retarded (see p. 116). Other examples of this state of affairs can be observed in the animal kingdom. The human mother relieves her offspring of the necessity of locomotion by carrying it about. The more civilized the race the greater will be the relief given. Rarely, therefore, among civilized races does the child progress in a truly quadrupedal fashion; yet, as would naturally be expected, among some uncivilized races such progression is almost the rule.

Fig. 1, Pl. I., shews the only one of my children which progressed in a quadrupedal fashion. It may be noted that it is a truly plantigrade progression with diagonal movement of the limbs.

Another photograph was taken at the same time. A block made from it appeared in "Nature," * with some notes by myself relative to some remarks concerning

* Vol. 51, November 4th, 1894.
African children by Mr. H. M. Stanley.* The annexed block is from an electrotype thereof.

After these pictures were taken the child had a slight illness. The weakening effect of this was seen, because she did not afterwards accomplish true quadrupedal progression, but crawled like other children.

When a four-footed animal tries to walk on its hind legs it shews its want of adaptation for that style of movement, particularly in the bowed character of the knee joint. This may be seen in the picture of a cat (Pl. I. fig. 3): it has been persuaded to reach up for something, and to stand momentarily on its hind legs.

Similarly, then, a human baby possessing the heritage from its four-footed ancestors, should, when it first attempts bipedal progression, shew the inability to straighten the knee joint, which characterizes four-footed animals under these conditions.

Fig. 2, Pl. I., illustrates this perfectly. The child, not yet able to balance itself for long on its hind limbs (note the position of the arm) is trying its best to reach as high

* October 18th, 1894.
as it can, yet it is unable to straighten the knee-joint. The comparison with the cat in a similar attitude is very interesting.

In fig. 5, Pl. I., another view of the same child, the same inability to straighten the knee-joints is apparent. This flexure of the knee, which is a necessity for quadrupedal progression, and is a heritage of great antiquity, is only lost gradually in the attempts to attain the bipedal position. That it is retained by the young baby in its early efforts to walk, shews that Man's pre-human ancestors were accustomed to a quadrupedal gait.

The small ability of this baby, and others of similar ages, in regard to the attainment of the bipedal gait, is analogous to that shown by the Gorilla. That animal, however, strong as he is, cannot attain to any greater bipedal proficiency throughout life; shewing that the baby's bipedal awkwardness is not the mere result of want of strength: it is simply a question of heredity, and of how long the race has attempted and achieved bipedal progression. Man, it may be surmised, started to attain the bipedal gait long before the Gorilla did; or at any rate he has made much better progress in the effort. So much better that now the accumulated inheritance of the bipedal character has, as it were, pushed back the quadrupedal character until the latter belongs merely to infancy.* Thus in bipedal attainment adult man is far beyond the Gorilla; while the human infant is its morphic equivalent. But such equivalence points to this—that Man's adult pre-human ancestors had for a long time no better bipedal ability than that possessed by the Gorilla.

* The earlier inheritance of characters, so that a prior character seems to be forced back and back, is specially illustrated in palaeontology, particularly in the progressive elaboration of ornament among Ammonites. And in Brachiopods we have a capital example near at home—the adult character of the earliest examples of *Terebratula fimbria*—the fimbriation—becomes quite a character of the early youth in the later appearing examples.
Another relic of quadrupedal ancestors which the human baby exhibits was first noticed by Dr Louis Robinson,* namely, that children go to sleep "with the abdomen downwards and the limbs flexed beneath them." I can confirm this from repeated observations of my own and other children. They go to sleep somewhat in the attitude of crawling, only with the arms tucked under the body and the head turned sideways. Mothers, ignorant of the child's and their own quadrupedal ancestry, will disturb the sleeper in order to put him into, as they think, a more comfortable position; and then they are surprised that the child is fretful.

c. Arboreal Traits

The arboreal episode in the history of Man's ancestors must have been short compared to what may be called the quadrupedal period.† For one thing during the time of arboreal existence a certain quadrupedal method of progression was still maintained. But in the arboreal life new manners of using the limbs were introduced, and the chief development pertained to the fore-limbs. So that though the arboreal period may have been comparatively short, yet for these reasons, and for another—that it shortly preceded what may be called the bipedal period—it has left some very striking traces on the human infant.

A few of these traces may be noticed. The picture, Pl. 1, fig. 4, shows a child grasping a flower pot. First may be remarked the sympathetic action of the other


† The first appearance of a kind of quadrupedal movement started with fishes. It is a genuine and firmly established quadrupedal progression with the Amphibians. Thence onward it remained the usual method of progression, except that arboreal habits induced for a short time a greater use of the fore-limbs.
hand—a character very likely to arise in an animal accustomed to hold by both hands at once to a branch. Next the flower pot has been picked up by dabbing down the hand on to the rim—the action which a monkey would use in catching at a branch: the thumb has not been brought into play as in an adult; but the fingers have been made to hold the flower pot between themselves and the palm of the hand.

The child has got hold of the flower pot just as an arboreal animal like a monkey would get hold of a branch. In fig. 6, again, where the child is grasping a stick, the thumb is very obviously not employed.

Now the fact that the thumb is not used, which at first sight seems remarkable, is the strongest piece of evidence for the Simian ancestry. The fingers are quite sufficient for tree-climbing purposes; and the more arboreal a monkey becomes the less service does he make of the thumb. "The most arboreal monkeys in the world, namely, Ateles in America, Colobus in Africa, and Hylobates in Asia, are either thumbless or their toes partially cohere, so that their limbs are converted into mere grasping hooks."* Also in arboreal animals like the Squirrel and the Dormouse the thumb has practically disappeared. It may be known, then, that the pre-human ancestor gave up living an arboreal life before there was time enough for abortion of the thumb. Yet the arboreal life lasted long enough to give a very noticeable character to a baby's hands.

Thus from the arboreal life it has inherited the habit of keeping the hands in a semi-clasped attitude. Fig. 5 illustrates this very well. Fig. 8 also shows the same character to a certain extent. In fig. 10 the idea of grasping something may be noted. And in fig. 2 the instinctive

* Darwin, "Descent of Man," Ch. II.
action to grasp at something in order to steady itself is particularly apparent: actually it would have got more balance if it had stretched the hand out flat.

Not only in children, but even in adults, may the effect of our ancestors' bough-grasping habits be seen; for it comes natural to place the hands in a semi-clasped position when they are at rest.

When children are asleep, particularly if they are not well—the time when reversion to ancestral habits would be most apparent—it may be observed that they throw the arms above the head, tightly clasping the hands. The monkey holding the branch above its head is exactly what this expresses. The fact was that the hands of our arboreal ancestor had obtained a permanent set into the bough-grasping attitude; and that we have not yet lost this till after the baby stage. This permanent set is so observable in the hands of the Chimpanzee, the Gorilla, etc., that now, though they have more or less abandoned the arboreal life, and have not attained to the bipedal progression, so that they have to move with the help of all four limbs, the "set" in the hands from bough-grasping prevents their putting the hand down as the baby does in figs. 1 and 7. "They walk on the outer margins of the palms or on the knuckles" (Darwin).

What are called "the wonderful adaptations of Nature" are often pointed to with astonishment to compel our admiration. Therein is much misconception. The adaptations are a matter of time and permanence of environment, and then are often only the making the best of a bad job due to some previous episode of history. Thus the anthropoid apes are examples of ill adaptation in the matter of their fore-limbs: those limbs are fitted for an arboreal life, and these apes have not been settled long enough in any other form of life to get their limbs thoroughly adapted thereto. In Homo clothed man is
a special instance of making the best of a bad job—the loss of a coat: beside him a cat shows what he may envy. And in adapting a quadrupedal body to a bipedal gait he has laboured under great disadvantages: his want of success is attested by many complaints to which he is subject. Then in adapting the stomach of his herbivorous ancestors to an organ fit for his present diet, he has been remarkably unsuccessful. He retains a relic of the stomach of his herbivorous ancestors in the vermiform appendix, which is not only totally useless to him, but has often been a cause of death. Then, in the present day, Man, adapting himself to the sedentary life, shows, in the trouble with his digestive, urinary, and other organs, in neurotic affections, and the great increase of insanity, how ill-suited he is to the conditions of his environment. He has been forced, comparatively recently, to adopt new ways of living: to acquire the necessary adaptation will require thousands of years, and cost a terrible sacrifice of life.

One more point about the hands—Man does not get over what may be called the "set" of the bough-grasping attitude until he is some 5, 6, or more years old. Two of my children, aged 6 and 5 years respectively, were told to hold out their hands as straight as they possibly could. I photographed their hands, and the bough-grasping curve is very apparent—both hands have a forward bending of the fingers: the children were unable to straighten them out.

I stopped several village school children—boys and girls—on one occasion, and offered a prize to the one who could hold out the fingers the straightest, showing them what was wanted. It was most interesting: the failure of some of them to straighten the fingers was ludicrous. Practically all but one showed a more or less definite curvature. The exception, who took the prize, was a girl—not the oldest of the group.
Now if acquired characters are transmitted, what may be called the human ability to straighten the hand should displace the inherited monkey attitude earlier in those children whose forbears have for several generations been engaged in work which would favour the human finger-extension. That is to say, that the ability to straighten might be expected to appear earlier in certain classes than in others. There is an interesting field here for the collection of accurate data.

Something else may be noted. Injury and unfavourable environment often cause the re-appearance of ancestral characters. This is very noticeable among fossil molluscs. Now in the human hand injury from an accident increases the bough-grasping tendency, or brings it back, so that no straightening of the fingers is possible. Cold, too, increases it, decreasing the ability to straighten.

The longer an arboreal life was maintained, and the more an animal became adapted thereto, the greater must be the tendency to lose the ability of digit movement in the hands and to lose the power of accurate arm movement,—because the fore-limbs must do the greatest share in weight sustaining. On the contrary, the toes of the feet might become the more flexible and delicate instruments. There are some interesting facts in this connexion in young children—they have the ability to move the toes separately (see fig. 6), but they are clumsy with the fingers, and the movements of the arm are very awkward. Trying to put something into its mouth the child will probably hit itself in the eye, and then turn the head to the hand instead of bringing the hand to the mouth.

In bipedal progression the functions of fore and hind limbs are just reversed to what they would be among arboreal quadrumana. The hind limbs are the weight-carriers and the front limbs manipulators. And so previously inherited traits have to be dispensed with, and
those fitted for the bipedal condition must be cultivated afresh.

So the ability of toe-movement does not make any progress—it rather retrogrades: it does so particularly in civilized children; but the ability of separate finger movement gradually increases, to finally become more perfect than that of the toes. The pointing with the finger, shown in fig. 7, is quite beyond the ability of the child at the age when fig. 6 was taken.

The baby's ability to move the toes,* and the flexibility of its ankles, point to an arboreal ancestor who used the hind limbs as the principal tactual instruments; and the flexibility of the ankles was necessary to a tree-climbing animal in order to make the soles opposable for the purpose of grasping limbs of trees.

d. Incipient Bipedalism

An attitude which babies are fond of assuming is that of sitting on the hocks, shown in fig. 8. It is significant of the transition stage from the quadrupedal to the bipedal attitude. It does not require the same amount of exertion as the poising of the body erect on the two hind limbs, and yet it leaves the fore-limbs free for any manipulative processes.

The same attitude is often adopted by quadrupeds. It may be noticed in the dog and cat when "begging," in the cat when performing her toilet, in the rabbit when listening, in the mouse on many occasions. It is the attitude which has been cultivated by the kangaroo, until it has

* The ability of toe movement has not been lost among savages. "Among these people [Kaffirs] the foot assumes its proper form and dimensions. The toes are not pinched together by shoes or boots, and reduced to the helpless state too common in this country. The foot is like that of an ancient statue, wide and full across the toes, each of which has its separate function just as have the fingers of the hand, and each of which is equally capable of performing that function" (J. G. Wood, "Natural History of Man" Vol. I, p. 15.)
become almost permanent, even in locomotion. And it must have been an attitude very extensively adopted among the Saurian-like ancestors of Birds, thus having been an important factor in Bird evolution.

Darwin was inclined to think that the sitting-down attitude had been largely responsible for the abortion of the tail in Man and the higher apes. This hardly seems to meet the case, considered together with instances of tail-diminution, amounting almost to tail-abortion, in other animals. Increased use of the hind limbs for locomotion might favour tail-reduction on a principle of economy. And there is another point to be considered—does disuse following excessive use cause the rapid diminution of an organ? That is to say, the arboreal ancestors of Man and the higher Apes made excessive use of the tail; and then Man and these Apes in abandoning, more or less, the arboreal life, give up use of the tail, and make more use of the hind limbs. Did the former excessive use of the tail hasten its later deterioration when disused?

III. EXPRESSION OF THE EMOTIONS

This is so large a subject that it can only be treated very shortly within the limits of the present paper. It may be divided into two parts—(a) Expressions of Pleasure, (b) Expressions of Pain; and under these headings the different expressions will be considered. It is, perhaps, necessary to take this opportunity to announce my complete dissatisfaction with the principle of antithesis in regard to expressions set forth by Darwin in his standard work on the subject, "The Expression of the Emotions;" the reason for such dissatisfaction may perhaps be gathered from what is stated presently. Space does not permit a full discussion.
a. Expressions of Pleasure

Roughly speaking the muscular movements which make up what are known as expressions of pleasure may be said to have a two-fold origin—(1) they are the movement of muscles made in connexion with the satisfaction of the sexual feelings, (2) they are the movements made in connexion with the satisfaction of hunger and thirst. But it may easily be understood that these movements have, in course of time, become conventionalized; that they may have little reference to the present habits of life of a species, but may have been first called into play by very different circumstances of the former life of more or less remote ancestors; and that the particular movements arising from the sexual and hunger origins would not be kept distinct, but that a movement originally expressive of sexual satisfaction might be used in connexion with pleasure felt in regard to food, and vice versa.

Thus a cat when stroked elevates the tail, and generally turns the hinder part of its body towards the person who is stroking, an obvious exhibition of sexual feelings; but these actions have become so habitual as signs of pleasure that it makes just the same movements when called to its food.* So a child, when expressing pleasure at a present

* The elevation of the tail is noticeable, and the manner in which the cat spins round and round in front of the person carrying a plate of food is due to the instinct which prompts the turning of the hinder part. Among many monkeys this exhibition of the hinder part (an obvious sexually prompted act) is an habitual greeting, and a sign of pleasure (Darwin, "Descent of Man,—Supplemental Note on Sexual Selection.") The same exhibition is a greeting among Man (Batoka Salutation, J. G. Wood, Nat. Hist. of Man, Vol. I., p. 389). It is a sign of pleasure among children forming a particular feature in many games, such as the one with the rhyme about "the dog went to Dover." The habit of bowing, probably, had the same origin, altered in course of time as other habits gave rise to new ideas, and then it was supposed to have another signification. Among certain savages it is etiquette only to speak with the back towards the king; and then would arise the idea of the impropriety of seeing the face of a king or deity. There are various developments of these customs in connection with worship of deities in many lands.
of sweets, will hug and kiss. These actions, however, have become expressive of pleasure because they were originally employed in connexion with the sexual embrace.

To consider the expressions of pleasure shown in the Photographs. The opening of the mouth, a slight parting of the lips to expose the teeth—or sometimes with babies the place where the teeth should be, though the teeth themselves have not yet cut the gum—shown to a small extent in fig. 5, more distinctly in figs. 7, 8, 9, is obviously an expression of pleasure from the food idea. A holding of the body, particularly a rubbing or patting of the abdomen, shown to a certain extent in fig. 9, is again an action from the food idea. So conventionalized as a pleasure token has this become, that it is with savages an expression of delight at what they cannot eat—thus some African natives rubbed their stomachs to express the pleasure which the sight of beads, bracelets, etc., gave them.

The partial closing of the eyes as a pleasure symptom, shown very distinctly in figs. 7, 8, 9, is difficult of explanation, unless it be connected with a kind of contraction of the face-muscles, for the purpose of enlarging and inflaming the visage as an act of courtship to excite the admiration of the mate.

The ridging of the nose, and of the cheeks on each side of it, as a pleasure symptom, is very common with children, and also in adults. It is well shown in fig. 8; it may be seen also in fig. 9. And running up from the nose on each side somewhat obliquely towards the eyes are little ridges and furrows of flesh—the photographs do not bring this character out, but it may be observed frequently in children when pleased, and in adults sometimes the furrows have become permanent. This ridging of the face in this manner is undoubtedly of sexual origin, and has reference to practices indulged in by pre-human
ancestors in order to excite the mate. The male mandril is a particular instance of the carrying of this character to excess, as may be seen from the figure of its head given by Darwin in his "Descent of Man." *

It may be inferred that in the pre-human ancestors of Homo, cheek lumps, though never elaborated to the same extent as in the mandril, attained to a certain development, and were always coloured, at times of excitement vividly so. Of this coloration a relic remains in the habit of blushing, perhaps to a certain extent in a rosy face. Colour at any rate appears as a sexual symptom in many animals, and becomes a sexual excitant.†

b. Expression of Pain

The muscular movements which make up what are known as expressions of pain, may be said to have originated in fighting, that being the principal source of injury; and the receipt of injury prompting an excessive employment of warlike weapons in order to retaliate. So that

* "When the canine teeth are fully developed, immense protuberances of bone are formed in each cheek, which are deeply furrowed longitudinally, and the naked skin over them is brilliantly coloured." (Darwin). "As the negro of Africa raises the flesh on his face into parallel ridges or cicatrices high above the natural surface, which are considered great personal attractions, as negroes and savages in many parts of the world paint their faces with red, blue, white, or black bars—so the male mandril appears to have acquired his deeply furrowed and gaudily coloured face from having been thus rendered attractive to the female." (Darwin). And it may, perhaps, be said that savages indulge in these practices because of the instinctive idea, inherited from Simian ancestors, that striking coloration of the face attracted the notice of the female. So what nature had begun they carry further by art.

† "In the Cercopithecus cynosurus and griseoviridis, one part of the body which is confined to the male sex, is of the most brilliant blue or green, and contrasts strikingly with the naked skin on the hinder part of the body, which is vivid red." "In the adult male mandril, the face becomes of a fine blue, with the ridge and tip of the nose of a most brilliant red." Other parts of the body are brilliantly coloured. "When the animal is excited all the naked parts become much more brilliantly tinted." "In the adult female the nose at certain regular intervals of time becomes tinted with red." (Extracts from Darwin, "Descent of Man," Part II., chap. xviii.)
directly an injury is received and the consequent pain felt, the muscular action started is that connected with inflicting injury in return. Such muscular action then becomes expressive of pain felt, even when there is no ability for retaliation. In the child crying, in fig. 10, the first thing to notice is the open mouth peculiarly squared. It may be seen that the lip of the lower jaw is particularly drawn down at both corners. The reason is that the pre-human ancestors were accustomed to fight with their canine teeth. The child has not cut its canine teeth yet; but that matters not. It has inherited the idea of exposing the canine teeth—the mere coming through the gums is not of importance in such a relic.

In fig. 11 is a cat made angry, and “swearing.” The action is exactly the same as the child’s—its one idea is to show the canine teeth, to indicate that it can and will fight.

It may be noticed, too, that the child, fig. 10, has the eyes tightly closed, and the cat, fig. 11, has the eyes nearly shut. The cat shows the reason of the child’s expression—it is to keep the eyes protected as much as possible when the foe strikes back.

The cat’s ears, in fig. 11, are turned back out of harm’s way, as much as possible, for the same reason.

In fig. 12 is a cat afraid of receiving a blow—taken, in fact, just as a person was pretending to strike at her with the hand. The attitude is instructive—the crouching, the turning away of the ears, the closing of the eyes—all to avoid injury as much as possible; and the paw is ready to strike back.

Now this habit of closing the eyes when injury is expected, and therefore as a symptom of pain, has in time become an habitual act to be performed when anything in the least suggestive of pain—such as mere mental difficulty—is experienced. Fig. 6 shows the partial closing of
the eyes, and the consequent corrugation of the eyebrows, in the case of a child, who finds the task of manipulation one of considerable difficulty. The corrugation of the eyebrows is similar to that seen in fig. 10.

The expression of fright would be principally a modification of that of pain. There would be the exhibition of fighting weapons; the use of the voice—the original motives for its employment being diverse; the shutting of the eyes and general crouching out of harm's way, as in fighting; the strained look of the hunted animal who has exerted every muscle in efforts to escape. But I have not had the opportunity to illustrate this subject with a photograph, and merely mention it for the sake of alluding to some rather curious childish traits.

Animals with fur on, and snakes would have been, from long and painful experience, two recognised enemies both to Simian ancestors and to primitive Man; and the fear which they excited would have been deeply impressed on our ancestors' minds.

I have observed a young baby which had not seen a live snake show very particular signs of perturbation at a picture of one; and the antipathy of women to snakes is notorious.

As to wild beasts, Dr Louis Robinson* noted the terror of children under two years old at an imitation of a wild beast. I consequently tried the experiment. A baby screamed at a fur boa, and was very disturbed. When at another time I covered myself with a fur cloak and walked towards her on all fours she was thoroughly terrified. When I crawled without the fur even, she was also terrified. When I got up she recognised me with pleasure, and said "Dadda!" When again I put on the fur cloak she was

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again very frightened. She seemed to know who it was; but instinctive habit conquered reason. A repetition of the experiment a few days later produced similar results; but on a third opportunity it was not so. She seemed to have learnt by experience that no harm resulted, and reason had conquered instinctive habit. She said "Dadda!" and was inclined to treat it as a new game.

IV. THE LAST STAGES IN MAN'S DEVELOPMENT

The following passage, which I have translated from Prof. Ernst Haeckel's standard work on the development of Man,* has particular reference to those last stages in Man's history, those stages to which the characters of babies that have been considered above especially point, and from which they have been derived.

"As the twenty-second stage† in our human genealogical tree we can place, next to the Half-Monkeys [Prosimians, or Lemurs] the oldest and lowest Platyrhines of South America, with jaws of 36 teeth. They have developed from the former by the perfection of the characteristic monkey-head, by the particular modification of the brain, of the jaw, of the nose, and the finger. From this Eocene Monkey-stem, by modification of the nose and loss of four teeth, have come the oldest Catarrhines or Old World Monkeys, with jaws of 32 teeth as in Man. These oldest stem-forms of the whole Catarrhine group would, at any rate, have been still very hairy, and furnished with long tails: Tail-Monkeys (Menocerca). They certainly lived during the oldest period of the Tertiary, and are found

† That is, reckoning up from Protozoon as the first.
fossil in the Miocene. Their nearest representatives, among the present-day species of Tail-Monkeys, are probably the Slim-apes (*Semnopithecus*).

"As the twenty-third stage of our genealogical tree we can place in order, after these Tail-Monkeys, the Tail-less Man-like Apes (Anthropoids) under which name, as we now know, are brought together the highest developed of the living Catarrhines—those which are nearest allied to Man. They developed from the Tailed Catarrhines by loss of the tail, by partial loss of the hairy coat, and by the greater improvement of the brain, which is indicated by the greater elaboration of the frontal portion of the skull [the greater development of the forehead]. At the present day there are but four species of this remarkable family in existence; and they form two distinct groups—an African and an Asiatic. The African Manlike Apes are confined to the western portion of tropical Africa; possibly, however, yet more species have spread into Central Africa. We only know two species with exactitude: the Gorilla (*Pongo gorilla*, or *Gorilla gina*) the largest of all Apes: and the little Chimpanzee (*Pongo troglodytes*, or *Troglodytes niger*) which at present often lives in our Zoological Gardens. Both the African Man-like Apes are black in colour, and are long-headed (dolichocephalic) like their countrymen, the negroes. On the other hand, the Asiatic Man-like Apes are mostly brown, or yellow brown, in colour, and short-headed (brachycephalic) like their countrymen, the Malays and the Mongolians. The largest Asiatic Man-like Ape is the well-known Orang, or Orang-Utan, which dwells in the Sunda Islands (Borneo, Sumatra, etc.) and is brown in colour. It is now possible to separate two species: the small Orang (*Satyrus morio*) and the large Orang (*Satyrus orang*). One genus of small Anthropoids, the Gibbon (*Hylobates*) lives on the Continent of Southern Asia, and in the Sunda Islands: of
this genus 4 to 8 different species are separable. None of these living Anthropoids can be pointed out as the most absolutely man-like Ape. The Gorilla stands nearest to Man in the shape of its hand and foot; the Chimpanzee in important characters of the skull; the Orang in brain-development; and the Gibbon in the development of the breast cavity. Obviously not any one of these living Anthropoids belongs to the direct ancestral line of the human species; they are all the last divergent remnants of an old Catarrhine branch."

"Although the human species (*Homo*) now follows immediately upon this Anthropoid family, and has undoubtedly taken its rise directly therefrom, yet we can insert as an intermediate form between them, and as a twenty-fourth stage of our ancestral series, the Ape-Men (*Pithecanthropi*).* By this name have I denoted the speechless Primitive-Men (*Alali*), who certainly in general appearance (namely, in the differentiation of the limbs) would properly stand as 'Men' in the ordinary sense; and yet one of the important human peculiarities, namely, articulate speech, and the greater understanding connected therewith, are wanting."

"As the twenty-fifth and last stage of our animal ancestry, the true man, the one able to speak, would now finally be seen. This is the man who has developed from the foregoing stages by gradually improving brute noise (sound-speech) into the human talk (word-speech). As to the place and time of this true 'Creation of Man-kind' we can only put forward very doubtful speculations. Probably primitive Man first had a beginning during the

* Dr Eugene Dubois has found in the Pliocene of Java a skull and other remains which he considers to be this link. He discusses them and their relations in a paper "On *Pithecanthropus erectus*: a Transitional Form between Man and the Apes;" Royal Dublin Society; Vol. VI., Series II., p. 1. February, 1896.
Pleistocene Period,* in the Torrid Zone of the Old World, either on the Continent of tropical Africa or Asia, or on a former Continent now sunk beneath the surface of the Indian Ocean—one which stretched from East Africa (Madagascar and Abyssinia) to East Asia (Burmah and the Sunda Islands).”

These are the views of Prof. Haeckel elaborated by that profound and most painstaking research which is so grand a feature in all German work, and illustrated by an immense mass of most interesting detail concerning the ontogenetic and phylogenetic history of the animal kingdom.

I will now venture to fill in slightly more detailed portraits of our immediate ancestors.

V. OUR PRE-HUMAN ANCESTOR

By studying the embryonic and youthful characters of fossils, and the characters of allied species in particular series, it is often possible to predict, by methods known to many palaeontologists, what the general appearance and characters of a particular ancestor should be—one which the rocks have not yet yielded to our researches. And in many cases it has happened that, subsequently, the predicted ancestor has been found, answering most satisfactorily to the portrait drawn on supposition.

There is no reason why the same method should not be pursued in the case of Man; and working on this basis it may be allowable to state, tentatively, the following description of our pre-human ancestor, of the one answering to about the middle period of what Haeckel calls the twenty-third stage.

* He must have been earlier than that; for the excellently worked weapons (Palaeoliths) are of Pleistocene Age. It would be reasonable to conclude that primitive Man began in the Pliocene.
A quadruped, or more properly four-handed animal, with fore-limbs longer than hind limbs; the body covered with a hairy coat; the face somewhat of a bull-dog style.

This animal walked somewhat clumsily on all-fours, being rather troubled with its front hands, which still retained the definite inward curve of the fingers, the bough-grasping attitude. In consequence, the animal would often rise on the hind limbs, using them for short, rather unsteady walking. It would also rise on the hind limbs in order to grasp, say fruit, and when feeding itself, and in play, and in courtship, and so forth. But the hind limbs were too ill-adapted for sustaining the weight of the body—the knees would not straighten out—the animal had no muscles properly developed for the arduous duty of balancing. There was no calf to the leg.

On the long hind hands (feet) were opposable thumbs, and well-developed fingers (toes) capable of considerable independent, and fairly accurate movement.

The front hands were short, broad, had short opposable thumbs, and fingers not capable of accurate, independent movement.

The body was thin, rather long, covered on the back with a dark reddish-brown, or in some cases, almost black hair,* on the belly, with lighter coloured hair. But the whole hairy coat tended to become lighter with age; it tended to get thin and fall off considerably, especially from the chest, abdomen, and insides of limbs.†

The posterior part of the body was bare, and, possibly, as in Macacus rhesus, of a bright red colour, especially in the female.

* "Not infrequently the woolly coat of the [human] Embryo differs considerably in colour from the later hair covering. Thus, for instance, sometimes it happens that in our Indo-German stock the children of blond parents are born covered with a dark brown or even black woolly coat. After this has come off, then there appears the blond hair which the child has inherited from its parents. Sometimes the dark coat remains for some weeks, or even months, after birth." Haeckel, Anthropogenie, Ed. IV., Vol. II., pag. 635.

† Partial shedding of hair characterizes many Anthropoids.
Head long (dolichocephalic); face decidedly prognathous, jaws heavy and prominent; lips heavy; mouth large, furnished, in the males, with fairly developed canine teeth for fighting. Nose very depressed, broad; nostrils large, parted by a broad septum. In the males each side of nose carried fleshy protuberances, spreading below the eyes; these protuberances furrowed and highly coloured with red, especially during the breeding period. Cheeks perhaps pouchèd for storage of food; eyes blue, large, prominent; ears rather large, slightly movable.

Head covered with reddish-brown hair, which in male probably stood up as a prominent crest over the skull. Both sexes furnished with beard, whiskers, and moustache, in colour yellowish-brown, inclining to become white.

The animal lived in herds, and carried on a certain amount of communication by means of guttural sounds. The breeding season would have been limited to a certain portion of the year. There would have been much fighting between the males. There would have been promisscuous intercourse subject to the law of battle.†

VI. Our Human Ancestor

The pre-human ancestor acquired the ability to walk more and more on the hind limbs, until the perfection of

* Among the bearded races of Man it is stated that the female is becoming more hairy about the face. This follows the well-known law of the gradual transmission of male characters of hair, horns, etc. to the female; so the female of the future Man should again become more and more bearded.

† The season would have been spring, and the effect is still felt in Man, according to poets. [As to the season and the nature of the intercourse there are relics in sundry customs—notably the kissing ceremony of Hungerford, in April; a similar practice in Birmingham—the subject of a police-court case this year; and the May-day revels. The actual significance of these customs is shown by the religious festivals of certain tribes of India, where the ceremonies are fully carried out (described by Westermarck in his “History of Human Marriage”); and also by the worship of Priapus. Oct., 1899.]
bipedal gait was obtained. This brought about a considerable differentiation in fore and hind limbs—the latter became longer, the former became shorter; the latter lost much of the grasping ability, the former acquired more tactual ability. Further, the bipedal position required very remarkable modification in the skeletal structure, and it induced, together with the necessity for providing greater brain-accommodation, a decrease of prognathism. While these changes were going on there was another in progress which produced a curious change of appearance—the animal lost nearly the whole hairy coat from all parts of the body, even from the head*—so that our human ancestor became almost as destitute of hair as a deal board.†

In other characters he was probably much like a negro, only shorter in stature, longer armed, longer footed, more prognathous, and of a reddish-brown colour.‡

This is my idea of what Haeckel would call the 24th-stage.

* There may have been a little hair on the head and on the back; but it almost seems as if for a short period of development there was a stage of complete hairlessness.

† Loss of the typical mammalian hairy coat has not been confined to Man. At a rather later date it occurred in other cases, for instance, in the Elephant, the Rhinoceros, Hippopotamus, etc.

‡ Both in the Semitic and the Indo-German languages the roots which gave a word for "earth" also gave a word for "Man"; as if both "Man" and "earth" were named from what they possessed in common—a reddish-brown colour.

And the negro infant is not black, but of a reddish colour, shewing that the blackness of the negro is not primitive.

But it may be asked if some of the now light races have been through a black stage, and then retrograded. There is this to be said—they represent their gods as black. Elworthy, in his work on "The Evil Eye," gives a list of Hindoo, Egyptian, Greek, Roman Christian, etc., deities and deified persons who are represented as being black; and he says (p. 190): "In India, the infant Chrisna, the incarnate deity, in the arms of Devaki . . . . . . the child is black with woolly hair—a thing strange in India." How is this to be explained? The people with black deities have either been through a negroid stage, or they have been subservient to a negroid race.
But as to *Homo alalus* I feel doubtful; that is to say, whether he was *alalus* strictly. I should imagine that he had a language, primitive enough perhaps, one of, say, 100 words at most, with of course no distinction as to parts of speech. But this would be a language; and by it, with gesture and intonation, primitive Man could let his fellow know very well what he wanted.

Anyone who has conversed with a young baby will know that with half-a-dozen monosyllabic sounds it can give a fair account of what is going on around. This has to be remembered, that the baby is perfectly understood by the young children who are its associates; it is better understood by them than by its parents; and far better understood by its parents than by strangers.

VII. CONCLUSION

I may bring this paper to a close with quotations from two of the great masters.

"Is Man something apart? Does he originate in a totally different way from Dog, Bird, Frog, and Fish? Or does he originate in a similar germ, pass through the same slow and gradually progressive modifications,—depend on the same contrivances for protection and nutrition, and finally enter the world by the help of the same mechanism? The reply is not doubtful for a moment. Without question the mode of origin and the early stages of the development of Man are identical with those of the animals immediately below him in the scale" (Huxley, 1863).

"'Know thyself!' That is the source of all wisdom! But for Man to have real self-knowledge it is of the first importance that he know his own development" (Haeckel, 1891).
Acceleration of development, or the inheritance of characters at an earlier stage in each generation expresses the process whereby the ontogenetic history recapitulates the successive stages of phylogeny. But though the recapitulation may be fairly accurate when each character is considered independently, yet it appears to be inexact when the whole series of characters of a particular stage is reviewed. Thus while in regard to many characters the normal acceleration of development has taken place, yet in others undue acceleration has become necessary to fit the organism for the part it has to perform in life, and in others again retardation has taken place.

The most noted case of retardation of development is that of the wisdom teeth of Man. They appear late in life, as if they were a character only recently developed; but actually they were very well developed in the pre-human ancestors.

The post-natal development of teeth in Man is a case of retardation.

The inability to see in the case of many animals until some time after birth is again retardation.

The inability to walk in the case of many young animals is an instance of retardation.

Some of the figures given in Plates I. and II. illustrate what may be termed the unequal rate of development in regard to certain characters. Thus in fig. 1 is the quadrupedal gait which would have characterised the old early Catarrhine ancestor. But he would have had a hairy body; here the body is destitute of hair, and that was a character of primitive Man. Again, the hind foot shows acceleration of the human foot-character: the quadrupedal
Catarrhine would have had a bough-grasping hind hand, with rather long toes and an opposable thumb (big toe). Again, the head (compare also fig. 2) shows extreme acceleration. It is of the Caucasian or orthognathous type. The head is of a more advanced type than that of the child shown in fig. 4, which has a certain amount of the prognathous character typical of primitive Man. And yet the curly hair shown in figs. 1, 2, etc. would seem to indicate an earlier stage of development than the head, for curly hair is associated with marked prognathism in the Negro.

The characters then may be summed up in this manner, referring to Haeckel's stages. There is the quadrupedal character distinctive of early 23 stage, the naked body of middle 24 stage, the foot of middle 25 stage, the type of head of late 25 stage, and the type of hair of early 25 stage, all making up an ontogenetic stage which should correspond to about middle or late 24 stage of phylogeny, so that it is easy to see which characters have been unduly accelerated and which retarded.

In fig. 10 there is an interesting case of retardation. The form of the mouth of the crying child is on purpose to display canine teeth. It is therefore an inheritance from remote ancestors who used their canine teeth for fighting; and such special use of the canine teeth would have arisen very soon after those teeth had been developed in a special form, suitable for such a purpose. So that, strictly to repeat phylogeny, the canine teeth should come first, and the special form of mouth suitable for their use should come afterwards. But, in the ontogeny of Man, the development of the teeth has been retarded. The special form of mouth suitable for the exhibition of canine teeth appears first; the teeth themselves do not appear till later. If the ontogenetic development of the teeth had proceeded equally with that of other characters, then the teeth should appear through the gum of the embryo, long before the child is born.
EXPLANATION OF PLATE I.

**Fig. 1.** A child 10 months old, showing quadrupedal habit of progression (p. 93).

**Fig. 2.** The same child, 11 months old, not able to walk, but able to raise itself momentarily on its hind legs. The knee-flexure is shown (p. 94).

**Fig. 3.** A cat raising itself on its hind legs to claw at something; to compare with fig. 2 (p. 94).

**Fig. 4.** Another child, about 12 months old; showing the manner of grasping (p. 96). The child is unable to walk.

**Fig. 5.** The same child as fig. 2, and at the same time; showing bough-grasping attitude of hands (p. 97), flexure of knee (p. 95), and facial expression (p. 104).

**Fig. 6.** Same child as fig. 4, and at same date; showing method of grasp (p. 97), movement of toes (p. 100), and facial expression (p. 107).
EXPLANATION OF PLATE II.

Fig. 7. Same child as fig. 4, but 19 months old, showing ability to use, and know the meaning of the use of one finger for a definite purpose (p. 101); also facial expression (p. 104).

Fig. 8. Same child as fig. 2, and about the same time, showing sitting-on-hocks attitude (p. 101), position of hands (p. 97), facial expression (p. 104).

Fig. 9. Same child as fig. 7, and about same age, showing, besides proportions of body, facial expression, and other symptoms of pleasure (p. 104).

Fig. 10. Same child, but at same age as fig. 4, showing facial expression (p. 106), also attitude of hands (p. 97).

Fig. 11. A cat "swearing," to compare with fig. 10 (p. 106).

Fig. 12. A cat afraid of a blow (p. 106).

All the illustrations in these two plates are from instantaneous photographs taken by myself. For the capital reproductions I tender my best thanks to Messrs Bemrose and Sons. Unfortunately in one or two cases they have shaved just a little too closely round the figures.
SOME COTTESWOLD BRACHIOPODA,

BY

CHARLES UPTON.

[Plate III.]

(Read March 21st, 1899)

INTRODUCTION.

In the Supplement to the British Jurassic and Triassic Brachiopoda by Thomas Davidson (Vol. IV., p. 230) is set out a list of 33 species collected by Dr F. Smithe from the Lias of Churchdown—that term denoting all the strata from the zone of *Am. opalinus* down to the base of the Lower Lias, inclusive.

In a paper read before this Club in 1889,* S. S. Buckman enumerated 34 species of Brachiopoda from the Inferior Oolite of the Cotteswolds, the term in that case comprising the strata from the Clypeus Grit to the base of the Pea Grit series, inclusive. In another paper read before the Geological Society in 1895, which is printed in the *Quarterly Journal* for that year (Vol. LI., p. 388) he increases the number to some 53 or 54 forms. The list, however, comprises a good many which are referred to merely by the generic appellation.

Taking these figures as representing at the time of publication the sum of the recognized forms of Cotteswold

* Published in the Proceedings, Vol. IX., p. 374.
Inferior Oolite and Liassic Brachiopods, we have some 86 or 87 species.

Since the publication of these works I have collected in the Cotteswold district a number of forms which neither Dr Smithe nor Mr Buckman mention. Some of them belong to species already described from other localities: others appear to be undescribed; and I thought it might be of interest to the Club to have their discovery recorded in its Proceedings, together with a more complete reference to some two or three species which Mr Buckman mentions in his second paper, above referred to, more or less on my authority. I wish at the same time to notice a very interesting and peculiar example of a somewhat scarce Brachiopod (Terebratula galeiformis, M'Coy) which has been found very sparingly up to the present time, and only in the Cotteswolds. The specimen, which is in my collection, I owe to the generosity of one of our members, Mr W. Thompson.

**Description of Species.**

**I. Terebratula galeiformis, M'Coy, var.**

*Pl. III., figs. 1—4.*


The species was first figured by Dr Davidson in his monograph from a single pedicle valve in the late Mr Lycett's collection, under the name *T. Bentleyi*, var. *sub-Bentleyi*. The figured specimen is stated to have been found in the Inferior Oolite of the neighbourhood of Minchinhampton.
At that date (1853) the brachial valve was not known to the author of the monograph. He subsequently discovered that a complete specimen, which was stated to have been found in the Oolite Marl of Brimscombe, was in the possession of Prof. Sedgwick, and that Prof. McCoy had already given it the M.S. name of *T. galeiformis*. This specimen he figured in the appendix to Vol. 1 of the monograph which was issued in the following year.

Each of the figured specimens has a deep medio-longitudinal sinus and one on each side. The present example differs from the type in having fimbriate margins, and an almost flat brachial valve. In other respects it is conformable.

The tests of all *Terebratula* are very thin, and consequently fragile; and in their more primitive forms have no frontal folds. The first advance on the simple form was the acquisition of a single, more or less elevated, frontal fold. The next advance in development consisted of a reflex fold in the centre of the simple fold; and this stage characterises the major portion of the Jurassic *Terebratula*. It is obvious that the acquirement of such folds, whether simple or complex, resulted in a gain of strength without an excessive expenditure of material. In the present specimen the required strength was obtained by the acquisition of a number of small folds instead of in the more usual manner.

The exact locality of the specimen is unfortunately not known; but from the adherent matrix I have no hesitation in stating that its horizon is the middle portion of the Oolite Marl Series, which, south of Stroud, usually consists of a white oolitic limestone. In respect to horizon, therefore, it would agree very closely with all other known specimens.

It is a somewhat singular circumstance that this shell should be associated with the only two other well-marked
fimbriate *Terebratula* known in the Jurassic rocks of England, namely *T. plicata*, J. Buckm. and *T. fimbria*, Sow., both of these shells being found in the Oolite Marl and the Pea Grit: the former being common in the Pea Grit, and the latter very abundant in the Oolite Marl. Two other fimbriate Terebratuloids (one being a *Terebratula*, and the other a *Magellania*) are found in the Lias on the Continent; and occasional specimens having additional plicae are found belonging to species which normally have either a plain margin, or a single, or a double fold, as *T. sphaeroidalis*, Sow., *T. conglobata*, E. Desl., and *T. globata*, Sow.

The species to which *T. galeiformis* is most nearly allied is undoubtedly *T. curvifrons*, Oppel, which in some localities is abundant in the Oolite Marl; though *T. curvifrons* belongs to a somewhat lower horizon than that to which I assign the present specimen.

In the very inflated pedicle valve and flat brachial valve the present species has a very strong resemblance to *T. simplex*, J. Buckm., which, however, is confined to the Pea Grit. The plicated margin is as I have already stated a character which it bears in common with *T. fimbria* and *T. plicata*. The brachial supports cannot of course be seen; but from analogy I do not hesitate to assert that the loop is very short, and that no mesial septum exists.

2. *Terebratula sub-sphaeroidalis*, sp. n.

Pl. III., figs. 5—7.

**Diagnosis.**—Shell inequivalve, pyriform; pedicle valve regularly convex; brachial valve considerably elevated near the umbo, sloping gradually towards the front, where it makes a somewhat acute angle with the pedicle valve; beak prominent, and well separated from the umbo, truncated by a medium-sized, round foramen; lateral ridges
indistinct; margin almost straight, with a slightly elevated front, which in some specimens becomes somewhat angular; shell smooth, growth lines faint; loop short. Length 23 mm., width 20 mm., height 15 mm.

_Terebratula sphaeroidalis_, Sow., has not hitherto been recorded from any Cotteswold locality. In Somerset and Dorset, and in Calvados it occurs abundantly in the upper beds of the Inferior Oolite, attaining its largest dimensions in the neighbourhood of Bayeux. The type came from Dundry Hill, where however it is scarce and ill-developed.

On Selsley Hill, near Stroud, there is a bed of fine-grained, non-oolitic limestone about two feet in thickness over-lying, or possibly constituting the uppermost bed of the Upper *Trigonia*-Grit which yields a form approaching closely to _T. sphaeroidalis_. The shells are slightly elongate approaching _T. decipiens_, but most nearly resembling the shell usually called _T. sphaeroidalis_ from Castle Cary. At North Nibley a somewhat similar, but usually more elongate shell occurs; and I have a couple of specimens approaching the Nibley forms which I found in a quarry on Wickeridge Hill near the Slad Village. This is the most northerly spot at which I have yet found them. This fossil differs from _T. sphaeroidalis_ in being much narrower in the neighbourhood of the hinge, in the greater projection of the beak which has a somewhat tubular character, and in the more acute angle formed by the junction of the valves. I therefore distinguish it by the name sub-_sphaeroidalis_.

3. _Terebratula Jauberti_, _E. Deslongchamps_.


Dr Davidson figured an imperfect specimen of this fossil from the Middle Lias of Ilminster. From the same beds at Stinchcombe I have obtained two specimens. The fossil is scarce in England, but appears to be abundant in several localities in France, and also in Spain. The Stinchcombe specimens closely resemble M. Deslongchamps’ types.

4. Terebratula subpunctata, Davidson.


A large form allied to T. punctata, Sow. occurs fairly abundantly in the Middle Lias of the neighbourhood of Ilminster. Dr Davidson considered it sufficiently distinct from T. punctata to justify his separating it from that species; and he named it T. subpunctata. I have collected a considerable number of both forms from near Ilminster, and I find no difficulty in distinguishing between them. Crushed specimens of T. punctata are abundant in one thin bed of the Middle Lias (Margaritatus Zone) of Stinchcombe, but hitherto no specimen of T. subpunctata has been recorded from the Cotteswolds. Last summer, however, I was fortunate enough to find a well characterised specimen at Stinchcombe, although unfortunately a considerable portion of the test is wanting.

5. Terebratula euides, S. Buckman.

Pl. III., figs. 8—10.


In the Appendix to the Supplements to Dr Davidson's Monograph is figured a Brachiopod from the Inferior Oolite of Sherborne as "T. fleischeri, Oppel?" Subsequently Mr Buckman distinguished the form as a new species under the name of T. euides. In the sandy beds which underlie the Pea Grit (Zone of Tmetoceras scissum) at Kimsbury Castle, Painswick, I have found several specimens which Mr Buckman identifies with his species.

T. euides most nearly approaches T. infra-ooolitica, E. Desl., but is distinguished from it by having a more or less carinate pedicle valve and laterally pinched-in beak.

6. Terebratula lentiformis, sp. n.

Pl. III., figs. 11—13.

Diagnosis.—Shell inequivalve, lenticular, almost circular in outline, pedicle valve having a somewhat indistinct longitudinal ridge; beak erect, not overhanging the umbo; foramen round; lateral ridges prominent extending up to, and producing an elevation on each side of the foramen; front margin in adult specimens wavy; test smooth; growth lines indistinct; loop unknown, but probably short. Length of figured specimen 29 mm., width 29 mm., height 14 mm.

To the large shell figured by Davidson under the name T. maxillata, which somewhat resembles the present species, Oppel* gave the name Terebratula marmorea: he took Davidson's figs. 4 and 5, pl. IX., (Mon. Brach.) as the types. Szajnocha † also figures T. marmorea, and states that it occurs in the Zone of Oppelia aspidoides of

* 'Die Juraformation,' p. 496.
Balin. He also refers to the specimen figured by Dr Davidson, and to a similar specimen from the Fuller's Earth of Metz, which is figured by M. Deslongchamps, (Terr. Jur. Pal. Franc., pl. civ., figs. 3, 4) as synonyms. Both Dr Davidson and M. Deslongchamps describe the specimens figured by them as the young of *T. maxillata*; and it cannot be denied that young *T. maxillata* are very like the figures.

In the Upper Ragstone beds of Rodborough, either the Upper *Trigonia*-, or *Clupeus* Grit, I have found a number of specimens of various ages which are totally unlike any other form occurring in those beds, but somewhat resemble Szajnocha's figure. However, I consider the Cotteswold forms sufficiently distinct from Oppel's species to justify my giving them a specific name. Moreover, the beds in which they occur in the Cotteswolds are older than those in which *T. marmorca* is found either in Wiltshire, at Balin, or Metz.

I am not aware that *T. lentiformis* is found in any locality outside the Cotteswolds.


I have two specimens from near Stroud. One I found at Swift's Hill in the top of the sandy bed which occurs in the *T. Buckmani* Grit, and the other is from the same horizon at the Frith. The specimens are the exact counterparts of examples which I have from the neighbourhood of Bradford Abbas, where it occurs plentifully.
8. *Rhynchonella Jurensis* (Quenstedt)
   Pl. III., figs. 14—17.


A small *Rhynchonella* which has been identified as Quenstedt’s *Jurensis* is found in the Upper Lias—Zone of *Am. communis*—of the neighbourhood of Banbury. There is possibly some little doubt about the identity, but nevertheless the Banbury fossil is always referred to as *R. jurensis*. The fossil has not hitherto been correctly recorded from any other British locality to my knowledge. I have, however, found two specimens in beds of the same age on the southern slope of Doverow Hill, near Stroud, and another from the *Margaritatus* beds of the Middle Lias at Haywardsfield. Dr Davidson figures the species in the Supplement to his Monograph (pl. xxvii., figs. 24—27), but the figures do not bring out well the peculiar flatness of the brachial valve which is characteristic of the English specimens.

   Pl. III., figs. 18—22.


**Diagnosis.**—Shell small, nearly circular in outline, slightly wider than long; pedicle valve rather flat; brachial valve very convex, umbo considerably inflated; beak acute, suberect, slightly truncated by the foramen which is small and encroaches on the valve; deltidial plates apparent and
only partially surrounding the foramen; beak area fairly prominent; hinge margin indenting the brachial valve. Valves ornamented by a great number of fine rounded ribs which extend from the beak to about two-thirds the length of the shell, where they merge in from 8 to 10 prominent angular ribs extending from about half-way along the shell to the margin. Sinus and mesial fold well defined, occupied by from two to four of the large ribs which are usually somewhat unequal in magnitude. A large specimen measures in length 13 mm., in breadth 14 mm., and in height 9 mm.

Dr Davidson on p. 224 of the Supplement to his Monograph of the Brit. Foss. Brach. states that Prof. Tate in the *Geological Magazine* for Dec., 1869, quotes *Rhyn. jurensis* from the Zone of *Am. opalinus*, but does not give the locality. His (Prof. Tate's) authority appears to be a record of Dr Lycett's in the Proceedings of this Club (Vol. II., p. 142, 1860), where it is stated to occur in the Upper Zone of the Supra-Liassic Sands. Dr Davidson goes on to say that he has seen the specimen referred to, and has no hesitation in stating that it is referable to *R. rimoso* of von Buch, and he gives a figure of it (pl. xxvii., fig. 10). I agree with Dr Davidson that the specimen figured is not *R. jurensis*, but I am unable to agree with him that it is correctly called *R. rimoso*. I am well acquainted with both *R. rimoso* and the shell figured by Dr Davidson, and I am satisfied that they are not the same. Moreover, *R. rimoso* has not certainly been found in strata of later date than the Zone of *Am. Henleyi*, which is below the Marlstone of the Middle Lias, whilst the form in question is confined to the *Dumortiera* and *Moorei* horizons of the Cotteswold Cephalopod-bed, which are very much later in date.
NOTE.—The shell is usually more globose than the specimen figured by Dr Davidson, which can scarcely be considered typical.

LOCALITIES.—The species does not appear to have been found except in the Cotteswolds. I have found it at Buckholt (Long) Wood, Pen Wood, and Haresfield Beacon.
EXPLANATION OF PLATE III.

Fig. 1—4. Terebratula galeiformis, M'Coy, var. Upper Freestone (Oolite Marl), Stroud.

Figs. 5—7. Terebratula sub-sphæroidalis, sp. n. Top of Upper Trigonia-Grit, Selsley Hill, near Stroud.

Figs. 8—10. Terebratula euides, S. Buckman. Ferruginous Limestone (Zone of Tinet. scissum), Painswick Hill.

Figs. 11—13. Terebratula lentiformis, sp. n. Clypeus Grit, Rodborough.

Figs. 14—17. Rhynchonella jurensis (Quenstedt). Upper Lias Clay (Commune Zone), Doverow Hill, Stonehouse.

Figs. 18—22. Rhynchonella cotteswoldiae, sp. n. Moorci Beds (Opalinum Zone), Buckholt Wood, Frocester.

All the specimens are in the Author's collection.
LIST OF TYPES AND FIGURED SPECIMENS OF BRACHIOPODA

BY

S. S. BUCKMAN, F.G.S.

Only a few words of introduction are necessary. The value of all types and figured specimens, and the necessity for their safe preservation are now duly recognised. The recognition has come none too soon. Specialists in particular have to regret the disappearance of many of the types figured by older authors. And the more doubtful the identification of a species, the more is the disappearance of the type to be regretted, and the greater would be its value if it could be recovered. A case in point is the type of *Ammonites Braikenridgii*, Sowerby, which has now been unfortunately lost sight of. It would be most interesting to recover the specimen, to set at rest the doubts as to its identification; hence its value is great.

To preserve types and figured specimens the British Association formed a Committee for their registration, and the present list is a partial contribution towards the end they have in view. And it is offered to show the manner in which such registration is performed. For I have followed in the main the plan adopted by Mr G. C. Crick, F.G.S., in his “List of the Types and Figured Specimens of Fossil Cephalopoda in the British Museum.”

I have, however, made one innovation. In square brackets I have added the date of each specimen, thus
This refers to the hemera, and it puts the position of a specimen in time with extreme precision, a detail very often wanting in regard to some of the earlier figured specimens. Opportunity has also been taken to amend certain statements of localities which were obviously incorrect; such emendation I can make from personal knowledge of the specimens and of other circumstances. Notice may be taken of the cases wherein a figure has been made from a combination of two specimens. This practice would easily lead to a non-identification of the types unless the facts had been carefully noted. It is an undesirable practice, unless special mention be made of it in the explanation of the plates. Even then it is dangerous. How easily for instance, supposing a figure were made from imperfect specimens, might the beak of *Terebratula curviconcha* have been added to the valves of *Waldheimia haasi*—two shells which are so remarkably similar in external appearance, and moreover occur together in the same bed.

BRACHIOPODA:

TYPES AND FIGURED SPECIMENS, S. S. BUCKMAN COLLECTION.


**Rhynchonella benekei**, Haas; Davidson, Mon. Brach. (Pal. Soc.) App. to Suppl. Pl. XX., figs. 8-10, 1884. Jurassic, Yeovil Sands; Bradford Abbas, Dorset. [Moorei]. These specimens became the types of *Rynch. cynica*, S. Buckman, Baj. Mid-Cotts. Q.J.G.S., Vol. li., p. 451, 1895: the fig. 8 of Davidson’s plate being taken as the Type. There were four specimens figured by Davidson, his figs. 9 and 9a being from different examples.


Rhynchonella cymatophora, S. Buckman, 1895. See *Rhynch. gingensis*.

Rhynchonella cynica, S. Buckman, 1895. See *Rhynch. beneckei*.


Rhynchonella liostraca, S. Buckman, 1886. See Rhynch. biloba.


Rhynchonella sp., S. Buckman, Baj. Mid-Cotts. Q.J.G.S., Vol. li., Pl. XIV., fig. 6, 1895. Jurassic, Yeovil Sands; Middle Chinnock, Somerset. [Scissi]. (Figured specimen).


Spirifer punctatus, Sedgwick: J. Buckman, Geol. Chelt. Ed. 2, Pl. X., fig. 7, 1845. Spirifer rostratus, Davidson, Mon. Brach. (Pal. Soc.) Pl. II., fig. 2, 1850. Jurassic, Middle Lias; Hewletts Hill (Battledown), Cheltenham. [Henley, or ? Ibeh]. (Type). The fig. in Geol. Chelt. is reduced, and restored; that in Davidson is also restored. Another specimen marked S. punctatus in J. Buckman’s handwriting was used perhaps for some details in both drawings.

Spirifer rostratus, Schlotheim. See Spirifer punctatus.

Terebratula ampla, J. Buckman: auct. See Terebratula perovalis var. ampla.

Terebratula buckmani, Davidson, Mon. Brach. (Pal. Soc.) Pl. VII., fig. 15, 1850. Jurassic, Inf. Ool. (Ragstone); Sudeley Hill, near Winchcombe, Glos. [Discile]. (Type).


Terebratula decipiens, E. Deslongschamps: Davidson, Brach. Proc. Dorset Club, Vol. I., Pl. II., fig. 1, 1877. Mon. Brach. (Pal. Soc.) Suppl. Pl. XX., fig. 4, 1878. Jurassic, Inf. Ool.; Broad Windsor, Dorset. [Zigzag]. (Figured specimen). A magnificent large example, probably unique as to size and condition. The locality in the text of the works is given as Bradford Abbas, but the colour and condition of the specimen wholly negative this statement, which was probably made on the authority of a fossil collector. It is certainly not from Bradford Abbas; it is most likely from Broad Windsor, or possibly from Crewkerne.


Terebratula gravida, Szajnocha; Davidson, Mon. Brach. (Pal. Soc.) App. to Suppl. Pl. XVIII., fig. 17, 1884. Jurassic, Inf. Ool.; Halfway House (Louse Hill), Dorset. [Blagdeni]. (2 Figured specimens). Two specimens were drawn to make the figure, as stated in a label in Davidson's handwriting, referring to them. They both bear the x wherewith Davidson marked figured specimens.


Terebratula leesi, S. Buckman; Davidson, Mon. Brach. (Pal. Soc.) App. to Suppl. Pl. XVIII., fig. 16, 1884. Jurassic, Inf. Ool.; Bradford Abbas, Dorset. [Murchisoni]. (Type). See Waldheimia carinata, var. Mandelslohi, under which name this shell was first figured.


Terebratula perovalis, var ampla, J. Buckman; Davidson, Brach. Proc. Dorset Club, Vol. i., Pl. I., fig. 2, 1877. Mon. Brach. (Pal. Soc.) Suppl. Pl. XXV., fig. 2, 1878. Jurassic, Inf. Ool.; Bradford Abbas, Dorset. [Concavi, or discite]. (Type). This form is now generally recognised as a distinct species, a less advanced form than Tereb. perovalis. The figures have been very much restored. A similar remark applies to fig. 1 on the same plates. In fact my father told me that figure was made up from two specimens.


Terebratula plicata, J. Buckman, Geol. Chelt. Ed. 2, Pl. VII., fig. 6, 1845. Davidson, Mon. Brach, (Pal. Soc.) Pl. XII., fig. 2, 1850. Jurassic, Inf. Ool. (Pea-grit); Crickley Hill, Glos. [Murchisonæ]. (Type). The fig. in the 'Geol. of Chelt.' is reduced, as was the case with many figures in that work. The dimensions given in p. 101 of that work agree with those of the specimen. In Davidson's figure the plications are exaggerated.


Terebratula sphaeroidalis, J. de C. Sowerby: Davidson, Brach. Proc. Dorset Club, Vol. i., Pl. II., fig. 6, 1877. Jurassic, Inf. Ool.; Broad Windsor, Dorset. [Zigzag]. The locality given in the text is Bradford Abbas; but the colour of the specimen does not agree with that: it came most likely from Broad Windsor. See note to Terebr. decipiens.

Terebratula stephani, Davidson, Mon. Brach. (Pal. Soc.) Suppl. Pl. XVIII., fig. 6, 1878. Jurassic, Inf. Ool.; Broad Windsor, Dorset. [Zigzag]. (Autotype). This is really a very pronounced development of Terebratula stephani, in the direction of
Terebratula lingwfera. The locality given in the text, 'Bradford Abbas,' is doubtful. The specimen has the appearance of Broad Windsor examples. See note to Tereb. decipiens.


**Waldheimia haasi**, S. Buckman: Davidson, Mon. Brach. (Pal. Soc.) App. to Suppl. Pl. XIX., figs. 11, 12, 1884. Jurassic, Inf. Ool.; Halfway House (Louse Hill), Dorset. [*Blagdeni*]. Fig. 12 is the uniplicate Type; fig. 11 is a very scarce biplicate development, probably connecting *haasi* with *reversa*. Two specimens were drawn for the details of fig. 11, as stated by a label of Davidson’s.


**Waldheimia reversa**, S. Buckman: Davidson, Mon. Brach. App. to Suppl. Pl. XIX., fig. 13; Pl. XX., fig. 13, 1884. Jurassic, Inf. Ool.; Oborne, Dorset. [*Nortonensis*, or *Blaugdeni*]. (Type).


**NOTE CONCERNING FIGURED TYPES**

I may take this opportunity to make a note concerning two specimens, both of which I have examined.

**Waldheimia sub-numismalis**, Davidson, Mon. Brach. (Pal. Soc.) Suppl. Pl. XXI., figs. 1, 2. The numbers are wrong in the explanation of the Plate. Figs. 1 and 2 should be interchanged. Fig. 1 (fig. 2 in the explanation) is in the Museum of the School of Mines. Fig. 2 (in explanation, fig. 1) which was in the collection of Mr D. Stephens, is now in the collection of Mr J. F. Walker. Its beak is incorrectly drawn. It is not a *Waldheimia*, but is *Terebratula subpunctata*.

PRESENTED

31 OCT. 1900
PROCEEDINGS
OF THE
Cotteswold Naturalists’ FIELD CLUB

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EDWARD B. WETHERED, F.G.S., F.C.S., F.R.M.S.

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THE COUNCIL OF THE CLUB WISH IT TO BE DISTINCTLY UNDERSTOOD THAT THE AUTHORS ALONE ARE RESPONSIBLE FOR THE FACTS AND OPINIONS CONTAINED IN THEIR RESPECTIVE PAPERS.

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PUBLISHED, AUGUST, 1900
The Library of the Club is at Mr John Bellows', Eastgate, Gloucester.

It is open every Tuesday afternoon from 2.30—4.30, when books may be examined, or borrowed.

Books, Pamphlets, etc., presented to the Club should be addressed to The Cotteswold Club, The Library, Eastgate, Gloucester.
PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

PRESIDENT
EDWARD B. WETHERED, F.G.S., F.C.S., F.R.M.S.

HONORARY SECRETARY
S. S. BUCKMAN, F.G.S.

Vol. XIII. Part III.

August, 1900
ANNUAL ADDRESS

TO THE

COTTESWOLD NATURALISTS' FIELD CLUB,

(Read at Gloucester, 3rd April, 1900)

BY

M. W. COLCHESTER-WEMYSS, PRESIDENT.

PART I.—FORMAL RECORD

During the past year death has, I regret to say, removed one member from our ranks. I refer to the late Joseph Arthur Gibbs, of Ablington Manor. Although quite a new member of the Club—he was elected in 1898—and although he had not contributed anything to our Proceedings, yet we had every reason to expect that he would prove one of our most valuable members; for his work, "A Cotswold Village," which I referred to in my last address, is a book full of literary promise. Unfortunately, almost before my address was printed, our hopes had been disappointed. Mr Gibbs' early death was particularly sad, coming as the result of an accident in the cricket field. I propose that the Club pass a vote of sincere consolation with his mother, and I would further propose
that his work on "A Cotswold Village" be added to our Club Library as a memorial of him.

From the "Cheltenham Examiner" of May 24th, 1899, I take the following obituary notice:—

"Mr Joseph Arthur Gibbs, of Ablington Manor, has passed away at the early age of 31. An injury from a cricket ball necessitated a surgical operation of a rather serious nature, and death resulted from failure of the heart's action. Mr Gibbs was the eldest son of Mr George Monk Gibbs, and was educated at Eton and Christ Church, Oxford. After his University days, Mr Gibbs resided with his mother at Ablington, entering keenly into all the pursuits of a country gentleman, and at the same time developing those literary tastes, of which his well-known book, 'A Cotswold Village,' published only last December, affords unquestionable evidence. Many people have read this book with keen enjoyment. It gives a remarkably graphic picture of Cotswold life, and presents a very unusual combination of interests. Rustic legends, sketches of village character, village cricket, old Cotswold pastimes, the origin of place names, harvest feasts and Christmas festivities, specimens of the dialect, and excellently illustrated descriptions of the typical Cotswold towns, Cirencester and Burford, and of that prettiest of Cotswold villages, Bibury, with its picturesque hamlet of Ablington—all these matters are brightly treated of. Then, too, there are pages of Wordsworthian musing, nature-sketches suggestive of Richard Jefferies, discourse of angling and of hunting in the spirit of a true enthusiast for sport, and, running through all, a distinct feeling for literature and real literary quality. In reading 'A Cotswold Village,' one could not help feeling a wish to meet the author and thank him for the human interest he had imparted to his book. It is sincerely to be regretted that a life so full of promise of real literary distinction should have closed thus early and abruptly."

Another announcement I have to make with similar regret,—that owing to the very sad state of his health, one of our oldest members, and our senior Vice-President, the Rev. Frederick Smithe, M.A., LL.D., F.G.S., has had to resign. As you may know, for a long period the state of
Dr Smithe's health has been very serious, and has prevented him not only from taking any share in the work of this Club, but also from continuing his other duties; and so his resignation of his position as an officer and a member of this Club is not unexpected. Still I am sure that I express the sentiments of all our members when I say that we greatly regret it.

Dr Smithe's connection with this Club has been a long one; his name carries us back to quite early days. He was elected at the Annual Meeting, February 15th, 1859—he and your late President, W. C. Lucy, being elected together on that day—and so he has been a member of this Club for 41 years. He was elected Vice-President in 1887. He became a Fellow of the Geological Society in 1858; but he has not contributed any papers to its Journal. In our Proceedings, however, will be found several contributions, indicating his high attainments as a geologist and petrologist. He specially devoted himself to the study of the Middle and Upper Liassic rocks, giving considerable attention to their development in his own parish of Churchdown. In fact, our chief knowledge of these beds in this county is derived from the researches of Dr Smithe, published in different papers in our Proceedings. Further, when Dr Thomas Davidson was publishing his important work "On Jurassic Brachiopoda," Dr Smithe was able to send him a very fine series of specimens from Churchdown, and to give him many details, all showing how much use he had made of his opportunities for studying the Liassic rocks.

I do not at present give any more detailed account of Dr Smithe's work. You will understand why. It is sufficient to show that we appreciate his labours, and greatly regret the cause of his resignation.

I now turn to notice work accomplished by our members during the year outside the Club's Proceedings. I do not
find so many contributions as I noticed in my last address. If I have overlooked any work that has been published, I hope members will kindly give me intimation thereof, so that I may rectify the omission.


And I may add, as a matter of some interest, that this work has been printed by John Bellows.

The Palæontographical Society has published another portion of the "Monograph of Inferior Oolite Ammonites" from the pen of our Hon. Secretary. This makes the eleventh contribution; and the work is now illustrated by 118 quarto plates.

The following, which I take from a newspaper, is of interest as reminding us of one of our members, Dr Francis Day, who did so much in his special line of research—fish culture: "The Society of Experimental Fish Culture is now in a position to begin work at the Crystal Palace . . . . The Day collection of fishes which the authorities at South Kensington removed from the Buckland Museum has been promised to the Society, and should form a nucleus around which other collections will be accumulated."

A formal record of the Club's work during the year may now be given.
COTTESWOLD NATURALISTS' FIELD CLUB

REPORT OF THE YEAR'S WORK, 1899

The Annual Meeting was held at the School of Science, Gloucester, on May 2nd, 1899, at 3.15 p.m. The President, Mr M. W. Colchester-Wemyss, was in the chair, and about 23 members attended. The Minutes of the last Annual Meeting were read by the Secretary and confirmed.

The President read his address, in which he referred to the work done by members of the Club as shewn by their papers, etc., published in the Journal of the Geological Society and elsewhere. He then gave a formal account of the Field Meetings, and finally read a description of his visit to a Californian Gold-bearing river. A vote of thanks was passed to the President for his interesting address.

The Secretary then explained a "Jurassic Time-Table" showing how its publication would conduce to future work and to the value of the Club's future volumes, by becoming a basis for contributions from specialists.

The Secretary also exhibited and explained some Jurassic Brachiopods.

The Treasurer then read his balance-sheet, which was approved.

The President then left the chair, which was taken by John Bellows, who proposed the re-election of Mr M. W. Colchester-Wemyss. This was seconded and carried unanimously.

Mr M. W. Colchester-Wemyss then took the chair, and proposed the re-election of the Vice-Presidents, the Hon. Treasurer and the Hon. Secretary. These proposals were seconded and carried unanimously.
Proposals for the summer meetings were then discussed; and the formal arrangement of places and dates was left to the Council.

The following was their arrangement:

- Thursday, June 1st. The Upper Coln Valley.
- Monday, June 26th. Salisbury; a two days' excursion.
- Tuesday, June 27th.
- Wednesday, July 26th. Sodbury, for the cuttings on the new railway.
- Tuesday, Sept. 19th. Lydney and Awre.

It was afterwards found necessary to make changes with respect to the last meeting; it was held at Coleford on Thursday, Sept. 21st.

There was a good attendance of members at the first of the summer meetings, and an interesting day was spent under the guidance of the Hon. Secretary, who conducted the party over Sevenhampton Common, down the Sevenhampton Valley, and to the village of Withington. The special study of the excursion being that of geological problems connected with the formation of the Severn Valley, and of the valleys through and adjacent to the Cotteswold escarpment, particular attention was paid to the evidence afforded by the valleys themselves.

The formation of the Severn Valley has hitherto been generally regarded as the work of the river itself. The western shore of the sea in which the Cotteswold rocks were deposited was probably the Malvern chain and the hills continuing from it through the Forest of Dean. It has been supposed that when the Severn began to make a channel it found a line of least resistance in the junction of the soft rocks of the Cotteswolds and the hard rocks of the Malverns, and that in process of time it widened its bed by cutting away the rocks on the eastern side and thus formed the Cotteswold cliffs. It has also been commonly believed that lateral valleys like the Dowdeswell
valley were formed by tributaries of the Severn—that, in fact, the pass of Andoversford was scooped out by a river which was an ancestor of the Chelt, fed from the Cotswolds when they were much higher than they now are.

Of late years, however, new investigations and particularly the researches of Professor W. M. Davis, as recorded in a paper on "Development of English Rivers," in the Geographical Journal, vol. v., 1895, have caused another theory to be advanced which, expressed briefly, is this: that before the Severn Valley was scooped out, rivers flowed from Wales in a south-easterly direction across the Cotswolds and the Chilterns to the sea; that the valleys which break through the escarpment were formed, not by tributaries of the Severn, but by feeders of the Thames; and that instead of the Severn Valley having been excavated by the Severn alone, the cutting-out process was begun by an extended Thames.

I referred in my last address to the paper on the "Development of Rivers" which our Hon. Secretary had just published in Natural Science; and it was to hear his views upon the spot that the meeting was arranged.

The discussion during the day was largely of an enquiring character, especially among the older school of geologists. The botanists of the party were interested by some specimens to which Mr W. L. Mellersh led them, while Mr John Sawyer and the Hon. Secretary called attention to the ancient roads of the Cotswolds. Luncheon was taken at the Andoversford Hotel. Afterwards a resolution was passed in support of the Wild Birds Protection Bill, about which Mr C. A. Witchell gave an address. He also read a short paper about a combat between a beetle and an ant (see p. 195).

On June 26th nearly a score of members assembled at Marlborough Station, whence they drove across the Wiltshire Downs via Oare Hill, Pewsey, Stonehenge, Amesbury, and Old Sarum, occasional halts being made at
interesting spots. Thus the Hon. Secretary demonstrated how the Kennet Valley and the Vale of Pewsey supply striking evidence of the theory of river valley formation considered at the first meeting, and those of the party interested in archaeology found much matter for discussion at Stonehenge, Vespasian's Camp near Amesbury, and the well-preserved ancient fortress of Old Sarum. On the following morning a visit was paid to the Blackmore Museum. Here the party was met by the Director of the Museum, Dr H. P. Blackmore, F.G.S., who kindly conducted them over the immense collection of stone implements, showing them types of the Eolithic, Palaeolithic and Neolithic work, illustrating the evolution in form and design. Such points as the evolution of the axe and hammer, and the transition from the stone to the bronze implements, were fully elucidated. A cordial vote of thanks was passed to Dr Blackmore for his courtesy. In the afternoon, a visit was paid to the Cathedral, and the party had a most painstaking guide in Canon Bourne, who pointed out the salient features of the structure in an extremely interesting manner.

Over twenty members attended an excursion to Sodbury on August 3rd, the object being to inspect the cuttings and tunnel shafts made by the Great Western Railway in connection with their new direct line from Wootton Bassett to the Severn Tunnel.

The party assembled at Yate Station, and then drove to the western end of the big Lilliput cutting. Here the Honorary Secretary gave a general account of the geology of the district, and the Rev. H. H. Winwood, F.G.S., followed, devoting his attention more particularly to the strata under inspection. The members then walked along the cutting, many of them interested in the mechanical developments now brought into play in the making of a railroad. Under the guidance of the Secretary and Mr
Winwood other points of geological interest were noted, and the party then drove to Chipping Sodbury, where lunch was taken at the Portcullis Hotel. Afterwards a move was made to the tunnel shaft at the foot of the hill and to that near the Cross Hands, where the various geological questions suggested by the exposed strata led to much interesting discussion. During the day the party was favoured with the presence of Mr W. W. Grierson, the engineer in charge of the works, to whom the President tendered the thanks of the Club for all the facilities and kind assistance extended to it. The members also had to thank Mr Hooper, of Stanshaws, for some hospitality very acceptable on a hot day.

An interesting day was spent in the neighbourhood of Coleford on September 21st.

The party assembled at Coleford Station on the arrival of the train from Gloucester, and drove to Staunton, stopping on the way to see a large stone which stands on end close to the road, just inside one of the Forest Enclosures. It is called "The Long Stone," or, in Welsh, *Maen hir*. There are many such stones in Wales, and they are said to have been used as mustering places for men summoned to serve in war. The Church at Staunton aroused much interest, many styles of architecture being visible in the building. It has an ancient font, which is probably Early Norman; it has been suggested that it is really a Roman altar converted into a font. The marks of staples can be seen on it, showing that it was one of those fonts that were locked up during very superstitious times. The order for locking fonts was made in 1236. The pulpit is entered by a flight of stone stairs which anciently led up to the rood loft.

A walk of about half a mile brought the party to the Buckstone, situated on an eminence which has an elevation of nearly 1000 ft., and commands a most extensive
view over the Forest enclosures, and the High Meadow woods, with many of the Welsh mountains showing in the distance. Unfortunately this curious old rocking stone can no longer be rocked. Some 15 years ago a party of men armed with crow-bars wantonly and maliciously upset the stone, and though it was re-erected in its former position, it had to be fixed firmly, and it cannot now be made to oscillate.

From the Buckstone the members drove to St. Briavels through the picturesque village of Newland, where time could only be spared to see the far-famed Newland Oak, one of the oldest and largest in the Kingdom. It is a grand tree with plenty of life in it yet; though it is perhaps a thousand years old.

An interesting visit was paid to St. Briavels Castle, built by Milo Fitzwalter about the year 1100. Many of the ancient walls are still standing, and there is a fine old kitchen where the original dog-wheel is still *in situ*, inside which the dogs ran whose duty it was to turn the spit.

The Castle of St. Briavels stands on a very picturesque site. Its long list of Constables extends in unbroken line from Fitzwalter, till in 1838 this ancient office devolved upon the Commissioners of Woods and Forests. Many quaint old legal Courts were held here as well as at the Speech House, dealing with the mining laws, the customs of the Forest, the rights of Freeholders and Freeminers, and the many privileges claimed by the Monarch.

After luncheon the drive was resumed, and by kind invitation of its owner a visit was paid to Priors Mesne, where Surgeon-General Cook has for many years devoted his great knowledge of plants to the formation of a subtropical garden.

It was with the greatest reluctance that the members left this charming and secluded spot, and partook of the
hospitality courteously offered by Mrs Cook and her daughters, and then drove to Lydney for the train.

Our Winter Meetings have been particularly well attended, and the interesting series of papers which has been read shows that the working activities of the Club are in a vigorous condition. To accommodate the papers it was necessary to hold an extra meeting besides the four which have hitherto been our limit. I give a list of the communications, which show that there is a wide field to which the Club can devote work.

The Recently Enclosed Common Fields at Upton St. Leonards, by the Rev. Canon Scobell.
How Nature Discards: a study of Relics and Make-shifts, by S. S. Buckman, F.G.S.
The Birds of Gloucestershire, by W. L. Mellersh, M.A.
Incrusting Organisms, by E. B. Wethered, F.G.S.
A Submerged Forest at Westbury-on-Severn, by E. W. Prevost, Ph.D., F.R.S.E.

PART II.—A VISIT TO ROBBEN ISLAND—THE LEPER SETTLEMENT

A few years ago I happened to be at Cape Town, and went out one afternoon to call on the Bishop, who lives at a most charming old Dutch house some miles away. At one part of the road I well remember an avenue of giant pines, vividly illustrative of the idea that is said to have given birth to Gothic architecture. These pines lined the road on either side at regular intervals, their stems rising
straight and clear without a single branch, and scarcely tapering at all until they reached a height of about 70 ft., when a few strong branches stretched out and joined hands, as it were, over the centre of the causeway.

The Bishop told me he was going over to hold a Confirmation at Robben Island the following day, and invited me to accompany him, a suggestion which I most gladly accepted, as in those days it was not easy to get leave to go there.

The island is certainly a most curious place. It is inhabited entirely by lepers, convicts, lunatics and paupers. At the time of my visit, there were in it about 120 lepers, 250 lunatics, 75 convicts and 50 paupers. It has been used for lepers and lunatics for some 50 years, and until a year or two ago the methods adopted here were primitive in the extreme. For instance, till quite lately all the foul linen from the lepers was carried by them to the female lunatics, who washed it in cold water; but the most disgusting thing of all was that the same vehicle which was used for conveying the corpses of lepers (the coffins are so frail that they frequently burst en route) was immediately afterwards used for carrying about the food for the lunatics and convicts.

The lunatics were in the constant habit of resorting to the leper settlement to clear out and devour scraps of food left, after meals, by the lepers. And yet, notwithstanding all this, I was assured most confidently that no instance is on record in the island where a case of leprosy can clearly be traced to contagion.

However, everything has been altered now. I went over the whole of the establishments, and no exception could be taken to anything in any department. Everything is clean, and there is a generous dietary, which is the same for all, except that the convicts have half-a-pound of meat a-day more than the others. The lepers do everything
for themselves, one white man only, besides the doctors, living with them. Their establishment consists of sundry long, low, thatched sheds, cool, clean and fairly convenient. They have their own compounds, reading-room, cook-house, &c., but they are not confined in any way, and can wander at will over the island. The female lepers have a small settlement to themselves a mile or so away. The year before my visit the Cape Parliament passed a law giving the authorities power to remove lepers compulsorily. When I was there all the lepers were natives except two men and one woman, and the males were to the females in the proportion of about three to one.

The Superintendent, Dr Dixon, said things were very different indeed now to what they were only a comparatively short time ago. All the doctors here have the very strongest belief that leprosy is not contagious or infectious, except perhaps in one special way. At any rate they assert most positively that no case of communicated leprosy has ever occurred on the island, even notwithstanding the degree of inter-communication that has always existed between the lepers and the other inhabitants. They believe it is inherited in the blood, and is also developed in some mysterious way. They had lately been trying Gurgun oil (produced from a fir tree in the Andaman Isles), but they have not yet had time to give it a fair trial, for which a period of three years is said to be necessary; and it is difficult to get the stomach to retain it in sufficiently large doses. They say, however, that in some cases it certainly has arrested the course of the disease. The disease, however, sometimes seems from no discoverable reason to arrest itself. I saw a man who had been on the island over 30 years, and they said he was no worse than he was 20 years ago. Another man of 94 was there, and his condition had remained unchanged for years.
There are two distinct forms of the disease, the tubercular and the anaesthetic; and sometimes both exist on the same patient. Sores break out over the body with most loathsome discharge. Nodules arise over the surface of the flesh, the extremities, fingers, toes, nose, gradually vanish and drop off, hands and feet becoming shapeless stumps, and often the whole face becomes so bulged and distorted that it hardly seems to bear any resemblance to a human countenance. Frightful looking objects many of them were, but they none of them seemed to suffer pain, and hardly to realize their position; all seemed wonderfully cheerful and quite ready to laugh at any little remark.

PART III.—AN ACCOUNT OF LEPROSY

There have been many diseases in the history of the world which from time to time have ravaged humanity, and then have seemed to disappear more or less entirely. Other diseases again, unknown of old, seem to have been produced by causes coincident with the advance of civilization. Leprosy stands in neither of these categories. It has been known some thousands of years: it exists to-day over the greater part of the world’s surface. It has, perhaps more than any other disease, afforded mankind subject for legislation and regulation; and yet it is a disease perhaps almost as mysterious to-day as it was when the Israelites passed out of Egypt; and it has, up to now, entirely baffled all those efforts of medical science and research which have been devoted to finding a cure for it.

The disease is first definitely described in the “Ebers Papyrus” which was found at Memphis, and was written during the reign of Rameses II. (1348—1281 B.C.), though prescriptions have been found for a disease called echetu, which seems to be leprosy, and these belong, it
is believed, to a period about 4600 B.C. In Persia, India, China, and Japan there are very ancient records of its existence. The first case mentioned in Europe is described by Aristotle in 345 B.C.; and from that time onwards the disease has been over and over again depicted in terms so clear and accurate, as to leave no doubt whatever that the leprosy of to-day is in every particular precisely the same disease which was known in classical days under the term *Elephantiasis Græcorum.* In the Middle Ages most exact descriptions were given by men learned in the medicine of the day, such as Theodoric of Bologna, Lanfranc of Milan, Barchuone of Barcelona, the famous Guy de Chauliac, and many others. Often the most minute and detailed account is given of the various symptoms which the physician ought to look for in examining a suspected person, and the exact method is pointed out by which he ought to proceed with his examination before venturing to consign a suspected person to the seclusion of a leper hospital, and thus for ever doom him to be a despised "child of St. Lazarus."*

It is but little realized how very widely spread was the disease over the whole of Europe in the Middle Ages. Evidence of this is afforded by the records still existing of the laws and regulations, some of the most stringent nature, dealing with the unfortunate lepers, and also from the enormous number of lazarettos or leper-houses that were erected for their reception. A list of over 150 of these existing in Great Britain has been compiled, and it is said that there were no less than 2000 in France. It is no doubt true that many other diseases were confounded with leprosy, and that, especially later on when leprosy was dying out in Europe, a very large number of the occupants of the leper-houses were not lepers. But

* Warrant of Edward IV. to examine a leper, 1468 (Simpson, *Edinburgh Medical and Surgical Journal*, 1841, 154.)
after making due allowance for this, there is no doubt that a great wave of leprosy passed over Europe commencing about the 8th century, gradually spreading, developing, and eventually passing away northwards and westwards.

There is a common belief that it was first brought into England by soldiers returning from the crusades, but though many of them may have come back lepers, they did not introduce the disease, which existed here long before their time. There is a well authenticated case reported in Ireland in 432. In 950 the Welsh King, Howel Dda, passed a series of laws permitting the divorce of married persons should the man become a leper. And Lanfranc, Archbishop of Canterbury, who died in 1089, six years before the first Crusade, founded, during his lifetime, at least one, and probably two leper-houses at Canterbury. Leprosy did not reach Scotland till somewhat later, but it had practically died out in England, while it was still virulent in the northern kingdom. In 1350 some statutes were drawn up for the leper-house at St. Albans, and it appears then that there were hardly any lepers requiring admission; but in the same year it was thought necessary to institute a leper-house for Glasgow, and nearly 100 years later, in 1427, the Scottish Parliament deemed it proper to legislate on the subject of lepers, though it is curious that the latest leper-house established in the kingdom was one at Highgate, and this was not founded until 1472, at a time when it was officially reported that there were very few lepers left in England. Some years later, in 1540, a Royal Commission was appointed to inspect the Lazarettos in England, and they reported that among the inmates were very few leprous persons, and yet it is well known that as late as 1693 there were lepers in the Lazaretto at Kingcase. It was long before it became actually extinct in Scotland; it lingered in the Shetlands
till late into the last century, and the last known case of a Scotch leper was a patient from Zetland who died in an Edinburgh hospital in 1798.

These Shetland lepers seem to have been sent to the Island of Papua, and the Session Books of Wales show the expense incurred in keeping them there from 1736-40.

But for over 100 years leprosy may be said to have been absolutely extinct in the United Kingdom, though cases are occasionally noticed almost every year, but in all these cases the disease has invariably been contracted during a residence of the patient in some other country. It has never died out in Iceland, and in Norway it exists to this day to a very serious extent. At the present moment there are about 1500 cases, mostly in two leper establishments, though 40 years ago there were over double that number.

In Italy there are a few spots where the disease still lingers, and also in Sicily, Spain, Hungary and Turkey; but these spots are extremely limited in area, and the number of cases very few indeed. With these exceptions, this malady may be said to be non-existent in Europe. Throughout Asia it is, however, still very active, in British India it is believed there are always at least 200,000 lepers. In China there are districts where a very large proportion of the people are affected; the disease is found throughout Japan except in the Loo Choo Islands, and, generally speaking, lepers are met with everywhere in the Tropics. In the Brazils the malady is virulent, and in many other parts of South America; but in North America it does not exist except in Mexico, where there are many cases; in California, where some leper spots exist, traceable to Chinese settlers; in Louisiana, where a few leper areas are to be seen, and in a Norwegian Colony in New Brunswick, where it was clearly imported from Norway. Broadly speaking, it may be said that, over by far the
larger portion of the earth's surface, the disease exists with greater or less virulence.

Numerous reasons have been given to account for the existence and prevalence of leprosy in infected areas.

1. It has been said that climatic influences affect it. But it exists as near the Arctic circle as Iceland, Norway, and Siberia; all during the Middle Ages it was most prevalent in temperate regions; and then, as now, it existed almost everywhere in the known Tropics. But in tropical countries, where there are great fluctuations of temperature and great moisture, the body becomes more or less enervated, and there is a predisposition to specific disease; hence perhaps the prevalence in the Tropics.

2. Again, it is said to be specially prevalent near the sea coast. To some extent this is true, but only partially so. In Syria, for instance, it is rare on the coast, and prevalent on the mountains. Precisely the same remarks apply to Madagascar. In India the chief centre is at Rumaon, with an elevation of 5000 ft. above the sea. In the Brazils it is terribly prevalent in many up-country districts, and very much less so on the coast. It has also been observed in all ages that there are certain spots or limited areas where the disease may rage; whereas immediately outside these areas, though the conditions are perhaps similar in every appreciable respect, there is absolute or comparative immunity from disease.

3. Again, it is a very common belief that leprosy is prevalent where fish, and especially salted fish, forms a large part of the diet of the inhabitants; but it is endemic in many places where no fish is eaten, and it has disappeared from many places where fish still continues to be largely consumed; and there are bad spots in the midst of large fish-consuming districts, while there is exemption outside the limited affected area. In Central China fish is essentially the food of the well-to-do, whereas the poorer
classes, who rarely touch fish, suffer far more from the disease.

4. The existence of leprosy is often ascribed to insanitary conditions, especially when they are combined with insufficiency of food. Doubtless insanitary conditions will produce a predisposition to many kinds of disease; but leprosy has been by no means confined to the poorer classes whose surroundings are more likely to have insanitary taint. Naaman, the Captain of the host of Syria, was a mighty personage in his country. Baldwin IV., King of Jerusalem, relinquished his sceptre in consequence of his leprosy. Constance, Duchess of Brittany, died of it in 1201. Robert the Bruce suffered from it for many years. Henry IV. of England is said to have been a leper, and Henry III. almost certainly was one.*

There is a most touching account extant how one Richard Orange, Mayor of Exeter, a wealthy and important citizen of the town, found himself to be a leper, and voluntarily cut himself adrift from friends, relations, and the world, and secluded himself in a leper-hospital.

Again, that the disease is hereditary it would be difficult to deny in general terms, though much can be urged against it. For one thing, sterility accompanies leprosy. From 2864 lepers of both sexes who in 18 years have been secluded in Molokai, only 26 children have been born, and of these only two were lepers; but there can hardly be any doubt that a certain predisposition to the disease can often be traced in certain families, though this is a different thing to a definite hereditary taint.

It is, however, on the subject of contagiousness that controversy has chiefly been raised, and it may be added that uniformity of belief has chiefly existed; and yet the proofs are by no means convincing. Certainly the opinion

* Vide Simpson, Edinburgh Medical and Surgical Journal, 1841, 396.
was most widespread in the Middle Ages that the malady was both infectious and contagious, and in fact this belief lay at the root of all the regulations that were passed; and yet Simpson says of the study of leprosy:

"The investigation of the cause of the disease has, more than in any other department of medicine, been marked by belief without evidence and assertion without facts."

Brunelli said (and he was no mean authority):

"L'opinione era contagiosa e non la malattia."

In support of Brunelli's view it may be urged that—

a. As I have said before, the limits of the diffusion of leprosy are often very narrow and very clearly defined.

b. It may be seen in some parts of the world where two races of men are living with complete intercourse, and yet one race will be affected with leprosy, and the other will be immune.

c. I believe it is a fact that the cases are very rare where there is even suspicion that one member of a family has communicated it to another.

d. Cases are innumerable where there are leprous marriages with leprosy on one side only. 855 such cases were counted in the N.W. Provinces in India, and in only, I think, two out of the number did the free person become tainted during the period of observation. A Parliamentary Report was drawn up in 1867, consisting of answers sent from Consuls and other officials in all parts of the world to a series of questions framed by the College of Physicians, and almost unanimously they reported against the contagion theory.

e. I believe there is no case on record where a nurse or a physician in a leper-hospital has taken the
disease, even though they do everything for their patients.

_\textit{f.}_ No cases have been ever described of the disease spreading outwards from the leper-houses.

_\textit{g.}_ There is no instance, with one exception, where a European, having contracted the disease in a leprous country, has then come home and conveyed it to others.

This is a strong body, if not of proof, at least of forcible evidence.

There is no doubt that in mediaeval times many Public Regulations were instituted affecting lepers, and it seems that affected districts had very full powers to control them in every way. Very few of these laws have been preserved. The first recorded edict is by Pepin in 757, who, amongst other things, proclaimed that leprosy in either sex was a legal ground for divorce, and so prevalent was the disease in Lombardy in his time, that we are told that in some cities there were many men with three wives living at the same time. Charlemeagne passed laws affecting lepers in 789; and in 950, as I have said, Howel Dda, the Welsh King, decreed, amongst other things, that a woman might divorce a leprous husband, differing thus very curiously from Pepin's law on the subject. We are told by "Maister Hector Boëce Channon of Aberdene" that before the time of Malcolm Canmore a man who was "sic infirmitie \textit{[e.g.} daft or wod] as succedis be heritage fra the fader to the son was geldit (castrated). The woman that was fallin lipper was banist fra the cumpany of men, and gif scho consavit barne under sic infirmitie, baith scho and hir barne war buryit quik" (alive).

Philip V. of France passed a law that all leprous persons were to be burnt; this was in consequence of a belief having

† Bellenden, Translation of Boëce's History, p. 58.
become current that they were guilty of poisoning all the wells in Christendom. The decree stated that "fire should at one and the same time purify infection of the body and of the soul."

I have come across the record of a most curious Edict of Henry II. of England. It was passed at the height of his quarrel with Becket, when he was most anxious to prevent the imposition of an Ecclesiastical interdict over his kingdom. So he took all possible precautions to avoid the conveyance of official letters to this effect into England. To secure this more fully it was declared that if any individual did carry thither letters of interdict from the Pope or Archbishop he should be punished "by the amputation of his feet if a regular; by the loss of eyes and by castration if a secular clergyman; he should be hanged if he were a layman; and burned if he were a leper" (*Si leprosus comburatur*).

This passage is very remarkable for several reasons. It indicates that lepers were treated as being outside the pale of ordinary law; it shows that notwithstanding all restrictions they were yet able to circulate pretty freely about the world; and it shows that it was considered possible that a person of such high rank as a Nuncio of the Pope might still be a leper.

Apparently, when a person became leprous, indirect pressure was brought to bear upon him to seclude himself in a leper-house, but when he refused, the friends or neighbours could bring the matter under the cognizance of the Crown, and a Chancery warrant could then be issued.* The earliest of these warrants now extant is one by Edward IV. in 1468, and it directs the Sheriff of Essex to take certain "discreet and loyal men of his county" and to cause Johanna Nightingale, a reputed leper, to be "diligently

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viewed and examined,” and if he finds her to be leprous “to cause her to be removed, in as decent a manner as possible, from intercourse with other people, and have her betake herself immediately to a secluded place as is the custom, &c.”

The Sheriff called in two “Doctors in Arts and Medicine,” who report as follows:—“We have examined her person, touched and handled her, and made mature, diligent, and proper investigation. On going through upward of twenty-five of the more marked signs of general leprosy, we do not find that she can be proved to be leprous, by them or a sufficient number of them, . . . . and it is not possible for any to labour under the disease in whom the greater part of these signs are not found. . . . We find . . . . that she is utterly free and untainted, and we are prepared to declare the same more fully by scientific process if and wherever it shall be necessary.”

On the strength of this certificate, which I have been informed is one of the earliest, if not the earliest medical certificate preserved, we may be allowed to hope that poor Johanna Nightingale was allowed by her neighbours to pass the rest of her days in peace.

It certainly appears that medical men of those days were fully impressed with the very serious responsibilities thrown upon them in connection with the disease. Bernhard Gordon, first Professor of Medicine at the School of Montpellier, devotes a very long chapter to the subject* in a book written about 1305, and says that there are two sets of signs, the occult or premonitory and the infallible; if the patient shows evidence of the first set, he is to be watched and observed, but not to be adjudged for separation; he is only to be secluded in a leper-house if he manifestly exhibits the infallible signs; and he enjoins the

utmost care and caution on any who may be called upon to examine leprous patients.

Guy de Chauliac again, perhaps the most celebrated surgeon of the 14th century, wrote on leprosy about 1363, and divides the signs or symptoms under six heads, and he then details at very great length the precise mode in which the physician ought to conduct the examination of every suspected case of leprosy referred to him. The examination is to commence one morning, and to be completed the following day, and "in the meantime," says De Chauliac, "let the physician cogitate upon what he has seen, and what he may yet see in the case," because "the injury is very great if he submit to confinement those who ought not to be confined." If, therefore, the patient is found to have some of the signs only "he must be carefully watched and confined to his own house or mansion; but if he is found with many both unequivocal and equivocal signs, he must be separated, with kind and consoling words, from the people, and committed to the leper-hospital."

I think I have said enough to show that the question of leprosy in Europe in the Middle Ages was considered of sufficient importance to demand the attention of kings and rulers, and that special legislation affecting it was very widely established.

Now let us regard the question from a more or less social standpoint, and see what general evidence we have indicating the importance that was attached to it. Nothing in this respect can be more convincing than the fact of the enormous number of Lazarettos that were everywhere established to receive the sufferers from the malady. It is no doubt true that at all times many of the inmates were suffering from other diseases (such especially as syphilis) which were freely confounded with leprosy. No doubt, too, as years passed away, and leprosy became less
and less prevalent, the houses were used as general hospitals and charitable institutions.

I believe the majority of these lazar houses (at any rate in the earlier days) were under the control of the Knights of the Order of St. Lazarus, a very ancient off-shoot from the great body of the Knights Hospitallers.* They were a most interesting Order, and took their name from the belief that Lazarus was a leper. For many years the Rule of the Order was that the Superior must be a leper. The knights were accorded many privileges, and at one time were possessed of great wealth and influence. Their chief station in England was at Burton Lazars, in Leicestershire, the richest and one of the most important of English Lazaretos. In Henry VIII.’s time its revenues were valued at £260. In 1608 Henry IV. of France united the Order of St. Lazarus to those of Notre Dame and Mount Carmel, and the candidates for this united knighthood were obliged to swear upon the Holy Evangelists, inter alia, “to exercise charity and works of mercy towards the poor and particularly lepers.”

Members of the Order appear to have been specially numerous in Scotland and France.

As far as can be ascertained, the first Lazaretto was established in the Frankish Kingdom about 800. The first established in Ireland (Innisfallen) was 869. In Spain (1007), England (1050), Scotland (1170), and Norway (1266), the Lazaretos were sometimes called “Mesellaria” and the lepers “Mesels,” a word derived from “Misellus,” the diminutive of “Miser,” miserable.

Next to Burton Lazars the most important Lazaretto in England was at Sherburne in Durham.† The diet roll of

* Simpson, I., Edinburgh Medical and Surgical Journal, pp. 303, 317.
† Surtee's History of County Durham.
this hospital has been preserved, as well as many particulars regarding its internal economy. The daily allowance of each leper inmate was a loaf weighing five marks, and a gallon of ale, in addition a mess of flesh three days in the week, and of fish, cheese, or butter the remaining four. Every day they had the seventh part of a razer (rasarium) of bean meal, and some pulse to make gruel, and they had special extra allowances on certain days. Each leper had a yearly allowance for his clothing of three yards of woollen cloth, white or russet, six yards of linen, six of canvas. Four fires of peat were allowed for the whole community, and at Christmas they had four yule logs, each a cartload; four trusses of straw three times a year, four bundles of rushes three times a year, and on the anniversary of Martin de Santa Cruce every leper received five shillings and five pence in money. The rules of the house were very strict and the religious duties austere. All the leprous brethren whose health permitted were every day expected to attend matins, none, vespers and complines. The bed-ridden sick were enjoined to raise themselves and say matins in their bed; and for those who are weaker "let them rest in peace and say what they can say" *(et quod dicere possint, dicant).* During Lent and Advent all were required to receive corporal discipline three days in the week.

They were punished for disobedience or idleness at the discretion of the Prior, by corporal correction with the birch—*modo scholarum.*

At the large establishment of St. Julian at St. Albans, the rules and regulations have also been preserved and are very full and precise.* The dietary table seems to have been much the same as at Sherburne, but on the Feast of the Nativity of the Blessed Mary each leper received an obolus "which is the charity of the hospital," and at the

* Paris, Historia Angli.
Feast of St. Martin each had a pig from the common stall; enough pigs were brought to some convenient place, and there each chose one pig according to the priority of entering the hospital. On the Feast of St. John Baptist each received two bushel of salt; on Ascension Day one obolus to buy pot herbs; and a penny on sundry other Feast days; and it was ordered that fourteen shillings was to be distributed in equal portions for their fuel for the year, "as has been ordained of old for the sake of peace and concord." The "residue" of the property of the hospital was "ordered and decreed to be applied to the support of the master and priests of the said hospital." The lepers were to wear a tunic and upper tunic of russet, with a hood cut from the same, so that the sleeves of the tunic were closed as far as the hand. They were to wear the upper tunic closed down to the ankles, and a close cape of black cloth of the same length as the hood. A particular form of shoe was also ordered, and, if the order was disobeyed, the culprit was condemned "to walk daily bare-footed until the master, considering his humility, said to him 'enough.'"

There was a very large number of Lazarettos in Norfolk, seven or eight in Norwich itself; and in fact they were fairly evenly spread over all England. The favourite Patron Saint was St. Mary Magdalene, and, after her, St. James, St. Leonard or St. John. Many lazar-houses, such as Sherburne and St. Albans, were richly endowed. Others were dependent upon casual charity, and the lepers were allowed under strict regulations to beg in the neighbourhood on certain days, and whenever they sallied forth they were compelled to carry a "cop and clapper," the cop being a sort of cup to receive money; the clapper a dish with a peculiar movable lid, with which they had to make a noise to announce their approach, and in which they received food given to them. Occasionally, where the leper-house was by the side of the road, they were allowed to
sit by the side and hold out a box for alms, hung by a chain at the end of a pole, and the identical box used at the house founded by Lanfranc at Harbledown, near Canterbury, is still preserved.

In Scotland there were many Lazarettos, the two most notable being at Kingcase, near Ayr, and Greenside, near Edinburgh.

In Gloucester there were certainly two, and possibly three, Lazarettos. One dedicated to St. Mary Magdalene belonged to the Priory of Llanthony, the other, St. Margaret's, was attached to the Abbey of St. Peter; they were both of course, as was the invariable custom, outside the walls, and the chapels of both are still standing. The first record of the existence of lepers in Gloucester is seen in a document by which Alured, Bishop of Worcester from 1153 to 1163, granted them leave to be buried in their own churchyard at St. Margaret's.

Mr Bartleet has written an interesting account of the Gloucester leper-houses in the Transactions of the Bristol and Gloucestershire Archaeological Society.

The only other known Lazarettos in Gloucestershire were one at Tewkesbury, and several in and about Bristol.

At the Assize opened by the Justices in Eyre at Gloucester* on the 21st June, 1221, it was presented that (translation) "two coffins of lead were found in the courtyard of Robert de Aqua full of bones." Such treasure trove belongs to the Crown, but the Judges directed as to the coffins and bones "let them be given to the lepers." This was more humane treatment than was at one time accorded to them in Scotland, for a decree has been preserved of the Council of Edinburgh that "any putrid or rotten fish condemned in the market was to be sent outside the town to the lipper folk."

* Maitland's Pleas of the Crown for the County of Gloucester.
A very ancient well-known leper-house, restricted to females, existed on the site of St. James's Palace in London. Henry VIII. obtained possession of this, which in his time had become a hospital, giving in exchange lands at Chatham in Suffolk.

But lepers were not always consigned to Lazarettos. Bishop Stapleton, of Exeter, in 1330, having heard that the Vicar of St. Neots in Cornwall had become a leper, appointed one Ralph de Roydene to be his deputy and take charge of him, "since he cannot, without danger, have intercourse with the whole people as he has been accustomed." The part of the vicarage inhabited by the leper is to be walled off from the rest of it, and a new entrance made, for the leper's use. Ralph is to pay him 2s. a week for his maintenance, and once a year 20s. for a new robe, &c.

According to the tenor of various old civil codes, when a person became affected with leprosy, he was looked upon as legally and politically dead. He lost the privileges of citizenship, and was incapable of being an heir or of disposing of any property that might have belonged to him.

There is an ancient French document in existence which describes most accurately the official procedure of proclaiming a man a leper.

The medical examiners having reported upon the case, if their verdict declared the man a leper, a Priest robed with surplice and stole went to his house. He first exhorted him to endure with a patient and penitent spirit the incurable plague with which God had stricken him. He was then conducted to church and all his ordinary clothes were removed. He was thereupon vested in a funeral pall, placed between two trestles before the altar, and the Mass for the dead was celebrated over him. He was then led to the Lazaretto; a cop, clapper, stick, cowl, and dress, &c. were given to him. He was then solemnly
interdicted from appearing in public without his leper's dress, from eating and drinking with any but other lepers, and he received a great variety of other ordinances. The ceremony terminated by the chief official throwing a handful of earth over the body of the poor outcast in imitation of the closure of the grave.

I said just now that the disease has hitherto baffled all the efforts of science to discover a remedy, and I believe this is strictly true. I did read the other day a German report of a case at Hamburg about 10 years ago which a Dr Unna claims to have cured as the result of a course of treatment spread over several months. He shows photographs of the patient before and after the treatment, but although these certainly indicate a great improvement in the condition of the patient, they also show that the disease was by no means very far advanced. His treatment consisted chiefly in the use of ichthyol, in rubbing the patient with pyrogallic acid, and in applying to the forehead and chin a plaster made of chrysophanic and salicylic acids with creasote.

In the Middle Ages leprosy was universally believed to be incurable, though from time to time all sorts of specifics were pronounced to be remedies, such as a bath of dogs' blood, and even a bath of the blood of young children was declared to be a certain cure.

Of late years two kinds of oil, gurjun oil and chaubmoogra oil, have been found to possess very considerable power, being taken internally and also rubbed over the skin, but the utmost that can be said of this treatment is that in some cases the progress of the disease is certainly arrested and kept in quiescence for a more or less extended period, though I believe that, when it does recur, it comes back with extra virulence.

I have seen a most curious account of a method adopted for cure among the natives in the Fiji Islands. The leper
is stripped naked, taken into a hut, his body rubbed with leaves of the Sinugaga tree (*Enecaecaria agallocha*), a small fire is lighted and heaped up with logs of the same tree, the smoke from which is poisonous and pungent. The patient is bound hand and foot, and a rope is made fast in such a way that, from outside the hut, he can be hauled up and suspended by the heels, his head hanging about 15 inches from the ground. His tortured screams and calls for pity and release are disregarded until he faints away, though this may not be for hours. He is then dragged out, the slime is scraped from his body, and gashes are cut into the skin to make the blood flow freely. This wonderful treatment almost always kills the patient; if it fails in producing this effect it is said to cure.

Such is a brief history of one of the most ancient diseases still existing in the world, most interesting from a historical, most mysterious from a professional point of view.
EXCURSION NOTES:
CHIEFLY ON RIVER FEATURES,

BY

S. S. BUCKMAN, F.G.S.

The programmes of the excursions undertaken in the summer of 1899 contained various notes and illustrations of the points for special study during the respective outings; and it seems desirable that these notes should find a place in the Proceedings. For this purpose they have been collected to form a paper, and in some cases further illustrations both in the way of additional figures and of explanatory text have been introduced. These illustrations, it is hoped, will more fully elucidate the necessarily brief notes given in the respective programmes. The different excursions may be taken in order, the notes of the programmes being given first, with such verbal emendations as may be necessary, and further remarks being added as occasion requires.

THE COLN VALLEY MEETING

The object of the day's excursion was to study the features of rivers and their valleys.

The ideas governing the investigations are that on the first initiation of the present drainage the streams flowed with the dip, from the Welsh mountains towards the south-east of England (Fig. 1); that these streams were afterwards in many cases intercepted by later-developed streams...
such as the Severn (Fig. 2, B), which, working along the strike of soft rocks, lowered the soft Lias country and so left the Oolite in relief; that from these strike streams anti-dip streams (Fig. 3, C) were developed, like the Chelt and the Isborne, which work, and are working, back to rob the original, but beheaded dip streams like the Coln (Fig. 3, D).

Thus it may be understood that there are developed—first, dip streams, on account of the surface slope; second, strike streams, on account of the relative hardness of the rocks; and third, anti-dip streams, on account of the difference of ground level.

It may also be noted that of so many dip streams flowing in a given direction (Fig. 4), one will become the master stream by capturing, by means of the strike streams which develop as tributaries (Fig. 5, B), the waters of the neighbours (Fig. 5).

It is by such capture as this that the Cotteswold streams flow to join the Evenlode at Oxford. They have been captured by a strike stream—the Upper Thames.

Examples of the various stages of river and valley development were studied.

The appended Figs. 6, 7, and 8 show the development of a stream from slight curves into pronounced meanders.
which become greater as the river impinges more, first on the one bank and then on the other. In these figures A A' are the sides of the valley, B is the curving stream, and C C are the “spurs” of the convex portions of the valley. These spurs tend to become more and more worn away with the development of the meanders, on account of lateral encroachment of the stream—encroachment, that is, on the sides of the spurs; and it is the up-stream sides of the spurs which are most worn away.

In time, when the curvature of the meanders becomes very great, the river straightens its course by cutting through the narrow neck of the meander at D, as shown in Fig. 9.
A most interesting example of Fig. 9 occurs near Withington; the cutting is all but completed—the neck is 5 feet, and around the meander is 50 yards. There, too, may be seen the different features in the cutting of a valley, due to shrinkage in the river volume.

The following is some of the literature on the subject:—


S. S. Buckman, 'Development of Rivers;' Natural Science, April, 1899.

By means of some of the blocks which appeared in my paper above mentioned, on "The Development of Rivers," I can illustrate these remarks somewhat more fully. It may be premised that dip streams are termed consequents, strike streams, sub sequents, and anti-dip streams, obsequents.* Then in Fig. 10, A there is a representation of a theoretical case, a series of consequents flowing with the dip being threatened by a subsequent which is developing along the strike of soft rocks, such as those of the Lias vale. In Fig. 10, B there is shown a further theoretical case, the result of the successful growth of this subsequent. It has captured the consequents successively, has turned them to its own system, and has started obsequent streams in the former valleys of the consequents.

* Such terms as dip streams, etc., would suit the Cotteswold district well enough; but would be inapplicable in other cases. For instance, strata which dip, say, east may cover unconformably older strata dipping west. The covering strata may give rise to a dip stream, may in course of time be entirely denuded—and then the same stream maintaining the same course has become an anti-dip stream because its channel is cut down through the underlying strata which dip the opposite way. Yet this stream is not an obsequent. There is what seems to be such a case in the Carding Mill stream which flows from the Longmynd into the Church Stretton valley, in Shropshire; it appears to be an original consequent which has by cutting down become an anti-dip stream.

But the terms such as consequent, etc., are awkward, because they clash with ordinary English words.
—such valleys being the natural places for such streams, because they were the lowest ground, and the immediate drainage would therefore find its way into them. These

obsequent streams work back more and more, to diminish the already beheaded consequents.

These are the theoretical cases,—the illustrations of what is supposed to have happened. Fig. 11, which is a tracing from the map of the Severn and its tributaries in the neighbourhood of Gloucester shows how closely the actual river features correspond to the theory. The remarkable point is that the tributaries on the left bank of the Severn are flowing in a direction more or less opposed to the course of the Severn itself; but that curious circumstance is understood if it be conceded that their direction was first marked out by the consequents, now on the right bank of the Severn, continuing their course
in the manner of the dotted lines shown in Fig. 11, when they were rivers draining into the Thames system.

With regard to the breaches of the Cotteswold escarpment, and such rivers as the Chelt, this means:—That

the breaches high above the valleys of obsequent rivers were cut by rivers which were extensions of the Thames system; that obsequent streams, such as the Chelt, Frome, etc., which now flow in their respective valleys below the breaches, are rivers of later date which have worked back from the Severn, cutting out newer and lower valleys beneath the floors of the original consequent valleys.
Fig. 12 then shows what may be supposed to have been the river system of the Thames with the original consequents. But, as pointed out in Fig. 5, these consequents

Fig. 12. The supposed original Dip Streams or Consequent, shown by dotted lines; the present rivers being marked in the ordinary way. There are some misprints in the block: Martso should be Marlborough (Marlbro'). Welden should be Wealden.
would compete among themselves; one would become a master stream by developing subsequents along the strike of soft rocks, and would in this way capture its neighbours, turning them to its own system. Fig. 13 shows the position of affairs which may be supposed to have existed while the Severn was engaged in working its way back. The Coln flowing through the gorge east of Cheltenham became a master stream, collecting to itself a considerable amount of the drainage of the then high level vale of Gloucester by beheading its neighbours, such as the Churn, the Leach, the Windrush.

Fig. 13. A supposed later stage of River Development than that shown in Fig. 12—the Severn working its way up the vale of Gloucester, but not yet having captured what may be called the Cheltenham river group—the Coln system. Consequents . . . . . . . Subsequents - - - - - Obsequents + + + + + +
And lower down the river, where a similar series of soft strata allowed a similar state of affairs, the Evenlode-Thames had sent out a strike stream, and had collected consequents in a similar manner. All the Cotteswold streams, such as the Windrush, Coln, Churn, have been captured by the strike stream, the Upper Thames, in this way. Fig. 13 shows it. And what is necessary to point out is that the same state of affairs exists at the present day, the captured rivers in the Vale of White Horse being taken up the Thames now, through the breach in the Chalk escarpment known as the Goring gorge. But what was presumably the analogous state of affairs with regard to the Lias streams taken through the Chelt gorge of Inferior Oolite has passed away, owing to the successful growth of the Severn.

If such was the case there should be evidence in the valleys. The Teme-Coln, as it may be called, making its way through the Inferior Oolite gorge should have cut back the sides of that gorge to form a valley with worn-away spurs and only slight concavities such as is shown in Fig. 8, or in a more degraded manner in Fig. 9. And so it has. If anyone will look at the successive spurs and concavities of the sides of the Chelt valley—the high level valley above the 600 feet contour line—they may notice the resemblance of these spurs and combes to the valley-sides formed by a meandering river.

This is an important point—the features of the present Chelt valley were really determined by the meandering of the original high-level consequent. The places where springs and rivulets would afterwards break out to feed the Chelt would be in the combes of the meander bends; because from them the protective Oolite capping had been most removed, and the water-retaining Lias had been brought nearest to the surface; and, again, atmospheric denudation would have the best chance to make valleys of these combes.
This is quite opposite to what has usually been taught. The combes have determined the position of springs, not the springs determined the making of combes. Or, really, the original meander bends determined where the springs and rivulets of the obsequent river should be situated. Even the valley turns of the obsequent river, seen to perfection near Dowdeswell, were determined by the meanderings of the original consequent.

And the result of these meanderings to produce valley sides like those of Figs. 8 or 9 may be further observed in the high level of the Coln valley above Withington. Here there are really four valleys, each with their own special features. 1st, the high level valley with nearly obliterated spurs; 2nd, the three valleys with diminishing river curves as pointed out by Prof. Davis, and illustrated in Fig. 14. This figure is only a rough diagram, but from

![Fig. 14. Rough Diagram of the Curves in the Coln Valley, South of Andoversford.](image)

the hill south of Withington, looking up the Coln valley, there may be seen the features which it indicates: namely, A, large curves; B, course of a lower valley making two turns in each original curve; C, very meandering course of the present river.

The features of B to be noticed are, first, the development of a subsidiary spur, jutting out like a buttress from the large valley concavity: this is seen excellently on the left
bank of the Coln just below the allotments north of Withington, and even better in the valley from Syreford to Sevenhampton; secondly, the development of a subsidiary concavity in a primary spur: this is well shown in the right bank of the Coln just below the allotments, and on the left bank just below Woodbridge, towards Casey Compton.

Diminution of river curves indicates diminution in river volume; the latter would be brought about by the successful growth of the Severn, as it beheaded, first the western, and then by means of the Avon, the northern tributaries of the Coln—those which would have cut the pass at Charlton Abbots. So the fact of finding these diminishing curves so plainly in the Coln valley is strong evidence for the assumption that the original Thames streams flowed from the Welsh hills over the Cotteswolds before any Severn existed, as in Fig. 12; and that the present condition of the drainage is due to their having been successively broken into by the Severn working along the strike of the soft Lias rocks.

A glance at Fig. 12 will show the possibility of the Bristol Avon doing the same for the streams which enter the Goring gorge, as the Severn is supposed to have done for those entering the Chelt gorge, and so leaving the Goring gorge as a riverless breach such as the Chelt gorge is now. The Bristol Avon would have to work back along the line of the Thames to Oxford; and it may be seen that it has already accomplished the process in part, and has captured some of the South Cotteswold streams which, by analogy with their neighbours, the Churn and Coln, there is every reason to suppose once formed part of the Kennet (i.e. Thames system) drainage.
THE SALISBURY MEETING

The Vale of Pewsey is an interesting example of a particular phenomenon of geomorphology. It illustrates what has been called a "valley of elevation," the result of the denudation of an anticlinal fold. The vale has been formed along the axis of the anticline, while the materials were carried away by the rivers which drained north and south from the anticline. Of these rivers the Salisbury Avon is the only one now in existence. It started on the high ground of the anticlinal axis when the Vale of Pewsey was still filled with strata as high as the hills which bound it; and, cutting for itself the channel which now forms a gorge south of Upavon, it carried away the softer rocks which separated the north and south Chalk hills around Pewsey. In doing this it developed a series of lateral streams more or less along the axis of the anticline, and these streams now form its head waters.

The annexed diagram, Fig. 15, shows the structure of the anticline, roughly indicating the general formation of the county from north of Swindon to south of Pewsey,
with the position of the Kennet in regard to the Avon. The Kennet occupies the synclinal trough. Its position and the eastern direction of the Kennet-Thames has been largely determined by the position of the Pewsey anticline. The diagram shows the possibility of the Avon robbing the underground water from north of the Kennet. How far this is applicable to the present case is a matter for future work; but the possibility of such river-robbery in this or other cases is interesting.

This diagram (Fig. 15), so far as ground levels were concerned, was merely a rough sketch made after cycling through the country; but since it was drawn, and the above notes were written, I have been able to work out the question more fully. Unfortunately the maps of the Geological Survey do not give contour lines, so the information as regards contours has to be obtained from one map, and that as regards geology from another, which is not a satisfactory plan.

However, I have now drawn a scale diagram of part of the country, and have put in the geology according to actual heights. The resulting diagram (Fig. 16), gives the ground level contour, exaggerated on account of the difference in horizontal and vertical scales; but the relative levels are correct. It will be seen that the valley of the Salisbury Avon is, even near its head, 100 feet lower than that of the Kennet, and that the springs supplying the Salisbury Avon are below the level of the Kennet.

The syncline beneath the Kennet valley really forms a basin wherein the water which, both north and south of the Kennet, falls on and mainly sinks through the pervious Chalk, is held up by the partly impervious Greensand and the very impervious Gault. And the water in this basin can be held up to the line marked as "water level for Salisbury Avon"—proved by this being the level of one of the Avon's springs.
Figs. 16, 17. Diagrams showing circumstances favouring river-encroachment above ground, and river-robbery underground.

Fig. 16. The syncline of the Kennet Valley, and part of the Pewsey anticline, showing how the Salisbury Avon, not the Kennet, drains most of the Marlborough Downs. So the visible water parting is very different from the actual one.

Fig. 17. At right angles to Fig. 16, showing how with a quicker fall the Bristol Avon can encroach on the Salisbury Avon.
The point is this:—That of the water which falls on the Marlborough Downs very little finds its way to the Kennet; it soaks down through pervious Chalk and is drained away by the Salisbury Avon which has the advantage of the lower level. And if the river bottom of the Kennet were at all leaky that water would be taken by the Avon. It is a very pronounced case of river robbery. And further, the more a river robs, the more it is encouraged to rob; for the robbery itself enables it to eat its way back into its neighbour's territory.

However, the Salisbury Avon has not got it all its own way. It is, and has been successfully attacked by the Bristol Avon.

The diagram (Fig. 17), which is at right angles to the last, along the axis of the anticline, shows the relative position. One of the Bristol Avon's streams is draining the ground below the Salisbury Avon, and as it can give a quicker fall in a shorter distance, it will certainly eat into the territory of the Salisbury Avon, and get stronger in the process. Already it has beheaded the stream immediately west of the Salisbury Avon, one which, rising from the anticline just south of Devizes, cut the pass through the Chalk from West Lavington to Tilshead:* cut that pass down to 418 feet, or within some 30 feet of what the Salisbury Avon has done. So the capture must be fairly recent.

The present position of the Bristol Avon in relation to the Pewsey Vale and the Salisbury Avon may be exactly compared to the state of affairs depicted in Fig. 13 as regards the growing Severn, when part of the Lias vale was drained by streams which flowed through the Chelt gorge of Oolite. What the Bristol Avon is to the Salisbury Avon now, so was the Severn to the then extended

* This is now the beheaded stream which flows by Winterbourne—the name means much in river-robbery. Winterbourne indicates shortage of supply in summer.
Coln; and the Chalk gorge at Upavon shows the counterpart of what the Oolite gorge at Charlton Kings must have been.

So that, changing the necessary names, putting Severn for Bristol Avon, Coln for Salisbury Avon, Chelt Oolite gorge for Upavon Chalk gorge, Severn Vale for Pewsey Vale, we get from a present day example an exact picture of what a Cotteswold river system was in the past.

Then, from analogy with what this river system of the Cotteswolds is at present, we can infer the future of the river system of the Pewsey Vale—the Bristol Avon will invade that vale further and will behead the Salisbury Avon; and then the Salisbury Avon will rise below Upavon on the slope of the Chalk escarpment as the Coln does now near Andoversford, and the Upavon gorge will be deepened to become the valley of an obsequent river like the Chelt.

But the success of the north-eastern part of the Bristol Avon along the vale by Swindon—detailed in an earlier part of this paper, p. 185—will probably precede this event. It would hasten it, perhaps.

There was one feature noticed about the Kennet in the day's excursion. Ascending the hill from Marlborough, a good view of the valley was obtained; and there could be plainly seen just those diminishing curves which are so characteristic of the Upper Coln—illustrated in Fig. 14. There was another observation. The south-western road by which we left Marlborough for Pewsey was evidently a British trackway leading first to earthworks on the downs overlooking the Pewsey Vale, and then perhaps continuing as one of the ancient roads to Stonehenge.
THE SODBURY MEETING

The Lilliput cutting shows some strata of Carboniferous Limestone dipping west at an angle of 45 degrees. Against, and overlapping them, are Mesozoic rocks with an easterly dip of about 3 degrees.

The Carboniferous Limestone exposed is a part of the shore-line of the late Trias and early Lias sea. It formed a kind of cape. It was gradually buried beneath the accumulation of Mesozoic strata.

The interesting geological history may be thus stated. After the deposition of the Coal Measures, the strata were thrown into anticlinal and synclinal folds. Denudation, probably marine, planed them down to a base level, destroying the anticlinal fold. Then the district being elevated to form a land surface, the unprotected Old Red Sandstone was removed by sub-aerial denudation to form a valley. The scenery which such denudation would have produced may be compared to that of the Vale of Pewsey. Afterwards depression admitted the sea to this vale, and it became filled with Trias rocks; and then continued subsidence allowed of the whole being buried beneath Jurassic strata. There was again elevation; and sub-aerial denudation removed some of the Mesozoic strata and again exposed the Palæozoic rocks on the western syncline, but left the eastern syncline buried beneath the Mesozoic rocks of the hills.

There is an important question of economical Geology here, namely, the position of the Coal Measures beneath the hills. Following the synclinal and anticlinal folds, it would be possible to indicate where the Coal Measures would be most likely to be found by a boring beneath the rocks of the Cotteswolds in the Badminton neighbourhood.
The effect of the Tunnel, which will be two-and-a-half miles long, on the drainage of the district, will be an important point. In its course it will knock a hole in the bottom of three water-retaining strata—the Upper Lias, the Fullers’ Earth, and the Forest Marble. Thus it will give the water of the hills which formerly went eastwards a chance to go westwards. The upper tributaries of the Bristol Avon will be robbed, and the lower tributary—the Frome—will gain. The effect on the water supply of the Badminton district may be very marked.

Two observations were made at this meeting, from the fossils shown in the Engineer’s office at the Cross Hands:—At 132 feet was obtained a specimen of the Grammoceras aalense group; at 178 feet, a specimen of Grammoceras striatulum. So the Cephalopod bed—the strata of the Hemeræ aalense-striatuli—is 46 feet thick here. This is a considerable increase on what obtains in the Frocester neighbourhood.

The above notes refer to some of the questions studied during the first three meetings in the summer of 1899. For the fourth meeting, as I was much engaged, the President very kindly relieved me of the work. On one feature of the excursion which he arranged he has made the remarks contained in the next contribution.
EXCURSION NOTES:
THE GARDEN AT PRIORS MESNE,

BY

M. W. COLCHESTER-WEMYSS

The garden to which Surgeon-General Cook has devoted so much attention possesses many features of altogether exceptional interest. It is about two acres in extent, lies on the southern slope of a hill, and, surrounded by a wood, is sheltered on all sides, though open to every ray of the sun. There are three ponds at different levels, with many aquatic plants, including six different varieties of water lily, white, yellow, primrose, rose-coloured, sweet-scented, and double. On an island are some fine specimens of Wellingtonia, with Japanese and other pines, and in the surrounding wood are many species of pine 60 years old: —P. excelsa, P. araucaria (from Chili), Deodara (from the Himalayas), and several younger trees (notably Abies douglasii) which have attained a height of over 40 ft. in 15 years. There is also a fine specimen of Eucalyptus, over 25 ft. high. Among the most striking objects are several grand specimens of the Abyssinian Musa (M. ensate) bearing leaves 14 ft. in length and 2½ ft. in breadth, without a rent in any part; several hardy palms, Chamerops excelsa, C. humilis, and C. fortunei, the first has been planted out about five years, and its fronds measure nearly 6 ft. round the circumference; the giant Polygonum (sachalinense) with stems 12 ft. to 16 ft. in height, huge leaves, and covered with spikes of small flowerets. This is the male plant; while groups of the female plant, which show drooping racemes of flowers, and several other species, overhang the ponds.
There is also *Hedychium gardnerianum*, with large soft leaves and flower spikes from 12 to 18 inches high, covered with from 100 to 150 flowers, orange-yellow with scarlet stamens; one of a family closely allied to the tropical arrow-roots; a new species of *Senecio* (groundsel) with leaves 18 in. by 12 in., fresh, soft and green; a stately plant (*Senecio arborea*) which promises to be a great addition to the sub-tropical group; a new *Musa (M. sinensis)*, its leaves striped or barred with purple. Amongst other tropical large-foliaged plants are the *Ricinus* (the castor-oil plant); the giant red-flowered tobacco; three species of *Azalea* (*A. sieboldi, A. cashmeriensis*, and *A. papyracea*); masses of *Canna indica*; and single specimens of the lovely *C. ehemanni*, by far the best of all the *Cannae*, with its large, pure, rose-coloured flowers on hanging terminals. Groups of the giant-leaved *Gunnera*, from South America, (*G. manicata* and *G. scabra*), which are said to be the largest leaved of all terrestrial plants, some of them being from 5 ft. to 6 ft. across, and having a superficial area of from 20 ft. to 25 ft.; they are here, however, exceeded by the leaves of the great *Musa* near them, some of which actually attain a surface of over 28 ft.

The *Arundo conspicua* from New Zealand, a plant resembling the Pampas grass, but far handsomer, flowering in July, and retaining its plumes until the winter; *Spiraeae*, some 12 or 14 species; and *Funkiae* in great variety, hardy plants which need no extra care, were also noted.

Prominent among the foreign accessions to the English garden are the different species of Bamboo; about a dozen species are here represented of heights varying from 5 ft. to 20 ft., some of them forming dense masses 6 ft. to 7 ft. across at the base. These grand plants give a most distinctly sub-tropical character to the garden. Such are a few of the many interesting plants which Dr Cook has succeeded in acclimatizing at Priors Mesne.
A FATAL COMBAT BETWEEN A ROVE BEETLE AND AN ANT,

BY

C. A. WITCHELL AND C. J. WATKINS,

(Read June 1st, 1899)

I.—DESCRIPTION OF COMBAT

BY

C. A. WITCHELL

On the 12th of May, at 6.45 a.m., when gardening, I found on a ball of mould two insects holding each other. One was a Rove beetle (*Xantholinus punctulatus*, Payk), and the other was a worker of the Garden ant (*Lasius niger*). The ant held in its jaws one of the antennae of the Rove beetle; and the latter bit at and held a leg or an antenna of the ant, but did not retain its hold for long. The ant appeared to be having the best of the combat. He held on firmly, and seemed quite at ease; the Rove beetle, on the contrary, seemed anxious to be rid of its enemy. The insects pulled each other from spot to spot on the mould; and after a quarter of an hour had elapsed I persuaded them to alight on a piece of brown paper. But they still held each other.

I covered them with a glass, and looked at them from time to time. Thinking to refresh them, I wetted the
paper, and the Rove beetle lay as if dead in the water, the ant above him. Indeed, I thought the ant had killed him. At half-past nine I dried up the water, and the insects at once resumed the strife. At this time the Rove beetle seemed to be getting the best of the "mill." I then left for the day.

At 6.30 p.m., when I returned, the ant still held the antenna of the Rove beetle; but the ant was dead. The Rove was as strong as ever, and ran about with the corpse of his foe clinging to him.

At six o'clock next morning the Rove was asleep, the ant still retaining his grim hold. I then killed the Rove beetle, which resisted vigorously.

I put the insects, as they were, on stamp paper, and took them to Mr C. J. Watkins, of Painswick, who kindly identified them, and returned them to me mounted, but, I regret to say, separated.

II.—REMARKS ON THE COMBATANTS

BY

C. J. WATKINS, M.E.S.

The Beetle is one of the great group of Brachelytra, of which nearly 800 species have been recorded as British. They are commonly called Rove beetles, which are readily known by their elongate abdomen, and very short, straight wing cases, covering, however, a pair of large, beautiful wings. One of our largest species is the well-known "Devil's coach-horse" (Ocypus oleus). From the length of an inch they vary down to a size so small as to require a strong lens to show whether they are insects, much less beetles. Most of these Rove beetles are carnivorous, and feed upon decaying animal substances. The larvae of these beetles resemble the perfect insect, and are found
under similar circumstances. They are very active and voracious, using their sharp jaws with great effect, and sucking the juices of their prey through them. The Rove beetle in question is known as *Xantholinus punctulatus*, Payk. There are 10 British species in this genus, whose members have a peculiar habit of curling, or rather "doubling" themselves up in repose.

Some kinds of Rove beetles are constantly found in the nests of certain species of ants. These myrmecophilous, or ant-loving species have been found even in the inner sanctuaries of the ant's nest, and appear perfectly at home, their numerous hosts never molesting them. Mr Rye records having seen a Rove beetle (*Ateomeles emarginatus*) being carried about tenderly in the mouth of an ant much less than itself. Another Rove beetle (*Myrmedonia funesta*) is often found in the nests of the Jet ant (*Formica fuliginosa*); it is very like its host in appearance, and even acquires the pungent odour common to its host—from living in an atmosphere impregnated with formic acid.

To return to our Rove beetle (*X. punctulatus*) and its seeming enemy which appears to be a worker of the Garden ant (*Lasius niger*). It is very possible that the ant was the aggressor while out on a foraging expedition, and had the combatants not been removed from the ground it is probable that other workers of the species would soon have assisted their comrade to overcome the beetle.
Fig. 1—GLOUCESTER CROSS, 1602

Fig. 2—DOGE'S PALACE, VENICE

Fig. 3—GROUND PLAN OF BASILICA, ROME

Fig. 4—CANTERBURY

Fig. 5—GREEK AGORA

Fig. 6—PEUTINGER'S MAP
SURVIVALS OF ROMAN ARCHITECTURE IN BRITAIN,

BY

JOHN BELLOWS.

(Read December 13th, 1898)

The West of England, especially the district of which Gloucestershire may be taken as a centre, is rich in architecture that shows a historical connection with the past; and some of its public buildings which more than any other have preserved to us features of a very high antiquity are its pillared market-houses. As a whole they are quaint and homely rather than beautiful; and possibly it is their very homeliness that has caused archaeologists to overlook the points which prove their true origin.

When the Tolsey, or Town-house, of the City of Gloucester was taken down in 1896, there were exposed under its foundations the remains of some mediæval structures; and below these again there were found portions of a still earlier Roman building, which has been decided by George E. Fox and Edward Jones, the explorers of Silchester, to have been a Basilica, or place connected with the city administration in the Roman period.

If we examine the old engraving [Plate IV., fig. 1] of the Tolsey which was built previous to the one that has lately given place to the Wilts and Dorset Bank we shall notice
three principal points in it. First, that it, too, has the Council Chamber in an upper floor; second, that it has very large and heavy sash windows, which were copied, with modification, in the plate-glass lights of the late Tolsey; and third, that the room stands upon pillars, and covers the side walk in the street, forming a portico. This older building dates from 1602. Where did the architect who designed this Tolsey of three centuries ago, get his idea of the covered gangway? for it was certainly a survival, not an innovation. An examination of the Roman building on the same site gives us the clue; for it, too, had a covered ambulatory; and so had the Basilica at Silchester.

The new Guildhall, which happens to stand on the site of the Roman Praetorium, is itself in some degree an evolution of the Tolsey which it replaces, inasmuch as it preserves the principal feature in the older building, which was the placing of the Council Chamber in the upper storey, instead of on the ground floor.

This arrangement was the result of experience; and it is clear that if the Tolsey has thus helped to determine the form of the newer building, it must in turn have received some impress from its predecessor: what it retained, with what it discontinued, make up the evolution we shall endeavour to follow.

It is remarkable that while the City of Chester has been so far destroyed in the disturbances it has suffered, that even the main cross of the streets is displaced, yet it has retained the style of building which provides such covered ambulatories on a larger scale than any other town in Britain; for in the Rows at Chester, with their two-storeyed covered passages, we have the parallel evolution to that which is offered by the Doge’s Palace in Venice. The only differences are those arising from the purposes of a commercial building being different to those of one intended for official occupation [Plate IV., fig. 2.]
The houses in Pompeii and other Roman cities were built, as our old timber-framed mansions are, with overhanging storeys, and the same style still prevails in towns of Roman origin in the East: as for instance in Constantinople, especially in the Stamboul quarter.

That the idea itself goes back to the Basilica and the Agora may be seen from the description of the latter given by Vitruvius, and from the double-storied porticos in the Basilica represented on a coin of Lepidus [Plate V., fig. 2].

The origin of this style of building goes back to the East. In the hot summers of Central and Southern Asia the great desiderata were shade and air; and this determined the arrangement of every structure, from the shepherd's tent to the palace of the king. To go back to the simplest group of dwellings in the old world, we get a number of tents facing inward, to form a square with an open court in the centre for the cattle: this is the arrangement of every caravanserai in Asia to-day.

In the larger and more permanent grouping of a town the same idea is kept in view; and a square space near the gate serves as the Bazaar, round which the shops stand under shaded ambulatories.

As the entrance of the town forms the market, it is also the most convenient spot for the administration of justice; so that "the Gate" very early becomes the synonym for Court, as in Job's allusion (xxix., 7, 9): "When I went out to the gate through the city . . . the Princes refrained talking"—which in western language would read "When I went to take my seat on the bench my fellow-magistrates gave me precedence." So in the Book of Esther, Mordecai sitting in the King's Gate is an orientalism for his attendance at Court: and in more recent times the mistranslation into French, of Babé Ali, has given us the nonsensical term "the Sublime Porte"
instead of “the Supreme Court”—for Bab is a gate in the sense of Court, and Al is the Arabic equivalent of the Hebrew El, “high” or “supreme,” as in the name of the Supreme Being.

In Greece, we find this combination of the market and the seat of justice in the Agora, which was at first a market square in front of the King’s Palace, gradually developed into a set of porticoed buildings round a court, or courts, with ample shaded ambulatories, the elevation of one of which is shown in Plate IV., fig. 5. These buildings included

1. The market and shops.
2. The town offices.
3. A temple for worship.
4. The Court of Justice and the prison.

This Court was presided over by the second Archon, who had to decide in matters connected with religion. As during the monarchy this had been the duty of the king, in his capacity of priest, the high magistrate on whom the office devolved when the monarchy was abolished, was styled the “Archon Basileus,” or King-Archon, and the court-house itself was called the Stoa Basilios.

About two centuries before Christ the Romans borrowed from the Greeks this combination of market and public buildings, which the higher civilization of the Greeks had so developed, and with it the Greek name of the Law-court, which they now termed the Basilica. At first the building was simply a pillared portico of two storeys—that is, without side walls, if we may judge from the representation of it on the coin of Lepidus, shown in Plate V., fig. 2. As its use extended, however, to parts of the Roman Empire where the climate made so much exposure impossible, side walls were added, the whole now forming a kind of cloister running round an unroofed or open square.
In the curious map of Roman Stations, known as Peutinger's, which has come down to us from probably the second or third century, thermal stations are depicted in this form of an ambulatory looking into an open square. [Plate IV., fig. 6]. Places in which there was a Praetorium or Imperial Court of Justice, are also thus shown. Cologne (Colonia Agrippina), for example, is drawn as in the second block of fig. 6.

If, however, the main building of the Basilica was open to all the winds, though it afforded shade from the heat, the law court itself was sheltered by a covered semi-circular building at the end. The seats rose in the form of an amphitheatrical: the presiding judge in the centre, and his assessors (adssiores or those who sat with him; i.e. advisers) on either hand of him. At the foot, across the chord of the arch a bar separated the "court" from the throng in the main building, and behind this was a low screen of lattice work or cancelli. The secretary who recorded the decisions of the judge sat inside this screen, and was therefore termed cancellarius, or, as we anglicise it, the chancellor. In some of the more magnificent basilicae the cancelli were replaced by a network of marble carving.

Now let us see what the simple court of the Greek Archon had developed into under the Roman Empire. A restoration of the grandest of these buildings in Rome, the Basilica of Trajan, is shown in Plate V., fig. 1. The atrium is no longer left open, but is roofed across with timber; the ceiling, 120 feet from the floor, covered with plates of gilded bronze. The great gallery that runs all round the building is guarded with gilded bronze railings, as in Santa Sophia, built by Justinian in Constantinople.

The galleries, supported by the granite columns, were reached by outside stairs; a thoroughly Eastern plan to which I shall again refer.
It is worth our while to pause for a moment and glance at the description Pliny gives (Epistle vi.) of the throng assembled in the galleries of the Basilica when he made one of his greatest orations in pleading before the court for an heiress of high rank who had been defrauded by her trustees.

It was this use of the basilicas as halls of assembly that fitted them so well for places of worship, after Constantine had made Christianity the religion of the state; when the seat of the judge in the apse at the end became the throne of the bishop, whose subordinate clergy took the places of the assessors of the court.

The galleries, however, played a more important part in the Greek Church than in the Western, as they were allotted to the women of the congregation, who, in accordance with Eastern etiquette, had to sit apart from the men: a custom still maintained, as everyone knows, among the Jews and the Mahometans. Thus it happens that while, as women are not secluded in western lands, the abbeys and cathedrals replacing the basilica in these countries have mostly discontinued the galleries, in the East, on the other hand, the basilica itself has been displaced in favour of a building square in its ground plan, as better adapted for galleries, while at the same time it admits of being roofed with a dome. This has become the almost universal type of Greek buildings for worship, as in Russia, as well as of Mahometan mosques and Jewish synagogues; Santa Sophia, in Constantinople, and the synagogue at Frankfort offering good typical examples of such gallery arrangement.

While the retention of the atrium, or fore-courts, with its covered colonnade as an approach to the basilica, had a distinct advantage in a hot country from the shade it afforded, yet it injured the architectural effect from its too great elongation. As, however, the covered ambulatory
was distinctly useful in a stormier climate such as that of Britain, as a place for exercise, we find the earlier architects of the abbeys and cathedrals retained the atrium; but they placed it at the side of the building instead of at the end. This change is well shown by a comparison of the original Basilica at Rome, which was demolished to make way for Michael Angelo’s great cathedral, with the original cathedral of Canterbury [Plate IV., figs. 3, 4.] In other words, the atrium, with its covered walk in front, has become, in ecclesiastical architecture, the cloisters at the side of the main building, instead of remaining a fore-courts.

We must remember that this idea of an atrium, derived from Eastern lands, was a governing one in the architecture of all Greek and Roman mansions of importance, and of inns for the accommodation of travellers. Examples of such an arrangement in inns have come down to our own century in the “Tabard,” the “Bull and Mouth,” the “Talbot,” the “White Hart,” the “Four Swans,” and the “Saracen’s Head,” hostelries in London [see Plate V., figs. 4, 5, 6]; in the “George” at Hungerford, in the “Falcon” at Cambridge, in the “Ram” at Cirencester (of which, by the way, there is a drawing by Hogarth, who once lodged in it), and in the “New Inn” at Gloucester [Plate V., fig. 3.] This “New Inn,” built nearly five centuries ago, is as real a survival of Roman architecture, as to its style, as the Colosseum itself. In most parts of Europe where the Roman influence was felt, similar inns still exist; as for example at Bucharest, where one finds the same open galleries looking into a courtyard, built by the Roumanians of to-day, who are descended from Italian colonists, still speaking the language.

It is worth noting for a moment that this Roman atrium of the old hostelries has left a mark on our English speech in a familiar word, the origin of which is not suspected perhaps by many Englishmen. We call the room
in which liquors are supplied, in an inn, "the Bar." This usually stood in the gangway or entrance to the courtyard, where the "bar" was dropped to close the premises during the night.

In many towns we have examples of the "bar" still occupying the same position; as in the "Greyhound" and "Green Dragon" Inns at Gloucester. I remember hearing a story, when a boy, of some acrobat who had taken a hackney coach to one of the old inns in London, and who in passing the open window of the bar as he was being slowly driven through the narrow entrance, sprang into it. The driver got down from the box when he reached the courtyard—opened the door—and finding no "fare" within, remounted in no pleasant temper and drove back to his stand. On the way out, the "fare" slipped from the bar back again through the carriage window unsuspected. On reaching the stand he put his head out and asked the man what he meant by driving him about in this way, when he had been ordered to go to the "Saracen's Head?" The man moodily drove to his destination a second time, but on being tendered a half-guinea in compensation for his wasted time, he grimly refused it, with the significant remark, "No! I won't touch your money! I know who you are!"

Some of these old inns have retained interesting features of the Roman architecture besides the open galleries, all indicative of their oriental origin. The outside staircase is one of these, as shown in the beautiful "New Inn," at Gloucester [Plate V., fig. 3]. In the "Bull and Mouth," in Aldersgate Street, London [fig. 5 in the same plate], we see a modern casing put over such an outside staircase: a condescension to the less hardy ways we have got into; or rather an adaptation to the climate, for which Italian architecture was not really suited. Another feature is the use of lattice-work for the railing of the galleries of
the same inn. A piece of latticing is also visible in the “Talbot,” an illustration of which appears in Plate V., fig. 6. This lattice or trellis will be referred to again.

The courtyard surrounded by these galleries was often used for a place of assembly: and the scene described in the book of Acts, where the young man Eutychus fell down “from the third loft,” doubtless refers to such a place. He had probably been sitting on the baluster of the upper gallery, listening to the preaching of the Apostle in the “Chamber,” or, it might be, from the lower gallery opposite, when he fell asleep and lost his balance. Shakespeare's and other plays used to be performed in the courts of London inns; and a picture of such a performance in Queen Elizabeth's time is given as a frontispiece to the second volume of Cassell's "London."

Typical examples of the open pillared market-houses which are so frequently met with in the specially Roman parts of Britain are given in Plate VI.: Tetbury [fig. 1], Minchinghampton [fig. 6], Dursley [fig. 2], and Ross [fig. 5]. Those at Whitby and Luton [figs. 4 and 7] are shown for comparison; and their similarity is striking. In each of these the building is of stone; but beautiful market-houses were built of timber-framing in Herefordshire: three of them by the same architect, John Adam, at Hereford, Ledbury, and Leominster, respectively. The town-hall of Leominster has been removed to the Grange, where it is now altered to a private dwelling-house; but the illustration in Plate VI., fig. 3, shows its original state.

Nearly all these old market-houses kept till a recent period the two-fold character they inherited from the Roman basilica, of places of business and rooms for the administration of justice: even the miniature but picturesque timber-framed one at Newent has its “magistrates' room” in the upper storey. It will be observed that one
architectural feature common to most of them is a bell-turret in the roof. These turrets are so exactly alike in form and in position, usually being in the centre, and not at the end of the roof (and this in market-halls widely separated both as to place and period,) that it is easier to believe them to have come from one common type than to be the results of undesigned coincidence. Thus in Plate VI. the turret at Minchinhampton, in Gloucestershire [fig. 6] is exactly like that at Whitby in Yorkshire [fig. 4], and that at Luton, in Bedfordshire [fig. 7]; while an old map of London shows precisely such another central belfry in a sketch marked "Honey Lane Market, off Fleet Street": a building that has long disappeared.

It is interesting to note how, as markets introduced into all parts of the Roman Empire were also carried by traders beyond its limits, the same style of open ambulatory was preserved in the buildings erected for holding them in, as in Northern Germany. Lübeck is a fine example [Plate VII., fig. 1]. Another is afforded by the beautiful old Rathhaus of Schwalenberg [fig. 2]; but here we see the cold of the German winter asserting the need of more shelter than is afforded by the open ambulatory. The rooms on the ground floor are not brought quite to the line of the street, but a survival of the ambulatory has kept a tiny space behind the pillars with just enough room for a cat to pass: certainly not for a burgomaster.*

In Russia, which was beyond the reach of the Roman influence in the establishment of markets, the Eastern bazaar has determined the form of the "Dvors," which are sets of shops, as in Petersburg and Moscow, surrounded by covered ambulatories: clearly copied from those of a hotter climate.

Metz, a Roman city, has preserved a street of open arches which are still used as shops [Plate VII., fig. 6];

* Similarly, the old houses in Hamburg imitate the Roman buildings by overhanging their upper storeys, but the projection of each storey is usually only about nine inches.
and many such examples may be seen in other parts of Roman Europe, notably in Berne; while, to return to our own Island, we find the tradition of the portico still leaving its mark, as it has done at Chester, upon the Roman towns of Winchester [Plate VII., fig. 4], Marlborough, Totnes [fig. 3], and Bath [fig. 5]. In the latter city the covered pillar-way has been copied by one architect after another till the last century. "Bath Street" has the side walls entirely under cover; while the entrance to the Abbey Close and the Pump Room, which stands on the site of the Temple of Sul-Minerva, has precisely the arrangement of pillared shade that is indicated in the map of Peutinger, already alluded to. The original of this map was, as I have said, a kind of birds’-eye itinerary of the great Roman roads with their stations, in which the towns were indicated by a double tower such as guarded city gates, while places in which there were principal courts of justice were shown by sketches like those on Plate IV., fig. 6. Thermae or Baths were also so indicated. What is sketched is evidently an ambulatory round three sides of an open court: the doors on the right representing entrances to rooms, while the front is a pillared portico carrying no rooms above it, precisely like that which the conservatism of architects has kept for the present approach to the Bath Pump Room and Abbey Close.

The Peutinger sketches show no roof over the sheet of water answering to that which is an object of such interest to visitors to Bath. The Romans, carrying with them the same climatic ideas that determined the open market-houses, built their baths, even in Britain, open to the sky: and so they remained all through the middle ages; for the hot spring at Bath was open to all weathers till after the Tudor times. It was simply a Roman Impluvium occupying the whole of the atrium.

While the ground plan of mediæval abbeys and cathedrals preserves to us the fore-court of the Basilica, but
changed in its position, as the cloisters, the plan of the Roman *Domus* has been remarkably kept to in some of the old galleried inns. A good illustration is afforded by the New Inn at Gloucester, the arrangement of which is so precisely like that of the "house of the tragic poet" in Pompeii that the plan of the latter, as given in Smith's Dictionary of Antiquities [*Domus*] would serve for it. [Plate VIII., figs. 2, 3].

This plan shows the same narrow passage from the street as that leading to the courtyard of the New Inn, with shops on either side, entered from this passage, exactly as the "bar" in such inns was entered.

Then both the Pompeian house and the New Inn have two courtyards, as have many other hostelries of the same type. This feature was universal in large Roman mansions, and in the Greek houses from which the plan was copied by the Romans. The reason for having two courts was the same as that which led to the building of galleries in the places of worship: *i.e.* the seclusion or partial seclusion of the women; for while the outer court gave access to the men's apartments, and was the one in which strangers were received, the inner court, with its little garden, was surrounded by the apartments of the women.

A comparison of the plan of a Greek house, from Bekkir, which is given in the article, *Domus*, in Smith's Dictionary, already referred to, with that of the house of the tragic poet, and with one of Pansa's house, at Pompeii, makes this origin of Roman arrangement unmistakable. [Plate VIII., figs. 1, 2, 3].

While, however, the house of Pansa, and the Greek house, both have the passage leading to the inner court placed exactly opposite the street entrance—which is also the arrangement in the great Roman Villa at Woodchester, the house of the tragic poet has the entrance to the inner
Fig. 1—GREEK HOUSE

Fig. 2—TRAGIC POET’S HOUSE, POMPEII

Fig. 3—NEW INN, GLOUCESTER

Fig. 4—TEMPLE OF MINERVA, ATHENS

Fig. 5—COIN OF BYBLOS

Fig. 6—TRELLIS GATE, GLOUCESTER

Fig. 7—GREEK TEMPLE (From Gem)

Fig. 8—TRAITORS' GATE, TOWER OF LONDON
court on the right hand of the outer one, exactly as we find it in the New Inn, as shown in Plate V., fig. 3. This secured greater privacy.

An examination of pictures of several of the ancient inns in London shows that they were also constructed on the Roman plan of the double courtyard, and with the entrance to the inner one not in line with that of the outer.

The elevation of some of these hostleries shows another survival no less remarkable than that just pointed out in the plan. Vitruvius advises that in building a house the southern wing, or side, should be one storey lower than the northern, in order to let the sun shine on the latter during part of the day. That this system has been followed from age to age is manifest from the examples of it still left to us. A glance at Plate V., fig. 3, will show the Vitruvian architecture of the two storeys on the southern side, and three on the northern, in the "New Inn"; although the photograph from which the sketch is copied has been taken so as to foreshorten the "third loft," making it less striking than it really is.

In smaller Greek houses, and those mansions in Turkey and Bulgaria which are copied from the Greeks, the separation of the Harem apartments is made by placing them on the upper floor: one large room on each floor taking the place of the atrium; the doors of the several chambers and other apartments opening directly into it, the windows of this central hall being all placed at one end of it; preferably on the north, for shade.

In Constantinople (Stamboul) one can distinguish the houses of Turks from those of Armenians or other nationalities by the windows being fitted with trellis-work, or lattice, to screen the women from observation: and here, again, we have a Roman and pre-Roman survival. In Plate VIII., fig. 4, the lights over the gate of the temple
of Minerva at Athens, and another temple engraved on a Greek gem [fig. 7], show beautiful specimens of trellis windows, which preceded those of glass: and the lattice or diamond panes of our older windows owe their shape to the trellis of which they took the place. And not only their shape, but their very angle: for while this is not invariable, it is so generally of one standard that this cannot be the result of accident. Thus I find the angle of the panes in a window of Ann Hathaway's cottage, near Stratford-on-Avon, precisely the same as that of the glass in the oldest windows of the Crypt in Gloucester Cathedral, and of the panes in the lattice window of the old tower at Llantwit, Neath. This angle is the obtuse angle of a pentagon: and it is also very nearly that of the beautiful wall ornamentation in the Alhambra, imitating trellis, while it is precisely that of the trellis in the Greek temple shown on the gem and in the temple of Minerva, at Athens, shown in Plate VIII., fig. 4.

But it is far older than the Greek temple; for the wall-decoration of the Palace at Birs-Nimroud, which is composed of plugs of clay coloured and enamelled at the outer ends, is of exactly the same lattice pattern, or elongated trellis.

Of course, in the modern developments of lattice work, there are often variations to suit odd measurements of the window-frame: the glazier simply dividing the total width and depth to avoid fractions of a pane in either direction: as in the window of the chamber occupied by Erasmus's servant at Queen's College, Cambridge, in which the pattern is slightly broadened.

How ancient the use of trellis is, in temples, is proved by a coin of Byblos, in Phœnicia, which shows the screen round the idol (Isis?) in the cella, composed of lattice-work. [Plate VIII., fig 5]. In the Imperial palaces at Rome the inner doors were of trellis, known, like lattice
screens in the Courts, as *cancelli*: and the guard of such a door was, like the secretary of a judge, called *cancellarius*. Trellis doors offered the two-fold advantage of giving free passage to air in hot weather, and of enabling the guard to see all who approached them. They could be screened from inside by curtains of purple cloth; and so completely did this arrangement come to be associated with the court, that we find trellis and *blue* cloth formed part of the regal paraphernalia on the King’s journeys in France in the middle ages.* In the “Nuremberg Chronicle” there is a quaint old engraving of the City of Buda, in which the King’s palace is indicated by trellised galleries in a building standing on the same spot that is now occupied by the palace of the King of Hungary.

Used as a railing, trellis is not only elegant in form, but it is stronger than balustrading, as each piece is sustained by the crossing of others. The bulwarks of ships are shown so constructed on some ancient coins.

When large or heavy gates were of open work, the timbers were best placed at right angles. The inner gates of the City of Gloucester, which were taken down in the time of Charles II. and are now in our local museum, are made of three-inch bars of oak thus crossed, and fastened together with iron bolts [Plate VIII., fig. 6]; and the upper portion of the “Traitors’ Gate” in the Tower of London is similar, but with the timbers set diagonally [Plate VIII., fig. 8], as is the case in the trellis above the gates in the market-house at Ross.

* See Article “Trellis” in Littre’s large dictionary. An illustration of the word given from a MS of the 13th century runs thus:

“Toutes ses herberges estoient closes de treillis de fust, et par dehors estoient les treillis couvers de toilets yades.” [His quarters were always closed in with wooden trellis, and on the outer side the trellis was covered with blue cloths.]
THE COMMON FIELDS
AT UPTON SAINT LEONARD'S
AND THE RECENT INCLOSURE (1897),

BY

REV. CANON E. C. SCOBELL.

(Read November 14, 1899)

In the parish of Upton St. Leonard's, near Gloucester, an event has occurred of considerable moment, not only on account of its effect on the present and the future, but because a system of remote antiquity has locally ceased to exist. All connection with the land customs of early times has come to an end. The future is severed from the past. One of the last instances of the ancient system of land tenure, as shown in the "Common Fields," is no more.

In treating this intricate subject it must at the outset be confessed that it is not easy, perhaps not possible, to satisfactorily describe the origin of this system, for those who have made a special study of the subject hold different views.

One theory, which may be described as "legal," supposes that rights in the Common Fields grew out of grants made subsequent to the Norman Conquest. "As the Lord of the Manor is the absolute lord of the soil in his manor,
the rights which the freeholders and copyholders in the manor enjoy depended originally on the grant of the lord.”

Another theory arises out of historical researches. It traces the origin to much earlier times, when the Teutonic village community cultivated and owned their land in common, holding that the degeneration of this community came through the strong influence of one of its members, who ultimately became its lord.

A third theory—which may be called “intermediate”—is the one supported by Mr Seebohm, who shows that, at all events before the Conquest, a system of agriculture did exist, in form, manorial.

It would seem, then, almost impossible to give a precise date, or assign any single cause to account for this early ownership and cultivation.

Professor Maitland* says “The open field system of agriculture prevails as well in the free villages as in those that are under the control of the lord.”

That certain customs, however, do exist dating from ancient, even perhaps pre-historic times, before the Aryan settlement, is probable, e.g. the election of a mock mayor in some towns in Cornwall, while a custom in the village of Randwick, in Gloucestershire, points to the former election of an official of whose duties all trace has been lost.

The title of certain plots of land called “No-man’s Land,” or, as in Upton St. Leonard’s, “Norman’s Acre,” looks back to the same archaic time. The explanation has been found among the villagers of India. “A Surna, among the aborigines of Gangapore, is a fragment of a primeval forest left where the first clearance was made as a refuge for the sylvan deities who might have thus been disturbed. On such plots, too, there is a record of a

* Edinburgh Review, 381, p. 117, July, 1897.
A BALK OR DIVIDING STRIP, SHOWING THE MEERSTONE, UPTON ST LEONARDS
(From a Photograph by A. J. Lumbert)
fowl being offered every year to the departed by the living
members of the house." *

The system, it may be noticed, is found to prevail in
India among savage races, and is fully developed in Ireland.
Such similar traits are shown that it may be fairly assumed
that this well-nigh universal system is one and the same
in general principle.

In it we clearly trace the primitive conception of unity
of kin—a family brotherhood: a clan or family, not, as
now, the individual, being the unit.

Whenever the system originated there can be no doubt
of its being general in England in the 14th century. 'The
vision concerning Piers the Plowman' bears witness to
this. In the vision he sees

"A faire filde ful of folke, fonde I there bytwene,
Of alle maner of men, the mene and the riche,
Worchyng and wandryng, as the worlde asketh.
Some putten hem to the plow, pleyed ful selde,
In settyng and in sowyng, swonken ful harde."

_Prol: 17 ff._

This must have been an open field in which the villagers
worked one fine morning—not several fields with hedges
around.

From the tithe map of Upton it would appear that
"Common Fields" were once more general than at the
time of the recent inclosure, for many fields were divided
into the narrow strips, or lands, which are of such special
interest.

These strips, which thus appear to have existed gener-
ally in this and other uninclosed parishes, were separated
from each other not by hedges but by lengths of un-
ploughed grass—called "balks" or "meers" (see Pl. IX.)
—the Latin equivalent is _salio_, the French _sillon_, the

* Gomme, 'Village Community,' p. 115.
Scotch and Irish term is *rig*; the word *dale* is also used; the system being thus termed the “run-rig” or “run-dale” system, implying that cattle were allowed to run over the ridges, dales, or divided strips, after Lammas Day, August 1.

Among the above terms “dale” may be the same as “dole,” meaning a portion, from Anglo-Saxon *dealan* to divide—cp. “deal,” a piece of timber cut off from the larger piece called the “balk”; hence also “run-rig,” conventionally to run riot (cp. proper name Rundell).

The term “balk” is found in Shakespeare, denoting a heap or ridge. We read

“Ten thousand bold Scots—two and twenty knights
Balked in their own blood, did Sir Walter see.”
I. King Henry IV., 1, 1.

Locally, “to balk plough” or “to rafter” is to plough so as to turn each furrow on to an unploughed piece, thus laying the field out like a series of rafters __________

We also find these terms in the Homilies of the Church of England in “An exhortation to be spoken to such Parishes where they use their Perambulation in Rogation Week for the oversight of the bounds and limits of their town.”

When the bounds were thus beaten by the substantial men of the parish, the Curate was directed to admonish the people at different stations—to give thanks to God and say Psalm ciii. In records of the Upton Perambulations it is stated that the Gospel was read and crosses were made.* Archbishop Winchelsea’s Constitutions, c. 1300, confirmed by Henry VIII., order the Parish to provide *Vexilla pro rogationibus*. At Todenham this custom is said still to prevail.

* There is a tree marking a place in Upton referred to in former surveys of the parish as “Gospel Beech,” and another as “Gospel Oak.”
In this homily we read “they do much provoke the wrath of God upon themselves which use to grind up the doles and marks which of ancient time were laid for the division of meers and balks in the fields to bring the owners to their right.”

“It is lamentable to see in some places how greedy men use to plough up and grate upon their neighbour’s land that lieth next them; how covetous men now-a-days plough up so nigh the common balks and walks which good men aforetime made the greater and broader, partly for the commodious walk of his neighbour, partly for the better shakk in harvest time, to the more comfort of his poor neighbour’s cattle. It is a shame to behold the insatiableness of some covetous persons in their doings; that where their ancestors left of their land a broad and sufficient bier-balk to carry the corpse to the Christian sepulture, how men pinch at such bier-balks; and now they either quite ear them up and turn the dead bodies to be borne farther about in the high streets; or else, if they leave any such meer, it is too strait for two to walk on.” *

We find a similar allusion in Piers the Plowman:
“Dikeres and Delveres digged up the balks.”

Now these balks—which hold such an important place in the common field system—must, owing to the various shapes of the fields, be of various lengths, and sometimes not in a straight line, but at the same time there does appear to be a norm upon which they were formed, showing that the length is not altogether arbitrary and fanciful. It will be observed that the ancient shape of an acre is oblong, for in the reign of Edward I. it is declared that “40 perches in length and 4 in breadth make an acre” : thus an acre may be said to consist of 4 strips, each 40

* A “corpse road” so called exists in Stratton, in Worcestershire.
perches long and 1 perch wide. Now the length—40 perches—is a furlong, *i.e.* a “furrow long” being the length of the drive of the plough before it is turned upon the land at the end, called the “headland.” It does not appear that the strips are always true to these measurements, but the shape is, where possible, oblong; and the fields consist of a number of long lands, or strips, divided by balks of fixed length, taking their shape as most convenient for ploughing. The complete acre would represent a day’s ploughing: hence a German term *Tagwan,* and late Latin *jurnalis.* The local word for a perch is “lug,” meaning first a stick or pole used to measure, as well as to pull up or pull down; hence what is pulled is termed “luggage.”

The term “acre” according to Professor Skeat means a “pasture” or “hunting ground,” clearly implying the absence of fences, *cp.*: “acorn”—fruit of the field.

It was common for the balks, or meers, to enclose two strips, so that the space within consisted of half an acre.

We read in Piers the Plowman—

“I have an half acre to erye, by the heigh way
Hadde I eried this half acre, and sowen it after
I wolde wende with you.”

This implies that the two strips made what was a usual holding or unit.*

Grass land, which could not be treated thus, was divided by stones.

It will thus be seen that the open field system was general—by no means exceptional—and that the shape and size of the various plots was intentional, with both purpose and meaning.

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* Rider Haggard, in ‘Jess,’ describes the purchase of 3,000 Morgen—*i.e.* ½ acre—in the Transvaal: the term is much used in Germany. The term “Jour de terre” is used in East France.
In the Appendix at the end of this paper (p. 229) will be found a plan (Pl. XI.) of the Great Awe Field at Upton St. Leonard's.

The plan, together with the list in the Appendix, giving the names of the owners and the sizes of the strips, will show how numerous were the holders, how scattered their holdings, and at the same time how uniform, as a rule, were these holdings in size.

It introduces for consideration matters of some interest, viz., the character of the tenure, and the scattered nature of the ownership. These features arose out of the old system of agriculture which was "co-operative," the supply of oxen and the necessaries for the plough being provided by various members of the community—a veritable ἐπάρος.

The land was often hard to cultivate, and the ploughs were of great weight. It was needful, therefore, to have great strength to move them: the ordinary plough team consisted of no less than eight oxen, and even more were sometimes required.

In proportion to the contribution made to the plough team so was the size of the holding. Some such proportion as this appears to have been accepted—a person who provided two oxen would be entitled to hold about 2 acres, not of necessity situate together, but scattered among the Common fields.

The holdings, too, of certain officials were also dependent on their contribution in some way to the common weal. Thus fields are named after the office held. In Upton we find "Constable's Grove," "Spencer's Piece," "Doctor's Ground," "Smith's Piece," "Grannie's Ground." Elsewhere there are "Carpenter's Piece" and "Punder's Piece."

The crops were taken from the lands as allotted—but when the crops were removed all the holders had the privilege of common pasturage over the whole after
Lammas Day, August 1—a custom which of late years had for practical purposes fallen into disuse, but one which was regularly observed by annually driving cattle over the fields, termed "breaking the fields," so as to maintain the common rights.

Green, in his 'Making of England' (p. 180), thus describes the village "tun"—"The unit of social life was the cluster of the farmers' homes, each set in its own little croft, which made up the Township or the tun. Within the earthen mound raised for purposes of defence lay the homes of the villagers, and outside this mound lay the home pastures and folds—beyond and around lay the village plough land, generally massed together in three or four large 'fields,' each of which was broken by raised balks into long strips of soil which were distributed in turn among the village husbandmen."

The peasant would be dressed in times of peace in his smock-frock,* falling to his knees—as still to be seen, though rapidly dying out—to be superseded by the Norman short coat, the "curthose."

Property had not then reached the stage of absolute possession. The plough land was merely allotted to the families of the Freemen, though subject to fresh divisions as the number of claimants grew greater or less.

These Freemen would meet in the "tun-moot," where the good sense and opinion of each would be contributed to form the wise decision—or "common sense," implying the good sense—of a community.

But we ask—Why was the ownership so scattered? why was it not compact, each property being together?

The reason may be found here. We have seen that the principle of co-operation prevailed, so that each who wished to join in the co-ploughing must bring his contribution—

* The word "smock" implies something crept into, being put over the head.
VIEW OF LYNCHES AT UPTON ST LEONARDS, LOOKING NORTH-EAST

(From a Photograph by A. J. Lumbert)
in wood, or iron, or oxen, etc., and hand them over to the common ploughman.

Under this arrangement the first strip ploughed would belong to the ploughman—the next to the provider of the irons—some strips to the owner of each ox, one to the provider of the wood, etc.

If any complaint as to the fairness of ploughing arose the ploughman's own furrow was to set the rule. Hence we have an explanation of the strips being scattered and varying in position each year—well termed "mingle-mangle." Thus when co-operation ceased and legal ownership followed, holdings belonging to the same person would be in various places rather than together—a feature increased by subsequent purchases.

We may observe that there is to be seen in a Common Field at Upton called "Brimps" a good instance of terrace-cultivation, or "Lynchces" (see Pl. X.) Their origin has been variously traced, e.g.: to water action, as having been once sea-shores; to encampments; to places of vantage, so as to witness the ceremonies of Druid priests; but they may rather be regarded as part of the system of ploughing in strips. The cultivators of the higher land, in order to prevent their soil being entirely washed down, would plough one way only, returning idle. Thus the soil would be gradually moved downwards, and the slope would be made level, between balk and balk. Every year's ploughing would take a sod, or furrow, from the upper to the lower part, with the result that the divisions would become steep banks; by this means the soil would be kept on its thus formed level terrace, or holding,* as shown in Pl. X.

To turn now to the subject of inclosures, which have removed the remnants of this system of such long duration, although the full intention had long ceased to exist.

* See Seebolms 'English Village Community,' p. 5.
The mode of cultivation was at length considered wasteful, and prevented the introduction of improved methods of tillage. One strip allowed to run waste would scatter seeds far and wide, and pasture rights in stubble interfered with the management of the land. Hence the desire was felt for a different tenure. It would seem that much land had been inclosed by mutual arrangement, especially in the County of Kent, and very probably in time past in Upton; for other fields besides "Common Fields," as recently existing, are shown in the Tithe Map as being divided like them into small portions; there are traditions, too, of inclosures by arrangement.

But a legal process at length became necessary. Under Queen Anne there were two Inclosure Acts, comprising 1439 acres; under George I. 16, comprising 17,660 acres; from the accession of George III. to the end of 1796, 1532, comprising nearly three millions of acres; in the present century up to 1844 there have been 2177 Acts. The movement was on the whole regarded with satisfaction, until 1845, when the present Inclosure Act became law. The statute is noteworthy as recognizing the importance of inclosure on economic principles, as well as the necessity of open spaces for recreation. The preamble runs:—

"It is expedient to facilitate the inclosure and improvement of commons and other lands now subject to rights of property which obstruct cultivation and the productive employment of labour, and to facilitate such exchanges of land as may be beneficial to the respective owners."

The time at length came when one of the last uninclosed Parishes, Upton St. Leonard's, should be dealt with, at the desire of the owners of the greater part of the Common fields by a Provisional Order under the provisions of the Inclosure Acts 1845 to 1882, confirmed by a Confirmation Act in 1895, which was duly ratified
October 18, 1897; the effect is that scattered pieces belonging to the same person are put as much as possible together and fenced, and the land thus apportioned held like any other property, free from former conditions.

The Common Fields amounted to 487a. 1r. 28p. in 1129 holdings (one as small as three perches) divided among 90 owners, the two largest owning 72 and 67 acres. Some of this was copyhold, some freehold. All was arable except one pasture field. The holdings were subject to the, usual customs and rules enforced by the Courts of the Manor—described as the Court Leet and the Court Baron; a jury was sworn consisting of 15 good and lawful men.*

The following is the form of Presentment:

"We present and order that the Pinlock† to be paid by persons resident in this parish or in Matson will be One shilling for any number of Sheep under a score, Two shillings for any number exceeding a score and under two score and in the same proportion for any greater number and Six pence for each Horse, Ass or other Beast and for every trespass after the first the sum of One shilling and sixpence for each such Horse, Ass or other Beast.

"We present that there ought to be no Staff keeping‡ in the Roads and Common Fields within the Manor, nor in the Bond End Lanes leading from Bowden Hall to Bottom Field in Church Field to Rookes Moorfield and to Avesfield nor in the Whornes Lane Peaches Green nor in the Lanes leading from Nuthill Field nor within side any Gate leading to any Common Fields.

"We present and order that no person shall use Staff keeping upon any such Roads Commonable Lands or Lanes under the penalty of

* Court Leet, i.e. of the people: cp. German leute. Court Baron of Freemen of the Manor. Jacob, in his Law Dictionary, derives "Leet" from Anglo-Saxon Lite, parvus, hence "little Court."

† Probably fee paid for unlocking the Pen, or Pound.

‡ Allowing a person to be in charge of cattle—presumably with a staff—to keep them within a certain part of the field; or perhaps fastening the cattle to a staff—tethering.
One Shilling and sixpence a head and which we do order the Hayward to receive for all such Cattle as shall be so Staff kept.

"We also present that no Cattle or Sheep shall be turned on the Waste Commons or Commonable Fields within this Manor without the initial letters of the Christian and Surname of the Owners being marked on each, under the penalty of Sixpence per head to be paid for all such as shall be so turned out without being so marked.

"We present and order that no Pigs shall be turned into the Streets Lanes or Wastes of this Manor unringed and unyoked under the penalty of Six pence per head for every such Pig.

"We present and order that no person shall turn any Stallion Bull or Boar Ram or Foul or Shabby or Foot Rot Sheep in the Common Fields or other places within this Manor under the penalty of Two Shillings for every such Stallion Bull Boar or Ram and Ten Shillings for every Foul or Shabby or Foot Rot Sheep so turned out.

"We present and order that the number of Sheep Cattle or Geese to be turned out upon the Common Fields within this Manor be stinted* in proportion to the Rent at which such Estate in respect of which the right of Common is claimed shall be charged to the Poors Rate and that the Stint* be as follows:

One Sheep or Three Geese for every Pound so charged and so in proportion for any greater number.
That every head of Cattle be deemed equivalent to Three Sheep and every Horse, Mare or Gelding to Six Sheep.

"And we present and order that the Hayward do impound the Sheep and Cattle of every person who shall turn in without a right and keep the same until he is paid a fine of Sixpence a head for the same.

"We present and order that the several persons who occupy lands in the Common Fields do keep the Grips and Watercourses in their respective lands properly cleaned and in case of default on Three days Notice given by the Hayward that the Hayward shall do the same and be paid Four pence per lug by the respective persons making default.

"We present A.B. as a proper person to serve the office of Hayward for the year ensuing and he being present in Court was sworn in accordingly.

* "Stinted," limited—shortened; cp, stunt.
"We present and order that all the Common Fields within this Manor be hained up from Cattle, Horses and Sheep from the day of and that the Hayward do impound all such Horses, Sheep and Cattle as shall be turned into the same Common Fields or any of them contrary to this Order and not release the same until payment of Sixpence per head for the Horses, Cattle, Sheep and Pigs so turned in, in addition to the sum he is authorized to charge for Fodder."

Such were the Presentments.

May we regard the title "Hayward" as implying the Warden of the "Haies" or boundaries? Cp. above "hained up," i.e. fenced from cattle by bounds.* Halliwell, in his "Dictionary of Archaic and Provincial Words," thus defines "Hayward."

"Originally a person who guarded the corn and farm-yard in the night time, and gave warning by a horn in case of alarm from robbers. The term was afterwards applied to a person who looked after the cattle, and prevented them from breaking down the fences."

These orders were rigidly enforced. In the records of a Court Leet early in the century it is ordered that 2d. a day be paid by all persons making encroachments, and if not paid by November 1 the same to be "thrown up." Penalties are also inflicted for gates not fixed and ditches thrown. These orders, when resisted, were enforced by the Justices of the Peace.

Under the altered conditions, caused by the inclosure, great changes have come. The holdings are re-arranged and placed more conveniently together, two Recreation Grounds of 6 acres, partly taken, and 13 acres of allotment, entirely taken, from the common fields before re-allotment, have been provided for the parish, vested in the Parish Council; the tenure of the land is like that of any other property, and soon, with fences and houses, all

* There is a Cotteswold term "to aim up" for hay, i.e. to keep free of cattle, etc., so that the crop may grow.
vestiges of the ancient customs will have disappeared. With these changes certain local words will also drop out of use and be lost—*balks*, *meers*, and *Hayward* will no longer be needed—we shall no longer speak of a *gore*, *i.e.* a small triangle of land; (cp. *garlick*—the leek with triangular or gore-shaped leaf), or of a *langet*, *i.e.* a longer piece like a tongue; although tongue-like pieces of land not in Common Fields are named *langet*. Nor shall we hear of a piece of ground described as *butts* because “abutting” on, or projecting towards another. Nor shall we hear of *Lammas* roads, *i.e.* field tracks to be used after Lammas Day—August 1—a day taking its name from the Thanksgiving Service for the safe supply for the *hlaf* or *loaf*; or of *dole*, a boundary mark in an open field. These will be meaningless terms—archaeological—out of date.

Although such changes have become necessary, it is with some regret that the link with the archaic past is severed, and the system adopted for centuries by the makers of England, abandoned.

This, however, is one of the processes at work by which

"The old order changeth, yielding place to new."

* Cp. "lady," loaf-kneader, supposed to be from *hlaf* and Anglo-Saxon *dæge*—a kneader (Skeat).
APPENDIX

List of the Landowners, with the size of each holding as shown on the Map, dated 1840. The holdings of Lord Sydney are coloured blue, those of J. Blissett, yellow, those of J. Wintle, pink.

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PRESENTED
31 OCT. 1900
LIST OF THE MEMBERS

MAY, 1900

OFFICERS:

President:
E. B. Wethered, F.G.S., F.C.S., F.R.M.S.

Vice-Presidents:

John Bellows.
Rev. H. H. Winwood, M.A., F.G.S.
Christopher Bowly, M.A.I.
M. W. Colchester-Wemyss.
C. Callaway, M.A., D.Sc., F.G.S.

Hon. Treasurer:

A. S. Helps,
The Knap, Great Witcombe, Gloucester.

Hon. Librarian:

H. G. Madan, M.A., F.C.S.,
Eastgate, Gloucester.

Hon. Secretary:

S. S. Buckman, F.G.S.,
Charlton Kings, Cheltenham.

THE OFFICERS CONSTITUTE THE COUNCIL.
Honorary Members:

The President of the Dudley and Midland Field Club,
The Hon. Secretary of the Dudley and Midland Field Club, Dudley.
The President of the Malvern Naturalists' Field Club,
The Hon. Secretary of the Malvern Naturalists' Field Club, Malvern.
The President of the Warwickshire Field Club,
The Hon. Secretary of the Warwickshire Field Club, Warwick.
The President of the Woolhope Naturalists' Field Club.
The Hon. Secretary of the Woolhope Naturalists' Field Club, 26 Broad Street, Hereford.
The President of the Bristol Naturalists' Society.
The Hon. Secretary of the Bristol Naturalists' Society, 145 White Ladies' Road, Redland, Bristol.
The President of the Bath Naturalists' Field Club.
The Hon. Secretary of the Bath Naturalists' Field Club, Bath.
The Hon. Secretary, Bristol and Gloucestershire Archæological Society, Eastgate, Gloucester.

Robert Etheridge, F.R.S., F.G.S., 14 Carlyle Square, Chelsea, S.W.
Nevil Story Maskelyne, M.A., F.R.S., F.G.S., Bassett Down House, Swindon.
George Maw, F.L.S., F.G.S., Benthall, Kenley, Surrey.
Dr E. Hübner, 4 Ahornstrasse, Berlin, W.
G. Embrey, F.C.S., Belmont, Brunswick Road, Gloucester.
H. Y. J. Taylor, Conservative Club, Gloucester.

Members:

Abbott, Major A. K. ... ... ... ... 5 Suffolk Square, Cheltenham.
Ashton, Brigade-Surgeon W. ... ... ... Marlborough Lawn, Cheltenham.
Babbage, Major-General H. P. ... ... ... Mayfield, Cheltenham.
Baily, W. A. ... ... ... ... Market Place, Cirencester.
Baker, G. E. Li., J.P. ... ... ... ... Hardwicke Court, near Gloucester.
Ball, A. J. Morton ... ... ... ... The Green, Stroud.
Batten, Rayner W., M.D. ... ... ... ... 1 Brunswick Square, Gloucester.
Bellows, John ... ... ... ... Upton Knoll, Gloucester.
Bishop, W. ... ... ... ... The Brick House, Stroud.
Bond, F. T., B.A., M.D., F.R.S.E. ... ... ... 3 Beaufort Buildings, Gloucester.
Bowly, Christopher, M.A.I. ... ... ... Siddington House, Cirencester.
Bruton, H. W. ... ... ... ... Bewick House, Gloucester.
Bubb, Henry ... ... ... ... Ullen Wood, near Cheltenham.
Buckman, S. S., F.G.S. ... ... ... ... Charlton Kings, Cheltenham.
Butt, Rev. Walter, M.A. ... ... ... ... The Vicarage, Minety, Malmesbury.
Callaway, Chas., M.A., D.Sc. ... 16 Montpellier Villas, Cheltenham.
Chance, H. G., M.A. ... Heathville Road, Gloucester.
Clark, Oscar, M.A., M.B. ... Spa Road, Gloucester.
Colchester-Wemyss, M. W. ... Westbury Court, Newnham.
Cooke, A. S. ... Badbrook House, Stroud.
Currie, G. M. ... 26 Lansdown Place, Cheltenham.
Dorington, Sir J. E., Bart., M.P. ... Lypiatt Park, Stroud.
Drew, Joseph, M.B., F.G.S. ... Montrose, Battledown, Cheltenham.
Ducie, The Earl of, F.R.S., F.G.S. ... Tortworth Court, Falfield, R.S.O.
Dyer-Edwardes, A. S. ... Prinknash Park, Painswick, Stroud.
Ellis, T. S. ... 6 Clarence Street, Gloucester.
Evans, Rev. J., B.A. ... Rosedale Villas, Kings Rd., Chelt’m.
Fisher, Major C. H., F.R.A.S. ... The Castle, Stroud.
Fisher, W. H. C. ... 6 Rowcroft, Stroud.
Foster, R. G. ... Spa Villas, Gloucester.
Gael, C. E., B.A., M.Inst. C.E. ... Charlton Kings, Cheltenham.
Gardiner, C. I., M.A., F.G.S. ... The College, Cheltenham.
Garnett, F. ... Adsett Court, Westbury, Newnham.
Garrett, J. H., M.D. ... 24 Promenade, Cheltenham.
Guise, Sir W. F. G., Bart. ... Elmore Court, near Gloucester.
Hall, Rev. Robert, M.A. ... Saul Rectory, Stonehouse, Glos.
Hannam-Clark, F. ... Hucclecote, Gloucester.
Hartland, Ernest, M.A. ... Hardwick Court, Chesstow.
Hayward, Archdeacon H. R. ... College Green, Gloucester.
Helps, A. S. ... The Knap, Great Witcombe, Glo’ster.
Jones, John H. ... Barrow Hill, Churchdown, Chelt. m.
Kay, Sir Brook, Bart. ... Battledown, Cheltenham.
Keeling, G. W. ... 10 Lansdown Terrace, Cheltenham.
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Margeton, W. ... Bright Side, Stroud.
Marling, Sir William H., Bart. ... Stanley Park, Stroud.
Marling, W. J. Paley ... Stanley Park, Stroud.
Marling, S. S. ... Stanley Park, Stroud.
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Northcott, R. W. ... New Mills Court, Stroud.
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H. D. Hoskold, Esq., Calle Chareas, 1210, Buenos Aires, South America.

Mrs Symonds, The Camp, Sunningdale, Ascot.
INCOME AND EXPENDITURE FROM RECEIPTS

To Balances, May 2nd, 1899:

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<thead>
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£215 5 9
MAY 2nd, 1899, TO APRIL 3rd, 1900

PAYMENTS

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<td><strong>Less</strong> from Bristol and Gloucestershire Archaeological Society, Proportion of Rent and Gas to Dec. 25th, 1899</td>
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By Cost of Proceedings:

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<td>West &amp; Sons, Lithograph Plates</td>
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<td>J. Pentland, Blocks</td>
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<tr>
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By Cost of Winter Meetings:

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<td>Custodian of Municipal Schools</td>
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<tr>
<td>Coffee Co., Refreshments, six Meetings</td>
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<tr>
<td>Norman &amp; Sawyer, Programmes (including those for Summer Excursions)</td>
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<td>Lantern, Operator, and Slides</td>
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<td><strong>Total</strong></td>
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By Officers' Out-of-Pocket Expenses:

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<td>The President, Coleford Meeting</td>
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<td>10</td>
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<tr>
<td>The Hon. Sec. (includes postages)</td>
<td>10</td>
<td>7</td>
<td>9</td>
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<tr>
<td>The Hon. Treasurer</td>
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<tr>
<td><strong>Total</strong></td>
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<td>1</td>
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By Balances, April 3rd, 1900:

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<td>Capital and Counties Bank, Deposit Account</td>
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</tr>
<tr>
<td>Ditto—Current Account</td>
<td>25</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>In Treasurer's hands</td>
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<td>15</td>
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<td><strong>Total</strong></td>
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<td>9</td>
<td>7</td>
</tr>
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</table>

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Vol. XIII. Part IV

March, 1901
HOMCEOMORPHY AMONG JURASSIC BRACHIOPODA,

BY

S. S. BUCKMAN, F.G.S.

(Read May 2nd, 1899)

PLATES XII, XIII.

I. INTRODUCTION ...
II. METHODS OF DEVELOPMENT ...
III. INDEPENDENT DEVELOPMENT OF THE MULTIPlicate CHARACTER ...
IV. INDEPENDENT DEVELOPMENT OF BIPlication ...
V. PSEUDORIPlicate (Bilobate) SERIES ...
VI. NON-plicate HOMEOMorphs ...
VII. NOTES ON CERTAIN SPECIES ...
VIII. SUMMARY ...
IX. APPENDIX I. ON PHOTOGRAPHIC REPRODUCTION...
X. APPENDIX II. A JURASSIC TIME TABLE ...

I. INTRODUCTION

The discovery of a multiplicate Brachiopod belonging to the *Terebratula-galeiformis* series, brought to the notice of the Club by Mr Upton,* is particularly interesting. It is a further, and as it happens, very striking example of the phenomenon known as parallelism of development. Thereby is produced what I have called homoeomorphy—that is to say, the phenomenon of

species nearly alike so far as superficial appearance is concerned, but unlike when particular structural details are closely examined. It is the phenomenon of similarity in general with dissimilarity in details.

What is known as mimicry in the animal kingdom is, of course, one phase of homœomorphy. Mimicry may be suggested in regard to homœomorphous fossil species. I seem to recollect suggesting it some years ago in regard to Ammonites—the genera Dumortieria and Grammo-ceras—but I have forgotten where. It would be, perhaps, impossible to prove mimicry in regard to fossils; but with them homœomorphy mostly arises from parallelism of development—the tendency of different genetic stocks to pass, quite independently, through similar phases of development—such as the tendency of distinguishable series of smooth Ammonites to become costate, of costate Ammonites to become spinous, in progressive development; or in retrogressive development, of spinous Ammonites to become costate, of the costate to become smooth. Similarly there is a tendency among Jurassic Brachiopoda for independent non-plicate species to become multiplicate: that is, analogous to the costation in Ammonites; and in the Rhyynchonellidæ for the multiplicate (costate) to become spinous (Acanthothyris), and in certain cases a spinous species may, with age, retrogress to lose spines (Acanth. obornensis).*

Again, in Jurassic Brachiopoda a simpler development may be found—the tendency of smooth non-plicate species to become uniplicate, of the uniplicate to become biplicate.

The various species of different stocks may either produce these developmental characters more or less contemporaneously, in which case such forms are called isochronous homœomorphs, or they may produce the characters at different dates—a later form simulating an

earlier one—in which case they are called heterochronous homœomorphs.*

An analysis of the methods of development pursued by some of the more notable stocks of Jurassic Brachiopoda may be given now, as having a particular bearing on the subject of homœomorphy.

II. METHODS OF DEVELOPMENT

The following tabular arrangement is only a rough analysis; but it may indicate the methods of development:

1.  
   a. Dorsal† sulcation slight.  

   b. Gradual development of gibbous valves.  

   c. Later marginal thickening of valves.

   From stage analogous to 1b. there is

   bb. Dorsal plication slight.  

   Z. Darwini; Z. disculus.

A gibbous-valved form analogous to 1b, (or perhaps the same, attained by passing through 1a, but of this there is no evidence yet,) develops:

1b  
   a. Dorsal and ventral sulcation.  

   b. Later in some cases, outgrowth of marginal lobes each side of sulci, produces bilobation (pseudobilobation.)  

   c. Later, repetition of bilobation produces quadrilobation.

   Z. quadrifida.


† Used arbitrarily, dorsal = brachial (valve), ventral = pedicle (valve).
Iva  
a. Bilobation directly, without any definite prior sulcation.  
  Z. emarginata (incipient); Z. bicornis (olim Z. emarginata);  
  Z. bullata; Z. obovata.

II  
a. Dorsal sulcation; developing into a somewhat linguiform ventral projection.  
  Glossothyris (Nucleatae.)  
b. Later bilobation, and the fusion of the lobes below the sulcus producing a perforated shell.  
  Pygope.

III  
a. Flattening or slight depression of dorsal valve.  
  T. Leesi; T. simplex; T. omalogaster; T. subomalogaster, sp. n.  
  b. Develops into dorsal sulcation.  
  T. curvifrons.  
  c. Later dorsal plication within the sulcus.  
  T. galeiformis.  
  Aulacothyris  
  Haasi  
  follows this plan.

The T. curvifrons series is quite distinct from Terebratula, the method of biplication being just the opposite. Some of the series have been put to Glossothyris; but always with a query, as genetic connexion therewith was obviously out of the question, though a certain morphic similarity could be seen by anyone. The necessity for a new generic name has long been felt; and I venture to propose Pseudoglossothyris (see p. 240.)

IV  
a. Dorsal sulcation pronounced, and even excessive in some cases.  
  Aulacothyris.  
  Aulac. crewkerniensis.

b. Bilobation added to pronounced dorsal sulcation.

IVa  
a. Dorsal sulcation pronounced; and later, ventral sulcation producing incipient bilobation.  
  Aulacothyris Moorei in some cases;  
  Aulac. bisulcata, S. Buckm.
Analogous stage to I. and III. in the Rhynchonellae, thus:

V  
\begin{align*}
  a. & \quad \text{Dorsal sulcation slight,} \\
  b. & \quad \text{subsequently there is added multiplication.}
\end{align*}
\text{Rh. liostra}a; \text{Rh. Meneghinii; Rh. standishensis, sp. n.}

These are most likely prior stages in the phylogenetic history of many of the fully multiplicate Rhynchonellae, so that

V  
\begin{align*}
  b. & \quad \text{passes to} \\
  c. & \quad \text{multiplication fully developed, continued to} \\
  d. & \quad \text{ventral sulcation developed after multiplication.}
\end{align*}
\text{Rhynch. spp.}
\text{Rhynch. spp. with raised mesial fold.}

Except from Vc., Rhynchonellae which attain a similar stage in other ways; for instance:

VI  
\begin{align*}
  a. & \quad \text{Ventral sulcation strong;} \\
  b. & \quad \text{with subsequently developed multiplication.}
\end{align*}
\text{Rhynchonella acuta group.}

VII  
\text{Striation develops into multiplication by anastomosis of striae.}
\text{Rh. furci}lata; \text{Rh. -rimosa group; Rh. Wrighti.}

VIII  
\begin{align*}
  a. & \quad \text{Striation alone;} \\
  b. & \quad \text{later a mesial fold developed.}
\end{align*}
\text{Rh. dundriensis, S. Buckm.} \\
\text{Rh. dorsetensis, S. Buckm.}

A stage analogous to Ia. and IIIa. may have been an early stage in the development of the biplicate Terebratula. It is found thus:

IX  
\begin{align*}
  a. & \quad \text{Flattened dorsal valve.} \\
  b. & \quad \text{Dorsal valve develops gibbosity.}
\end{align*}
\text{Terebr. Edwardsi (juv.)} \\
\text{T. subpunctata (juv.)} \\
\text{T. Edwardsi; T. sphaeroidalis} \\
\text{T. gravida; T. microtrypa, sp. n.}
From form attained in IX. b. various lines of development proceed. One begins uniplication directly, which subsequently passes into biplication, and possibly quadruplication. Another elongates the valves before plication commences; another develops multiplication directly.

X  a. Dorsal plica developed.  
(compare Ibb.) Tereb. Etheridgii; T. Wrighti;  
T. ampla.  
b. Subsequent sulcation of  
plica produces biplication. T. globata series, and a large  
number of the biplicate Terebratula.

The formation of the sulcus is perhaps a case of hypostrophy to the form of I. a.b.  
*T. withingtonensis* illustrates a. and b.; perhaps *Plesiothyris* does too. *T. maxillata* illustrates a tendency towards quadruplication.

A slightly different course is taken by some other species.

XA  a. Dorsal plication and al-  
most contemporaneous  
flattening of the plica. T. shirburniensis; T. hyalina,  
sp. n.  
b. The flattening proceeds  
to sulcation, and so biplica-  
tion is produced. T. Eudesi.

A large number of the biplicate Jurassic *Terebratula* would be compre- 
hended in Divisions X, XA. There is, probably, no real difference in method except that perhaps in X the uniplica is persistent awhile before any infolding begins, while in XA a certain infolding (flattening) begins early and has some duration before definite sulcation commences.

Many of the other biplicate *Terebratula* followed the course of first elongating the valves: thus from IXb. there is:—

XI  a. Elongation of valves be-  
fore plication. T. punctata; T. Buckmani, etc.  
b. Dorsal valve with uni-  
plica. T. cortonensis; T. Buckmani, in  
some cases.  
c. Sulcation of plica pro-  
duces biplication. T. crickleyensis; T. Phillipsi;  
T. Phillipsiana.
Starting from stage attained in IXb there is again:

**XII a.** Non-plication (gibbous valves) developing directly into multiplication.

Fimbriate Terebratula; Fimbriothyris; the recent Magelania flavescens; Rhynch. spp.

**XIII** Dorsal and ventral sulcation; and later a subsidiary plica developed within the dorsal sulcus.

Dictyothyris.

**XIV** Ventral sulcation pronounced. Epicyrta Eugennii (von Buch.)

This rough analysis of these phases of Brachiopod development will show how homœomorphy may arise. Non-plicate forms may both start towards plication in similar ways. Or starting in dissimilar ways they may become similar (biplicate Terebratula and Glossothyris to a certain extent.) This is particularly marked in the Rhynchonella; in one case the mesial fold is developed and the multiplication follows, in the other case this order is reversed; but obviously after a while the result must be a similarity in form, a multiplicate shell with a mesial fold in both cases.

In another case, non-plicate forms may take what are independent lines—one series becoming biplicate, the other bilobate; yet so far as general appearance is concerned the shells of the two series may have a very similar aspect—only different in marginal view.

The introduction of old age features may often bring about resemblance in what were diverse forms; but the term “old age features” is relative rather than absolute. For by the principle of earlier inheritance, or tachygenesis, what is an old age feature, in species at an earlier period of phylogenetic development, may soon become a youthful feature in those at a later one. Thus, multiplication is an old age feature in some fimbriate forms; it is not so in
others where another character, valve-thickening* is, and comes later. So again multiplication is an old age feature in some Rhynchochonella, it is a normal and very youthful feature in most of them.

Multiplication as an old age character pertains to the fimbriate fossil figured by Mr Upton. The interesting point about his discovery is this. There were already known in the Inferior Oolite two nearly related fossils showing homœomorphy—namely, Terebratula plicata and T. fimbria. They both develop similar multiplication; yet it is obvious from their beak characters and general shape that they do it quite independently—that is to say, after they have parted from the common ancestral stock. Now Mr Upton produces another fimbriate fossil; and, as it happens, one not allied in a close degree to T. plicata or T. fimbria. It belongs to what is known as the curvi- frons group, the proposed genus Pseudoglossothyris. Mr Upton calls this fossil T. galeiformis, a form in which a further development of the curvi frons sulcus is shown. But in his fossil a fimbriate margin is produced, and the curvi frons sulcus has been partially obliterated, or has not been developed (see later, note p. 262.)

The point then about these fossils is this. T. plicata and T. fimbria show by their characters that they had a common but not very remote ancestor—one, say, in the Ludwigian Age (early Inferior Oolite.) But this fimbriate Pseudoglossothyris shows by its characters a different line of development since it separated from the common stock. Presumably its date of departure therefrom was earlier, and a species of Harpoceratan Age (Upper Lias) gives possible support to the idea that the time was quite an "Age" earlier.† Yet in the course of its development this

* By this term I mean the principle of separating the valves by marginal deposit without adding to their superficial area, example Zeilleria Waltoni.

† Bajocian Mid-Cotteswolds, p. 447.
curvifrons stock takes on characters which have hitherto been regarded as special to the fimbria group. Now I have to point out another case in the same genus in which the fimbria character is taken on by a shell earlier in the Pseudoglossothyris series, because it had hardly commenced to show dorsal sulcation before it added fimbriation. And since these notes were written Mr L. Richardson has brought to my notice a fossil of another group, the maxillata series of Terebratula, which shows similar indications of developing fimbriae.

Thus in the Cotteswold district, in rocks of about the same date, there are five independent developments of the same character among species of Terebratulidae.

It may be noted, in passing, that one of the recent Brachiopods, Magellania flavescens shows the same development of fimbriae, and is remarkably like T. fimbria in every way. The likeness is an excellent instance of heterochronous homoeomorphy. And in the Lias a fimbriate series of the Magellanidae forms the genus Fimbriothyris.

As may be easily imagined, homoeomorphy has led to many errors in identification of species—particularly among Brachiopoda. When the homoeomorphous species are nearly related—two stocks of Terebratulæ, for instance—much excuse may be made. When, however, the species belong to two families, Terebratulidae and Magellaniæ (Waldheimiæ), whose structural details, especially the internal arrangements, are quite distinct, then the confusion of two species of these families under one name becomes serious. Yet such confusions have been made even by the great authority on Brachiopoda, Thos. Davidson, as may be seen in his work on the Jurassic species. It is the object of the present paper, in part, to call attention to the mixing of examples of two families under one name, to figure other remarkable homoeomorphous
forms, and generally to indicate the development of such species.
I will now proceed with the description of some species.

III. INDEPENDENT DEVELOPMENT OF THE
MULTIPlicative CHARACTER

Genus:—Pseudoglossothyris, S. Buckman.
(Type:—Ps. curvisfrons, Oppel, sp.*)

Definition:—Non-septate Terebratuloids, the beak stout, short, without beak ridges, and generally with a large, complete foramen. The brachial valve develops from flat to sulcate, with subsequent pro-
duction of a plica within the sulcus.

Distinction:—From Glossothyris, the whole of the brachial valve is involved in the making of a broad sulcus, whereas in that genus only the middle third is taken to make a kind of narrow linguiform depression.

Remarks:—The following species belong to this genus:—Leesi, S. Buckman; simplex, J. Buckman; curvisfrons, Oppel; Brebrissoni, Deslongschamps; galeiformis, McCoy; provincialis, Desl.; all of the Ludwigian Age (lower Inferior Oolite.) There is in the Harpoceratan Age (upper Lias) a species, obviously a non-septate Terebratuloid, hitherto confounded with Zeilleria (Waldheimia) Lycetti, which may be expected to be a member of Pseudoglossothyris.

* I take as type of the genus the Cotteswold shell known as Terebratula, or Glossothyris curvisfrons, from the Oolite Marl.
I. PSEUDOGLOSSOTHYRIS SIMPLEX, J. Buckman.
Pl. XII., figs. 1—3.

1845. TEREBRATULA SIMPLEX, J. Buckman, Geol. Cheltenham, Ed. ii., pl. vii., fig. 5.

1851. TEREBRATULA SIMPLEX, Davidson, Jurassic Brach., Vol. i., pl. viii., figs. 1—3.

Remarks:—This species is so well known that it needs no detailed description.

The interest attaching to the present unusually large example is that in maturity it shows certain small plications similar to those exhibited by its contemporary, Terebr. plicata, though not so numerous. These plications are also noteworthy in connexion with the plicate, later-appearing "Terebr. galeiformis" described by Mr Upton.

Another point that may be noticed is that the brachial valve of this specimen is rather more convex than usual.

There is a rather interesting history connected with this specimen. It was found at Birdlip by Robert Holland,* of Cheshire, when a student at the Royal Agricultural College, Cirencester, during one of the excursions conducted by my father as Professor. This would be something like fifty years ago. The specimen attracted attention on account of its unusual size and condition. So much so that some thirty years later my father had not forgotten this find; but he told me that this T. simplex was one of the ornaments of Mr Holland’s collection.

Mr Holland subsequently became my father-in-law, and so, through my wife, the specimen has at last come into my collection.

* Robert Holland was a cousin of the Gloucestershire Hollands, one of whom, Miss Holland, made a collection of Liassic fossils, which was the subject of a paper by Dr Wright in the Club's Proceedings. Robert Holland compiled the Cheshire Glossary, and, with James Britten, of the British Museum, that useful book "A Dictionary of English Plant Names."—both works published by the English Dialect Society.
Locality and Stratum of the Figured Specimen:—
Birdlip, Gloucestershire, in the Pea-grit.
Date of Existence:—Murchisonae hemera.

2. "Terebratula"* Polypecta, S. Buckman, sp.n.
   Pl. XII., figs. 4–7.

Description.—A gibbous valved, broadly ovate shell; the valves are
fimbriate for about one-third from the front margin, which itself is
usually thickened, obtuse, and fimbriate. Beak very short and obliquely
truncate.

Distinction:—From T. plicata, J. Buckman, it is an alto-
together smaller shell, the plications begin at a much earlier
age and are much more pronounced. From T. fimbria,
Sow., it has not the globose form of that species, it is
more elongate, its beak is shorter, obliquely truncate, and
does not overhang the brachial valve.

Remarks:—This species is a development of Terebr.
plicata, and occurs at a later date. In that species the
plications are rather rare, and are only found as the adult
character, and then they are not much developed. In this
species the plications begin in early maturity, and in late
maturity or senility another character commences, namely,
 thickening of the margin of the valves without increase in
the size of the shell—a character well shown in figs. 6, 7
of Pl. IV., the plication still being continued. Therefore
what is a character of late maturity in Terebr. plicata has
become a feature of early maturity in this species, which in
late maturity introduces another developmental phase.

Locality and Stratum:—Notgrove Station, Gloucester-
shire, in the Oolite Marl. A good series of specimens
has been obtained from this locality; but the species has
not been found elsewhere.

Date of Existence:—Bradfordensis hemera.

* Generic separation of the fimbriate from the biplicate Terebratula would be
desirable.
Two fimbriate Terebratuloids have now been noticed, *Pseudoglossothyris simplex* and *Terebr. polyplecta*. To the latter is related *T. plicata* as direct parent, to the former *Ps. galeiformis*, var., Mr Upton's shell, as not quite a direct descendant. There remains another series, *T. fimbria*, collateral of *T. polyplecta*, though not derived actually from *T. plicata*. The *fimbria* series commences in the Pea grit (*Murchisonæ hemera*) probably a little later than *T. plicata*. It has two characters pointing to its close connexion with that fossil—first, a somewhat obliquely truncate beak, such as characterizes the *plicata* stock all through; secondly, a circular shape, which characterizes only the young *T. plicata*. But its independence is seen in this: it does not wait to become elongate before it is fimbriate; it becomes fimbriate while still circular.

Then the next stage is seen in the Oolite Marl (*Bradfordensis hemera*.) The beak has developed; it is not obliquely truncate, but it curves over the umbo somewhat. And the development of the *fimbriæ* has been accelerated—they appear earlier and become more pronounced.

The third stage is seen at a later date—the Upper Freestone (later *Bradfordensis hemera*.) The earlier inheritance of the *fimbriæ* has become so marked that little of the original smooth shell is seen: the *fimbriæ* begin in early immaturity. And in immaturity elongation takes place; so that somewhat the shape of *Terebr. polyplecta* is simulated. But as the *fimbria* stock in its second stage of development—in the Oolite Marl—becomes possessed of the curved-over beak, it has in its third stage a character of distinction, no matter how much it may simulate another shell. The curved-over beak, in fact, is the character: it is a further development than that of *T. polyplecta*; but that fossil had not acquired it when elongate. The *T. fimbria* series does so before becoming elongate.
It almost seems necessary when speaking of this very complete developmental series of the *fimbria* stock to have certain names for the stages attained. They might be *subfimbria*, *fimbria*, and *perfimbria*.

Their characters might be defined as follows:—

*Terebr. subfimbria.* Truncate beak; circular form of shell, with slight fimbriation. Pea grit.

*Terebr. fimbria.* Curved beak; circular form of shell, pronounced fimbriation. Oolite Marl.

*Terebr. perfimbria.* Curved beak; elongate form of shell, excessive fimbriation extending over most of the test. Upper Freestone.

It need not be insisted upon that the advance towards greater fimbriation is always uniform. It is not; and it would not be expected. But such advance is the general tendency—the less fimbriate become scarcer and scarcer, the more fimbriate become more numerous.

How far the development of the *fimbria* series corresponds with that of other fimbriate fossils may be seen in the following Table:—

<table>
<thead>
<tr>
<th>Layer</th>
<th><em>Ps. galeiformis</em>, var., &quot;somewhat fimbriate.&quot;</th>
<th><em>T. perfimbria</em>, very fimbriate; elongate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Freestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oolite Marl</td>
<td><em>T. polypecta</em>, distinctly fimbriate; elongate.</td>
<td><em>T. fimbria</em>, distinctly fimbriate; circular.</td>
</tr>
<tr>
<td>Pea Grit</td>
<td><em>Ps. simplex</em>, very slightly fimbriate, and that rarely.</td>
<td><em>T. plicata</em>, slightly fimbriate; elongate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>T. subfimbria</em>, slightly fimbriate; circular.</td>
</tr>
</tbody>
</table>

It is between *T. polypecta* and *T. perfimbria* that homeomorphy is most marked; but they are not truly isochronous, they are slightly heterochronous.
The multiplicate stage of development is uncommon among the Terebratulidae; but among the Rhynchonellidae it is dominant. With the great majority of them it begins with the growth of the test, showing that it has been a long inherited character. With others, however, it does not begin till some growth has been completed. Mr Upton shows one such form, which he calls *Rhynch. cottesvoldiae*: wherein the multiplicate character is just beginning to assert itself. Such a character, judging by the young of the species, must be a development independent from the settled multiplicate character of *Rhynch. tetraedra*, or from the curious developments of plicae in the *Rh.-acuta* group. So it may be assumed that *Rh. cottesvoldiae* is developing plications as a new feature of its own, not as the result of inheritance; and that the multiplicate character in the Rhynchonellidae is polygenetic.

I take the opportunity to figure an interesting new species, which shows plicae of a more settled character than *Rh. cottesvoldiae*, and yet that they do not begin till the shell is well grown—so that in this case the character appears to be new. Further in this species the brachial valve is sulcate, and that is a character which most *Rhynchonella* have grown out of, though it is the dominant character in genera of Terebratulidae and Magellaniidae; viz., *Pseudoglossothyris, Glossothyris, Aulacothyris*.


*Description.*—A small, sub-circular, depressed Rhynchonelloid, with a carinate pedicle valve, a sub-sulcate brachial valve, the sulcus extending nearly to the umbo; in each valve about 16 plaits extending only half-way from the margin, no definite mesial fold, but the three central plaits slightly larger than their fellows.

*Distinction.*—From *Rhynchonella Meneghinii*, Zittel, the general form of the shell is rounder, the plicae are
more distinct, and they begin earlier, so that they are longer as well as broader; the sulcus in the brachial valve is less pronounced, and the pedicle valve is less convex.

Remarks:—The differences from the Italian shell, *R. Meneghinii*, are particularly interesting, because that shell is distinctly earlier in date. It is said to come from Middle Lias, presumably hemera *spinati*. And in accordance with its earlier date it shows less development of plicae than the present species. The general build of the little Italian shell is pretty much the same as the English one, and it has a similar sulcus in the brachial valve; but it is smooth longer, and plicate later, while the sulcus is more distinct. So the English species, which is, say two hemeræ later, shows a particular advance in development corresponding with its date; it has carried on and elaborated the development of plicae, just as we find in the case of the *Terebratula-fimbria* series.

Locality and Stratum:—From a small exposure of Upper Lias Clay on Standish Park Farm, below Standish Beacon, the beds yielding *Harpoceras falciferum*, etc.

Date of Existence:—*Falciferi* hemera, Harpoceratan Age (Upper Lias). *Rh. Meneghinii* is from Middle Lias, that would be probably *Spinati* hemera of the Deroceratan Age, about two hemeræ earlier than *R. standishensis*.

IV. INDEPENDENT DEVELOPMENT OF BIPLOCATION


*Pl. XII., figs. 8—12.*

*Description:—* A small, globose, uniplicate, or biplicate Terebratuloid, with a short, obliquely truncate beak, and an inflated umbo.

*Distinction:—* From *Terebr. Etheridgii*—the uniplicate form is rather more circular, more globose, and has a less
pronounced fold; and a truncate beak. From *Terebr. notgrovienis*, the biplicate form is rather less globose, and the folds are not so pronounced. From *T. Eudesi*, the obliquely truncate beak.

Remarks:—The three specimens of the present species which have been figured show the development of the uniplicate form (fig. 10), the incipient biplicate form (fig. 11), and the definite biplicate form (fig. 12). They indicate that the species is derived from a uniplicate form of the *Terebr.-Etheridgii* type, and that it develops towards a pronounced biplicate form like *Terebr. notgrovienis*. It is therefore a strictly transitional form, and a connecting link of marked importance between two very distinct species. It is the parent of *Terebr. notgrovienis*, preceding it in time, as this species occurs in the Pea-grit, that one in the Oolite Marl of the same neighbourhood. The length of time is represented by a deposit of some 80 to 100 feet of limestone. *T. Etheridgii* is not exactly the parent of this form, because it has not the truncate beak like this one; but it is a homœomorph of the uniplicate form. *T. Eudesi* develops its folds in a different manner; and it belongs to a more sphaeroidal stock: it is a homœomorph of the biplicate form.

The specimen of *Terebr. notgrovienis*, figured by me in the Proceedings of this Club, Vol. ix.,* is really an extreme (senile) form. It is rather a degenerate form with somewhat pronounced plications. Other specimens from the Oolite Marl are more robust, rather larger, and have less developed plications.

Locality and Stratum:—The cuttings on the Midland and South-Western Junction Railway near Withington (Gloucestershire), in Pea-grit.

Date of Existence:—*Murchisonæ* hemera.

* Plate iii., fig. 5. 1887.
4. Terebratula hyalina, S. Buckman, sp. n.

Pl. XIII., figs. 8a, b, c.

Description:—Valves convex, the pedicle valve the most. Outline of shell ovoid, and in lateral aspect globose, elongate. Front margin elevated to form a single fold, level across. Beak small, short, close pressed to umbo. Foramen small.

Distinction:—From Terebratula radstockensis, the smaller foramen, the curved lateral margin, the frontal fold. From Terebr. shirburniensis, longer, less globose, less distinctly plicate.

Comparison:—Many of the Zeillerieae are more or less homeomorphs.

Remarks:—This extremely elegant species, with a glassy-looking and apparently very thin test, has much resemblance to deep sea forms of the present day. The clayey marl wherein it is found probably indicates deeper water conditions than the limestone of the same date in the Bradford Abbas neighbourhood—where the species has not yet been obtained.

This is almost an incipiently biplicate form, closely connected with the sphæroidal stock of which T. shirburniensis and T. Eudesi are examples. Though later than the former, it is in some respects less developed, as in its plication; in other respects—departure from the sphæroidal to the ovoidal form—it is more developed.

Locality and Stratum:—Somerset, Horethorne Down, in a bluish, clayey marl; scarce.

Date of Existence:—Discitæ hemera.

5. Terebratula siderica, S. Buckman, sp. n.

Pl. XIII., figs. 11a, b, c.

Description:—Valves inæqui-convex, the brachial valve being nearly flat. Side margin curved, front margin biplicate; but the plices begin rather abruptly. Beak short, rather stout, somewhat hanging over umbo, hiding deltodial plates; foramen oval, with a kind of labiate extension over umbo.
Comparison:—Zeilleria subcornuta is somewhat of a homœomorph.

Distinction:—From Terebratula Stephani, the shortness and abruptness of the plicæ.

Remarks:—This is a distinctly biplicate form, but its general build shows it to be an independent development separate from either the sphæroidal stock, or T. withingtonensis. Not unlikely, it is the parent of the more plicate T. Stephani. Its date agrees with that idea.

Locality and Stratum:—Dorset, Wyke Quarry, near Halfway House, in the Irony bed.

Date of Existence:—Blagdeni hemera.

V. PSEUDOBIPLICATE (BILOBATE) SERIES

(The emarginata homœomorphs.)

Attention may now be directed to another series of shells, which show development of pseudo-biplication (bilobation,) This series contains some species which have been seriously misunderstood on account of their homœomorphy; and the opportunity may now be taken to point this out. Some of the following pages were written several years ago; but time did not then allow of the work being completed. Perhaps fortunately; for they come in very well in connection with the subject of this paper.

The particular character of bilobation is not uncommon among the Magellanaidae; and its independent development in different stocks is well known. The interesting fact is its occurrence also, though rarely, among Terebratulidae. And in some cases the resemblance between the species of the two families with this bilobate front margin is remarkable.

It is always a matter for regret when any reason compels the changing of the name by which a particular
species has been familiar for some time; but, unless some fault attach to the work of the original nominator—such as the giving of no figure, or of a flagrantly incorrect description, which would excuse the mistake of subsequent writers, the notoriety obtained by any particular form under an incorrect name cannot become an excuse for its permanently retaining a designation rightly belonging to another. A case in point calls for rectification now.

Among a series of Brachiopoda sent to me some years ago for identification by the late Mr E. Wilson, F.G.S., was a specimen from the Fullers’ Earth Rock of Nunney, near Frome. On comparison I found that this example agreed exactly with what Sowerby had originally figured as “Terebratula emarginata—discovered at Nunney, near Frome.”* But for many years we have been giving the name emarginata to a more elongate and flatter species found at a much lower level, namely, in the Inferior Oolite. The mistake had arisen in this way. Davidson re-figured Sowerby’s types in 1851,† and said that they came from the Inferior Oolite—in other words, that the rock which yielded these specimens at Nunney was Inferior Oolite. With them he figured another specimen which may have been from the Inferior Oolite, but it is admittedly a malformation, and is in any case not like the Nunney specimens of emarginata.

Not improbably the assumption that the rocks of Nunney were Inferior Oolite may be traced to continental authors, for in 1849 d’Orbigny‡ had put Terebratula emarginata as a species of his “10e Étage:—Bajocien,” which would be translated in English as Inferior Oolite.

Then, in 1877, Davidson§ figured from the Inferior Oolite of Broad Windsor, two specimens as Waldheimia

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† “Oolitic and Liassic Brachiopoda” (Palæont. Soc.), pl. iv., figs. 18, 19, 20.
‡ “Prodome de Palæontologie,” p. 287.
emarginata—the long-looped, septate Terebratuloids having been separated as Waldheimia. These specimens are truly enough from the Inferior Oolite; but they do not at all agree with Sowerby's shells except in being bilobate. The view, fig. 11a, shows almost a circular form, whereas the same view of Sowerby's shells gives a depressed octagonal figure.

In 1878 Davidson figured the same two specimens,* and he also depicted another bilobate example very different from them. It is undoubtedly from the Inferior Oolite, and, as he says, from Bradford Abbas. It is more like the Sowerbyan specimens, but it is somewhat proportionately longer and its valves are more flat across. It is well known what this specimen represents, although the majority of the examples from the Dorset Inferior Oolite are rather longer; it is the form which has of late years been exclusively known as Waldheimia, or Zeilleria, emarginata. It is found in the upper beds of the Inferior Oolite, particularly at Bradford Abbas, Broad Windsor, and Burton Bradstock; and it has been recorded from the Cotteswolds.†

So the case about "emarginata" really stands in this wise: we have three different forms from two different horizons figured by the name of "emarginata" in English literature. Thus there is:

1. From the Fullers' Earth, a subpentagonal shell with somewhat gibbous valves transversely.

2. From the Inferior Oolite, a subpentagonal, but rather more elongate shell, with rather flat valves, transversely.

3. Also from the Inferior Oolite, a subpentagonal shell, with very gibbous valves, transversely.

Of these three forms, 1 is that which is entitled to the name emarginata, Sowerby: 2, though hitherto known as

* "Monograph Brachiopoda : Oolitic and Liassic," Suppl. pl. xxiii., figs. 5—7.
† See the Author's "Bajocian of the Mid-Cotteswolds," Quart. Journ. Geol. Soc., Vol. li., p. 440, 1895
emarginata, is a distinct shell, but it belongs to the same genus; while 3, in spite of the fact that Davidson has drawn it with the angular beak ridges characteristic of Waldheimia (or Zeilleria), is undoubtedly a Terebratula—a short looped, non-septate species, with rounded beak ridges.

Lastly, there is an altogether new species which has not been figured or described:—4, from the Inferior Oolite, like No. 3 in general shape, but longer. But it is not a Terebratula, it is a Zeilleria; yet again it differs from the other Zeillerie by having an incurved beak.

This species is very like Z. cornuta of the Middle Lias. I found it about twenty years ago, and sent it to Dr Davidson with several of the other new species described in this paper.* He agreed with me that they were new species, and that they required naming, but he had drawn all the plates for his work, and was unable to include them. He hoped that I should undertake the task of describing them. At last I have partly carried out his wish.

These species may now be definitely noted in the following manner:

6. (1) Zeilleria emarginata (J. de C. Sowerby).

1825. Terebratula emarginata, J. de C. Sowerby, Min. Conch., Vol. V., pl. cccccxxxv., fig. 5. The large specimen only.

1851. Terebratula emarginata, Davidson, Ool. Brach. (Pal. Soc.), pl. iv., fig. 18 only, re-figure of Sowerby’s type.


Non. Waldheimia emarginata, Davidson, and many other authors.

* For instance: T. hyalina, T. microtrypa, T. subomalagaster, Z. ferruginea; and others not figured yet.
The species is found in the Fullers' Earth Rock of Nunney, near Frome, Somerset. Its date is, therefore, presumably the hemera of *Macrocephalites subcontractus*.

The specimen now figured is the one found by Mr Wilson; it is now in the collection of that keen Brachiopodist, Mr J. W. D. Marshall,* who has kindly sent it to me again, with another example, for the purpose of this paper.

7. (2) *Zeilleria Bicornis*, S. Buckman.

1878. *Walheimia emarginata*, Davidson, Supplement to Jurassic Brachiopoda, pl. xxiii., fig. 7 only.

Description:—Sub-pentagonal in outline, with a bilobate front margin. Brachial valve flattish, pedicle valve sub-gibbous. Valves thickened at margin, often considerably; and the thickened bilobate portion often protruded; beak sub-elevated, well separated from umbo; deltidial plates exposed; beak ridges defined, acute.

Comparison:—*Terebratula imitator* is a remarkable homœomorph in another genus. *Z. subcornuta* is a homœomorph in the same genus. Both are isochronous homœomorphs, or nearly so.

Distinction:—From *Z. Waltoni*, the bilobate front margin.

Genetic affinity:—It is a bilobate development of the form of *Z. Waltoni* which lived during *Garantiana* hemera. (There is more than one form called *Z. Waltoni*).

Localities and Strata:—Dorset: Bradford Abbas, Broad Windsor, in the upper beds; Louse Hill, near Halfway House, above the Irony bed. Somerset: Crewkerne Station, upper beds; Milborne Wick, *Garantiana* beds.

Date of existence:—*Garantiana* hemera; perhaps later also.

8. (3) Terebratula imitator, *S. Buckman*, nom. nov.

Pl. XIII., fig. 6a, b, c.


*Description:*—A somewhat ovoid, globose shell. The side and front margins thickened, the latter indented, with a lobe each side of the indentation. Junction of valves straight or nearly so, not definitely waved as in biplicate forms. Beak short, stout, separated from umbo, showing deltidial plates; no definite beak ridges; foramen somewhat large, circular.

*Comparison:*—Zeilleria bicornis is so much a homoeomorph that Davidson figured specimens of *T. imitator* and of that species as examples of *Waldheimia emarginata*. Zeilleria subcornuta is an even more remarkable homoeomorph. Specimens are identical in shape, the beak is the only point of difference, but of course the septum in *Z. subcornuta* is indicated by a dark line in the umbo.

A heterochronous homoeomorph is *T. eudesiana*, another bilobate Terebratuloid.

*Distinction:*—From *Terebr. eudesiana*, the larger size of the shell, the less globular form, the flatter brachial valve, the straighter side margin, the beak less incurved and definitely separated from the umbo.

*Genetic relations:*—Probably with *T. sphaeroidalis*, whereof it is what may be called a bilobate, not a biplicate, development. Its likeness to *T. eudesiana* does not indicate direct genetic affinity, but parallel development over again from a similar stock.

*Localities and Stratum:*—Dorset: Broad Windsor, and Bradford Abbas, in the upper beds.
Date of Existence:—Truellii hemera, most likely; or possibly zigzag hemera.

9. (4) Zeilleria subcornuta, S. Buckman, sp. n.
   Pl. XIII., fig. 7.

   Description:—Valves about equally convex; front margin indented, and a depression running up each valve. Beak small, with defined, subacute beak ridges; beak curved over umbo, and not much separated therefrom. Foramen small.

   Note.—A broader form with less marked indentation may, for the present at any rate, be reckoned as the same species.

   Comparison:—Terebratula imitator is a remarkable homœomorph. Zeilleria Marie is notable.

   Distinction:—From Z. cornuta, the less definite indentation, the bilobate (cornute) character less developed, the marginal lobes less marked. From Z. bicorne, the incurved beak. From Z. Marie, the less incurved beak, less acute beak ridges, smaller foramen, generally flatter form.

   Notes.—In Z. cornuta there is a somewhat quadrilobate appearance; this species is but bilobate. The similarity to Z. Marie is certainly remarkable, because of the difference in date. There is no difficulty in their separation if the beak be studied.

   Localities and Stratum:—Dorset: Bradford Abbas, in the railway cutting near Yeovil Junction; Clifton Maybank, in a temporary opening; both in the base of so-called "upper beds of Inferior Oolite."

   Date of Existence:—Garantiae hemera.

There is a certain similarity in the following incipiently bilobate form to the preceding species, so it may be noticed here.
10. Microthyris tardecrescens, S. Buckman, sp.n.
   Pl. XIII., fig. 1a, b, c.

Description:—A somewhat elongate, globose shell, with nearly equi-convex valves, which are marked with close-set, distinct ridges of growth. Front margin obtuse, slightly indented. Beak short, curved over umbo. Beak ridges very short, only defined just under foramen, the beak appearing to have no ridges; foramen small.

Comparison:—There is much similarity to Terebr. imitator, except for the growth ridges. A Terebratula figured by Deslongschamps as Terebratula sphaeroidalis, Brachiopodes jurassiques, Pl. lxxxi., fig. 1, is similar in shape, and also has growth ridges, which are, in fact, exaggerated growth lines.

Distinction:—From Zeilleria ferruginea, the difference in shape, but particularly the absence of well-defined beak ridges.

Remarks:—The aspect of the beak is almost that of a Terebratula; but there is a long and fairly marked dark line indicative of a septum in the brachial valve. The beak is of quite a different character from that of the Z.-Waltoni series with the sharp beak ridges, or from the incurved beak of subcornuta, which also has distinct beak ridges. The character of the beak seems to justify the placing of this species to Microthyris, E. Desl., whereof lagenalis is the type. At any rate it does not deserve to be called Zeilleria.

Localities and Strata:—Dorset: Burton Bradstock, from the upper beds; Bradford Abbas, from about the horizon of the Marl bed. Somerset: Stoford. A scarce shell, but most distinctive, and several specimens have been obtained.

Date of Existence:—Garantiana hemera.

Note:—The character of ridges really arises from exaggeration of valve-thickening, alternating with normal growth to finally become a settled feature. The ridges presumably mark times of slow growth.
VI. NON-Plicate Homœomorphs

11. Terebratula microtrypa, S. Buckman, sp. n.
   Pl. XIII., figs. 3a, b, c.

Description:—Valves convex, the pedicle valve more so than the other; valves tapering to the margin. Shell in outline sub-circular. Beak small, short, sub-tumid, slightly overhanging, not distant from umbo. Beak ridges defined, sub-acute; foramen small.

Note.—A ground-down specimen shows a short loop.

Distinction:—From Terebr. ampla and T. Uptoni, it is a smaller shell. From young T. ampla, it has more gibbous valves, it is not so broad posteriorly, it is more inflated around the beak, which is more curved and has more definite beak ridges, and the foramen is smaller. From immature T. Uptoni, the more gibbous valves, transverse shape, and the beak characters, with beak closer to the umbo, separate it.

Locality and Stratum:—Somerset: Horethorne Down, near Corton Denham, in a bluish marly clay with Rhynchohella Forbesi, etc.

Note:—I have two specimens sent from Dundry by Mr Marshall, which are very like this species; but as the beak characters are not well preserved, there may be doubt as to specific identity.

12. Zeilleria circularis, S. Buckman, sp. n.
   Pl. XIII., figs. 9a, b, c.

Description:—Valves about equally convex, tapering rather to margin, in outline nearly circular. Umbo prominent, tumid. Beak short, erect, truncate. Beak ridges distinct, sub-acute; foramen not large.

Comparison:—Homœomorphs are Terebratula ampla, J. Buckman, and Ps. Leesi (S. Buckman) especially; T. microtrypa to a certain extent; and Terebr. lentiformis, Upton, in less degree.
Distinction:—From Z. Leckenbyi (Walker), the more transverse shape, and particularly the truncate beak.

Genetic relations:—With Z. Leckenbyi, and Z. Witchelli, S. Buckman. It precedes the former in time distinctly, being sometimes as much as 100 feet lower. The two species named as its descendants express the change of shape from transverse to much elongate.

Localities and Stratum:—Gloucestershire, Crickley Hill; Bull Bank, Miserden; in Pea-grit.

Date of Existence:—Murchisoni hemera.

Notes:—The most transverse specimen is from Miserden: it measures 30 mm. across and 26 mm. in length. The largest specimen from Crickley measures, length and width, 35 mm. It shows a more overhanging beak like that of Z. Leckenbyi, so that with age it approaches that species in this character, as would be expected.

Young Z. Leckenbyi have the proportions and appearance of Z. circularis.

The Pea-grit of Randwick Ash, near Stroud, which is about the date of the Lower Freestone of Cheltenham, has yielded some broad specimens with rather overhanging beaks; they are really the forms connecting Z. circularis and Z. Leckenbyi.


Pl. XIII., figs. 11a, b, c.

Description:—Inequivalve, sub-ovoid to sub-pentagonal in outline, brachial valve nearly flat, pedical valve per-convex. Beak projected, overhanging the umbo; beak ridges fairly defined, sub-acute; foramen small.

Comparison:—With the heterochronous homœomorph Terebratula subomalogaster.

Remarks:—The inequivalve appearance of the shell viewed sideways, which suggests the specific name, gives a longitudinal section the figure of a D.
Distinction:—Like Zeilleria Leckenbyi (Walker), but distinguished by the very unequal convexity of its valves.

Locality and stratum:—Gloucestershire, Cleeve Hill, in the Phillipsiana beds of the Rolling Bank Quarry; rare.

Date of Existence:—Sauzei hemera?

Note.—As so many of the Cotswold Brachiopoda are specifically distinct from their contemporaries in the Anglo-Norman basin; and as these particular Phillipsiana beds have been destroyed by Bajocian denudation except over the Cleeve Hill plateau, it is likely that that place will be the only locality from which the species can be obtained.

14. Terebratula subomalogaster, S. Buckman, sp.n.

Pl. XIII., figs. 2a, b, c.

Description:—Inequivalve, subpentagonal in outline, brachial valve nearly flat, pedical valve convex. Growth lines prominent at intervals. Beak projected, overhanging the umbo considerably; beak ridges fairly prominent, sub-rounded; foramen rather large.

Comparison:—With the heterochronous homœomorph Zeilleria anisoclines. There is a certain likeness, on account of the transverse ridges, and even in shape, to Dictyothyris Morieri, which occurs almost in the same bed.

Distinction:—From Terebratula omalogaster, Zieten. Verst. Würt. Pl. xl., fig. 4, by its less transverse shape, and greater compression.

Remarks:—As the specific name implies, there is considerable likeness to Zieten’s T. omalogaster, which is similar in inequality of valves, has an overhanging beak, but of less pronounced character; the shell is, however, remarkably transverse, with a beak, as depicted by Zieten, rounded and largely perforate.

There is reason to conclude genetic connection between these species; and as Oppel* states that Zieten’s species

occurs in the *Humphriesianus* zone, it might be the ancestor, as its shape indicates.

Oppel further remarks that Zieten's specimen differs from most examples by being too much truncate in front.

This species has lain in my cabinet some 20 years, with the present specific name, indicative of its resemblance to the German form.

*Note.*—About transverse ridges, see *M. tardecrescens.*


*Date of Existence.*—*Garantiana* hemera.

15. *Zeilleria ferruginea*, S. Buckman, sp. n.

Pl. XIII., figs. 4a, b, c.

*Description.*—Valves convex, outline of shell elongate. Front margin more or less rounded, and a little elevated. Beak acute, projecting, with defined, acute ridges. Growth lines prominent at intervals.

*Comparison.*—The elongate, non-plicate forms of the *Terebratula* of the *punctata* and *Buckmani* groups are homoeomorphs. One, a new species of the latter group, occurs in the same bed.

*Remarks.*—In the figured example the valves are separated by test deposition, which throws them further apart without real increase of valve area. In some examples this has been carried to an extraordinary excess. In most cases there is not this thickening; then the specimens have a rather compressed appearance, and are not unlike what a somewhat elongate, narrow *Z. anisoclines* might be.

*Distinction.*—From *Z. subbucculenta* (Chapuis and Dewalque), more elongate; more gibbous valves; more elevated beak, further separated from the umbo.

*Localities and Stratum.*—Dorset, Louse Hill, and Wyke Quarry, near Halfway House, in the Irony bed.

*Date of Existence.*—Blagdeni hemera.
VII. NOTES ON CERTAIN SPECIES

The opportunity may be taken to notice the two following species, one of which requires a name:—


1832. Terebratula bullata, Zieten, Verst. Würt., pl. xl., fig. 6 (non Sow.)

Oppel named this species, taking Zieten's figure as the type. He says it is common in the highest beds of the Inferior Oolite in Württemberg, and that Terebr. sphaeroidalis is distinct from it because it has a much rounder shape.

The species is really a kind of elongate T. sphaeroidalis, with rather marked ridges of growth. It is probably passed over as Terebratula decipiens, E. Deslongschamps, a specific name made to cover a number of forms, few of which are really referable thereto.

17. Terebratula Permaxillata, S. Buckman, sp. n.

1884. Terebratula maxillata, Davidson (non Sowerby), Monogr. Brach.; App. to Supplements, pl. xx., figs. 12, 12a, 12b.

Description:—A maxillatoid species, with very strong folds, which would almost justify its destination as a quadruplicate shell. The side margin is in consequence very strongly curved.

Distinction:—From T. maxillata, the greater strength of its plications in proportion to its size, the beak more separated from the umbo.

Localities and Stratum:—Cotteswolds. Rodborough Hill, near Stroud; Salperton (in the railway cuttings); Brimpsfield, near Birdlip; Clypeus grit; rare.
Date of Existence:—Truellii hemera, assuming that Clypeus-grit was contemporaneous with Truellii strata of Dorset.

Remarks:—It lived considerably earlier than the true Terebratula maxillata, but it is a form with more old age character. T. maxillata comes from a non-licable form of the Terebr.-marmorea type. The fact is that T. maxillata, T. permaxillata, and T. submaxillata are not truly genetically connected. They are heterochronous homœomorphs, independent plicate derivatives from a non plicate stock, the plicate character being the old age feature which they independently assume.

18. PSEUDOGLOSSOTHYRIS sp.


I find some difficulty in agreeing with Mr Upton's identification. The shell seems to be really an independent development from Ps. simplex, whereof the incipiently plicate form (Pl. XII., figs. 1-3) indicates the method of development. In that case it deserves a name as a new species, separable at any rate from Ps. galeiformis. I hope Mr Upton will give it one.

NOTABLE HOMŒOMORPHS

A notice of some of the more remarkable homœomorphs is given below. They may be said to form veritable "traps" in the matter of identification. Besides them, there are the various uniplicate, and the various biplicate Terebratula which are really homœomorphous developments; so are what may be called the various quadruplicate forms of the T.-maxillata series; so are the bilobate Zeilleries; and the different multiplicate series.
### Isochronous

(more or less)

<table>
<thead>
<tr>
<th>Species</th>
<th>Heterochronous</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aulacothyris Haasi</em></td>
<td><em>Pseudoglossothyris curvifrons</em></td>
</tr>
<tr>
<td><em>Glossothyris curviconcha</em></td>
<td><em>Aulacothyris alveata</em></td>
</tr>
<tr>
<td><em>Terebratula subpunctata</em></td>
<td><em>Microthyris lagenalis</em></td>
</tr>
<tr>
<td><em>Zeilleria subnunismalis</em></td>
<td><em>Terebratula subpunctata</em></td>
</tr>
<tr>
<td><em>Zeilleria circularis</em></td>
<td><em>Zeilleria ferruginea</em></td>
</tr>
<tr>
<td><em>Terebratula ampla</em> (juv.)</td>
<td><em>Terebratula Buckmaniana</em></td>
</tr>
<tr>
<td><em>Pseudoglossothyris Leesi</em></td>
<td><em>Zeilleria anisoclines</em></td>
</tr>
<tr>
<td><em>Zeilleria Lycetti</em></td>
<td><em>Terebratula subomalogaster</em></td>
</tr>
<tr>
<td><em>Pseudoglossothyris sp.</em></td>
<td></td>
</tr>
<tr>
<td><em>Zeilleria bullata</em></td>
<td><em>Zeilleria ornithocephala</em></td>
</tr>
<tr>
<td><em>Terebratula sp.</em></td>
<td><em>Terebratula Buckmani</em></td>
</tr>
<tr>
<td><em>Zeilleria ferruginea</em></td>
<td></td>
</tr>
<tr>
<td>*Terebratula sp. aff. <em>Terebr. Buckmani</em></td>
<td></td>
</tr>
<tr>
<td><em>Terebratula imitator</em></td>
<td><em>Terebratula spheroidalis</em></td>
</tr>
<tr>
<td><em>Zeilleria bicornis</em></td>
<td><em>Zeilleria bullata</em></td>
</tr>
<tr>
<td><em>Zeilleria subcornuta</em></td>
<td><em>Zeilleria Marie</em></td>
</tr>
<tr>
<td></td>
<td><em>Zeilleria perobovata</em></td>
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</tbody>
</table>

#### VIII. Summary

Species of Jurassic Brachiopods dissimilar internally, or in regard to particular features, but similar in general aspect, or developing a certain similarity in general features, have been noticed in this paper as homœomorphs.

The following new genus has been proposed:—*Pseudoglossothyris*.

The following species have been noticed; those printed in heavy type are new; those marked with an asterisk are figured in this paper.
IX. Appendix I.—On Photographic Reproduction

Plate XIII. of this paper forms an interesting experiment in photographic reproduction, and a few words may be said about it.

Photography is the ideal method to employ for depicting fossils, because thereby the small personal errors of the artist are avoided—errors inseparable even from the best work. But few people realize how difficult is the photography of fossils, on account mainly of the different actinic values of their tests (or casts).

The plate in this paper is not put forward as an altogether successful result of photographic reproduction; but it was considered fair as a first experiment.

For successful fossil photography the following conditions are requisite:—Careful lighting by a side light, the specimens being horizontal, and the camera being mounted
vertically; long, even over-exposure, with a small stop, the plates being developed with much restrainer,* some uniformity in regard to the colour of the examples—whereof the eye is not an efficient guide; elimination of shadows.

The last detail was not attended to in the photographs which were taken for the plate, hence some of its inferiority. To obviate shadows cast by one specimen on another, it is necessary to place them far enough apart. To obviate shadows on the background, Mr Chas. Upton has suggested an excellent plan, which I take the liberty to mention. Mount the Brachiopods to be photographed on small pieces of clay on a glass plate, support the glass plate by glass legs (tumblers) some distance above a white sheet of cardboard. Shadows will thereby be eliminated. I have tried, with success, a modification of this plan in the case of Ammonites.

X. Appendix II.—A Jurassic (part) Time Table

Herewith is given an outline of the Jurassic Time Table explained at the Annual Meeting, 1899. It is important in one respect, as an appendix to this paper on Brachiopods, because it explains the chronological terms used herein. It is hoped that it will be of greater importance later—that it will serve as a basis for making records both of the stratal and faunal sequence; and that such records, whether made by members of the Club, or by other geologists and palæontologists, may furnish important technical papers for publication in the Proceedings, to which they would give a very special scientific value.

The Appendix is divided into three tables:—(A.) Explanatory of the chronological terms. (B.) The stratal sequence. (C.) A list of hemerae, with blank spaces left to be used for registration purposes.

* In November, 35 minutes with f. 32 gave very good results with Ammonites.
### TABLE A.—Chronological Terms

<table>
<thead>
<tr>
<th>HEMERAL NAMES</th>
<th>FULL TITLE OF DISTINCTIVE FOSSIL</th>
<th>AGES</th>
<th>EPOCHS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>SONNINIAN AGE</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>LUDWIGIAN AGE</td>
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<td></td>
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<td></td>
<td>HARPOCERATAN AGE</td>
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<td></td>
<td>ARIETIDAN EPOCH</td>
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<td></td>
<td>DEROCCERATAN AGE</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>ASTEROCCERATAN AGE</td>
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<td></td>
<td></td>
<td></td>
<td>CALOCERATAN AGE</td>
</tr>
</tbody>
</table>

* This Age is regarded as belonging to the Triassic Period
A similar Table was first given by the author in "Grouping of Jurassic Time;" Quart. Jour. Geol. Soc., Vol. liv., p. 442, 1898. This one is substantially the same, with a few additions and emendations.

The next Table gives some of the localities where may be found strata deposited during the various hemeræ. Additions thereto are invited.

**TABLE B.—STRATAL DETAILS**

Some Deposits made during respective Hemeræ, with the localities where found.

<table>
<thead>
<tr>
<th>Disci.</th>
<th>DORSET; and other counties.</th>
<th>The strata known as Cornbrash.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarctæ</td>
<td>DORSET.</td>
<td>The Forest Marble.</td>
</tr>
<tr>
<td></td>
<td>WILTSHIRE.</td>
<td>The Bradford Clay of Bradford-on-Avon; and the Forest Marble.</td>
</tr>
<tr>
<td></td>
<td>GLOUCESTERSHIRE.</td>
<td>The Bradford Clay of Tetbury Road Station; and the Forest Marble.</td>
</tr>
<tr>
<td>Maxillæ</td>
<td>GLOUCESTERSHIRE, WILTSHIRE.</td>
<td>The upper part of the Great Oolite.</td>
</tr>
<tr>
<td>Subcontractæ</td>
<td>DORSET, SOMERSET.</td>
<td>The upper Fullers' Earth Clay, and the Fullers' Earth Rock.</td>
</tr>
<tr>
<td></td>
<td>GLOUCESTERSHIRE.</td>
<td>The lower part of the Great Oolite.</td>
</tr>
<tr>
<td>Fusci.</td>
<td>DORSET: Bridport.</td>
<td>&quot;The scroff,&quot; a marly stone on top of limestones; and some of the overlying clay.</td>
</tr>
<tr>
<td></td>
<td>Bradford Abbas, Halfway House, &amp;c.</td>
<td>The upper part of the white stone which is burnt for lime.</td>
</tr>
<tr>
<td>Region</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>---------</td>
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<td></td>
</tr>
</tbody>
</table>
| **Zigzag.** | **DORSET:**  
Broad Windsor, 
Bridport.  
Bradford Abbas, 
Halfway House, &c.  
**SOMERSET:**  
Crewkerne Station.  
Dundry.  
**GLOUCESTERSHIRE:**  
Cotteswolds.  
**NORMANDY:**  
Port-en-Bessin. |
| The upper limestones, or *zigzag* beds.  
The lower part of the white stone.  
The upper limestones.  
(?) The strata at Barnes Batch. The Coralline Beds.  
Limestones above the *Clypeus*-grit.  
Blue calcareous stone beds, about level of shore, east of the village. |
| **Truellii.** | **GLOUCESTERSHIRE:**  
Cotteswolds.  
**SOMERSET:**  
Dundry.  
**DORSET:**  
Halfway House, Bridport.  
**NORMANDY:**  
Around Bayeux and Caen. |
| The *Clypeus*-grit.  
The Freestone.  
The fossil-bed with *Truellii* and *dorsetensis*; a hard, bluish limestone.  
"Oolithe blanche." |
| **Garantiana.** | **GLOUCESTERSHIRE:**  
Cotteswolds.  
**SOMERSET:**  
North Stoke, Midford.  
Dundry.  
**DORSET:**  
Sherborne.  
Bradford Abbas, Halfway House, &c.  
**NORMANDY:**  
Around Bayeux. |
| The upper *Trigonia*-grit.  
The upper *Trigonia*-grit.  
The Conglomerate-bed of Maes Knoll; the thin bed below the Freestone at other places.  
The Building Freestone.  
"Marl Bed" and adjacent strata.  
Upper part of "Oolithe ferrugineuse." |
<table>
<thead>
<tr>
<th>Species</th>
<th>Area</th>
<th>Subarea</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Niortensis</td>
<td>Dorset</td>
<td>Oborne</td>
<td>The upper part of the roadstone.</td>
</tr>
<tr>
<td></td>
<td>Normandy</td>
<td>Sully, near Bayeux</td>
<td>Lower part of “Oolithe ferrugineuse.” “Bifurcan Schichten.”</td>
</tr>
<tr>
<td></td>
<td>Württemberg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blagdeni</td>
<td>Dorset</td>
<td>Oborne</td>
<td>The lower part of the roadstone.</td>
</tr>
<tr>
<td></td>
<td>Normandy</td>
<td>Sully, near Bayeux</td>
<td>Conglomerate at base of “Oolithe ferrugineuse.” “Coronaten Schichten.”</td>
</tr>
<tr>
<td></td>
<td>Württemberg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sauzei</td>
<td>Gloucestershire: Cleeve Hill</td>
<td></td>
<td>The <em>Phillipsiana</em> beds.</td>
</tr>
<tr>
<td></td>
<td>Dorset</td>
<td>Sandford Lane</td>
<td>The upper part of the Fossil bed.</td>
</tr>
<tr>
<td></td>
<td>Somerset</td>
<td>Dundry</td>
<td>The Ironshot Oolite.</td>
</tr>
<tr>
<td>Witchelliae</td>
<td>Dorset</td>
<td>Sandford Lane</td>
<td>The middle part of the Fossil bed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chideock</td>
<td>The upper part of the “Red beds.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bridport</td>
<td>A reddish limestone.</td>
</tr>
<tr>
<td></td>
<td>Gloucestershire: Cold Comfort, and Cleeve Hill</td>
<td>An ironshot limestone, with <em>Terebr. Wrighti</em>.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Somerset</td>
<td>Dundy</td>
<td>The Upper White Ironshot.</td>
</tr>
<tr>
<td>Sonniniae</td>
<td>Gloucestershire: Cotteswolds</td>
<td></td>
<td>The Notgrove Freestone, and the <em>Gryphite</em>-grit of Leckhampton, &amp;c.</td>
</tr>
<tr>
<td></td>
<td>Dorset</td>
<td>Sandford Lane</td>
<td>The lower part of the Fossil bed.</td>
</tr>
<tr>
<td></td>
<td>Somerset</td>
<td>Dundry</td>
<td>The Lower White Ironshot — the <em>fissilobata-ovalis</em> horizon.</td>
</tr>
</tbody>
</table>
### Discitae

**Gloucestershire:** Cotteswolds.
- **Dorset:** Bradford Abbas.
  - Sandford Lane.
  - Stoke Knapp.
- **Somerset:** Dundry.
  - Horethorne Down, Seven Sisters.
- **Normandy, near Bayeux.**

The *Buckmani*-grit, and the *Lower Trigonia*-grit.
The upper part of the Fossil bed.
Below the Fossil bed.
Top of Building Stone.
The upper part of the Grey Limestone and Marl beds.
Bluish clay with Brachiopods.
Upper part of "Malière."

### Concavi

**Gloucestershire:** Cotteswolds.
- **Somerset:** Dundry.
- **Dorset:** Bradford Abbas.
  - Sandford Lane.
  - Stoke Knapp.
- **Normandy: near Bayeux.**

The Snowshill Clay, and the Harford Sands.
The lower part of the Grey Limestone and Marl beds.
The lower part of the Fossil bed.
A bluish sandy bed.
Middle of Building Stone.
Middle part of "Malière."

### Bradfordensis

**Gloucestershire:** Cotteswolds.
- **Dorset:** Bradford Abbas.
  - Halfway House, Louse Hill, Marston Road, &c.
  - Chideock.
  - Stoke Knapp.
- **Somerset:** near Corton.
- **Normandy: May-sur-Orne, nr. Caen.**

The Upper Freestone, and the *Oolite* Marl.
A marl bed, associated with the Paving bed.
The *Rhynchonella ringens* beds.
Ironshot stone above *Wild Bed*.
The base of the Building Stone.
The *Rhyn. ringens* beds.
A chalky limestone, with some iron grains.
<table>
<thead>
<tr>
<th>Murchisonae</th>
<th><strong>Gloucestershire</strong>: Cotteswolds.</th>
<th>The Lower Freestone, and the Pea-grit.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Somerset</strong>: Dundry, Misterton, Haselbury, &amp;c.</td>
<td>The hard, irony, massive beds. The &quot;lower beds.&quot;</td>
<td></td>
</tr>
<tr>
<td>Scissi</td>
<td><strong>Gloucestershire</strong>: Cotteswolds.</td>
<td>The sandy ferruginous beds. At Kineton, near Guiting, <em>Rhych. subdecorata</em> is abundant, cf. Otley Hill; at other Cotteswold localities it is occasional.</td>
</tr>
<tr>
<td><strong>Dorset</strong>: Stoke Knap.</td>
<td>The <em>Brachiopod</em>-beds in the Sands.</td>
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</tr>
<tr>
<td><strong>Northamptonshire</strong>: Duston.</td>
<td>Northampton Sands.</td>
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<tr>
<td><strong>Oxfordshire</strong>: Otley Hill.</td>
<td><em>Rhych. subdecorata</em> bed.</td>
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<tr>
<td>Opaliniformis</td>
<td><strong>Gloucestershire</strong>: Frocester &amp; Haresfield District.</td>
<td>Hard ironshot stone capping the <em>Cephalopod</em>-bed.</td>
</tr>
<tr>
<td><strong>Dorset</strong>: Bridport and Chideock.</td>
<td>Upper part of yellow Sands.</td>
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<tr>
<td>Aalenius</td>
<td><strong>Gloucestershire</strong>: Frocester &amp; Haresfield District.</td>
<td>Top of the <em>Cephalopod</em>-bed.</td>
</tr>
<tr>
<td><strong>Somerset</strong>: Dundry.</td>
<td>A bluish clay stone.</td>
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<tr>
<td><strong>Dorset</strong>: Chideock and Bridport.</td>
<td>Towards upper part of Bridport Sands.</td>
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</tbody>
</table>
**Moorei.**

- **GLOUCESTERSHIRE:** Frocester district.
  - A portion of *Cephalopod*-bed.
  - Building stone.
  - Upper part of Yeovil Sands, with some building stone.

- **SOMERSET:** Ham Hill, Stoford.
  - Upper part of Yeovil Sands.
  - Rather above middle part of Bridport Sands.

- **DORSET:** Bradford Abbas, Chideock.
  - A clay bed yielding limonitic fossils.

- **NORMANDY:** Tilly-sur-Seuilles.

**Dumortierie.**

- **GLOUCESTERSHIRE:** Frocester district.
  - The middle part of the *Cephalopod*-bed—brown ironshot marl, a very Ammoniferous horizon at Penn Wood, Dursley, &c.
  - The Upper Clay beds.

- **SOMERSET:** Dundry, Ham Hill, and Yeovil district.
  - The Yellow Sands.

- **DORSET:** Bradford Abbas district, Chideock.
  - Yellow and blue Sands.
  - Blue clay of Down Cliffs, about 70 feet, and about 100 feet of yellow sand above.

- **NORMANDY:** May-sur-Orne.
  - An ironshot marl in Carrière Cavalle.

**Dispansi.**

- **GLOUCESTERSHIRE:** Frocester district.
  - About middle of *Cephalopod*-bed.

- **SOMERSET:** North Stoke.
  - A brown, ironshot, marly stone.
  - Yellow sands, with hard sandstone, yielding *Hammatocerata*.
  - near Cole, Somerset and Dorset Railway.

- **Ilminster district.**
  - Top of “upper Lias” clay, below Yeovil Sands.
| **Struckmanni.** | **GLOUCESTERSHIRE:** | The lower part of the Cotteswold *Cephalopod*-bed. |
| | Frocester district. | |
| | SOMERSET: Bath. | The lower part of the Midford Sands. |
| | | Part of blue ironshot beds. |
| | Dundry. | |

| **Striatuli.** | **GLOUCESTERSHIRE:** | The base of the Cotteswold *Cephalopod*-bed. |
| | Frocester district. | Yellowish sand and hard sandstones. |
| | Sodbury. | The bed below the Midford Sands. |
| | SOMERSET: Bath. | Clay and clay stones of upper part of upper Lias. |
| | Ilminster district, | Blue Ironshot bed. |
| | Dundry. | |
| | DORSET: Down Cliffs. | Upper layer of Junction bed, often missing. |

| **Variabilis.** | **GLOUCESTERSHIRE:** | The upper part of the Cotteswold Sands. |
| | Frocester, | |
| | Nibley, &c. | |
| | Chalford. | |
| | SOMERSET: Ilminster district. | Clay and clay stones of "Upper Lias." |

| **Lilli.** | **GLOUCESTERSHIRE:** | Lower part of Cotteswold Sands. |
| | Coaley Wood, | A hard yellow, often blue sandstone. |
| | Frocester, &c. | |
| | Nailsworth. | |
| | SOMERSET: Ilminster district. | Clay and clay stones, not far below Yeovil Sands. |
| | NORTHAMPTONSHIRE: | Upper *Leda ovum* beds. |
| | Moulton. | |
| **Bifrontis** | **GLOUCESTERSHIRE**: Stinchcombe, Alderley. | Clay and clay stones. |
| **SOMERSET**: Dundry, Batcombe. | Some part of Blue Ironshot bed. |
| **NORTHAMPTONSHIRE**: Vigo. | A reddish yellow Ironshot bed. |
| **DORSET**: Down Cliffs. | Clay and stone. |
| **NORTHAMPTONSHIRE**: Vigo. | Brickyard. |
| **DORSET**: Down Cliffs. | Junction bed, part with iron-oxidised Ammonites. |

| **Falciferi** | **SOMERSET**: Dundry, Ilminster, Yeovil, Trent. | The Pink bed. Clay and clay stones above the Marlstone. |
| **DORSET**: Down Cliffs. | The part of the “Junction bed” above the Marlstone. |
| **GLOUCESTERSHIRE**: Stinchcombe, Standish. | The clay and clay stones above the Marlstone. |

**[Pre-falciferi? (Horizon of Terebratula globulina and Rhynchonella pygmaea).]**

| **GLOUCESTERSHIRE**: Dumbleton. | Insects beds and paper shales. |
| **SOMERSET**: Ilminster. | Fish beds. |

| **Acuti** | **GLOUCESTERSHIRE**: Stinchcombe. | Thin layer on top of Marlstone with *Ar? acutum*. |

| **Spinati** | **DORSET**: Down Cliffs. | “Junction bed,” lowest layer. |
| **Spinati.** (continued) | **GLOUCESTERSHIRE:**  
| | Stinchcombe,  
| | Wotton-under-Edge,  
| | Alderton Hill,  
| | Bredon Hill, &c.  
| | Marlstone. |
| **Margaritati.** | **SOMERSET:** Ilminster district.  
| | Marlstone (lower part).  
| | **DORSET:** DownCliffs.  
| | Clay below the "Junction bed.  
| | **GLOUCESTERSHIRE:**  
| | Dudbridge (Stroud)  
| | Hard ironshot stone. |
| **Algoviani.** | **NORTHAMPTONSHIRE:**  
| | *Algovianum zone* (Thompson in litt). Lower *Margaritatus* zone (Thompson).  
| | **DORSET:** Ilminster district.  
| | Sands below Marlstone? |
| **Striati.** | **SOMERSET:** Radstock.  
| | Clay above ironshot stone.  
| | **GLOUCESTERSHIRE:**  
| | Cheltenham, near Gloucester,  
| | Dumbleton, &c.  
| | Brickyards on the hill flanks. |
| **Latæcostæ.** | **DORSET:** Chideock  
| | (Seatown Cliff).  
| | Clay.  
| | **GLOUCESTERSHIRE:**  
| | Dudbridge.  
| | Hard bluish sandstone.  
| | **NORTHAMPTONSHIRE:**  
| | Catesby.  
| | Zone of *Henleyi* (Thompson). |
| **Valdani.** | **SOMERSET:** Radstock.  
| | Upper part of ironshot limestone.  
| | **GLOUCESTERSHIRE:**  
| | Leckhampton Station. Brickyard.  
| | Brockworth (near Gloucester).  
| | Brickyard.  
| | **DORSET:** Chideock.  
<p>| | Under Golden Cap. |</p>
<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
<th>Description</th>
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### Oxynoti

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<thead>
<tr>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Dorset: Cliffs</td>
<td>Pyritized fossils.</td>
</tr>
<tr>
<td>Charmouth</td>
<td></td>
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<tr>
<td>Somerset: Radstock</td>
<td>Above the <em>Spirifer</em> bed.</td>
</tr>
<tr>
<td>Gloucestershire:</td>
<td>Lansdown Station.</td>
</tr>
<tr>
<td>Cheltenham</td>
<td>Railway cutting.</td>
</tr>
<tr>
<td>near Frocester</td>
<td>Canal cutting.</td>
</tr>
<tr>
<td>near Gloucester</td>
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<tr>
<td>Warwickshire:</td>
<td>Hillmorton (Thompson).</td>
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### Obtusi

<table>
<thead>
<tr>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Dorset:</td>
<td>Lias limestones.</td>
</tr>
<tr>
<td>Near Charmouth</td>
<td></td>
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<tr>
<td>Cliffs</td>
<td></td>
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<tr>
<td>Gloucestershire:</td>
<td>Docks.</td>
</tr>
<tr>
<td>Gloucester</td>
<td></td>
</tr>
<tr>
<td>Warwickshire:</td>
<td>Zone of <em>Obtusus</em> (Thompson).</td>
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<tr>
<td>Hillmorton</td>
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### Turneri

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<thead>
<tr>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Somerset:</td>
<td>Barrow Gurney Reservoir.</td>
</tr>
<tr>
<td>Near Bristol</td>
<td></td>
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<tr>
<td>Gloucestershire:</td>
<td>Coldpool.</td>
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<tr>
<td>Between Cheltenham &amp; Gloucester</td>
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### Birchi

<table>
<thead>
<tr>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Dorset:</td>
<td>Cliffs.</td>
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<tr>
<td>Near Charmouth</td>
<td></td>
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<tr>
<td>Somerset: Radstock</td>
<td><em>Arnioceras</em> bed.</td>
</tr>
<tr>
<td>Warwickshire:</td>
<td>Zone of <em>Turneri</em> and <em>semi-costatus</em> (Thompson).</td>
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<tr>
<td>Hillmorton</td>
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### Gmuendensis

<table>
<thead>
<tr>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Somerset:</td>
<td>“Spirifer bank” of Lias limestone.</td>
</tr>
<tr>
<td>Radstock</td>
<td></td>
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<tr>
<td>Gloucestershire:</td>
<td>The Cliff.</td>
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<tr>
<td>Fretherne</td>
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</table>
**Rotiformis.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<tbody>
<tr>
<td>Gloucestershire: Willsbridge, near Bitton.</td>
<td>Limestones.</td>
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<td></td>
<td>Blocks of stone seen at a Somerset &amp; Dorset Railway Station.</td>
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</tbody>
</table>

**Marmorea.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<tbody>
<tr>
<td>Gloucestershire: Willsbridge, near Bitton.</td>
<td>Lower part of Quarry.</td>
</tr>
<tr>
<td>near Churchdown.</td>
<td>Quarries (F. Smithe).</td>
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**Megastomatos.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<tbody>
<tr>
<td>Somerset: near Radstock.</td>
<td>White Lias.</td>
</tr>
<tr>
<td>Gloucestershire: Sedbury Park, near Chepstow.</td>
<td>Lias in Cliff.</td>
</tr>
</tbody>
</table>

**Planorbis.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<tbody>
<tr>
<td>Somerset: Radstock.</td>
<td>White Lias.</td>
</tr>
<tr>
<td>Watchet.</td>
<td>Lias.</td>
</tr>
</tbody>
</table>

The third Table is a list with blank spaces. It is hoped that Geologists and Palæontologists will make use of the blanks for recording the dates of deposits, or of fossil species of different groups, and will send the results to the Club for publication. By that means a series of records, valuable not only to the Geologist and the Palæontologist, but also to the student of evolution, will be obtained.
TABLE C.—LIST OF HEMERÆ
With spaces for insertion of species or deposits.

<table>
<thead>
<tr>
<th>Disci.</th>
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<th>Coarctatae.</th>
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<th>Maxillatae.</th>
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<tr>
<th>fuscae.</th>
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zigzag.

Truellii.

Garantiana.

niortensis.

Blagdeni.
Sansei.

Witchelliae sp.

Sonniniae sp.

discitae.

concavi.

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<tr>
<td><em>bradfordensis.</em></td>
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<tr>
<td><em>Murchisonae.</em></td>
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<td><em>scissi.</em></td>
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<td><em>opaliformis.</em></td>
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<td><em>aalensis.</em></td>
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<td>Moorei</td>
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variabilis.

Lilli.

bifrontis.

falciferi.

acuti.
| spinati.                           |
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| margarilati.                     |
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Valdani.

Janesoni.

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gmuendensis.

rotiformis.

marmoreae.

megastomatos.

planorbis.
PLATE XII.

*Murchisonae* hemera

Figs. 1—3.—*Pseudoglossothyris simplex* (J. Buckman).
Three views of an unusually large specimen showing small plications as a character of maturity. Pea Grit, Birdlip, (Ludwigian Age). (P. 241).

*Bradfordensis* hemera

Figs. 4—7.—*Terebratula polyplecta, S. Buckman, sp. n.*
Four views of a specimen showing well-established plications as a character of maturity, and thickening of margin as a character of senility. Oolite Marl, Notgrove Station, Gloucestershire, (Ludwigian Age.) (P. 242).

*Murchisone* hemera

Figs. 8—12.—*Terebratula withingtonensis, S. Buckman, sp. n.*
Three views (figs. 8—10) of a uniplicate example. Fig. 11, marginal view of an incipiently biplicate specimen. Fig. 12, same view of a definitely biplicate example. Pea Grit, Railway Cuttings, Withington, Gloucestershire, (Ludwigian Age). (P. 246).

*Falciferi* hemera

Figs. 13—15.—*Rhyn choc onella standishensis, S. Buckman, sp. n.*
Three views of a specimen showing plicae only as an adult character. Upper Lias Clay, Standish Park Farm, Gloucestershire, (Harpoceratan Age). (P. 245).
PLATE XIII.

Garantiana hemera
Figs. 1a, b, c.—Microthyris tardecrescens, S. Buckman, sp. n. Burton Bradstock, “upper beds of Inferior Oolite,” (Parkinsonian Age). (P. 256).
Figs. 2a, b, c.—Terebratula subomalagaster, S. Buckman, sp. n. Bradford Abbas, Dorset, just below “Marl bed.” (Parkinsonian Age). (P. 259).

Discita herema
Figs. 3a, b, c.—Terebratula microtrypa, S. Buckman, sp. n. Horethorne Downs, Somerset, in Blue Marl, (Sonninian Age). (P. 257).

Blagdeni hemera
Figs. 4a, b, c.—Zeilleria ferruginea, S. Buckman, sp. n. Louse Hill, near Sherborne (Dorset), the Irony bed,” (Sonninian Age). (P. 260).

Subcontracti hemera
Figs. 5a, b, c.—Zeilleria EMARGINATA (J. de C. Sowerby) Nunney, near Frome, Somerset, “Fuller’s Earth Rock,” (Parkinsonian Age). (P. 252). Collected by the late E. Wilson, F.G.S., now in the cabinet of Mr J. W. D. Marshall.

Truellii, or Zigzag hemera
Figs. 6a, b, c.—Terebratula imitator, S. Buckman, nom. nov. Broad Windsor, Dorset, “upper beds of Inferior Oolite,” (Parkinsonian Age). (P. 254).

Garantiana hemera
Figs. 7a, b, c.—Zeilleria subcornuta, S. Buckman, sp. n. Railway Cutting between Bradford Abbas and Yeovil Junction, upper beds with Terebr. Holländê, (Parkinsonian Age). (P. 255).

Discita hemera
Figs. 8a, b, c.—Terebratula hyalina, S. Buckman, sp. n. Horethorne Down, Somerset, on Bristol road about four miles north of Sherborne, (Sonninian Age). (P. 248).

Murchisoni hemera
Fig. 9.—Zeilleria circularis, S. Buckman, sp. n. Crickley Hill, Gloucestershire, Pea Grit, (Ludwigian Age). (P. 257).

Sauzei hemera?
Fig. 10.—Zeilleria anisoclines, S. Buckman, sp. n. Gloucestershire, Cleeve Hill, Rolling Bank Quarry, from sandy beds with Terebr. Phìllpsiana, (Sonninian Age). (P. 258).

Blagdeni hemera
Fig. 11.—Terebratula siderica, S. Buckman, sp. n. Dorset: Wyke Quarry, near Halfway House, from the Irony beds, (Sonninian Age). (P. 248).
THE PYRENEES AND ANDORRA,

BY

WILLIAM BELLOWS.

(Read January 26th, 1900.)

PLATES XIV.-XVI.

I. THE MOUNTAINS

In south-western Europe a continuous mountain range runs from the Mediterranean on the east almost to Cape Finistère on the west, a distance of considerably more than 500 miles. The Asturian and Cantabrian mountains make up the western section of this chain, whilst the barrier of rock, snow, and forest standing between France and Spain, and known to us as the Pyrenees,* forms the eastern portion.

The Pyrenean chain is, roughly speaking, 250 miles long. Its highest peaks rise above the snow line; and within its depths may be found some of the grandest scenery in western Europe. I sighted it first from the windows of the train travelling south from Bordeaux to Bayonne in the summer of 1895. We had crossed the

* Onisime Reclus states that the term Pyrenees may be derived from a word *biren*, or *piren*, formerly employed in the Department of Ariège, signifying an upland, or mountain meadow.
flat, sandy, pine-clad district of the Landes, and were entering the broken country of the river Adour, when the huge line of peaks came into view, disappearing again in the distance to the eastward. We were approaching the mountain wall, and I left the train at Bayonne, in the country of the Basques, within a few short miles of the Spanish frontier.

The Pyrenees are not in all places accessible by railway. On the southern side there is very little communication at all, while on French soil the line running from east to west is generally at some distance from the chain. At certain points, however, convenient branch lines run to the southward, bringing the traveller to the very foot of the mountains; and in this way, by following the main line eastward and by making continual digressions from it to the south, my companion, Henry Simmons, and I were enabled to visit some of the finest scenery of these mountains.

We left Bayonne and the Atlantic coast behind us, and by evening reached the town of Pau. This historic place, the first centre from which we attacked the range, stands beautifully on the plains; and from the terrace of the town we could take in at a single glance one of the finest sections of the chain. A line of peaks of all shapes, battlemented, snow-capped, and indented, stretched unbroken from east to west before us. The next morning we travel southward to the foot of those huge masses until finally our train is buried in the beautiful woodland that fills the lower valleys of the western chain. The railway suddenly comes to an end; and we take a coach and journey southward through deep gorges and beneath magnificent slopes to the little watering-place of Eaux-Chaudes. This place is further south than the Alps, and the warmer temperature does two things: it raises the snow line by 1500 feet, and seems to give to these valleys
a richer vegetation and a denser foliage. It is in the western Pyrenees, where the mountains are more exposed to the Atlantic rains (according to the Encyclopedia Britannica) that the foliage is seen at its best: on the higher summits more snow falls than on the eastern peaks, and hence glaciers and protecting snow-fields exist in these parts that are unknown at the Mediterranean end.

Eaux-Chaudes, a little village with natural warm springs strongly impregnated with sulphur, is lighted with electric light. These Pyrenean villages make good use of the wonderful mountain torrents that come so close to their doors: many that we visited had electric installations, however backward they might be in other matters. The Val d'Ossau, in which the village stands, runs southward for many miles towards the Spanish frontier, when it is finally blocked by the huge Pic du Midi d'Ossau, less known, but a mightier mass, than its sister further eastward, the Pic du Midi de Bigorre. But the Pic du Midi d'Ossau is well worth a visit, rising above the surrounding forests to a height of over 9,400 feet from sea level. My friend and I walked many miles to see it: but the clouds hung round its crags and we were disappointed. There were other things of interest, however, to reward the traveller. At intervals the loneliness of the forest road was relieved by some passing native. Further down we had seen both men and women working in the fields; but here we were in a lonely haunt not far from the Spanish frontier, and doubtless in a happy land of smuggling. At very few places can these mountains be crossed by road. The passes (called "ports" in the Central Pyrenees) are at lofty elevations, and only three or four of them, in the whole length of the chain, would allow the passage of a carriage. Certainly on the French side, in this Val d'Ossau, the road was a good one; but we did not see the corresponding road in Spain.
The next valley visited was the one at Cauterets; and there is nothing more beautiful in all these mountains than the valleys, though they are extremely warm in summer. The Pyrenees run east and west: their greater valleys run north and south. Standing in one of them you are separated from the next by one of the huge spurs that depend from the main chain; and though by crossing the subordinate ridge you may attain the adjoining valley by direct route, it is often quicker to return to the plains and re-enter the mountains further on. This would apply principally to the French side of the range, the surrounding country being much more broken on the Spanish side.

In this way we reached the town of Cauterets, only 17 miles away in direct line, but 71 miles round by coach and train. The journey up the Cauterets valley was typical, the road winding through one of those wonderful and almost terrifying chasms that exist here. Far down below could at times be seen the angry Gave, and above our heads the huge walls of perpendicular rock that seemed to close the valley from the outer world. We saw more than one of these defiles in our wanderings, portals as it were to the immense valleys they commanded, and in some respects similar to the Aarschlucht at Meiringen, in Switzerland.

A little further on we passed the track of a huge and recent avalanche, and found ourselves in Cauterets, with its hot springs of varying value and its numerous establishments of cure. Attendants in native Pyrenean costumes were there busying themselves with the wants of invalids; but the cure we needed was the pure air of the woods and mountain slopes, and an early opportunity found us again on foot, and on our way up through the forest to the Lac de Gaube. The lakes of these regions are smaller and fewer than those of Switzerland, and lie generally at greater elevations. The Lac de Gaube is the largest in the chain, and
Fig. 1.—LAC DE GAUBE, FRENCH PYRENEES

Fig. 2.—“CHAOS,” GAVARNIE VALLEY, FRENCH PYRENEES
stands at 5800 feet above sea-level. We were accordingly anxious to see it. Climbing through the Pyrenean pines we presently came to the lovely waterfall at the Pont d'Espagne, bringing down the surplus waters of the lake. Another climb, and we finally stood on the bleak shore of this lonely Lac de Gaube and gazed across the water, to where the Vignemale, the highest summit of the French Pyrenees, rose with its glacier into the clouds above (Plate XIV., fig. 1.)

Our next destination was the village of Gavarnie in the Central Pyrenees, lying beneath the shadow of Mont Perdu, and in the presence of that huge "cirque" or amphitheatre of rock for which it is so rightly famous. More than one huge "cirque" is to be met with in these mountains, but that of Gavarnie is the finest. We follow the Gave up its huge ravine, and in a few hours are in a wild country, practically treeless, and walled in by barren slopes. The road ascends, and towards dusk we are 5000 feet above the sea. Then we enter a desolate gorge, strewn with huge boulders of fallen granite and known as Chaos (Plate XIV., fig. 2,) and by evening the little village comes in sight, with the frowning cliffs of the cirque towering behind it. We have reached the head of the valley, and the immense precipices of that amphitheatre of limestone seem to bar all further progress southwards.

Gavarnie has been described as the Chamonix of the Pyrenees: and although its mountains hardly attain 11,000 feet above sea-level, there is dangerous climbing to be done here, too, by those who wish it. The famous "cirque" offers a semicircular wall or series of rocks, rising in stages from 3000 to 5000 feet above the bed from which they spring. The amphitheatre is two miles across at the base, and measures nine miles along its upper crest. The melting snows on the heights above form beautiful cascades that come tumbling into the abyss below, gleaming
at times in the sunlight with all the colours of the rainbow. The principal cascade is, with one exception, the loftiest in Europe: descending in the summer months in one unbroken fall of nearly 1400 feet (Plate XV.)

As was natural at Gavarnie, we succumbed to the prevailing contagion and made arrangements to climb a mountain. In the hotel passage hung the *tarif* for the various peaks, and having decided to try Mont Perdu, a guide and porter were chosen, and the afternoon found us climbing the steep slopes near the entrance to the "cirque." Towards sundown we were high above the village and the valley, and approaching the first traces of perpetual snow. The pine trees became scarcer, and we could now see more and more of the adjacent peaks, the backbone of the Pyrenees. Opposite, but several miles away, the famous Brèche de Roland stood out on the skyline and marked the frontier of Spain. From where we now stood it looked but a mere cleft in the mountain line; but we were able to realize more forcibly the huge size of this famous breach as we passed through it on our descent from the summit of Mont Perdu the following day.

It was becoming dusk as we climbed the long snow couloir, at the head of which we were to spend the night. Away below the snow disappeared over a precipice into the gloom, and as we carefully followed the upland steps cut in the couloir by our leading guide, we felt more than one misgiving as to our position. Zigzagging up the frozen steep, and hardly daring to look round, we at length came to its upper end and scrambled on to the rocks. In a few minutes, passing a bed of edelweiss on the way, and clinging to the iron bars placed at the most critical points by the French Alpine Club, we found ourselves at the hut of the Tuquerouye—a stone cabin standing on the ridge between the vast chasm we had just emerged from and another abyss in front of us. We
CIRQUE AND FALL OF GAVARNIE, FRENCH PYRENEES
(Total Height of Fall, 1380 ft.)
were now 8700 feet above the sea, and here in this cold and lonely spot we spent the night. I urged the guides to light a fire, but the firewood had been brought from many miles away and was not to be wasted. We therefore reserved the privilege of warmth for breakfast time, and turned in for the night upon the rack of straw. We therefore reserved the privilege of warmth for breakfast time, and turned in for the night upon the rack of straw. We therefore reserved the privilege of warmth for breakfast time, and turned in for the night upon the rack of straw.

The moon had risen, and the scene from the rocks outside was one not to be forgotten. Mont Perdu, the chief summit in the Pyrenees, after the group of Maladetta, and within five feet of 11,000, rose in front of us from the gloom below, apparently within a stone's throw, but two miles away across the abyss. Cold as it was inside the hut, it was colder out, and we soon settled in for the night. Early next morning we descended hundreds of feet on to the snow fields below, and after another hard climb beyond, found ourselves cutting steps across the snow to the foot of the final dome. A little later we were at the summit.

The descent was easier: we halted for breakfast at the edge of a frozen lake; towards midday we passed a herd of "izards," or Pyrenean chamois: in the afternoon we stood within the walls of the Brèche de Roland: and by evening were once again in the village of Gavarnie.

II. The Republic of Andorra

This strange little republic lies between France and Spain in the eastern Pyrenees, its people dating their independence back to the days of Charlemagne, who thereby rewarded them for assisting him against the Moors. At
the present hour, their strength lies perhaps in their very weakness: or perhaps it may be found in the protection of their mountains: or perhaps in their possessing between France and Spain a territory not worth the fighting of a war. They pay an annual tribute of £40 to France, and another of a smaller sum to the Spanish bishop of Urgel. They are ruled on democratic principles. Each of their six parishes returning four members to the Andorran Chamber. The head of the Chamber is the first Syndic or President of the Republic, the executive power being wielded by officials known as Viguiers.

To reach Hospitalet—the village at which I intended to spend the night before crossing the Pyrenees into Andorra—involved a lonely walk of twelve miles from the railway terminus of Ax-les-Thermes. The road thither led up an immense mountain valley, in which, at a lonely turn, I overtook a French priest. He was bound for Mérens, a village three miles further on: and the thought of an hour's mutual company pleased us both.

We reached Mérens just before sunset; and when my fellow-traveller offered me hospitality at his rural dwelling, I accepted, and enjoyed a meal with him. My host hoped I would stop the night; but my object was to reach Hospitalet that evening, and to cross the mountains into Andorra the next day.

Darkness was coming on, and the little village of Hospitalet was still some miles away. As I trudged on, the road got worse. However, towards nine o'clock some straggling lights shone down the valley, and a little later I crossed the quiet cobbles of Hospitalet and found the village inn. I tumbled up some wooden stairs, and having met the landlady, was welcomed with a warmth that made up for the deficiencies of the establishment. Having satisfied my hostess with an epitome of my programme, she asked how I proposed to reach Andorra. I told her
“on foot, if possible;” when she at once suggested the more usual plan of hiring a guide and horse. I thought the idea good, and soon the stalwart Raymond was introduced as one well fitted for the work; he proved a most satisfactory guide.

We started early next morning, and in half an hour had crossed the frontier of France, and were within the confines of the Republic of Andorra. There was nothing to tell the traveller that he had reached another land except a few small and unassuming stones inserted in the ground.

All around was solitude and silence as we stumbled and panted up the bleak mountain-slopes. We were bound for the Col de Saldeu, a saddle 8200 feet above sea level, by which the track to the capital of the Republic crosses the main chain of the Pyrenees. We reached the summit about ten o’clock, and here, in the haunt of eagles, and in the region of eternal snow, we rested a few moments to admire the superb view. All around were mountains; in the distance to the right of us could be seen the great snow peaks of the Maladetta region: to the left rose the rocky crags of the Eastern Pyrenees; while far down below our feet we could now see the splendid forest valleys of Andorra.

We were soon descending the other side, and down and down we went till we had left the pass some 3000 feet above us. Our first stopping place was to be Saldeu, the first village in the Republic. We reached it about midday. It was here, I think, that we first saw the inhabitants: they were out in the fields, bringing in the harvest. Their appearance was primitive, and the head-dress of the women quaint.

The telegraph is found at Saldeu: and here we saw the single wire that connects the people, somewhat against their will, with the outer world. At the village of Escaldas we passed through large plantations of tobacco: a hot-bed,
without a doubt, of Andorran smugglers. The water, too, in this hamlet was worthy of attention: for it issued from the ground almost boiling. Near here I was shown the remains of some ancient Moorish graves, apparently lined with slate, and visible in section, protruding from the earth.

We were now approaching the capital, and I was looking forward to the event with much interest. Our arrival took the form of a state entry on a small scale; and as we proceeded up the narrow passage leading into the town, and slowly crossed the little public square (Plate XVI., fig. 2) I could see that Englishmen were scarce here. We passed up a very narrow cobbled alley, to the hotel where we were to spend the night: and I must say I was disappointed at the sight of the inn in question, when Raymond gave the signal to halt opposite what would be called in this country, not a hotel, but a "travellers' rest." In a few moments the horse was relieved of its burden, and with little urging descended an inclined plane into a dungeon of a stable beneath the eating room of the posada.

It was already growing dusk, and impatient to see and do as much as possible in the shortest time, I suggested to the guide a visit to the Legislative Chamber (Plate XVI., fig. 1.) Nothing could be easier: it was up an adjoining lane, while the key, about 15 inches long, and very quaint, was kept by the landlord of our inn. The building was dark, gloomy, and cob-webby; and we had some difficulty in finding our way up the stone steps that led to the first floor.

Whatever else the Republic is famous for—and its principal claim to fame is that it is no larger than it is—its House of Commons is managed on a really economical plan. On the first floor one room is devoted to the National School, another serves as a place in which the 24 Legislators of the Republic may either enjoy a
Fig. 1.—MAIN ENTRANCE, PARLIAMENT BUILDING, ANDORRA

Fig. 2.—AT THE CAPITAL OF THE REPUBLIC OF ANDORRA
banquet or take the oath of allegiance to their fatherland; a third apartment is the Palace of Justice; from the ceiling of another is suspended a huge hook for producing Parliamentary dinners, over an open hearth; whilst to another is reserved the honour of the seat and centre of Andorran legislation.

We returned to our inn across the public square (where the Chief of the State—an acquaintance of my guide—was to be seen upon a balcony) and awaited with impatience the preparation of our evening meal. Meanwhile I silently contemplated operations; down below could be heard from time to time the dismal braying of a donkey in the gloomy stable of the inn; around the doorway were inquisitive groups of children pressing forward to see the foreigner who had just arrived; while in the kitchen the authorities were preparing an Andorran supper. The local doctor, the guide, and myself were the only persons at table; and the meal being a triumph of Andorran culinary art, I was not sorry when it was over. Raymond then descended into the depths of the underground stable to see that all was going well with his little black mare—perhaps even to see that it had not been exchanged for a mule of the same colour—whilst I retired to bed.

We started at a very early hour next morning, crossed the frontier into Spain, and reached the ancient city of Seo d’Urgel. A further trudge of twenty miles brought us to the little town of Bellver, and after another day together on the plains of Catalonia, Raymond and I said good-bye.
POLYDACTYLISM IN CATS; AND OTHER FEATURES,

BY

REV. A. R. WINNINGTON-INGRAM.

(Read November 6th, 1900).

A remarkable race of many-toed cats has recently come under my observation. These cats have usually seven toes on each of their front feet, the extra toes being three dew claws instead of one; while on the hind feet they have six toes like ordinary hind toes, but six instead of four. The number of toes, however, is occasionally varied, for I examined one cat which had seven toes on one front foot, six on the other front foot, and the hind feet had respectively six toes and five toes.

Now it seems highly probable that this polydactylism is atavie—a throwing back to remote ancestors who were polydactylous, ancestors between the Fishes and Amphibia. We, in common with Amphibia and all descended therefrom, developed our pentadactylous condition by a gradual abortion of the digits. Yet in these days polydactylism is known among us; and in former days this was also the case; for we read in the Bible (II. Samuel, xxix., 20) of a polydactylous man "that had on every hand six fingers, and on every foot six toes, four-and-twenty in number,"
who was killed by David's nephew. The re-appearance of an ancient character is well known, and such chance re-appearance is propagated.

When I discovered that these many-toed cats existed in considerable numbers in Highnam, I set myself to discover how they originated. I was informed by a reliable person that some years ago a she Manx cat was brought to the place, and this cat, breeding with local cats, has produced a race of many-toed cats, which, nevertheless, have long tails like ordinary cats. There have been several Manx cats in the place, one of the descendants of which, with a short tail some five inches or so in length, I have seen. This cat had the ordinary number of toes; and I was informed by a person who formerly possessed one of the original Manx cats from which these many-toed cats are descended, that this Manx cat had five and four toes as in other cats. I am also credibly informed that the bridge-keeper at Saul Bridge has some many-toed cats, which are also the result of a cross between a Manx cat and a local cat.

There is, of course, always a difficulty in proving paternity of cats when they are allowed to run at liberty, because although cats live in closer relationship with man than any other domestic animals, they are less influenced by us than any other creatures. But there is no difficulty in proving maternity; and in the case of the many-toed cats of Highnam, they are undoubtedly descended from a female Manx cat, which lived at the gardens at Highnam Court.

Why the cross with the Manx cat should have produced this many-toed breed, I cannot say; but it is worth observing that the many-toed cats have always tails of the usual length.

A friend of mine, who has a landed estate near Ramsey, Isle of Man, informs me that the tail-less Manx cats are now very scarce in the Island, because when visitors see
a good specimen, they buy it and take it away. The Manx cats, besides being tail-less, are shorter on their fore-legs than ordinary cats. I may also mention that the Japan cats of Koemfer have likewise very short tails, or are deficient in those appendages altogether.

Having always been fond of cats, I have observed their habits very closely, and have remarked the strong evidence afforded, that the cat is a solitary animal. The way in which a cat takes its food is a sure sign that in its natural state it is not in the habit of associating with greedy companions. When given something to eat, a cat first smells the morsel and then takes it in a deliberate manner, and sits down to finish it at its leisure. Unless a cat has got something which it likes very much, such as a fish, a mouse, or a bird, it allows people to approach it without jealousy. And, moreover, when a cat has caught a rat or a mouse, it will often bring it into the house, and lay it down near some person of whom it is fond, and offer it to him, making at the same time a kind of humming affectionate call-note; and if the person is in another room, the cat will try to attract his attention by rubbing against him, and by this humming note, so that he may follow it to where the prey is laid.

Cats are said to attach themselves to places, and not to people, but that is only partially true. For I have a cat who is so attached to me that he will walk with me for a considerable distance; and when he has gone as far with me as he chooses, he will hide himself near the spot where I left him, and wait an hour or more for me; and when I return he will spring out of his hiding place with great demonstration of pleasure, and accompany me home. This cat is, also, so bold that he will come with me, with my gun and dogs, and stand close to me, quite unconcerned at the report of the gun, and then will rush to get what is shot.
Cats have occasionally taken to the water. Mr Bellows has kindly sent me the following interesting extract from a paper by Mr F. Sessions:

"Some years ago our firm had two large brick-yards in Gloucestershire, on the banks of the Severn. Many acres of each of them became pools of water from the excavation of the clay. A breed of web-footed cats belonged to the foreman who resided at one of the yards. These cats, generation after generation, nearly all being tabbies of very ordinary appearance, took the water almost as freely as spaniels, catching fish, and bringing them up to the cottage to eat. In order to tell whether their taking to the water was the result of heredity or of education, we had some young kittens taken from one brick-yard to the other, a distance of about two miles. We were interested to learn that, as soon as they were old enough, they went into the water as naturally as their mothers. Some time ago, our foreman left that neighbourhood, and took the cats with him. I have learned since that the cats have become extinct. I understood that he never had one of that breed that did not take to swimming and fishing, and I believe, but am not sure, diving also. Our foreman, who owned the cats, is still living [1885]: his name and address are—Stephen Skidmore, Oxford Road, Gloucester. I have myself seen the cats bring the fish from the water, and examined their paws, and it was at my own and my father's wish that the kits were carried to the other pools."*

Mr Jesse mentions a cat belonging to a miller near Fakenham, in Norfolk, who would dive into deep water after fish. This was almost a daily practice with this cat. Darwin also relates a similar circumstance of a cat, who caught trout in a stream at a mill near Lichfield. I have never personally observed an instance of this habit in a cat, but I have been told of a cat which catches fish in the Severn near Tewkesbury.

I will very shortly allude to the protective markings of cats. There can be no doubt that the ancient dwelling-place of the cat was the forest, because kittens at once

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take to climbing trees, and because most cats are mottled and striped after a fashion generally adopted by inhabitants of woods. This sort of marking is very advantageous to animals living among trees, where the light which shines through the leaves, falls in spots and streaks on the ground below. I remember reading an instance of protective mimicry in cats which greatly interested me. Namely, that when a tabby cat is curled up the dark bands on its coat arrange themselves into concentric circles or spirals suggestive of a coiled snake, which would be a protection against eagles. Also that the hissing and spitting of an enraged cat, and the display of its fangs, are another instance of its imitating a snake. In both cases the hissing is of the nature of an ultimatum.

But cats not only protect themselves, they have been deemed worthy of protection by men. Among the ancient Egyptians the cat was not only protected but worshipped. Many thousands of cats have been found embalmed in the grottoes of Beni-Hassan-el-Aamar. The chief cat-shrine was at Bubastis. To the Egyptians the cat was a symbol of the moon, its eyes expanding and dilating in the pupil like as the moon waxes and wanes. The cat's ability to see in the darkness—as generally imagined—sanctified it as an emblem of chaotic night. A cat suckling its young symbolized growth.

In Britain, too, there was a Prince, who lived about the year 950 A.D., named Howel the Good, who enacted a law that whoever killed a cat which guarded his granary should forfeit a milch ewe, with its fleece and lamb, or else as much wheat as would cover the cat when it was suspended by its tail, its head touching the floor.

I fear, however, that in these days cats do not get quite as much protection as they formerly did, for I remember once recommending a man as a gamekeeper who, for the first week in his new situation, had thirteen cats on his
vermin bill. Another keeper, who is a great friend of mine, once caught a favourite cat belonging to me in a trap. He attached a label to its collar, bearing this suitable inscription: “Keeper Dick caught me last night,” and then turned the cat loose. Much amusement was occasioned at Lassington Rectory next morning when poor Tib arrived with one foot swelled up, and the label round his neck.
RHYNCHELMIS: A RARE AQUATIC WORM,

BY

W. A. BAILY.

(Read November 6th, 1900).

PLATE XVII.

In March, 1896, my attention was drawn to a worm in my water jug, which, upon examination, appeared to have a glossy, tube-like proboscis.

The water had been pumped up from the well which supplies my house, 129 Dyer Street, Cirencester.

When the worm was submitted to Dr Benham, he wrote:—

"Department of Comparative Anatomy,
The Museum, Oxford,
March 11, 1896.

It is a most interesting worm, yeple Rhynchelmis. Nearly ten years ago Harker sent me a living specimen from your place, obtained from a well, and that was the first time that it had been observed in Britain, at any rate there is no record of it. I did not publish anything at the time, as Harker hoped to find more specimens, and proposed to write something about its habits. However, it never came off. I should be very glad to have another specimen or two. I cut sections of the original (Harker's) example; and I have preserved yours for Museum purposes. But I should like another to study, as this specimen is sexually mature, and there are one or two points that are worth clearing up, so urge your folk to bring them to you. . . . .

WM. B. BENHAM."
I remember the specimen alluded to by Dr Benham. It was found in a well at Ewen, near Cirencester, and Prof. Harker was very interested in its discovery. He made numerous unsuccessful attempts to obtain another example from the locality, dredging a neighbouring stream with a large heavy landing net. But he was unsuccessful, and so it remained until my discovery of an example in 1896.

Some three years after that, in November, 1899, two more specimens were pumped up from the well at my house. One example was about 230 mm., the other about 119 mm. in length. The larger example I sent to Dr Benham, at Oxford.* He had, however, left for New Zealand, and the parcel was opened, in his absence, by Prof. W. R. Weldon, who wrote as follows:—

"Department of Comparative Anatomy,
The Museum, Oxford,
3rd November, 1899.

As your parcel evidently contained a specimen which could not be forwarded without examination, I took the liberty of opening it.

Seeing a Rhynchelmis alive I was led to open your letter.

You will find the best account of the structure of the animal in Vejdovsky's System der Oligochaeten (Prag, 1855?), and the same writer's, Entwickelungsgeschichtliche Untersuchungen (1888-92 Prag), contains an excellent monograph of its development.

A summary of knowledge about the creature is given in Beddard's 'Monograph of the Oligochaeta.'

Yours very truly,
W. F. R. Weldon."

[* Since this paper was written I have received a note from Prof. Weldon. He says: "I have left your letter unanswered for a long time, in the hope of finding the older specimen to which you refer, but I can find no trace of it.

"The specimen you sent last year is in the Museum, properly labelled with the locality, and your name as donor. Its length is now naturally less than when alive: it measures about 22:1 centimetres in its present condition. I see no reason to doubt the identity of this worm with Rhynchelmis limosella, Hoffmeister; but I have not gone over the specific characters very thoroughly, for fear of injuring your specimen." Nov. 20th, 1900.]
The following notes on *Rhynchelmis* I have taken from 'Monograph of the Order of Oligochaeta,' by Frank Evers Beddard, F.R.S., 1895.

"Family:—**Lumbriculidae.**

**Definition:**—Aquatic *Oligochaeta* of moderate size. Setæ paired and S-shaped, sometimes with the free extremity bifid. The dorsal blood-vessel or the transverse vessels with blind contractile appendages (exc. *Stylodrilus*). Two pairs of sperm ducts (exc. *Alluroides*) uniting to open by a single spermatoducal gland on each side, which lies in front of oviducal pores. No primal setæ. It contains only eight characterised genera, viz.: *Lumbriculus*, *Rhynchelmis*, *Trichodrilus*, *Stylodrilus*, *Claparedilla*, *Phreatothrix*, *Eclipidrilus*, *Alluroides*, and *Sutroa*.

"The two distinctive characters of the family, which are not found in any other family, or genus, are the contractile appendages of the blood-vessels, and the arrangement of the *vasa deferentia*.

**Genus:**—*Rhynchelmis*, Hoffmeister.

*Syn.* Euaxes, Grube.

*? Lycodrilus*, Grube.

**Definition:**—Setæ not bifid at tip; clitellum viii-xvi [segments]; prostomium elongate; testes in [segments] ix, x; ovaries in xi; sperm sacs and egg sacs paired, extending through a large number of segments; spermi-ducal glands opening on to segment x., with a coating of glandular cells broken up into rounded masses; spermathecae, one pair opening on to seg. viii, each pouch with a single diverticulum; a single median albumen-gland opens on to seg. ix.

"The genus *Rhynchelmis* is, so far as our present knowledge goes, confined to the fresh waters of Europe; it has been met with in Bohemia, Russia, Belgium and Germany; I point out later that certain species, referred to this genus from other parts of the world, are probably not referable to it."
"I have seen a specimen from some part of England, but cannot give any details [this specimen was seen by Beddard in the Oxford Museum so long ago as 1880, when it was in the possession of the late Prof. Westwood.] There is every possibility that it is a native of this country.

"The most salient external character of the genus is the long prostomium; the peculiar form of this is sufficient to prove that Hoffmeister and Grube were dealing with the same worm in their description of Rhynchelmis and Euaxes; the same kind of prostomium occurs also in the nearly-related genus Sutroa, from North America; but nothing of the kind is found in any other Lumbriculid; in Nais proboscidea, however, there is a prostomium of the same character.

"The Nephridia are, of course, paired structures: they commence in immature individuals in the seventh, in mature individuals in the twelfth segments. The Nephridia become enormously large in proportion to the worm; they stretch so far back beyond their point of opening that on a superficial inspection each nephridium has the appearance of occupying several segments. The nephridiopores are placed in front of the ventral setæ.

"The Vascular System of Rhynchelmis is described in some detail in Vejdovsky’s original paper upon the anatomy of the worm; a figure of some additional particulars is to be found in the ‘Entwicklungsgeschichtliche Untersuchungen’ (Pl. xxviii., figs. 7, 8). The dorsal vessel is pulsatile; it communicates with the ventral vessel by a series of perivisceral trunks, a pair to each segment; after the eighth segment there are, in addition, a pair of vessels arising from the dorsal trunk, which do not end in the ventral vessel, but give off a number of contractile branches as in other Lumbriculidæ; there are six or eight pairs of these branches, which were confused by Grube with diverticula of the gut; when the worms have attained to sexual
maturity, the ninth, tenth, and eleventh segments are seen to contain each a pair of long vessels giving off a rich network, which ramifies over the sperm sacs and the other reproductive organs; the intestine has a rich plexus, derived from the paired non-contractile perivisceral trunks. The ventral vessel consists, in the first five segments of the body, of two separate halves, each half receiving the perivisceral trunk of its own side.

"The testes, at first overlooked by Vejdovsky, were subsequently recognised by him as two pairs of gonads in the ninth and tenth segments; as the worm gets to be mature, the testes disappear, their contents being transferred to the sperm sacs; the same thing happens to the ovaries, which lie in the eleventh segment.

"Sense organs of epidermis:—The cells of the epidermis are in part modified to form sense-organs.

"In Rhynchelmis there are developed, at the breeding season, continuous zones of sense-cells arranged in groups; the cells have the same elongated form that the sense-cells generally show, and appear also to possess the fine processes which arise from the epidermic cells. Vejdovsky believed that he could trace nerves into connexion with these cells.

"Nervous system (Ventral nerve-chain):—The commissures which arise from the brain and embrace the gut unite below it to form a ganglionated chain. This runs from end to end of the body; in the extreme posterior region, where a regeneration of segments is going on, the ventral nerve-cord may be often seen to lie in the thickness of the epidermis; otherwise it always lies in the body cavity. The ventral nerve-cord gives off branches in each segment. These branches arise in two different ways: in the earthworms and many of the aquatic genera they arise on either side of the nerve-cord and lie in the body cavity for a greater or shorter distance until they plunge into the thickness of the body wall."
"In Rhynchelmis the two nerves, although lying close together, are quite distinct as two nerves. They are not present in the middle segment.

"In Rhynchelmis, Vejdovsky could only find a single pair; three pairs is a much more usual number.

"Respiratory System:—In the great majority of Oligochaeta there are no special respiratory organs—the general body-surface occupying the place of a lung or branchia. When the integument is thick there are always plexuses of blood capillaries in the integument which bring the vascular system into close relations with the external medium, and presumably allow an exchange of gases. The blood is in all Oligochaeta, with few exceptions, tinged with haemoglobin.

"Reproductive System:—The Oligochaeta, like some other animals which are hermaphrodite, possess a complicated series of organs, related to the reproductive system.

"The essential organs are the ovaries and testes—the gonads—which are developed from the peritoneal epithelium, and are nearly always paired structures, and are present in all Oligochaeta.

"The ovaries are usually a single pair; but there is sometimes an additional pair. The ovaries invariably agree in position with the testes, but they are of course situated in different segments. The ovaries always lie behind the testes. In Rhynchelmis the testes are contained in segments ix, x, and the ovaries in segment xi; the male pore in segment x, the oviducal pores in segments xi, xii. The gonads are the first part of the reproductive system. The various organs, essential and non-essential, have fixed positions in the body of the worm; one organ is found always in one segment, another in a second segment, in every species, the position being characteristic of the species, or genus, or family, as the case may be.
"The Ova are now known in a large number of Oligochaeta; but it is in Rhynchelmis that they have been most thoroughly studied by Vejdovsky.

"It is a remarkable fact that the Oligochaeta can be divided into two groups according to the character of their ova. In the aquatic Oligochaeta the eggs are large, and contain an abundance of yolk; in the terrestrial forms the ova are of microscopic size, and contain but little yolk. The mature egg of Rhynchelmis, which may be selected as a type of a large yolked ovum, is spherical; it has a peripheral and extremely fine membrane, beneath which is a dense layer of protoplasm; connected with this is a protoplasmic net-work which ramifies through the entire egg, and in the meshes of which are contained the yolk spherules.

"The Cocoon:—All Oligochaeta form cocoons in which the ova and the sperm are deposited, with or without albumen set apart for the nourishment of the embryos. The cocoon consists of a chitinous substance, and is formed by the activity of the clitellum. In the cocoon of Rhynchelmis Vejdovsky has found that there is albumen, which is of course destined for the nutrition of the embryo, and is transparent.

"The cocoons of Rhynchelmis are attached to aquatic plants. The process of formation being carefully watched by Vejdovsky in the genus Rhynchelmis: the worm throws off the cocoon over its head, crawling backwards to free itself therefrom. The eggs, spermatozoa, and albumen reach the interior of the cocoon as it passes over the orifices of the respective ducts. Out of the numerous eggs which a single cocoon originally contains, only a few, sometimes only one, reaches to maturity."
There are the following species in the genus *Rhynchelmis*:

"*Rhynchelmis obtusirostris*, Menge.

*Definition*:—Length, 55 mm.; number of segments, 100; prostomium obtuse; habitat, Belgium, Germany."

"*Rhynchelmis limosella*, Hoffmeister.

*Definition*:—Length, 120 mm.; number of segments, 150; body more or less quadrangular; prostomium long; setae posteriorly reduced to one in each bundle; chloragogen covering of gut commences in the seventh segment; habitat, Europe."

According to Prof. Weldon's remark (p. 310), this is the species found at Cirencester.

With regard to its habits and food, I am at present unable to give any satisfactory information. The example of this species which was captured in November, 1899, I kept in a small aquarium in which I had placed a small amount of decaying vegetation. There it lived in confinement for just a year; and although I frequently placed it under observation I could never perceive it in the act of feeding.

As will be observed, I am indebted to Mr F. E. Beddard's Monograph for the greater portion of this paper; and I have quoted from that work sufficient to show that *Rhynchelmis* is a worm which has been studied with considerable attention, and has yielded important results from an anatomical point of view. More details can be obtained by consulting the works cited; but for the better understanding of what has been given here I append certain figures copied from Vej dovsky's work. They are given in the appended Plate XVII.
PLATE XVII.

RHYNCHELMIS

**FIG. 1** (Tafel xxi, fig. 1.)—Dorsal view of the anterior portion of a young worm: $g$ Cerebral ganglion; $vv$ Dorsal vessel; $a$ Loops of the lateral vessel.

**FIG. 2** (Tafel xxi, fig. 2.)—The same from the ventral side. $vv$ Branches of the ventral vessel; $n$ Degenerating nephridia of the anterior segments.

**FIG. 3** (Tafel xxi, fig. 3.)—Older stage of the young worm. $vd$ Dorsal vessel; $a$ Anterior; $b$ Posterior lateral vessels of a segment; $g$ Cerebral ganglion.

**FIG. 4** (Tafel xxviii, fig. 8.)—Longitudinal section through two body-segments of the adult *Rhynchelmis*, which has developed a portion of the intestinal wall with the vascular network ($dg$), the ventral vessel ($vv$), and the ventral cord ($gz$); $d$ Division of segments; $mv$ Median vessel between the intestinal network and the ventral vessel; $a$ Preseptal side vessels; $nch$ Neuro-chord; $lm$ Long muscle of the ventral chord; $m$ Ring-muscle of the ventral cord.
RESOLUTIONS CONCERNING MAPS.

At the Second Winter Meeting of the Session 1900-1901, held at the School of Science, Gloucester, on Friday, Dec. 7th, 1900, the following resolutions, proposed by C. Callaway, M.A., D.Sc., F.G.S., and seconded by Mr Chas. Upton, were unanimously carried:—

I. That this Club, having been informed that the work of the Geological Survey of the United Kingdom is under official review, desires to express the opinion that the following maps are required for the district. Their general adoption would be of great advantage to geological science, and to the material welfare of the nation.

1. One-inch map of the solid geology, the information to be put on the new ordnance maps which have contours, the contours to be very plainly lined in; the geological maps at present obtainable for this district being without contours and very inaccurate as to roads. The results of deep borings might also be inserted [by colour circles.]

2. A similar map on the six-inch scale, on which should be indicated the nature and composition of the subsoil. It is also suggested that the details of important coast or other vertical sections should be inserted in the margins of the sheets.

3. One-inch and six-inch colour-printed Drift maps. These would aid in the solution of important theoretical questions at present unsolved. They would also be of great economic value, as bearing upon water-supply, drainage, house-sites, general sanitation, and economic questions of agriculture.
4. A physiographic map on the quarter-inch scale, coloured to height, with the rivers accurately inserted, and with details as to dips, anticlines, synclines, and faults, but omitting details likely to impair the clearness of the map, such as roads, railways, canals.

II. That copies of this resolution be forwarded to the proper official quarters, as, for instance, the Director-General of the Geological Survey of the United Kingdom, the President of the Board of Agriculture, the Board of Education; also to other Scientific Societies, and that the latter be invited by circular to give it their support.

E. B. Wethered, F.G.S.,
President.

S. S. Buckman, F.G.S.,
Hon. Secretary.

Charlton Kings, Cheltenham.

The following members who were unable to be present at the meeting, but are particularly interested in the subject, desire to cordially support these resolutions:—

THE RIGHT HON. EARL OF DUCIE, F.R.S., F.G.S.
SIR J. E. DORINGTON, BART., M.P.
REV. HY. HOYTE WINWOOD, F.G.S.
M. W. COLCHESTER-WEMYSS, ex-President Cotteswold Club.
C. I. GARDINER, F.G.S.
W. L. MEREDITH, C.E., F.G.S.
C. H. STANTON, F.R.G.S.
ARNOLD THOMAS, F.G.S.
G. H. WOLLASTON, F.G.S.
[Copies of the above Resolutions were sent to the Institutions, Scientific Societies, etc., mentioned below, with the following note addressed to the Societies.]

The Council of the Cotteswold Naturalists’ Field Club beg to submit to your Society a copy of the resolutions recently passed at a meeting of the Club with regard to geological maps, and to ask your Society, if they approve thereof, to pass similar resolutions with regard to the geological maps required for your district, and to forward copies thereof to official and other authorities. The importance of the subject is evident to all Geologists, while the educational and economic value of such maps is undeniable.

The Hon. Secretary of the Cotteswold Club will be pleased to be informed as to any action your Club may take.

E. B. Wethered, F.G.S.,
President.

S. S. Buckman, F.G.S.,
Hon. Secretary.

Charlton Kings, Cheltenham.

List of Institutions, Societies, etc. to whom copies of the Resolutions concerning Maps have been sent:

Barnsley Naturalist and Scientific Society.
Bath Natural History and Antiquarian Society.
Birmingham Natural History and Philosophical Society.
Board of Agriculture.
Board of Education.
Bristol Naturalists’ Society.
British Association.
Caradoc and Severn Valley Field Club.
Cardiff Naturalists' Society.
Cheltenham Natural Science Society.
Chester Society of Natural Science.
Dorset Natural History and Antiquarian Field Club.
Dudley and Midland Geological and Scientific Society.
Essex Field Club.
Folkestone Natural History Society.
Geological Society of Liverpool.
Geological Society of London.
Geological Society of Manchester.
Geologists' Association.
Hertfordshire Natural History Society and Field Club.
Institute of Mining Engineers.
Lincolnshire Science Society.
Maidenhead Field Club.
Newbury District Field Club.
Norfolk and Norwich Naturalists' Society.
Northumberland Natural History Society.
Nottingham Naturalists' Society.
Reading Natural History Society.
Royal Geological Society of Cornwall.
Royal Society (London.)
Swansea Scientific Society.
Torquay Natural History Society.
Warwickshire Natural History and Archaeological Society.
Woolhope Naturalists' Field Club.
Yorkshire Naturalists' Union.
Yorkshire Philosophical Society.

(END OF VOL. XIII.)
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In Vols. IV to XII each volume has three parts, with the following exceptions:—Vols. VI and IX have four parts, Vol. VII has two parts.

There is also published as a Supplement to Vol. IX, The Origin of the Cotteswold Field Club, and an Epitome of the Proceedings from its formation to May, 1877, by W. C. Lucy, F.G.S. Price to Members 3s, to the Public 4s 6d.