Portrait of Thomas Wright (said to be in this vol.) appears to be missing.

See General Index i-xviii, p. 43.

PROCEEDINGS

OF THE

Cotteswold Naturalists' FIELD CLUB,

For 1877—1878.

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COTTESWOLD NATURALISTS'

FIELD CLUB

VOLUME VII

PRINTED BY JOHN BELLOWS, GLOUCESTER

1880

CONTENTS

Address to the Cotteswold Naturalists' Field Club, delivered at the Annual Meeting at Gloucester, on the 2nd of April, 1878, by the President, Sir W. V. Guise, Bart., F.L.S., F.G.S.

Gentlemen,—

In calling together the members of the Cotteswold Club for the first meeting of the present year, it affords me pleasure to be able to give a good report of our condition and finances. The latter, under the able administration of our Hon. Secretary, show a balance in our favour of about £70.

We have to lament the loss by death of our friend and colleague, the Rev. Hugh Fowler, whose presence will be much missed, as he will be personally regretted by all who knew him.

Our numbers are well sustained, and our meetings have been generally fully attended. We have for publication some valuable papers. It is upon these that our reputation as a scientific body rests, and I desire to press strongly upon our working members the importance of maintaining and advancing our reputation in this respect. It has been said that in consequence of the short time generally allowable after dinner for the reading of papers there is no time for discussion, and that in consequence some are deterred from contributing papers at all. If this be so, I would urge in reply that our communications, to be of value, should seek a calmer criticism than can be given in an after-dinner discussion; and as regards technical papers, a short abstract is sufficient at such a time, leaving the paper to be published *in extenso* in our Transactions. In order, however, to meet the views of those who think that a longer time for discussion is desirable, it is proposed, if it meets the views of members generally, to appoint two or three afternoon meetings during the season for the purpose of reading and discussing papers. This proposition will be formally brought

forward and submitted to the meeting; and if adopted, I hope it may lead men of learning and research—and we have many such amongst us—to supply the deficiency now complained of.

With these prefatory remarks, I will proceed to read my report of our meetings during the past season.

THE ANNUAL MEETING

of the Club was held at the Bell Hotel, Gloucester, on Tuesday, the 10th of April, 1877, when the President read his Address, and the usual business, including the election of officers and the fixture of meetings for the ensuing year, was transacted, on which occasion you honoured me by a renewed token of your confidence in choosing me for your President, with Dr. Wright and Mr. Lucy as Vice-Presidents, and Dr. Paine as Honorary Secretary.

The Club then adjourned to the School of Art, to hear Mr. Lucy's paper on "The Extension of the Boulder Clay and Drift over the Cotteswold Range."

Mr. Lucy referred to a former paper, read before the Club in 1869, in which he stated that he had not then found "Northern Drift" pebbles at a higher elevation than 750 feet, confirming the observations made by Professor Hall when surveying the district. Mr. Lucy also mentioned that he was not aware of the presence of "boulder clay," unless some clay which had been found in the partings of a quarry at Woodchester, with a few pebbles embedded in it, should prove to be it. The special object of his paper seemed to be the discovery of the same highly silicified clay in various parts of the Cotteswolds, including the highest point of Cleeve Cloud. This clay he had had analysed by Prof. Church and Mr. Embrey, and the result, as will be seen by the following table, showed so marked a resemblance in the percentage of silica as to leave no doubt that it was all derived from the same source; and from the "Northern Drift" pebbles being found with it, Mr. Lucy classed it as belonging to the "boulder clay" period, indicating that the whole of the Cotteswold range was submerged during that time. Mr. Lucy also traced the same clay in a gravel pit

in the vale at Frampton, which clay he believed was once on higher ground, and by the weathering of the friable Oolite rocks had been brought into its present position.

	Woodchester Park.	Cleeve Cloud.	Symonds Hall Farm.	Painswick Hill.	Frampton Gravel Pit.
Silica	70·50 ...	67·2 ...	69·58 ...	68·2 ...	69·60

Mr. Lucy further pointed out the undoubted evidence of ice action, as shown at Limbury, near Hartpury, and at Aston Magna, and other parts of the Upper Cotteswolds, and explained that striations were not found in the Gloucester area because of the soft character of the Oolitic rocks.

Mr. Lucy likewise mentioned a second boulder clay which he had found in many places in the Valley of the Severn, and then referred to the eroded surface upon which the gravels in the valley rest, which is well shown at the Cliff at Sharpness Point, and which he had traced beyond Tewkesbury. He quoted from a paper by Mr. Charles Moore, in the *Quarterly Journal of the Geological Society* for December, 1867, in which he states that "in the neighbourhood of Bath wherever the drifts are passed through they are found to lie on the upper blue marls of the Lower Lias, which present long lines of furrows channelled out either by glacial action or the effects of post-pliocene erosion." Mr. Lucy said he had noticed the same thing in Berkshire, Kent, Norfolk, and in the Isle of Wight, and expressed a confident opinion that in these planed-off surfaces he had found a starting point which would enable him to correlate the gravels of this district with those of other parts of England, a work which is now occupying his attention.

A paper was then read by Professor Boulger, of the Royal Agricultural College, Cirencester, in which he developed a plan for the preparation of a flora for the county, founded in some respects on the plan followed in Watson's *Cybele Britannica*. He proposed to divide the province into twelve districts, each distinguished by some local peculiarity—whether "marshy," "pastoral," "arable," "hilly," &c., as the case may be—and he invited co-operation from all possessed of botanical knowledge or herbaria.

The First Field Meeting of the Club for 1877 took place at

CHELTENHAM,

on Tuesday, 15th May. A large party gathered at the trysting-place, for the day was beautiful, and our eloquent Vice-President, Dr. Wright, had promised from the Windlass on Leckhampton Hill to point out and explain the physiography of the Severn Valley as seen from that spot, and to give a geological lecture on the beds composing the Cotteswold hills, at the same time indicating their co-relations with those of other districts.

Punctually at the hour the party assembled. The Doctor then directed their attention to the physical features of the Valley. First, there were the Malvern hills, which may be regarded as the miniature type of a great mountain chain, with their short slope to the east, and their long slope to the west, and the angular outline indicating the presence of the intrusive rock, the Syenite, which formed the axis of the hills, having the New Red Sandstone abutting against the eastern side, and the Silurian Limestones upheaved at various angles on the west, raised up by the eruptive rock which had elevated the chain. Coming southward the Woolhope dome could be seen, and in the western distance the highlands of Herefordshire, formed of Old Red Sandstone. Carrying the eye still southward, we come to the Silurian boss of May Hill, and the Forest of Dean, with its beds of "Old Red" and Carboniferous Limestone, and its Coal-basin. Near the middle of the Valley occur the junction beds between the New Red and the Lias, the latter formation entering largely into the structure of the Cotteswolds, and extending up to the spot whereon the party were then assembled. A few yards above this point could at one time be seen the line of junction between the Upper Lias and the Inferior Oolite; for only the uppermost parts of the Cotteswolds, on which they were then looking, are covered with Oolitic Limestone, and form the eastern side of this grand picture. Looking again up the Valley, we see Bredon Hill in the north, Churchdown projecting forward in the middle, and beyond, southward, Robin's Wood Hill, all three forming so many outliers of the

Cotteswolds, and telling how at one time these hills extended so much farther across the Vale than they do now. Here, then, was a demonstration of three primary elementary facts in geology—viz., that igneous rocks (or *fire*), aqueous rocks (or *water*), and atmospheric action (or *erosion*), have been the powerful agents that have produced this scene.

The Valley likewise (as pointed out by the lecturer) is covered by extensive beds of sand and gravel, which have been transported by water from a distance, and this gravel tells us of other times and other conditions, another climate, and other lands, for in these gravel beds are found the remains of species of quadrupeds which no longer exist, and belonging to genera that now live in tropical regions; for in these gravels have been discovered teeth and tusks of the fossil elephant, the teeth of rhinoceros, the jaws and tusks of hippopotamus, with bones of deer, oxen, and other mammalian associates.

When we examine attentively the hard rocks of the Malvern side of the Valley, we have unmistakeable evidence that the great ice sheet which once enveloped so much of the British Islands carried its graver over these rocks, and smoothed, scratched, and polished them, as it has done in other regions, and that much of the rounded outlines which the Cotteswolds now present was due to the movement of the same ice sheet which covered them during the glacial epoch, carrying its graving tools over their summits and rounding them as it moved slowly away towards the estuary of the Severn.

"These," said the learned Doctor, "are some of the more salient points which the physiography of the Valley presents when studied in a general view from our present stand-point."

Before taking their walk round the hill, Dr. Wright pointed out the structure of the Cotteswolds. "They had seen how much of these hills was composed of the Lias formation, which is divided into lower, middle, and upper beds. Now each of these divisions was again made up of subordinate beds, characterized by the forms of living organisms which had left their remains in the bed of the sea in which they existed during the liassic age. Singular forms of reptiles, and chambered shells

like the nautilus, were then abundant in the waters, and each of the stages or zones of life into which the Lias is now divided possesses specific forms that characterize it and are found in no other. The top of the Upper Lias—on which they were then standing—was covered by a bed of sand, which in certain localities—as at Frocester Hill—is overlaid by a remarkable bed, full of Ammonites, Nautili, Belemnites, and other shells. This is the true 'Cephalopoda bed' of this district, and this name should be restricted to it, as we have Ammonite beds in other parts of the section, but only one true 'Cephalopoda bed,' as originally defined. The next bed above this is the lower portion of the Inferior Oolite, known as the 'Pea Grit,' a coarse rubbly Oolite, full of flattened concretions cemented together by a calcareous matrix, forming, when it weathers, the remarkable rock called 'Pea Grit.'"

The party then moved onward to a part of the escarpment where the upper "Pea Grit" beds are well developed. At this point our colleague, Major Barnard, invited the party to luncheon at his residence at Bartlow, where the naturalists found provided for their refreshment an ample supply of "creature comforts," to which they did full justice.

After luncheon, at the Doctor's summons the march was resumed, and as the party moved along the western escarpment he pointed out all the remarkable features of the section. The "Roe-stone" bed, with its numerous beautiful small shells, very much like those on Minchinhampton Common; the rich bed of brachiopods that lies under the Freestones; the variety of fossils in the thick-bedded Oolite Limestones, indicating changes of condition in their formation;—all engaged the attention of the party at each successive point where good examples were exposed.

A sharp pull up the long slope brought the party to the summit. By the way the position of the "Oolite Marl" was pointed out; and a walk over the Upper Freestone brought them to the ground which had once been occupied by the "Upper Ragstones," which had been quarried out and removed for road material for many a long year. From hence the party

proceeded towards the northern escarpment, where a section of the "Gryphite Grit," which formed an oyster bank in the old Oolitic sea, is well exposed.

On the return to Cheltenham the carriages made a halt at the College, where a number of the members inspected the Museum; and the party then re-assembled at the Queen's Hotel, and, to the number of about forty, sat down to dinner.

After dinner, a paper was read by the Rev. Dr. Smithe, "On the Operculum of some Silurian Gasteropods," which will appear in our Transactions.

The Second Field Meeting took place at

CIRENCESTER,

on Tuesday, 26th June. On their arrival, the members of the Club proceeded to examine some extensive excavations which had lately been made on ground once occupied by Gregory's nursery gardens, situated in that portion of the town of Cirencester formerly known as the "Leauses," which has proved prolific of Roman remains, and those of a character which point to that site in particular as having been occupied by the principal public buildings of the Roman city. Here had first been brought to the light of day, from beneath the accumulated rubbish of fourteen centuries, the basement walls of some large building extending over more than a quarter of an acre of ground. The complete destruction which whelmed all in one common ruin was evident from the fragmentary condition to which even the largest worked stones were reduced; yet enough remained in portions of massive cornices and volutes to show that this must have been a building of importance. Amongst other architectural relics were four stone columns about four feet high, and portions of others. Of smaller articles were pottery, with much Samian ware, and another ware of a black colour externally, of good form, with well worked masks. On one fragment of Samian was a potter's mark (Celsiam). With these were portions of glass vessels, bronze implements, a boar's tusk, bone skewers, and a large number of copper coins, greatly

oxidized. The quantity of stone then extracted was extraordinarily great, all of which had once formed the substructure of buildings; and much yet remained to be excavated, which might be expected to yield objects of interest to the antiquary, and of a nature to explain the purpose of the buildings, the ruins of which covered so large a space of ground.

From hence the party proceeded to Preston, to the residence of Mr. H. J. Elwes, who had kindly invited the Club, of which he is a member, to partake of luncheon at his house, and to inspect his extensive collection of birds and plants. The gracious welcome which here awaited them from Mrs. Elwes added to the satisfaction with which the visitors discussed a most excellent luncheon, after which they adjourned to an apartment in which were displayed the treasures of Mr. Elwes's splendid ornithological collection. This collection contains over 3000 specimens from all parts of Europe and Asia, but is especially rich in the birds of the Eastern Himalayas, where large collections were made by Mr. Elwes in 1870 and 1876. The small State of Sikkim, which is little if any larger than Yorkshire, had yielded him a greater number of species than can be found in the whole of Europe, or in any part of the world of equal area; for it not only includes a vast range of elevation, from the level of the plains of India up to that of perpetual snow at 20,000 feet, but is in most parts clothed with a luxuriant vegetation.

The distribution of birds in Asia generally, and in Sikkim particularly, were then explained and illustrated by specimens; from which it appeared that the birds of the higher levels were mainly of European affinity; those from the middle region (1,000 to 4,000 feet) principally peculiar to the Himalayas; and that those of the lower valleys and hills belonged for the most part to genera found in the Malay peninsula and islands. Many curious and beautiful birds, and remarkable cases of geographical distribution having been commented on, the members of the Club proceeded to view the garden, which, though quite newly formed, and still unarranged, contained a collection of rare and interesting plants; among which the

bulbs alone, which are Mr. Elwes's special hobby, numbered over 1000 species. Among those then in flower which were most admired were the lovely Californian *Calochorti* and *Cyclobothras*, growing in great luxuriance, also the hardy *Cypripediums* or Ladies Slippers, and other hardy terrestrial orchids, and pitcher-plants from North America.

The collection of lilies (which forms the groundwork of the monograph of those plants which Mr. Elwes is now engaged in publishing) is the most complete in the world; and though not yet in bloom, many pretty varieties were beginning to show their flowers.

Some rare Himalayan and Alpine plants adorned the rockery, among which the miniature primrose from the north of Scotland *(P. Scotica)*, the Highland azalea *(A. procumbens)*, and the Cheddar pink *(D. cæsius)*, were of special interest to the botanists of the party.

In the greenhouse were some remarkable Cape bulbs, including a hyacinth with a spike of large white flowers four feet high *(H. candicans)*, the lovely *Disa grandiflora*, from Table Mountain, and the *Brunsvigia toxicana*, used by the Bushmen in the preparation of their arrow-poison.

Some curious little orchids of the genus *Pleione* were pointed out, which grow on the rhododendron trees up to an elevation of 11,000 feet in Sikkim; also a plant of the Himalayan asparagus *(Smilacina oleracea)*, the shoots of which furnished for some days almost the only sustenance of our greatest living botanist, Sir Joseph Hooker, during his travels in Sikkim.

After dinner, at the King's Head Hotel, Cirencester, the Rev. W. S. Symonds read a paper on the New Red Sandstone, which will appear in the published Transactions of the Club.

The Third Field Meeting for the season was held on Tuesday, 31st July, at

NEWNHAM,

where carriages awaited the arrival of the party, and a beautiful drive brought them to the section in the cutting near Flaxley, where the "Upper Ludlow" and "Wenlock Limestone" are

seen resting against the "Old Red Sandstone." Here a halt was made, and, at the request of the President, the Rev. W. S. Symonds, spoke at some length on the interesting Geology of the district around May Hill, Flaxley, the Forest of Dean, and the wide-spread vale of the Severn. "Years had passed away since he first visited that neighbourhood in company with Mr. Strickland, one of the earliest and most distinguished members of the Cotteswold Club, who conducted the old Silurian chief, Sir Roderick Murchison, to the excavations on the Gloucester and Hereford railway and the faulted rocks of 'Upper Silurian' on which they were then looking." Mr. Symonds reviewed the history of the palæozoic rocks, and glanced at the fossils they contained. Alluding to the Carboniferous period and its wonderful land vegetation, Mr. Symonds explained how, after that period had passed away—in Permian times—those great upheavals took place, the result of volcanic energy, to which we owe it that the coal-fields of South Wales, of Dean Forest, and of Bristol are brought within the reach of our mining industries.

The address closed with a description of the Severn Straits and the days of the Mammoth and prehistoric man. Mr. Symonds referred his hearers for fuller information on the subject to Murchison's "Siluria," Strickland's paper on the "Upheaval of the Malverns," Phillips's "Memoir on the Malverns," and Dr. Holl's paper in the *Quarterly Journal of the Geological Society* for 1856.

The next point made was the Camp at Welshbury. The carriages being left in the road below, a rather arduous climb brought the party to the top of the hill, and to the site of the Camp, where they were rewarded by a glorious outlook east and north over the Severn, with May Hill and its well-known clump of trees in the centre of the prospect. This place was not marked as a Camp in the Ordnance Map, and attention was first drawn to it by Mr. G. F. Playne, whose valuable paper on "the Ancient Camps of Gloucestershire," will be found in the last volume of the Transactions of the Cotteswold Club. In company with Mr. John Bellows he explored this locality about

two years before, and they had arrived at the conclusion that this was unquestionably a spot of some considerable importance immediately after the Roman invasion of Britain, and while the Severn, with Gloucester, was the western boundary of the province afterwards known as Britannia Prima. This "bury" would be the first fort with which the Romans would meet when they crossed into the country of the Silures, and conversely would be the most advanced of the strongholds from whence those untameable tribes would harry the Cotteswold folk and their masters. It is a prominent spot from many of the Roman Camps on the Cotteswold range, as may readily be seen by anyone who scans the prospect carefully. The name is remarkable, for it shows that the Britons held the Forest of Dean until long after the Saxons had possession of the opposite bank of the Severn; just as Welsh Bicknor, some miles to the north, marks a second stand made by the native tribes on the banks of the Wye. If the Saxon conquest had swept over this part simultaneously with the taking of Gloucester by Ceawlin in 577, or had even followed it speedily, such a name would not have been given to the hill; for the fact of its having once or formerly been a British Camp would have been nothing distinctive in a country where, until the Saxons came, all the Camps were alike British, inasmuch as the Britons alone had occupation of them after the Romans left the island. Clearly therefore what took place at the Saxon invasion of this district is an exact recurrence of what happened at the Roman invasion, viz., that Gloucester, with the Severn, remained for some time the limit of the conquered territory westward; and that the sons of the Silures gave to the Saxon invaders as much trouble in their further advance as their fathers had given to the legions of Claudius and his successors.

On resuming the drive the members noticed the now dry beds of the former ponds belonging to Flaxley Abbey, which served the double purpose of reservoirs for fish, and of mill-ponds for water-power required in the iron-works. The Flaxley iron-works were in use to a late period, probably later than the commencement of the present century; but the ponds near

Flaxley Abbey, in which the monks stored their fish, have, for obvious sanitary reasons, been drained, and are now represented by the beautiful green meadow in front of the house.

"Gun's Mills" were next visited, now paper mills, but marking the site of a cannon foundry, formerly the property of the crown. From this point the Club proceeded to "Tibbs Cross," at which place the Roman paving is visible under the present road-metal in many places, particularly the margin stones—like those so well seen by the Club last year in another part of the Forest—and in one part of this road the central paving itself can be well distinguished, the stones being apparently derived from the "Old Red Conglomerate." These marks of Roman occupation were examined by the Club with great interest.

Passing on from this spot, the carriages soon arrived at Littledean, and here, at a roadside hostelry, a slight lunch was disposed of. Proceeding to the crest of the hill, in a field near Dean Hall, the Club examined the small circular Camp which is noticed by Mr. Playne in the last number of our "Transactions," where he describes it as not unlike a large circular tumulus, with a ditch six feet deep, surrounding a mound twelve feet high, with an enclosed area of seventeen yards in one direction by twenty-two in another. There is an entrance from the south-east, and the outer sides are steep, being from eighteen to twenty feet above the ditch. It is the smallest Camp in the county; and it is noticeable that the enormous strength of the rampart is very much out of proportion to the enclosed area. There are many hill forts of this kind elsewhere in England and Wales; this was probably used as a stronghold for a small force, and probably as a signalling station. No doubt it was British, that is a Camp of the Silures; and the road down to Newnham traverses the line of what must have been a British trackway to the ford or crossing-place of the Severn at Arlingham. Tacitus, describing this kind of stronghold formed and occupied by Caractacus, says: "They fortified themselves on steep hills, and wherever there was any possibility of access they constructed great banks of stones." In this curious Camp the stones of which the ramparts are constructed

are small, for the early Britons were deficient in quarry tools, while the Romans employed for their purpose much larger stones, and those for the most part squared.

On their way from this point to Newnham the party halted at a spot known as "The Pleasant Stile," and there lingered awhile to enjoy the magnificent prospect, so well known to those to whom this locality is familiar. The mists which had prevailed during the early morning having lifted, the grand outline of the Cotteswold range could be traced from beyond Cheltenham to Cam Down and Stinchcombe, while the rich vale of Gloucester with the silver windings of the Severn, lay glowing in the sunshine far beneath.

A move was presently made to Newnham, and half an hour was spent in the churchyard and church; the latter, once very interesting, has been so completely "restored," that scarce a vestige of the original structure is left to attract even the passing notice of the antiquary.

A dinner at the Victoria Hotel brought to a close this most agreeable and instructive field-day.

The Fourth and last Field Meeting of the season was held at

TINTERN,

on Thursday, 23rd of August. On the arrival of the members of the Club at the Chepstow station, a brake was in readiness to convey the party to Tintern. Having arrived at the Abbey, the President, Sir William Guise acted as guide over the ruins, and read to those present such notes on the Abbey and its founders as he had been able to gather from authorities within his reach.

It is strange how little is recorded or known of the Cistercian Abbey of Tintern. It is connected with no great historical event, nor, with the exception of the great houses which were its founders and principal benefactors, is any name of note associated with it. The records of the Abbey, with the names of its Abbots, are lost; Dugdale shows that the Abbey was founded by Walter de Clare in 1131—but of this, first built Abbey, no recognizable portion is now left. How it has so entirely

disappeared, there is no record to tell; but, it may be held as certain that the existing building dates from 1269, when it was commenced by Roger Bigod, Earl of Norfolk, a descendant of Walter de Clare, and was completed in 1287, when Mass was celebrated in the church for the first time. Thus it sprung into existence at perhaps the noblest period of English architecture, and to this is due the happy uniformity of its style, and the graceful simplicity of its lines. The East window before the great altar is described as having contained eight glazed panels, with the arms of the founder Roger Bigod. Heath states that the church was famous for tombs and monuments of several great personages, amongst whom may especially be named, Walter de Clare, the founder; Gilbert, Earl of Pembroke; his brother Walter Marshall, fifth Earl of Pembroke; and his brother Anselme, the last Earl of the name; and William Herbert, Earl of Pembroke, who being taken prisoner in the wars of the Roses, at Danes Moor, in Northamptonshire, was executed with Richard Woodville, Lord Rivers and his son, and his own brother, in 1469, by order of the Duke of Clarence, and the Earl of Warwick, then in revolt against Edward the fourth.

Leaving Tintern the party proceeded to Chepstow Castle, a grand feudal pile, occupying an imposing position, but void of all historical celebrity until the period of our Civil War, when it was carried by assault by the Parliamentary Forces, and its Governor Sir Nicholas Kemys, with 40 of his men were slain. It afterwards became the prison of Henry Martin, one of the members of the High Court of Justice, before which Charles the I. was arraigned, and one of those who signed the warrant for his execution, and his confinement here is now regarded as the most memorable event in connexion with Chepstow Castle.

The Club dined at the Beaufort Arms, Chepstow. After dinner Rev. Dr. Smythe read a paper on the "Distribution of the Liassic Brachiopoda in the Cotteswolds with a description of some species new to our fauna."

The object of the writer in this paper, has been to obtain—as regards the class of fossil Brachiopoda—an exact record of the

first appearance of a given fossil species, its subsequent recurrence, and its final disappearance or extinction; using these factors as contributions towards the life history in geological time, of each species. This he has carefully done, and has exactly tabulated the results for the Lias of the Cotteswold; each species being marked in the zone in which he has found it. As a supplement to the table of Brachiopoda, the writer has added an account of some species new to the fauna, or rare, selected from the thirty-five species recorded from Churchdown. The descriptions, references and synonyms, make up the rest of the paper; which is a valuable contribution to that branch of Geological Science of which it treats.

This was the last meeting of the Club for the year 1877—and thus terminated a season which has not been without pleasure or profit, nor wanting in solid contributions to the scientific reputation of the Cotteswold Club.

Report of progress towards the completion of the Flora of Gloucestershire, communicated to the Annual Meeting of the Cotteswold Naturalist's Field Club, April 2nd, 1878, by

G. S. BOULGER, F.L.S., F.G.S.,

Scientific Club, Savile Row, W.

Mr. President, Gentlemen,—

I am happy to say that the appeal for help towards a proposed county Flora, which I made at our last annual meeting, has been most amply responded to. This is evidenced by nearly 70 letters which I have received on the subject, from nearly 30 different persons. I am glad to say that my intentions and "Preliminary Notes" were well noticed in the local and scientific papers, including the *Journal of Botany*, the *Gardener's Chronicle*, *Nature*, and the *Globe*. On the day preceding our Cheltenham meeting I was kindly permitted to examine the herbarium of Miss Millard at Gloucester and on the day following that meeting I made the acquaintance of Mr. Allen Harker who had, I found, been some time collecting materials for a Flora. We decided on a joint work and some twenty letters have been written by each of us to the other in the progress of our plans and their partial execution.

We are particularly indebted to Major R. C. Barnard, who has made over to us the result of many years work round Cheltenham, to James Cubitt, Esq., of Loughton, Essex, for a list from Bourton-on-the-water, to Professor J. F. Duthie of Saharanpur, formerly of Cirencester and to Mr. T. F. Elton of the same town for lists from that neighbourhood, to the Rev. H. Ellacombe of Bitton for a list from that district, to W. E. Green, Esq., of Bristol, to Dr. Edwin Lees of Worcester, to Miss Millard, to J. Onions, of Bromsberrow, to Miss Ormerod and Miss E. A. Ormerod, formerly of Sedbury Park, and to G. S. Wintle, Esq. Help has also been promised by Professor Buckman, F. Townsend, Esq., and the Rev. W. H. Purchas.

My colleague, Mr. Harker, has been able, by the kindness of W. C. Lucy, Esq., to make a thorough examination of the herbarium collected about ten years ago by Dr. G. O. St. Brody. This grand collection, comprising 1036 species and 105 varieties, was meant to be the basis of a county Flora, but the plan was abandoned, as was also a Flora of Clifton, commenced by Mr. M. J. Barrington-Ward. Mr. Harker has also examined the herbaria of the Gloucester Museum and of the Philosophical Society. We have also lists of the Cheltenham College Herbarium and that of the late Dr. S. P. Woodward at the Agricultural College, Cirencester. Mr. Harker has been further engaged in tabulating his observations, made during four years, in assisting correspondents and in observing the *Juncaceæ*, *Naiadaceæ*, *Cyperaceæ*, *Gramineæ*, and *Umbelliferæ*, especially the aquatic forms in the canals, along which he has made several canoe excursions. He has also made a search through the Proceedings of the Club since its foundation, for all allusions to county plants, in which he has again to thank Mr. Lucy for loan of Proceedings.

I, for my part, have been engaged in examining the British Museum Herbarium for Gloucestershire specimens, and in drawing up, in a tabular form, lists of the floras of Gloucestershire and the eight adjoining counties. Whilst prosecuting the former work I have been much indebted to the courteous counsel and aid of the officials of the Botanical Department, especially to Dr. Trimen and Mr. James Britten, and to the ever-ready advice of the Rev. W. W. Newbould, whose work is always at the disposal of others. To Mr. T. B. Flower of Bath, the Rev. T. Preston of Marlborough, Mr. James Britten and A. French of the Botanical Department, British Museum, I am indebted for lists of the floras of Somerset, Wilts, Berks and Oxfordshire.

I have commenced a chronological examination of general works on British Botany, some of the results of which I hope shortly to lay before you in the form of a History of Botany in Gloucestershire.

The general result of our work is that we now have records within the county of 1065 species of Flowering Plants, Ferns, &c.,

Lycopods and Horsetails, out of the 1665 forms numbered as species in the seventh edition of the London Catalogue of British Plants. We have also some 36 other species, out of the 210 in the lists of "excluded species" of that work, or not mentioned in it; and 131 varieties out of 558 lettered in the Catalogue, besides 9 not there mentioned. Among these forms are all those whose existence in the county was queried by me last year.

These statistics show that much is yet to be done with reference to varieties. We have far more records of rare, beautiful, and conspicious plants than of common weeds. Our information, moreover, comes mainly from the neighbourhood of our larger towns. Thus, having determined to adopt the twelve hydrographical districts *as laid down on the map* accompanying my "Preliminary Notes,"* *excluding all outlying parts* of the county, such as the parish of Minety, we find our information thus distributed:

I. Chipping Camden, or Upper Warwickshire Avon and Stour District, very badly represented; but some help anticipated from Mr. Townsend. There are also some localities in Dr. Lees' Flora of Worcestershire.

II. Cheltenham, Tewkesbury and Winchcomb, or Chelt and Lower Warwick Avon District, well represented by Professor Buckman's Flora, a list from Dr. Lees, Major Barnard's list and other sources.

III. Newnham and Newent, or West Severn District fairly worked by Mr. Harker and others, with a list by J. Onions from Bromsberrow and localities from the Rev. W. H. Purchas and others.

IV. Vale of Gloucester District very well worked.

V. Vale of Berkeley, or Tortworth Avon District not well represented. Some information from near Dursley and help promised by H. Jenner Fust, Esq., Junr. of Falfield, whom I hope to visit this summer.

* Owing to a slight error of mine the boundary between districts VIII and IX will be modified; so we must ask for *exact* localities in the country between Tetbury, Boxwell, Oldbury, Didmarton and Shipton Moyne.

VI. Forest of Dean District not well represented. A list in Woolhope Club Transactions and some notes from the Misses Ormerod; but more information must be obtained.

VII. East Wye District represented by a very perfect list by the Misses Ormerod from Sedbury and the Chepstow district, but very few localities recorded north of Coleford.

VIII. Bristol Avon District very well represented by Swete's *Flora Bristoliensis*, lists by the Rev. H. Ellacombe, W. E. Green, Esq., and other matter.

IX. Stroud Water and Frome River District well represented by notes in many books, the herbarium of the Misses Smith of the Highbeeches, Nailsworth, and that of Dr. Playne of Maidenhead, for information as to which I am indebted to G. F. Playne, Esq. These I hope to examine shortly. Professor Duthie, Mr. Harker and myself have collected in this district and we have also the help of resident collectors at Stroud and Birdlip. Information is, however, wanted from the neighbourhood of Tetbury and Didmarton.

X. Cirencester, or Churn and Upper Thames District well represented by Dr. Woodward's Herbarium, lists by Professor Duthie, Mr. Elton and myself, notes by Professors Buckman, Thiselton Dyer and others.

XI. Fairford and Northleach, or Coln and Leach District very poorly represented, almost entirely by a few of Major Barnard's localities round Dowdeswell and Sevenhampton in the north. I hope partly to remedy this soon by a few day's excursion between Northleach, Fairford, Lechlade and Burford.

XII. Stow, or Windrush and Evenlode District poorly represented by Mr. Cubitt's list from Bourton-on-the-Water and a few notes in the *Botany of Cheltenham.*

We hope that Mr. Townsend and ourselves may do something towards filling the hiatus.

With such information, or prospects of it, we have commenced our work, giving detailed localities, authorities, early records, notes on varieties and exceptionally interesting physiological points and soil, as in the specimen page we can now lay before you. We propose also giving diagnostic notes to aid

in the discrimination of the more difficult forms,—*Carex* and *Potamogeton*, *Orchis incarnata* and *O. latifolia*, for instance.

We also contemplate a brief introduction on the geology and physical geography of the county as bearing on the Flora, such as is given in all our best local floras. This extensive subject will be necessarily much condensed, but references may be given to a select bibliography. Mr. W. C. Lucy and Mr. Witchell have kindly given aid and advice in this branch of our work.

We believe our work will occupy altogether from 250 to 350 pages, crown 8vo. and that this size and form is essential to its use for field work. We propose that it shall include a thoroughly good map, giving my district lines, the surface geology, distinguishing the Northern Drift and the Oolite Gravels, and as much topographical detail as possible.

It may also be desirable to have lithographic plates from Mr. Harker's drawings of some critical forms.

We hoped that our work might have been published by the Club, as the representative body of all branches of local natural history; but the necessity that our numerous observations should be placed within the reach of a wider circle of readers renders this impossible. We, therefore, merely ask the support and co-operation of the members of the Club for our publication.

The Flora of Gloucestershire.

Order I.—RANUNCULACEÆ.

Herbs, with alternate leaves, except *Clematis*. Usually acrid. 45 British sp., 37 in county.

Clematis, *L.*

C. vitalba, *L.*—Traveller's Joy, Old Man's Beard, Honesty. June—Aug. Hedgerows and plantations, mostly on limestone; general and abundant, climbing occasionally to a height of 30 or 40 feet round trees. *Comp.* 79 *Top. Bot.: E.*, Buckman; *W.*, Rogers. *Herb. St. Brod.* Common in all the districts, but strikingly absent on the cornbrash—Duthie.

Thalictrum, *L.* Meadow-rue.

1. **T. minus,** *L.*—July—Aug. Small rocks and sandy shores. S. limit in Devon, Somerset, and Hereford. *Comp.* 79 *Top. Bot.: W.*, Thwaites' Cat. *Herb. St. Brod.*

VIII. St. Vincent's Rocks—*Herb. St. Brod.* and *Flor. Bris.* Probably sown from Cheddar—Thwaites. This is var. β of Lond. Cat., *montanum*, Wallroth; *calcareum*, Jordan.

2. **T. majus,** *Sm.*, "*Jacq.*"—Rocks. *Comp.* 79 *Herb. St. Brod. Herb. Mus. Brit.*

IV. Crickley Hill—Dr. St. B., 1864, *Herb. St. Brod.; Herb. Mus. Brit.* This is the var. α of Lond. Cat., *flexuosum (Bab. Man.)*

3. **T. flavum,** *L.*—July—Aug. Marsh. S. limit Devon and I. of Wight. *Comp.* 80 *Top. Bot.: E.*, *W.*, Thwaites' Cat. *Herb. St. Brod.* Banks of Severn—*Herb. St. Brod.* This is var. α Lond. Cat., *sphærocarpum*, Syme, with broadly oblong achenes.

II. Combe Hill, Canal, and banks of Severn—Barnard.

IV. We have seen specimens.

VIII. Banks of Avon—Ellacombe. Sandy Lane, Baptist Mills, and R. Frome at Stapylton—*Flor. Bris.*

XII. Bourton-on-the-Water—Witts, in *Buck. Chelt.* Meadows by road from Bourton to Little Rissington—Cubitt.

On some Archæological remains in Gloucester relating to the burning of Bishop Hooper. *Read at the Annual Meeting of the Cotteswold Club, at Gloucester, 1878. By* John Bellows.

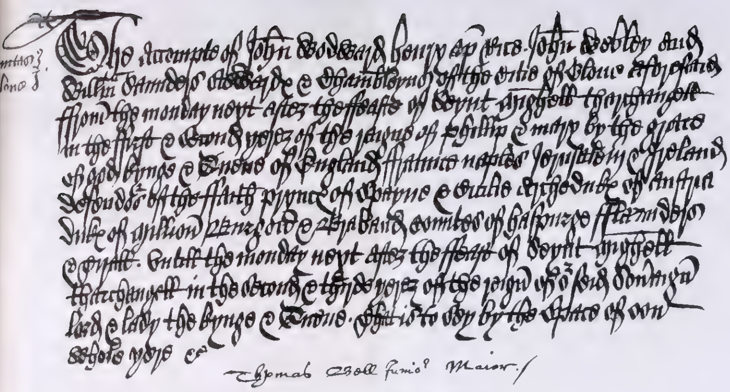
Among the objects of archæological interest lately added to the Museum at Gloucester, is one which is probably unique of its kind, as coming down to us from the time of the persecution by which Queen Mary Tudor, under the guidance of Cardinal Pole and the Roman priesthood, strove to drive back the torrent of the Reformation.

One of the foremost marks of vengeance during this period was John Hooper, the Protestant Bishop of Gloucester, who was burned to death in this city in the year 1555, upon a spot just outside the Cathedral precincts, formerly known as "St. Mary's Knapp." Nearly three centuries after this event, and during the removal of the "Knapp" or *mound* in question, the labourers employed in making the alteration struck upon a quantity of wood ashes, below which they found, firmly embedded in the ground, a portion of the stake itself, to which the sufferer had been fastened. It is this portion of the stake at which Bishop Hooper was burned, that has just been presented to the Gloucester local Museum; and the history of which, in the interval since its discovery, it is the purpose of the present paper to place upon record.

The chief source of information which we have of the details of the martyrdom of Hooper, is the well-known work of Foxe, who was personally acquainted with him, and who appears, from internal evidence in the narrative, to have had his account of Hooper's closing scene from a *Gloucester* man who was probably an eye-witness of the execution.

It so happens that within the last few weeks I have been permitted, by the kindness of the Town Clerk of the city, K. H. Fryer, to examine the oldest book of accounts which now remains among the Archives of Gloucester. This is a folio volume, which begins with the fourth year of Edward VI. and goes on to the time of Elizabeth. It therefore takes in the entire reign of Queen Mary, which, after her marriage was officially styled the reign of "Philip and Mary;" and on searching under the latter heading I have found a page containing some entries relating to the bringing down of Hooper from London, and to expenses for the morning and afternoon of the day that he was "brente." This page, together with the heading of the year's account to which it belongs, has been carefully lithographed in facsimile to accompany the present paper: and the reader will find on examining some of the items contained in it, a remarkable confirmation of the accuracy of the account given by Foxe, coming as it does from a source not only entirely independent, but in its very nature impartial. These entries relating to "Maister Hooper," as he is styled, occur in the midst of a multitude of other business matters, such for instance as receipt of moneys for town dues, fees paid on entry into office, and the like; and expenditure for repairs of the "key," and of the city walls, &c. One item preceding the 50th page here shown, is for the *bottom of a trow,* bought to make a roadway across the Westgate Bridge during the rebuilding of a portion of it; and as the reader may note, the last two lines on the facsimile record the payment of twelve pence to "oon" for going "to Tewkisbury after an Oisterbote that stole a wey from the key;" the captain of the said boat having by some means forgotten to pay the corporation the quantum of oysters required for the city dues, before continuing his voyage from Swansea to Tewkesbury.

The accounts seem to have been officially posted into this volume after having been examined and passed in the day-books kept by the Stewards and Chamberlains of the city; and the total of each series of items is given in large letters at the foot, as a check to the balances. They were evidently better looked after than used often to be the case with the Parish accounts of a



Civitas Glouc

The accompte of John Wodward Henry ap Rice John Wetley and Willm Sawnders Stewards & Chamberleyns of the citie of Glouc aforesaid ffrom the monday next after the ffeaste of Seynt Myghell tharchangell in the first & second yeres of the raygne of Phillip & Mary by the grace of god kynges & Quene of England ffraunce naples Jerusalem & Ireland defendors of the ffaith prynce of Spayne & Cicile Archedukes of Austria duke of Million Burgondie & Brabant Countes of Haspurge fflaunders & Tyroll untill the monday next after the ffeaste of Seynt Myghell tharchangell in the second & thirde yere of the reign of our said Sovereign lord & lady the kynge & Quene That is to say by the Space of oon whole yere &c

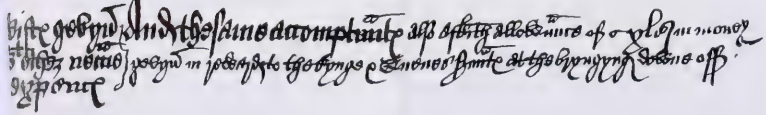
Thomas Bell Junior Maior./

Civitas } [illegible] of John Wodward Henry a[illegible] John Wetley and
Glouc } [illegible] Steward[illegible] & Chamberleyn[illegible] aforesaid
[illegible] Myghell tharchangel
[illegible] Mary [illegible]
[illegible] Ireland
[illegible] Archedukes of Austria
[illegible] Flaunders
[illegible] Myghel
[illegible] said Sovraigne
lord & lady the Kyng & Quene [illegible] the Space of oon
[illegible]

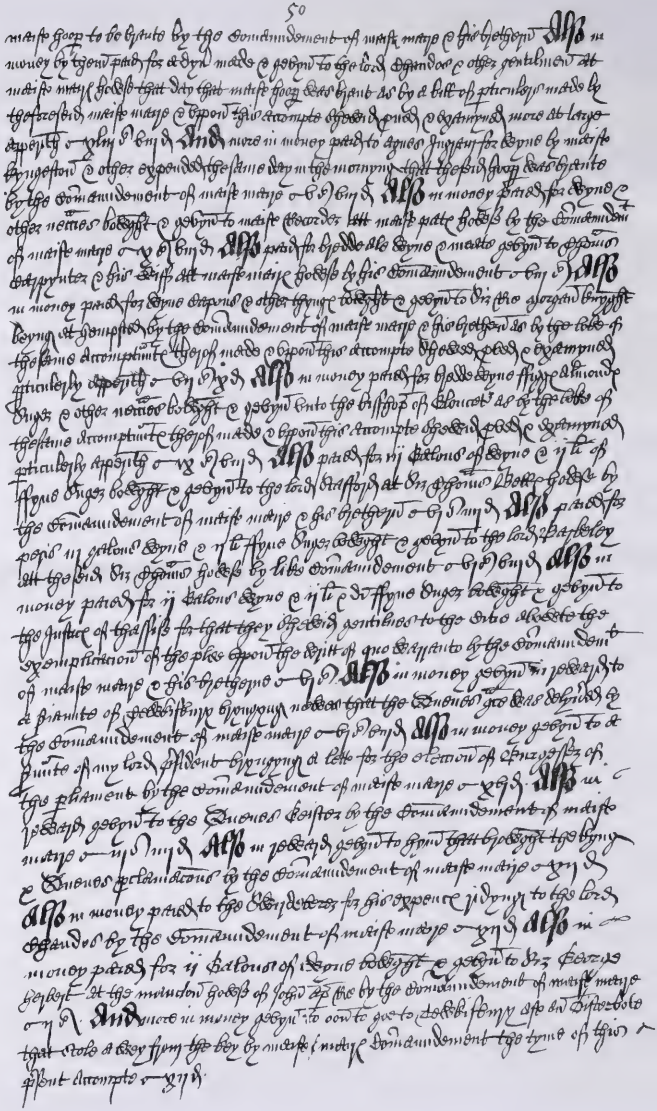
Giftes geven } And the same accomptaunte axeth allowaunce of [illegible] in money
wt other necess } [illegible] rewarde to the kynge and Quenes [illegible] at the bryngyne downe off
expences }

[illegible]

master Hoop [illegible] commaundement of master maire & his brethern **Also** in
[illegible] Chandos & other gentilmen at
[illegible] a bill of [illegible] made by
[illegible] examyned more at large
[illegible] **And** [illegible] for wine by master
[illegible] the said Hoop was [illegible]
[illegible] **Also** [illegible] paid for wine &
[illegible] master Pates howse by the comaundemt
[illegible] **Also** [illegible] & meate geven to Thomas
[illegible] Comaundement o viijd **Also**
[illegible] geven to Sir Ric Morgan Knyght
[illegible] & his brethern as by the boke of
[illegible] shewed pvsd & examyned
[illegible] **Also** [illegible] wine fygges almondes
[illegible] of Glouc as by the boke of
[illegible] pvsd & examyned
[illegible] **Also** [illegible] & ij li of
[illegible] Sir Thomas Belles howse by
[illegible] **Also** paied for
[illegible] geven to the lord Barkeley
[illegible] **Also** in
[illegible] bought & geven to
the Justice [illegible] to the citie aboute the
[illegible] the writt of quo warranto by the comaundemt
[illegible] **Also** in money geven in reward to
[illegible] that the Quenes grace was delyvred by
[illegible] **Also** in money geven to a
[illegible] for the election of burgesses of
[illegible] **Also** in
[illegible] master
[illegible] **Also** in reward [illegible] the Kyng
[illegible] master maire o xijd
Also [illegible] his expence rydynge to the lord
[illegible] master maire o xijd **Also** in
[illegible] to Sir George
[illegible] of John ap Rice by the comaundement of master maire
o [illegible] **And** [illegible] to go to Tewkesbury after an Oisterbote
that stole a key from the boy by master maires Comaundement the tyme of this
present accompte o xijd



Gifte geven } **And** the same accomptaunte axe allowaunce of — xl s. in money
& other necess } geven in rewarde to the kynge & Quenes [illegible] at the bryngyng downe off
expence }



50

maister Hoop to be [illegible] by the comaundement of maister mayre & his bretheren **Also** in
money by them paid for a dyn made & geven to the lord Chandos & other gentilmen at
maister mayre house that day that maister Hoop was [illegible] as by a bill of particlers made by
the foresaid maister mayre & upon this accompte shewed pused & examyned more at large
appereth — xlvj s. viij d. **And** more in money paid to Agnes [illegible] for wyne by maister
Kyngeston & other expended the same day in the mornyng that the said Hoop was [illegible]
by the comaundement of maister mayre — v s. viij d. **Also** in money paied for wyne &
other necessaries bought & geven to maister Recorder att maister Pates house by the comaundement
of maister mayre — x s. viij d. **Also** paid for brede ale wyne & meate geven to Thomas
Carpynter & his wiff at maister mayre house by his comaundement — viij d. **Also**
in money paied for wyne capons & other thinges bought & geven to Sir Ric Morgan knyght
beyng at Gloucester by the comaundement of maister mayre & his bretheren as by the boke of
the same accomptaunte therof made & upon this accompte shewed pused & examyned
particulerly appereth — xxxiij s. x d. **Also** in money paied for wyne ffyges almondes
sugar & other necessaries bought & geven unto the bisshop of Glouc as by the boke of
the same accomptaunte therof made & upon this accompte shewed pused & examyned
particulerly appereth — xx s. vj d. **Also** paied for iij galons of wyne & ij li. of
ffyne sugar bought & geven to the lord Stafford at Sir Thomas Belles house by
the comaundement of maister mayre & his bretheren — vj s. viij d. **Also** paied for
[illegible] iij galons wyne & ij li. ffyne suger bought & geven to the lord Barkeley
att the said Sir Thomas house by like comaundement — vj s. viij d. **Also** in
money paied for ij galons wyne & ij li. & di. ffyne suger bought & geven to
the Justice of thassise for that they shewed gentilnes to the Citie aboute the
exemplificacion of the plee upon the writt of quo warranto by the comaundement
of maister mayre & his bretheren — vj s. **Also** in money geven in reward to
a servaunte of Tewkesbury bringing newes that the Quenes grace was delyvred by
the comaundement of maister mayre — vj s. viij d. **Also** in money geven to a
servaunte of my lord president bringing a lettre for the election of Burgesses of
the parliament by the comaundement of maister mayre — xx d. **Also** in
reward geven to the Quenes Jester by the comaundement of maister
mayre — iij s. iiij d. **Also** in reward geven to them that brought the kyng
& Quenes proclamacons by the comaundement of maister mayre — xij d.
Also in money paied to the Sargeaunte for his expence rydyng to the lord
Chandos by the comaundement of maister mayre — xij d. **Also** in
money paied for ij galons of wyne bought & geven to Sir George
Herbert at the Inholders house of John ap Rice by the comaundement of maister mayre
— xij d. **And** more in money geven to one to go to Tewkesbury after an Oisterbote
that stole a key from the boy by maister mayres comaundement the tyme of this
present accompte — xij d.

generation or two ago, such as those of Daylesford ; where the overseers once got into such hopeless confusion that an official was sent down from London to examine their books. At the bottom of a page he struck out an item upon which they had relied as their only means of getting a balance, and which ran thus:

"*Maumbled away*" ..... so and so .....

The event recorded by FOXE, and the records relating to it in this book of the Gloucester city expenditure, date back for more than three hundred and twenty years; but before entering on the comparison of them, it may be well to say a word or two as to the general trustworthiness of the Martyrologist as an historian.

As must be expected in a work of such magnitude as the Acts and Monuments, there are inaccuracies as to dates: for in compiling from a multitude of sources, not a few of them oral descriptions, it is not possible in all cases to fix the exact dates, even when the facts themselves are beyond doubt. Probably every one who reads these lines can recall many circumstances which have occured within his own positive knowledge, and yet of which he would be unable to specify the times when they happened.*

The points we look for in an historian, as tests of his trustworthiness, are, first, his ability, and next, his honesty. No one who examines the Book of Martyrs, as it is popularly called, will feel any doubt that FOXE was a man of vast reading; and the position he held in the esteem and friendship of men who were the great stars in the reign of ELIZABETH would be evidence of

* Inaccuracy in dates *arising from lack of means at hand for fixing them*, is easily distinguished from the discrepancy in dates that results from an endeavour to manipulate facts. A writer in a local newspaper, some time since, to show that EDWARD VI, or those under him, persecuted, made a statement that during his reign certain Anabaptists were burned; and that JOHN LAMBERT was put to death for disbelief in transubstantiation. Now as the Anabaptists were burned in 1535, and JOHN LAMBERT in 1538, according to this writer EDWARD VI must have signed the death warrants of the former, *between two and three years before he was born*, and that of the latter *nine years before he became King.*

his ability, even had his book not come down to us;—such as WALSINGHAM, and DRAKE, and Secretary CECIL, who obtained for him a prebend at Salisbury. GRINDEL, WHITGIFT, and GRESHAM were all intimate with him: and but for his extreme conscientiousness he might have occupied one of the highest positions in the Church of England. He could not however subscribe to the service book of EDWARD VI, or to the canons of Archbishop PARKER: and we have clear proof of his honesty in his answer to the latter when called upon to do so: "I have nothing but a prebend at Salisbury: and if you like to take it away, much good may it do you." Toleration at that time was but faintly beginning to show itself after a banishment from the world of some centuries; but the bishops of the new order had the good sense not to persecute FOXE, and he was left in possession of his prebend, though never promoted.

We have further the direct testimony of the men nearer to his own time, who were in the best position to judge of his accuracy: such as STRYPE and BURNET; as well as that of one of our best modern historians, JAMES ANTHONY FROUDE. STRYPE says FOXE was "a most painful [*i.e.* painstaking] searcher into records, archives, and repositories of original acts and letters of state, and a great collector of MSS.....and as he hath been found most diligent, *so most strictly true and faithful in his transscriptions.*" FROUDE writes, as the result of his twenty years constant comparison of FOXE's statements with those of original documents from which they were taken:

"I have already said that *whenever* FOXE prints *documents*, instead of hearsays, I have found him UNIFORMLY TRUSTWORTHY."

Vol. v., p. 505., crown 8vo. edit.

What makes it needful to dwell somewhat fully on FOXE's accuracy is the circumstance that it has of late years been made a question of party bias rather than one of scientific examination. When men *wish* to disbelieve certain facts, they cease to be competent judges of the character of one who witnesses to such facts; and assuredly the writers who openly declare their hatred of the Reformation, and of the men who suffered in order to its accomplishment, are bound by their position to profess a disbelief in FOXE's history.

One of this school (LITTLEDALE) who states that he and his colleagues are trying to restore "the forgotten worship" [*i.e.* Romanism] in the Anglican church, in a pamphlet "on the Reformers," speaks of FOXE as a "*matchless liar.*" We may estimate the worth of this statement from the general tenor of his book. He states that the leading Reformers left the chief men of the French Revolution "far behind, in cruelty, impiety, and licentious foulness;" that LATIMER was a "coarse, profane, unscrupulous, persecuting bully," and CRANMER a "thief" and a "liar." He apologises for the doings of Queen MARY on the ground that she had reason to believe it her duty to purge the land of the "horde of licentious infidels" whom she burned to death.* This writer, after declaring that the reading of the Bible in the vulgar tongue led to a great increase of crime in the country—especially of "murder and adultery" goes on to speak of FOXE's Martyrology thus:

> "So much for the Bible reading, *joined on, as we must remember to the encouraged perusal in the churches* of that magazine of lying bigotry, *Foxe's Acts and Monuments*, a book which no educated man now living, possessed of any self-respect or honesty, does otherwise than repudiate with contempt and aversion, but which was then put on a practical level with the scriptures."

There is something grotesque in thus first describing the Bible as so *bad* a book that reading it led to an increase of crime in the country: and in the next sentence implying that it is so *good* a book, that the putting a magazine of lying bigotry on a practical level with it was deserving of severe censure. Absurd however, as is LITTLEDALE's inference, the fact to which he calls attention is one of great weight as a testimony to the general trustworthiness of FOXE. That fact is this: the council of QUEEN ELIZABETH regarded the *Acts and Monuments* as so fair and unimpeachable that they ordered a copy of it to be placed for public perusal in the common halls of all Archbishops, Bishops, Deans, Archdeacons, Heads of Colleges, etc.,

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* "Once more, dwell as much as you will on MARY's three hundred victims. She honestly thought (and she had a good deal to make her think) that she was saving the christian religion from a horde of licentious infidels."
Littledale on the Reformers, p. 20.

throughout the kingdom. No other work in the range of history has ever had so severe a test as this; for common sense will show that if its statements were incorrect, thousands of witnesses would have risen up against them in every district in which the alleged martyrdoms were said to have taken place. Not only were the events themselves fresh in the memory of all men then living; but out of the entire body of the clergy in England, some *eight* or *nine thousand* had been the Roman Catholic priests of the days of QUEEN MARY, having kept their livings by giving in their adherence to the new form of worship on the accession of ELIZABETH; and these men would have risen as a legion of witnesses against the book if its contents had not been beyond dispute. The great statesmen like LORD BURLEIGH and WALSINGHAM, with whose knowledge this step was taken, were by no means deficient in wisdom to hit upon such a method of witnessing to all posterity the facts which had been of such vital importance in the national history. We must remember that they had to deal with a body of Jesuits, who were not only plotting against the life of the Queen, but who were capable of any craft or deceit to hide the truths which so inconveniently told against their party. In the reign of MARY a terrible body of evidence against the monasteries, had been got rid of by calling in and destroying the report of the Government commission under HENRY VIII, popularly known as the "*Black Book*"; and so cleverly and completely was this done, that not a single copy of this Black Book has come down to us, though quotations from it occur in contemporary writers.* It was therefore an adroit move on behalf of the truth

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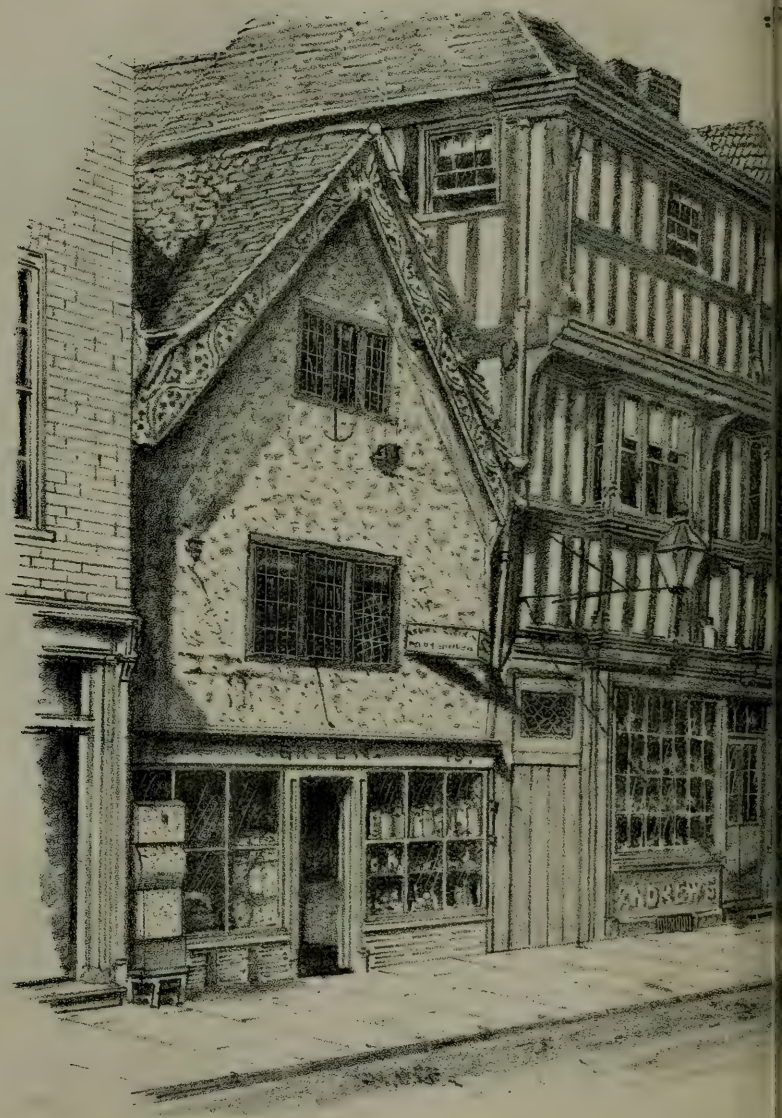
* Bishop BURNET says in the preface to his *History of the Reformation*, that he was greatly puzzled at finding many state papers *missing* from the national records, of whose former existence there was abundant proof in the reference made to them by contemporary writers. At last he stumbled on an order of Queen MARY'S, which accounted for this. It was as follows:

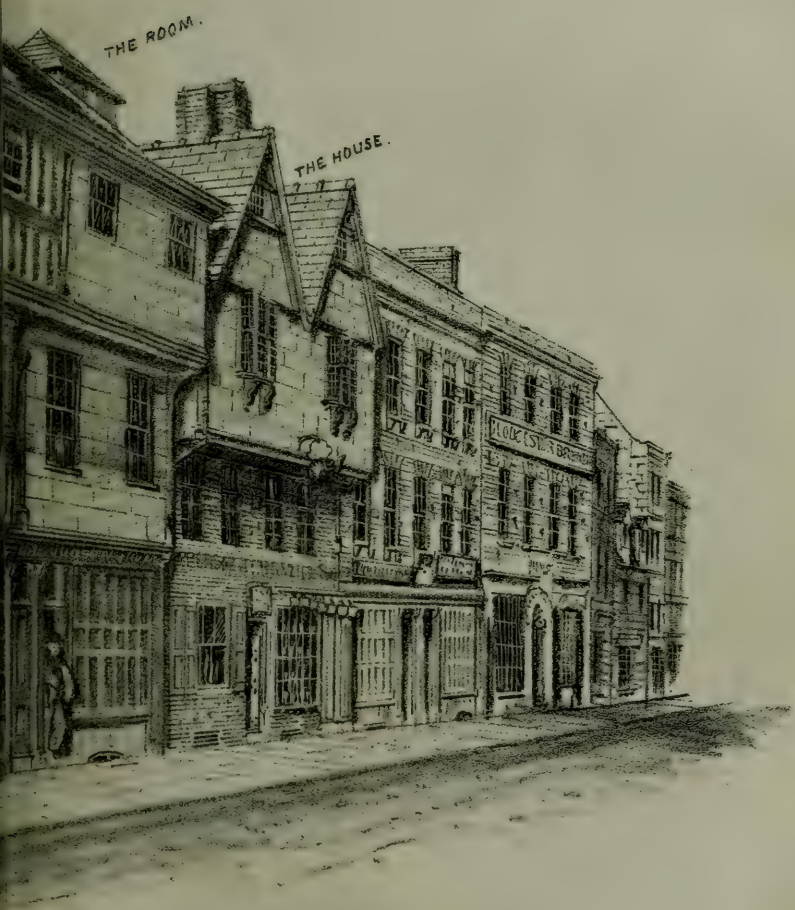
"Whereas it is come to our knowledge that in the time of the late schism, "divers accounts, books, scrolls, instruments and other writings were "practised, devised, and made, concerning professions against the pope's "holiness and the see apostolic; and also sundry infamous scrutinies taken

: OLD HOUSES IN

: In



WESTGATE ST, GLOUCESTER:
LUDING THE ONE FORMERLY BELONGING TO:
ROBERT INGRAM, IN WHICH HOOPER WAS CONFINED:



- J. P. MOORE JULY. 78 -

thus to confront FOXE's Book of Martyrs with the entire mass of the nation, while the facts were fresh: and while in every district in England, it would be made the centre of an eager throng, listening to the narration of what had taken place under their own eyes, and who would discuss every detail, not as we do to day, as a matter of quiet archæological interest, but with burning hearts, and tears, and I fear in some instances with imprecations on the system of which these cruelties were the inevitable and bitter fruit.

It is enough to say that no attempt appears to have been made on the part of any person resident in any place which was the scene of a martyrdom, to offer the slightest evidence in disproof of FOXE's account of it.

Besides the testimony of STRYPE and of FROUDE, to the accuracy of FOXE's quotations from documents, and the overwhelming proof afforded by the publicity given to his book during the life-time of those who were acquainted with the circumstances it records, we have a remarkable confirmation of the account he has left of the martyrdom of Bishop HOOPER in this city (Gloucester) from the entries in the book of expenses of the Mayor and Burgesses of the city, already referred to.*

"in abbeys and other religious houses, tending rather to subvert and over-
"throw all good religion and religious houses than for any truth contained
"therein, which being in the custody of divers registers, and we intending
"to have those writings brought to knowledge, whereby they may be con-
"sidered and ordered according to our will and pleasure, thereupon, those
"three or any two of them are empowered to cite any persons before them
"and examine them upon the premises upon oath, and to bring all such
"writings before them, and certify their diligence about it to Cardinal
"Poole, that further order might be given about them."

* Since I began writing this paper, I have met with another confirmation of a narrative in FOXE. FOXE, in his account of the martyrdom of JOHN CUBBERLEY, a Gloucestershire man, at Salisbury, describes a visit paid to him by his wife, whose *name* he casually mentions, as "ALICE." Compare this with the following, which has been given me by S. H. GAEL of Cheltenham, who occupies the first position in the county as an archæologist acquainted with ancient local records :—

"CHELTENHAM HUNDRED,
VIEW OF FRANKPLEDGE,
17 APRIL, 2 & 3 PHILIP AND MARY.

"Presentment that JOHN CUBBERLEY, who held a Messuage and 13 Acres of Land in Westall, Cheltenham, was lately attainted and burnt for divers

I have mentioned that there is internal evidence to show that the narrative must have been furnished to FOXE by a native of Gloucester or its neighbourhood. He calls, for instance, Cirencester by its *local* name Ciceter; and tells us, in true Mercian dialect, that HOOPER arrived at Ciceter about *a leven* of the clock. This is precisely the form used by the country people about here now, in speaking of numbers. If six cows are seen feeding in a field, and one asks a labourer standing by, how many there are, he will not answer, *six*, but "*about a six*." Again when he describes the means used to fire the faggots round the stake at which HOOPER stood, instead of speaking of the bundles of *straw*, he calls them by the local name *reeds:* for wheat straw has always been called *reed* in this district so far as I have had knowledge of it. In the course of the narrative he speaks of the Bishop as being lodged in the house of "*one* INGRAM"; and later on incidentally says it was determined he should remain "in *Robert* INGRAM's house." Now an entire stranger to the place would not have used the first name "Robert" here at all, but would simply have repeated the second, as before, and said, "INGRAM's house." The "Robert" evidently slipped out naturally and unconsciously from the narrator, who knew him. Again, he incidentally mentions as accounting for the great crowd of seven thousand people who came to witness the burning, that it was *the market day* at Gloucester: and if we compare the date of HOOPER's leaving London, which is stated to be on "*Monday* the fourth of *February*," with the day of the week on which this would make the ninth of the month to fall (for he was burned on the ninth) we shall find it was on the market day: for

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heresies and false opinions at Salisbury, whereby his lands were forfeited to the Lords."

"A note in the margin questions whether a forfeiture so accrued, and so it would appear it was held, as in 4 & 5 PHILIP AND MARY, 23 August.

"ROBT. IBLE, who married ALICE, JOHN CUBBERLEY's widow, takes admittance to his lands *sibi et suis*.

"The customs of the Manor were that no forfeiture arose for a Tenant's crimes. That the widow of a deceased tenant marrying again empowered the second husband, on paying a fine, to come in and claim the first husband's lands."

Gloucester, like all the county towns in England, with some five exceptions, has its market on the last day of the week.

Let us now compare some statements in FOXE with the entries in the book of expenses at Gloucester.

In the second paragraph of the portion I have quoted (see p. 38) we read that HOOPER was delivered in charge to *six* of the Queen's guards to be taken down to Gloucester. In the fourth paragraph it states that on his arrival he was taken to INGRAM'S house, where the guards were first in the same chamber with him, and afterwards in the room next the one he occupied. In the portion next following we have an account of a visit paid to him in this house of INGRAM'S, by "SYR ANTHONY KINGSTON, knyght," who, it is stated, was appointed to be one of the Commissioners to see him executed.

Turning to the Corporation accounts we find under chapter of receipts and expenses for the year beginning first and second of PHILIP and MARY, and ending third and fourth of that reign—that is to say relating to the year 1555,—the following:

> And the same accomptants also asketh allowance of xl. *s.* in money given in rewarde to the Kings and Queenes servants at the bryngyne down off Mast^r. HOOPER to be brente.

Notice for a moment how the figure of this amount—Forty shillings—would accord with the probable sum which would be given to *six* soldiers.

When we make a present in money to anyone, whether large or small in amount, it is usual to let it be an *even* coin. It may be half a crown, or five shillings; half a sovereign, or a sovereign; and so on.

In the Tudor time they gave pence where we give shillings; and marks or fractions of a mark where we give sovereigns. Thus we find lower down in the account twelve pence given to the "Swirdebearer" for riding to LORD CHANDOS; and twelve pence to "oon" to go to Tewkesbury after the "oisterbote" that stole away from the "key."

The Queen's Jester gets 3/4, that sum being an even quarter mark; while the serjeant from Tewkesbury bringing the important, but more than premature, news of the birth of a Prince, was rewarded with 6/8, or half a mark.

Now if we divide the 40/- stated to have been given to the King's and Queen's servants who brought down MASTER HOOPER, by *six*, the number stated by FOXE, we find it gives them *half a mark each;* just the sum which would be in proportion to the other payments at which we have glanced. This six and eightpence would be about equal at the present day to six guineas.

FOXE states that "the Lord SHANDOIS," was one of the Commissioners appointed to see to HOOPER's execution. Compare this with the item in lines I have numbered 4 to 6, where we find expenses for a dinner given at the house of Sir THOMAS BELL, to the Lord CHANDOS and other gentlemen on the afternoon HOOPER was "*brente.*" Sir THOMAS BELL was the father of the Mayor of Gloucester (THOMAS BELL, jun$^{r.}$) and his house was the Black Friars' Monastery, which was granted to him at the dissolution by HENRY VIII. The expense of the dinner was 43/8; equal to between £40 and £50 of the present day. THOMAS BELL, jun$^{r.}$ was member for the city in the course of the year following.

Next comes a very remarkable item for wine paid to AGNES INGRAM, by order of "Master KINGSTON" and others "that same day in the morning that the said Hoop$^{r.}$ was brente." This confirms the two statements of FOXE, that Bishop HOOPER was lodged at the house of one INGRAM, and that among those who came to visit him there, "Sir ANTHONY KINGSTON, Knyght, was one." AGNES INGRAM would probably be the mother or wife of ROBERT INGRAM. The family is an old one in the county; and I believe the shop at the Cross, now held by MANN, the jeweller, was, a generation or two ago, in the occupation of a watch and clockmaker of that name. FURNEY, who lived about midway between our own time and HOOPER's, states in his MS. that "INGRAM's house was opposite the steeple of St. Nicholas Church."

ANTHONY KINGSTON, whom FOXE states to have visited HOOPER, and who, as this document now shows, was on the same premises on the morning of his death, was the son of Sir WILLIAM KINGSTON, Constable of the Tower, to whom HENRY VIII. granted Flaxley, Haresfield, and Painswick. He had

been a bad man by his own confession; and we know he had been a barbarous one; for he was the same ANTHONY KINGSTON who when sent to punish the rebels in the West of England, dined with the Mayor of Bodmin, and then called his host out to show him a gallows he had ordered to be ready; when he had the unfortunate mayor hanged upon it himself. The story of his calling on a miller who had taken part in the rebellion, and hanging the man, who had been duped by his wily master into personating the said miller, was also characteristic of him.

He was not a very affectionate or loyal subject of Queen MARY, and it is likely that this scene of HOOPER's cruel death helped to turn the balance and convert him into an open rebel; for he took part, in the year following, in the DUDLEY plot, in which he undertook to raise 10,000 men in Wales and about the Marches, to assist in dethroning her. He was a man of considerable position, not only as a county gentleman of Gloucestershire, but as holding the office of Vice-Admiral of the Severn Ports. When the plot was discovered, one of his fellow conspirators was so alarmed at the prospect before him that he declared "his heart swelled up in his body as big as a loaf;" and it is not unlikely that ANTHONY KINGSTON's swelled up as big as a loaf too; for he died suddenly on his way to London, when summoned to give an account of his share in the matter.

It is rather striking to contrast the effect of Bishop HOOPER's teaching with the conduct of many of the priests of the period that had just closed, when they were so constantly guilty of immorality that one of the Gloucester city bye-laws of HENRY VII.'s time was framed specially for the punishment in a "whyche" (or cell) in the market place of "priests and religious persons" offending in this respect.

We may note in FOXE special mention of Lord CHANDOS as chief commissioner in the execution. The prominence given to his name in the item of the dinner paid for by the Mayor and his brethren fully agrees with this. FOXE styles him by the double title of "Syr JOHN BRIGES Lord SHANDOYS;" and this again is a proof that he had his narrative from a resident in the

district, and close upon the time of the occurrence itself. The fact is that Sir John Brydges had only been created a peer a few months before, so that people about here had scarcely got accustomed to his new title.

The part played by this man in some of the great scenes of his own time, was remarkable. He had fought under the young King Henry VIII, at the battle of the Spurs, in France, in 1513; and Henry made him Constable of Sudeley Castle. On the death of Edward VI, he was one of those who brought the Princess Mary Tudor to London to claim the throne: he rode with her to the Tower, which she at once put under his charge. As Constable of the Tower he had, about a year before the period which concerns this paper, stood on the scaffold with the unhappy Lady Jane Grey, when the latter presented him with her prayer book, as a parting token. Ten months before he was in Gloucester with Bishop Hooper, he had received the Princess Elizabeth on the Tower steps; where she sat down in the rain, and seemed in no hurry to pass the bourne from which so few, similarly circumstanced, had ever returned. Sir John Brydges begged her to come in, for that she sat unwholesomely there in the rain; when the future Queen replied with some shrewdness, "Better sit here than in a worse place." It was for these services to Queen Mary that he had just been created Baron Chandos.

His son Edmund, who was one of the spectators of the burning, became on his death, the Lord Chandos of Sudeley: but so far from the memory of the stake making a good Romanist of him, the effect of the lesson seems to have told the other way: for Edmund Brydges became very active as an enforcer of the new or Protestant form of worship under Elizabeth.

It is worthy of remark that several of the names occurring in the page of accounts I have facsimiled, are those well known as of staunch adherents of Queen Mary. The "Sir Richard Morgan, Knight," who is described as being at Hempstead (*i.e.* about a mile from Gloucester) was made Recorder of the city a few years before this. He was Chief Justice of Common Pleas; and Fosbroke mentions his having used some very bitter

words about Bishop Hooper. The "Lord Stafford" who was "at Sir Thomas Belles howse" had just been reinstated in some small part of the family possessions, with the title, by the Queen. The "Lord Barkeley" to whom were presented iij gallons of wine and ij lb. of fine sugar, was Henry, the seventeenth Baron Berkeley, an account of whom is given in Cooke's History of Berkeley. On the outburst of the Wyatt rebellion, Lord Henry had armed 500 of his tenants, and was on his march to London to fight against the rebels, when he heard that Wyatt was already taken, and in the Tower. He therefore returned to Gloucestershire and disbanded his men. He afterwards lived in London, to be near the Court; keeping a retinue of 150 servants, and a number of dogs with which he hunted in Gray's Inn Fields and other places. Eight months subsequent to this visit to Gloucester he married Lady Katherine Howard, niece of the Queen of Henry VIII.; and they spent Twelfth-day following with Queen Mary at Greenwich. Lord Berkeley continued high in favour, not only with Mary, but after the accession of Elizabeth, who, eighteen years later than this period, came on a visit to Berkeley Castle. He lived to see the close of the Tudor dynasty. He was born in 1534 and died in 1613; being made a Knight of the Bath at the coronation of James I.

The Sir George Herbert who here figures as the guest of John ap Rice, was one of the Worcestershire family, and a firm supporter of Queen Mary.

The Bishop of Gloucester who is mentioned as receiving at the hands of the city wine and figs, and almonds and sugar, was Brooke, who took Hooper's place on his deprivation. He was prominent in the Marian persecution as one of the Judges of Ridley and Latimer, as well as of Cranmer.

One more word as to the exact coincidence of Foxe's account in its details with the records of the Gloucester Corporation. He mentions the Sheriffs of the city by name, Jenkins and Bond. In the search of which the results are now given to the Cotteswold Club, on a page preceding the one lithographed, there is an

entry of certain customary fees paid on the entry into office as Sheriffs of the city for this very year, by "William Jenkins and William Bond."

Nothing so tests a witness as an examination upon petty details, because they are precisely what anyone framing an untrue story would naturally overlook. It was not essential to Foxe's narrative of the burning of a Gloucester man at Salisbury, to state that his wife came to visit him while there in prison, and that her name was Alice; yet he does so perfectly naturally; and here centuries after, an archæologist in Cheltenham stumbles on an old court roll, in which John Cubberley is described as lately burned for divers heresies at Salisbury, and in which also it speaks of Alice, widow of this John Cubberley, claiming his lands at Cheltenham in virtue of a peculiar local custom.

At the same time, here three hundred and twenty three years after the event, we find a dry business book of receipts and expenses supporting in the minutest details the account given by Foxe of the imprisonment and martyrdom of Bishop Hooper at Gloucester.

It is clear as sunlight that no work in the world could stand the successive tests of an enforced national publicity for its statements at the moment of its being written; of the cautious examination of historians like Strype and Froude, at a wide interval of time; and of comparison with local records after the lapse of centuries, unless it were as a whole true and trustworthy.

Let us now compare the description of the spot on which Foxe states the burning to have taken place, with the circumstances under which the piece of oak forming the subject of this paper, was discovered; and, I believe, no one who is capable of an impartial judgment, will fail to be struck with the perfect accordance between them.

Foxe describes Hooper as led between the two sheriffs,

"his hatte vpon his head, and a staffe in his hand to stay himself withal; "for the grief of the sciatica, which hee had taken in prison, caused him "somethyng to halt. * * * When he came to the place appoynted, "where he should dye, smilingly he beheld the stake and preparation made "for him, which was neare vnto the great Elme tree ouer agaynst yt

"Colledge of Priestes, where he was wont to preach. The place round "about the houses and the bowes of the tree were replenished with people; "and in the Chaumber ouer the Colledge gate stode the Priestes of the "Colledge."

This indicates to us very precisely the spot where the stake stood—namely, that covered by the mound already spoken of as "St. Mary's Knapp," and immediately outside the then burial ground. At the time of the alterations a quantity of wood ashes was turned up, and in the midst of these the piece of oak which forms the subject of the present paper. It was about two feet below the surface, and tightly rammed round with stone. This strong lodgement in the earth would sufficiently account for its preservation: for it would of course be much easier to saw off the projecting or burnt part of the stake level with the (then) surface, than it would be to dig it up from the foundation and get out the rammed stone to set it free. The quantity of matter resulting from such a burning must necessarily have been considerable, for the fire was *twice renewed* before Hooper could be killed; and few things stand the action of time better than charcoal. A few years ago a similar discovery, but on a far larger scale, was made at Madrid, during some excavations in the quarter formerly devoted to the *autos da fé*.

The workmen who found the stake sold it to James Peach, a broker, of Gloucester, who again sold it to William Hickman. From Hickman it passed into the possession of J. B. Kirk, who sold it to G. A. D. Goodyear. From the latter it was purchased by Arthur Stewart, of Barton House, Gloucester, who afterwards removed to Saintbridge. On his leaving Saintbridge, it was sold with other effects by auction, and became the property of C. H. Thomas, bookseller; from whom it is purchased for presentation to the County Museum at Gloucester, at the joint expense of

W. P. Price, Commissioner of Railways for the United Kingdom, and formerly M.P. for Gloucester.

W. K. Wait, M.P. for Gloucester.

C. J. Monk, Chancellor of the Diocese of Gloucester and Bristol, and M.P. for Gloucester.

Charles H. Hooper, Manufacturer, Eastington, Stonehouse.

We are not all gifted alike, and while some people are satisfied with the simplest and most likely way of accounting for things, there are others who have a special faculty for making difficulties where none exist, and who, as the French put it, like to "*chercher midi à quatorze heures.*" Some of these may doubt the possibility of such a thing being found, as the remnant of the stake at which a man was burned in the time of MARY TUDOR; but if it be once granted JOHN HOOPER *was* burned for heresy, there is no improbability in the particular spot having been selected, which FOXE describes; nor in the lower portion of the stake having been left in the ground on that spot, seeing it was not worth the trouble of digging out at the time. Further, as oak constantly turns up in a fair state of preservation, hundreds of years older than the time of the TUDORS, there is nothing in itself remarkable, or staggering even to a weak faith, in the circumstance that a piece of oak over 20 inches long, and 9 in diameter, should be found when the earth around it was being carted away. It would have been more remarkable if, under the circumstances, it had *not* been found.*

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* It has been suggested to me that others may have been burned on the same spot; and that, therefore, this particular stake may not necessarily have been the one at which HOOPER suffered. But the site was not one which would ordinarly be so employed. It was evidently selected in accordance with the royal order, as the nearest possible to the scene of HOOPER'S former preaching (*i.e.* the Cathedral): being just between the college precincts, and the *then* graveyard, to which it has since been added.

FOXE'S NARRATIVE.

The same Monday at night, beyng the fourth of February, his keeper gaue hym an ynkeling that he should be sent to Gloucester to suffer death, whereat he reioysed very much, liftyng vp his eyes and handes into heauen, and praysing God that he saw it good to send him amongest the people ouer whom he was Pastour, there to confirme with his death the truth which hee had before taught them: not doubtyng but the Lord would geue hym strength to performe the same to his glory: and immediatly he sent to his seruantues house for his bootes, spurres, and cloke, that he might be in a readynes to ryde when he should be called.

The next day folowyng, about foure of the clocke in the mornyng before day, the keeper with others came to hym and searched him, and the bead wherein he lay, to see if he had written any thyng: and than he was lead by the Shriffes of London, & other their officers, forth of Newgate, to a place appoynted not farre from S. DUNSTONES Church in Fleetestreete, where vi. of the Queenes Gard were appointed to receaue hym and to cary him to Gloucester, there to be deliuered vnto the Shriefe, who with the Lord SHANDOIS, M. WICKES, and other Commissioners were appoynted to see execution done. The which Garde brought hym to the Aungell, where he brake his fast with them, eatyng his meate at that tyme more liberally then he had vsed to do a good while before. About the breake of the day he went to horse, & and leapt cherefully on horse backe without helpe, hauyng an hode vpon his head under his hatte, that he should not be knowen, and so tooke his iourney ioyfully towardes Gloucester: and alwayes by the way the Gard learned of hym where hee was accustomed to bayte or lodge, and euer caryed him to an other Inne.

Upon the Thursday folowyng, he came to a towne in his Dioces called Cicester 15 . myles from Gloucester about a leuen of the clocke, and there dyned at a womans house which had alwayes hated the truth, and spoken all euill she could of M. HOPER. This woman perceauyng the cause of his commyng, shewed hym all the frendshyp she could, and lamented his case with teares, confessyng that she before had often reported, that if he were put to the triall, he would not stand to hys doctrine.

After dyner he rode forewardes, and came to Gloucester, about v of the clocke, and a myle without the towne was much people assembled, which cryed and lamented hys estate: in so much that one of the Garde rode post into the towne, to require ayde of the Maior and Shriffes, fearyng least he should haue bene taken from them.

The Officers and their retinue repayred to the gate wyth weapons, and commaunded the people to keepe their houses, &c. but there was no man that once gaue any signification of any such rescue or violence. So was he lodged at one INGRAMS house in Glocester, and that night (as he had done all the way) he did eate his meate quietly, and slept hys first sleepe soundly, as it was reported by them of the Garde and others. After hys first sleepe he continued all that night in prayer vntyll the morning, and then he desired that he myght go into the next chamber (for the Garde were also in the chamber where hee lay) that there being solitary, hee might quietly pray and talke with God: So that al that day, sauing a litle at meate, and when hee talked at any tyme with such as the Garde licensed to speake wyth hym, he bestowed in prayer.

Amongest other that spake with him, Syr ANTHONY KINGSTON knight was one. Who seeming in times past hys very friend, was then appoynted by the Queenes letters to be one of the Commissioners, to see execution done vpon him. Maister KINGSTON being brought into the chamber, found hym at his prayer: and as soone as he saw Maister HOOPER, he burst forth in teares. Maister HOOPER at the first blush knew him not. Then said Maister KINGSTON: Why my Lord, doe ye not knowe me an old frend of yours ANTHONY KINGSTON?

Yes Maister KINGSTON, I doe now know you well, and am glad to see you in health, and do prayse God for the same.

But I am sory to see you in this case: for as I vnderstand you be come hether to dye. But (alas) consider that lyfe is sweete, and death is bytter. Therefore seing lyfe may be had, desire to lyue: for lyfe hereafter may doe good.

In deede it is true Maister KINGSTON, I am come hither to end this lyfe, and to suffer death here, because I wyll not gaynsay the former truth that I haue heretofore taught amongest you in this dioces, and elswhere: and I thanke you for your friendly counsell, although it be not so friendly as I could haue wyshed it. True it is (Maister KINGSTON) that death is bitter, and lyfe is sweete: but (alas) consider that the death to come is more bytter, and the lyfe to come is more sweete. Therefore for the desire and loue I haue to the one, and the terrour and feare of the other, I do not so much regard thys death, nor esteeme this life, but haue setled my selfe through the strength of Gods holy spirite, patiently to passe through the tormentes and extremities of the fire, now prepared for me, rather then to denye the truth of hys worde: desiring you and others in the meane tyme, to commend me to Gods mercye in your prayers.

Well (my Lord) then I perceiue there is no remedy, and therefore I wyll take my leaue of you: and I thanke God that euer I knew you, for God dyd appoynt you to call me being a lost childe: & by your good instructions, where before I was both an adulterer and a fornicator, God hath brought me to the forsaking and detesting of the same.

If you haue had the grace so to do, I do highly praise God for it: and if you haue not, I pray God ye may haue, and that ye may continually lyue in hys feare. After these and many other words, the one took leaue of the other, Maister KINGSTON with bitter teares, M. HOOPER wyth teares also trycklyng downe hys cheekes. At which departure Maister HOOPER tolde hym, that all the troubles he had susteyned in pryson, had not caused hym to utter so much sorrow.

The same night hee was committed by the Garde (their commission being then expired) vnto the custody of the Shirifes of Gloucester. The name of the one was IENKINS, the other BOND: who with the Mayor and Aldermen repayred to M. HOPERS lodging, and at the fyrst meeting saluted him, and toke him by ye hand. Unto whom HOPER spake on this maner: Maister Mayor, I giue most harty thankes to you and to the rest of your brethren, that you haue vouchsafed to take me a prisoner and a condemned man by the hand: whereby to my reioysing it is some deale apparant that your old loue and friendship towardes me is not altogether extinquished: and I trust also that all the things I haue taught you in times paste, are not vtterly forgotten, when I was here by the godly kyng that dead is, appointed to be your Bishop and Pastor. For the which most true and sincere doctrine, because I wyll not now accompt it falshood and heresie, as many other men do, I am sent hither (as I am sure you knowe) by the Queenes comaundement to dye, and am come where I taught it, to confirme it with my bloud. And nowe Maister Shieriffes, I vnderstand by these good men and my very friendes (meaning the Gard) at whose hands I haue found so much fauour and gentlenes by the way hetherward as a prisoner coulde reasonably requyre (for the which also I most hartely thank them) that I am comitted to your custody, as vnto them that must see me brought to morrow to the place of execution. My request therefore to you shall be only that there may be a quicke fire, shortly to make an end, and in the meanetime I wyll be as obedient vnto you, as your selues would wysh. If you thinke I doe amysse in any thing, hold vp your finger, and I haue done. For I come not hether as one enforced or compelled to dye (for it is well knowen I might have had my lyfe wyth worldly gayne): but as one willing to offer and geue my lyfe for the truth, rather then to consent to the wycked papistical religion of the bishop of Rome, receyued and set forth by the Magistrates in ENGLAND to Gods hygh displeasure and dishonor: and I trust by Gods grace to morrow, to dye a faythfull seruaunt of God, and a true obedient subiect to the Queene.

These and such like wordes in effect vsed M. HOOPER to the Mayor, Shiriffes, & Aldermen, wherat many of them mourned and lamented. Notwithstanding the two Shiriffes went aside to consult, and were determined to haue lodged him in the common Gaole of the Town, called Northgate, if the Gard had not made earnest intercession for him: who declared at large how quietly, mildly and patiently he had behaued hym selfe in the way,

adding thereto that any childe might keepe hym well inough, and that they them selues would rather take paynes to watch with him, then that he should be sent to the common pryson. So it was determined at the length, he should styll remayne in ROBERT INGRAMS house, and the Shiriffes and the Sergeants and other officers did appoint to watch with him that night them selues. His desire was that he might go to bed that night be times saying that he had many thinges to remember: and so dyd at fiue of the clocke, and slept one sleepe soundly, and bestowed the rest of the night in praier. After he gat vp in the morning, he desired that no man should be suffered to come into the chamber, that he might be solitary tyll the houre of execution.

About . viij . of the clocke came Syr IOHN BRIGES L. SHANDOYS, wyth a great Band of men, Syr ANTHONY KINGSTON, Syr EDMUMD BRIGES and other Commissioners appoynted to see execution done. At nine of the clocke M. HOOPER was willed to prepare hym selfe to be in a readynes, for the time was at hand. Immediatly he was brought downe from hys chamber by the Shiriffes, who were accompaynied wyth byls, gleaues and weapons.

When he sawe the multitude of weapons, he spake to the Shiriffes on thys wyse: Maister Shiriffes (sayd he) I am no Traytor, neyther needed you to haue made such a busines to bryng me to the place where I must suffer: for if ye had wylled mee, I would haue gone alone to the stake, and haut troubled none of you all. And afterward looking vpon the multitude of people, which were assembled, beyng by estimation to the number of seuen thousand (for it was Market day, and many also came to see hys behauiour towardes death) he spake vnto those that were about hym, saying: Alas, why be these people assembled and come together? Peraduenture they thynke to heare somthing of me now, as they haue in times past: but alas, speech is prohibited mee. Notwithstanding the cause of my death is well knowen vnto them. When I was appoynted here to be their Pastor, I preached vnto them true & sincere doctrine, & that out of the word of God. Because I will not now accompt ye same to be heresy and vntruth, this kind of death is prepared for me.

So he went forward, led betwene the two Shriffes (as it were a Lambe to the place of slaughter) in a gowne of his hostes, his hatte vpon his head, and a staffe in his hand to stay him selfe withal. For the grief of the SCIATICA, which hee had taken in prison, caused hym somethyng to halt. All the way beyng straitly charged not to speake, he could not be perceiued once to open his mouth, but beholdyng the people all the way, which mourned bitterly for hym, he would some tymes lift vp his eyes towardes heauen, and looke very cherefully vpon such as he knew: and he was neuer knowen, duryng the time of his beyng amongest them, to looke with so cherefull & ruddish a countenaunce as he did at that present. When he came to the place appoynted where he should dye, smilyngly he beheld the stake and preparation made for him, which was neare vnto the great Elme tree ouer

agaynst ye Colledge of Priestes, where he was wont to preach. The place round about the houses & the bowes of the tree were replenished with people: and in the Chaumber ouer the Colledge gate stode the Priestes of the Colledge. Then kneeled he down (for as much as he could not be suffered to speake vnto the people) to prayer, and beckned vnto hym vi. or vii. tymes whom he knew well, to heare the sayd prayer, to make reporte therof in tyme to come (pouryng teares vpon his shoulders & in his bosome) who gaue attentiue eares vnto the same: the which prayer he made vpon the whole Crede, wherin he continued for the space of halfe an houre. Now after he was somewhat entred into his prayer, a boxe was brought & layd before him vpon a stoole with his pardon (or at the least wise it was fayned to be his pardon) from the Queene, if he would turne. At the sight therof he cried: if you loue my soule, away with it: If you loue my soule, away with it. The boxe beyng taken away, the L. SHANDOIS said: seing there is no remedy, dispatch quickly. M. HOPER said: Good my Lord, I trust your Lordshype will geue me leaue to make an end of my prayers.

Then sayd the Lord SHANDOIS to Syr EDMOND BRIDGES his sonne (which gaue eare before to M. HOPERS prayer at his request): EDMOND take heede that he do nothyng els but pray: If he do, tell me and I shall quickly dispatch hym. Whiles this talke was, there stepped one or two in vncalleds which heard hym speake these wordes folowyng.

LORD (sayd he) I am hel, but thou art heauen: I am swill and a sinck of sin, but thou art a gracious God and a mercifull redemer. Haue mercy therfore vpon me moste miserable and wretched offendour, after thy great mercy and according to thyne inestimable goodnes. Thou that art ascended into heauen, receaue me hel to be partaker of thy ioyes, where thou sittest in equall glory with thy father. For well knowest thou Lord wherfore I am come hyther to suffer, and why the wicked do persecute this thy poore seruaunt: not for my sinnes and transgressions committed agaynst thee, but because I wyl not allow their wicked doinges, to the contaminatyng of thy bloud, and to the denyall of the knowledge of thy truth, wherwith it did please thee by thy holy spirite to enstruct me: the which with as much deligence as a poore wretch might (being thereto called) I haue sette forth to thy glory. And wel seest thou my Lord and God what terrible paynes and cruell tormentes be prepared for thy creature: such, lord, as without thy strength none is able to beare, or patiently to passe. But all thinges that are impossible with man, are possible with thee. Ther fore strengthen me of thy goodnes y^t in the fyre I breake not the rules of patience, or els asswage the terrour of the paines as shall seeme most to thy glory.

Assoone as the Maior had espyed these men which made report of the former wordes, they were commaunded away, and could not be suffred to heare any more. Prayer beyng done, he prepared him selfe to the stake, and put of his hostes gowne, and deliuered it to the Shriffes, requiryng them

to see it restored vnto the owner: and put of the rest of his geare vnto his doublet and his hose, wherein he would haue burned. But the Shriffes would not permit that (such was their gredynes:) vnto whose pleasures (good man) he very obediently submitted him selfe: and his doublet, hose, and peticote were taken of. Then beyng in his shirt, he tooke a point from his hose him selfe, and trussed his shyrt betwene his legges, where he had a pound of gunne pouder in a bladder, and vnder ech arme the like quantity deliuered him by the Gard. So desiryng the people to say the Lordes prayer with him, and to pray for hym (who performed it with teares duryng the tyme of his paynes) he went vp to the stake. Now when he was at the stake, iij. yrons made to binde hym to the stake, were brought: one for his necke, an other for his middle, and the thyrd for his legges. But he refusing them, sayd: ye haue no nede thus to trouble your selues, for I doubt not but God will geue strength sufficient to abyde the extremitie of the fire without bandes: notwithstanding, suspectyng the frailty and weaknes of the flesh; but hauyng assured confidence in Gods strength, I am content ye do as ye shall thinke good.

So the hoope of yron prepared for his middle, was brought, which beyng made somewhat to short (for his belly was swolne by imprisonment) he shranke, and put in his belly with his hand, vntill it was fastened: and when they offered to haue bound his necke & his legges with the other two hoopes of yron, he vtterly refused them, and would haue none, saying: I am well assured I shall not trouble you.

Thus beyng ready, he looked vpon all the people, of whom he might be well seene (for he was both tall, and stoode also on an high stoole) & beheld round about him: and in euery corner there was nothyng to be seene but weepyng and sorowfull people. Then liftyng vp his eyes and handes into heauen, he prayed to hym selfe. By and by he that was appointed to make the fire, came to him and did aske him forgiuenes. Of whom hee asked, why he should forgeue him, saying: that he knew neuer any offence he had committed agaynst hym. Oh Syr (sayd the man) I am appointed to make the fyre, Therein (sayd M. Hoper) thou doest nothyng offend me God forgeue thee thy sinnes and do thine office, I pray thee. Then the reedes were cast vp and he receaued two bundels of them in his owne handes embraced them, kissed them, and put vnder either arme one of them, & shewed with his hand how the rest should be bestowed, & pointed to the place where any did lacke.

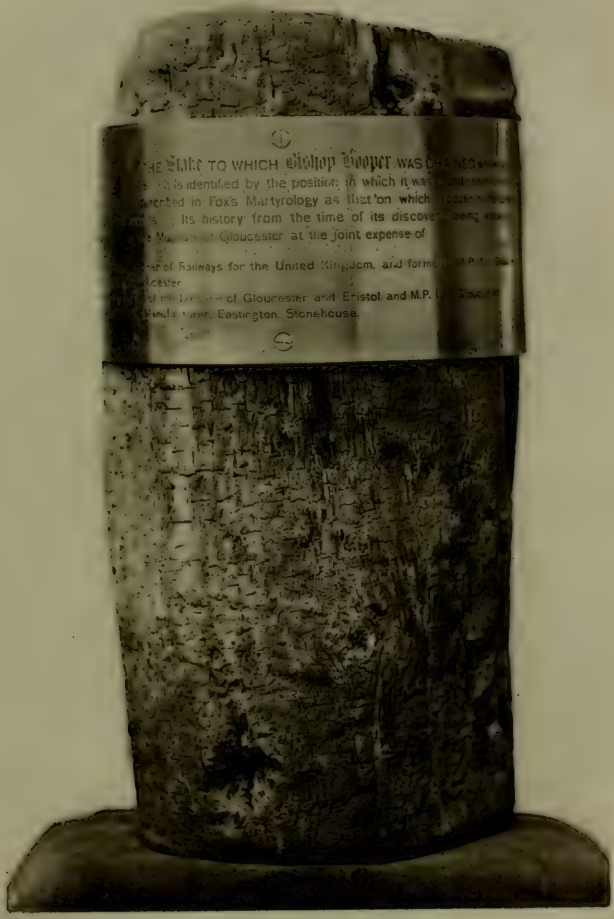
Anone commaundement was geuen that fire should be set to, & so it was. But because there were put to no fewer greene Fagots then two horses could cary vpon their backes, it kyndled not by and by, and was a prety while also before it tooke the reedes vpon the Fagottes. At length it burned about him: but the wynd hauyng full strength in that place (it was also a louryng and a cold mornyng) it blew the flame from hym: so that he was in maner no more but touched by the fire.

Within a space after, a few drye Fagottes were brought, and a new fire kindled with Fagottes, (for there were no more reedes): and that burned at the neither partes, but had small power aboue because of ye wynd, sauyng that it did burne his heare and scorch his skyn a litle. In the tyme of the which fire, euen as at the first flame, he prayed, saying mildely and not very loud (but as one without paines): O Jesus the sonne of DAUID haue mercy vpon me, and receaue my soule. After the second was spent, he did wype both his eyes with hys hands, and beholdyng the people, he sayd with an indifferent loud voyce: For Gods loue (good people) let me haue more fire. And all this while his neither partes did burne: for the Fagottes were so few, that the flame did not burne strongly at his vpper partes.

The third fire was kindled within a while after, which was more extreme then the other two: and then the bledders of gunnepouder brake, which did him small good, they were so placed, and the wynd had such power. In the which fire he prayed with somwhat a loud voyce: Lord Jesu haue mercy vpon me: Lord Jesu haue mercy vpon me: Lord Jesus receaue my spirit. And these were the last wordes he was heard to vtter. But when he was blacke in the mouth and his toung swollen that he could not speake: yet his lyppes went till they were shronke to the gummes: and he knocked hys brest with hys handes vntill one of his armes fell of, and then knocked still with the other, what tyme the fat, water, and bloud dropped out at his fingers endes, vntill by renewyng of the fire, his strength was gone, and his hand did cleaue fast in knockyng, to the yron vpon his brest. So immediatly bowyng forwardes he yelded vp his spirite.

Copy of the order for Burning Bishop HOOPER.

Whereas, JOHN HOOPER, who of late was called Bushope of Worcestere and Glocestere, is by due ordere of the lawes ecclesyastyque, condempned and judged for a most obstynate, false, detestyble heretycke, and commytted to our seculere poure, to be burned accordynge to the holesome and good lawes of our realme, in that case providede, forasmuche as, in those cittyes and diocyes, thereof he hathe in tymes paste preached and taughte most pestelente herrecies and doctryne to our subjects theare; we have therfore geven ordere, that the said HOOPER, who yet persistethe obstynate, and hath refused mercye when it was gratyously offerede, shall be put to executyone, in the sayd cyttye of Glocestere, for the example and terrore theare. And woll that yo^re^ callynge unto you some of reputacone dwellynge in the sheere, such as yee think beste, shall repayre unto o^ur^ sayde cittye, and be at the sayd executyone, assystynge o^ur^ mayre and sherifes of the same cyttye in his behalfe; and forasmuche also as the sayde HOOPER is, as heretickes be, a vayne gloryous person and delytethe in his tonge, and havynge lybertye maye use his sayde tonge to persuade such as he hathe seduced to persyste in the myserable opynyne that he hath sown amongeste them, o^ur^ pleasure is thearfore, and wee require yo^u^ to take ordere that the said HOOPER be nether at the tyme of his executyone, nor in going to the place thearof, sufferede to speak at large, but the other to be lede quietly, and in silence, for eschuenge of further infection, and such inconvenyencye, as maye otherwise ensue in this p^ar^te. Whereof faylle yo^u^ not, as ye tendere o^ur^ pleasure.


THE STAKE TO WHICH Bishop Hooper WAS CHAINED
Gloucester
of Gloucester and Bristol, and M.P.
Eastington, Stonehouse.

DOCUMENTS ACCOMPANYING THE STAKE.

The following are copies of documents accompanying the stake; the originals being deposited with it in the glass case in the Museum.

It will be observed that J. B. KIRK, the auctioneer in a statement he made at the request of ALAN STEWART, (barrister, son of ARTHUR STEWART, of Gloucester) says HICKMAN bought it *direct* from the workmen; but COUNSEL the historian, who as an archæologist resident on the spot, at the time, would naturally be more observant of the details, shews that it was sold by the finders to JAMES PEACH, and that HICKMAN bought it of the latter. COUNSEL wrote a parchment attestation, in due legal form, in 1842; while KIRK only speaks from memory, twenty-six years later; and twenty-three years after it had passed out of his possession.

JOHN JONES is one of the oldest members of the Cotteswold Club, and well known as a contributor to its published Proceedings.

The identical Stake here referred to marked by me the undersigned G. W. COUNSEL with the initials of my name was purchased by JAMES PEACH of the City of Gloucester Broker deceased and was afterwards sold to Mr. WILLIAM HICKMAN of the same City Boot-maker in whose custody it now remains.

I do hereby certify that the above statement is to my own knowledge true in every respect. As Witness my hand and seal this 15th day of August 1842.

G. W. COUNSEL, (seal)

Attorney at Law—senior proctor of the consistory Court of the Diocese of Gloucester and Bristol—one of the Aldermen of the same City—and Author of the History of Gloucester.

GLOUCESTER, May 15, 1858.

ARTHUR STEWART, ESQ., recently settled in Gloucester having purchased of GEORGE DINELEY GOODYEAR, ESQ., the relic known to many persons as the portion of the stake at which Bishop HOOPER suffered martyrdom has applied to me as one acquainted with local history to give him an account of the manner and cause of its discovery and the reasons why the said relic should be presumed to be what it is reputed.

I can state of my own positive knowledge that it was found upon the site now occupied by Bishop HOOPER'S monument in the Churchyard of St. Mary de Lode in this City, on the occasion of an extension of its boundaries by the enclosure of a piece of waste ground previously known as St. Mary's Knapp [mound] in the year 1826.

Prior to the enclosure referred to this site appeared to resemble precisely other localities in the neighbourhood to which the same term was applied, as for example St. Catherine's Knapp in the next parish. On the last named spot I remember that a Maypole was erected, and the usual Whitsuntide games were celebrated; but nothing of the kind existed or ever took place upon St. Mary's Knapp within the memory of the oldest inhabitant, so far as I can learn; and I have made special enquiries upon the subject.

In the older editions of FOXE'S Book of Martyrs the engraving of the execution of the Bishop was evidently made from a drawing taken on the spot as will be evident upon a comparison of the buildings there represented with those of that period still existing there unaltered.

The site of the monument corresponds with that represented as the position of the pile accurately enough; and common tradition has always pointed out the spot, as well as written records. The portion of the charred stake was found from two to three feet below the surface.

The piece now shown to me by MR. STEWART in its case is the same which was shown to me very shortly after its discovery by the late GEORGE WORRALL COUNSEL, ESQ., and the same which has been since repeatedly exhibited as the remains of the veritable stake at which Bishop HOOPER was burnt.

JOHN JONES.

GLOUCESTER, June 11th, 1845.

MISS GOODYEAR. BOT. of J. B. KIRK.

Part of the Stake to which Bishop HOOPER was chained, when burnt in St. Mary's Square at Gloucester £5 0 0

Settled same time JOSH. B. KIRK.

Future favors most respectfully solicited.

GREENWICH, 26th Oct. 1868.

With reference to the stake which I sold to MISS GOODYEAR in the year 1845 and which is, as I am informed, at present in the possession of ARTHUR STEWART, ESQ., I can state the following facts of my own personal knowledge.

Some workmen employed in enlarging the churchyard of St. Mary de Lode in the city of Gloucester by adding to it a piece of ground called St. Mary's Knapp, discovered the stake above mentioned. When discovered it was firmly fixed in the ground and surrounded by a quantity of broken stone tightly rammed down for the purpose of screwing it in its place.

It was immediately bought of the said workmen by Mr. WM. HICKMAN, Bootmaker, of Westgate St., Gloucester, and by him shewn to several persons

amongst whom were Mr. G. W. COUNSEL, Solicitor, of Gloucester, and a well known antiquarian, also to a Mr. JONES and Mr. THOMAS TURNER of Gloucester, Banker, and they all pronounced it to be in their opinion the remains of the identical stake at which Bishop HOOPER suffered martyrdom; judging from its appearance and from the position in which it was found.

In the year 1842 or thereabouts (the precise date I am unable now to recollect) I purchased it of the above mentioned WILLIAM HICKMAN, it having been in his possession from the time of its discovery until the time when I bought it of him.

In the year 1845 I sold it to MISS GOODYEAR then living at Barton House Gloucester.

I was very intimate with Mr. HICKMAN, and I saw the stake immediately after its first discovery, in his house, and very frequently since.

I have no doubt whatever in my own mind, and never had any doubt, as to the identity of this stake.

JOSH. R. KIRK.

Signed by the said JOSHUA RUSSELL KIRK, at his house, Claremont Cottage, George Lane, George Street, Greenwich, in my presence.

ALAN STEWART.

26th Oct. 1868.

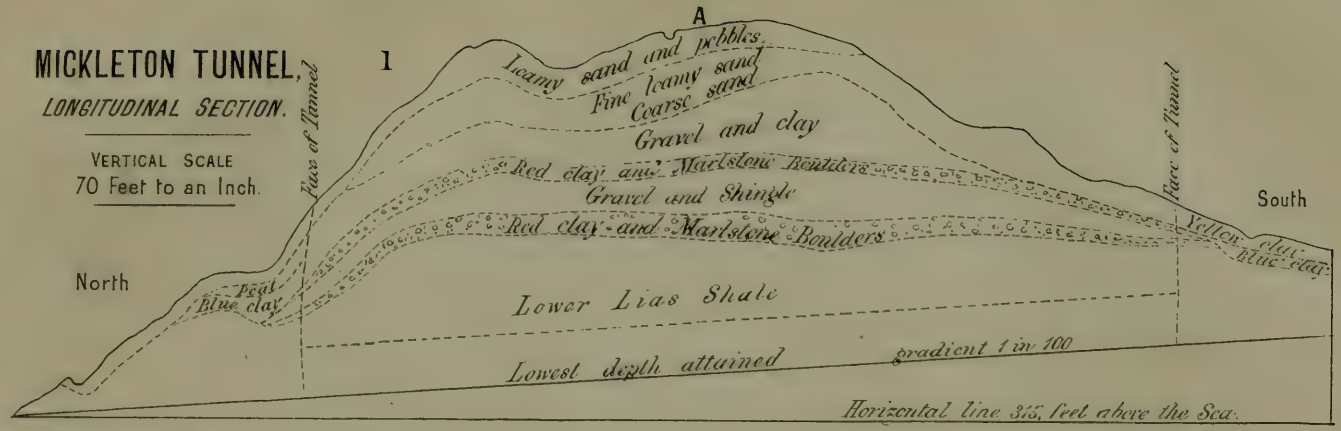
I certify that the stake I have sold to Mr. STEWART, is the one named on the other side this paper, that it has never been out of my possession from that date to this, the 15th day of April, 1858, as witness my hand and seal.

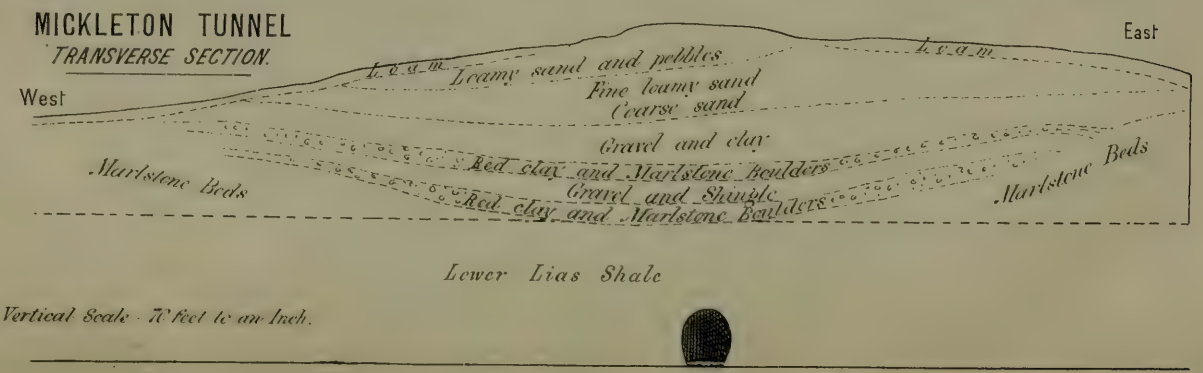
G. A. D. GOODYEAR.

On the extension of the Northern Drift and Boulder Clay over the Cotteswold Range. Read at the Annual Meeting of the Cotteswold Club, at Gloucester, April, 1878. By W. C. Lucy, F.G.S.

In the paper which I read at the meeting of the Cotteswold Club in April, 1869, on "*The Gravels of the Severn, Avon, and Evenlode, and their Extension over the Cotteswold Hills,*" I referred to, and gave an analysis of a peculiar Clay found in the fissures of some of the Oolite quarries, in which small quartz pebbles were found, and stated that I was not aware of the existence of Boulders or Boulder-clay on the high ground of the Cotteswolds, unless on further investigation this Clay should be found to belong to that period. (Vol. V. page 3.) During the time I was carrying on my researches upon the Drifts, I noticed, as recorded, (Vol. V. page 109) that on the high ground of the Cotteswolds, where there was hardly any soil, the N. D. pebbles were rarely found, and that Mr. Brown, of Cirencester, had observed the same thing, (Cotteswold Club, vol. V. page 116) and that I had not found N. D. pebbles at a higher elevation than about 750 feet. I could not however understand how that could be the measure of the submergence, and I determined to make further investigation.

In a subsequent communication to the Club in March, 1873, "*On the Submerged Forest at Holly Hazle,*" I mentioned that continued observations had brought to my knowledge the presence of Boulder-clay over the Cotteswolds, which I hoped soon to shew; and in fulfilment of my promise I now proceed to lay before the Club the information I have acquired on the subject.


MICKLETON TUNNEL,
LONGITUDINAL SECTION.
VERTICAL SCALE
70 Feet to an Inch.
1
A
Face of Tunnel
Face of Tunnel
North
South
Peat
Blue clay
Loamy sand and pebbles
Fine loamy sand
Coarse sand
Gravel and clay
Red clay and Marlstone Boulders
Gravel and Shingle
Red clay and Marlstone Boulders
Yellow clay
Blue clay
Lower Lias Shale
Lowest depth attained
gradient 1 in 100
Horizontal line 375 feet above the Sea.


MICKLETON TUNNEL
TRANSVERSE SECTION.
West
East
2
t. c. a. m.
t. c. a. m.
Loamy sand and pebbles
Fine loamy sand
Coarse sand
Gravel and clay
Red clay and Marlstone Boulders
Gravel and Shingle
Red clay and Marlstone Boulders
Marlstone Beds
Marlstone Beds
Lower Lias Shale
Vertical Scale 70 feet to an Inch.

The Clay is found nearly all over the Cotteswold range, varying in thickness from a few inches to three feet, and often occurring in pockets, but without any inequality in the surface of the land indicating the existence of small hollows prior to its deposition; and in many places where it could never have been levelled by cultivation.

To begin with the *Mickleton Tunnel*, the summit of which is 490 feet above sea level, and therefore not on the high plateau; but it is there that the greatest development of the Boulder-clay is met with, and I want to trace its course. The following Section is from Mr. GAVEY's paper, in the *Quarterly Journal of the Geological Society*, for 1853, and was made, it should be remembered, long before Ice action *and Boulder-clay* were thought of in connection with the Cotteswold district. *(See drawing.)*

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

Mr. GAVEY says, "The loamy silicious gravel, sand, and red clay beds give an average thickness of about 76 feet, and the Red Clays are non-fossiliferous, but contain large detached blocks of Marlstone of a bluish colour and uneven fracture, and with edges considerably rounded by attrition, and they were from one hundred-weight to three tons each."

About a mile after leaving Tetbury, on the way to Malmesbury, in a level field on the left hand side, adjoining the road, is a small quarry with one and a half feet of Boulder-clay forming the subsoil. In the quarry is an opening or fissure shewing Clay fully six feet thick. My attention was drawn to this by my friend Mr. G. F. PLAYNE, and who also informed me that he had found Quartz Pebbles in a fissure of a large quarry close to Tetbury, the same from which Mr. HOLFORD is using the stone for the erection of his house.

The Clay is well shewn in several places between Stroud and Miserdine, more particularly about Stancombe Ash.

Again under the guidance of Mr. G. F. Playne I visited Uley Bury, where, at a height of 760 feet, we found a considerable layer of Clay, with a good many N. D. pebbles in it, and in other parts of the hill, where there was less clay, as usual, there were but few pebbles. We went on to the Ridge, and in a field of Great Oolite, near Symonds Hall Farm, on the opposite side of the road to the Tumulus, I found N. D. pebbles, and Mr. Playne picked up a lump of Clay which was lying on the surface of the ground, and on examination we discovered two small Quartz pebbles in it. The pebbles and clay were of the same character as those which occur in the fissures of the Oolite quarries in various parts of the Cotteswold range. The clay I submitted to Professor Church, who wrote to me: "It is quite clear the clay has nothing in common with the so-called of the Forest Marble. It contains as much Silica as is present in China Clay, while the amount of Carbonate of Lime is quite insignificant when compared with that of the true Oolite Clays, which varies from 35 to 70 per cent. 100 parts of your Clay, taken in a perfectly dry state, gave 69·58 per cent. of Silica." Within the last week I have found the same Clay on Painswick Hill, which, on analysis, was found to contain 68·2 per cent. of Silica.

Accompanied by Mr. Bellows I visited Cleeve Cloud, the highest point of the range, 1093 feet, which being table land, led me to hope we should meet with some evidence of the existence of Boulder-clay and N. D. pebbles. The Clay seems to have been prevented from resting on the plateau itself, by powerful water action; while it was protected from this action on the slopes, by its greater depth from the surface. This would account for the fact that it is usually thicker on the slopes than on the level land above.

Within ten feet of the highest point, in a field which was being ploughed and had a good covering of clay upon it, Mr. Bellows picked up a veritable N. D. pebble. We took home two pieces of Clay from different parts of the field, which

on analysis by Mr. Embrey, shewed 54 and 67 per cent. of Silica respectively.

To shew how observations carefully made often give the clue to the solution of interesting Geological difficulties, I hope I may not be deemed egotistical in the two following illustrations.

When the Cowley property was on sale I went with a friend to look over it, and we were shewn the land by a very intelligent bailiff, from whom I enquired, "If he had ever seen any round liver-looking pebbles?" to which he answered "No." The fields we were walking over were very bare of soil, and I asked, "If there were any in which there was clay?" He said "There is one field upon the estate;" and we had not been in it five minutes before I recognized my old acquaintances the N. D. pebbles and some flint.

Again, last year, on enquiring of my friend Mr. F. Witts, of Upper Slaughter, if he had any round pebbles on his farm, he replied also in the negative. I then said, "Have you any clay ground?" "Certainly," he replied; "I have a very stiff field;" and I remarked, "Then I can find the pebbles." He kindly invited me to visit him, and accompanied by his father, the Rev. E. Witts, F.G.S., one of our members, who had also never seen any; we went to the field where we were soon rewarded by picking up white quartz pebbles and some flint.

I trust I have now shewn the occurrence of the N. D. from the neighbourhood of Stow in the north, to Uley Bury in the south, a distance of fully thirty miles, and that the Boulder-clay, usually associated with the drift, is met with in many places over the Cotteswolds.

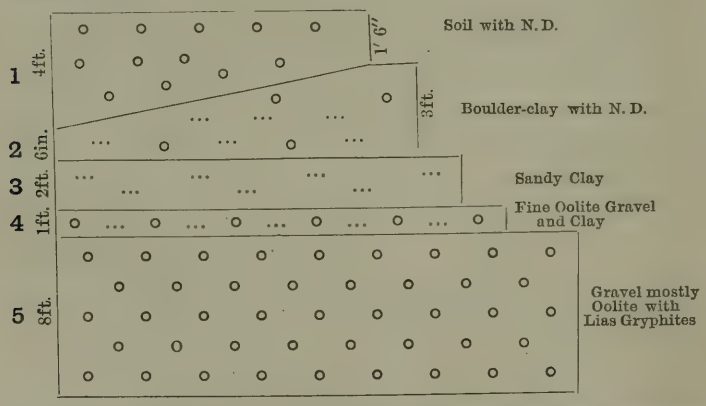
Professor Phillips, in his work on "*The Geology of the Valley of the Thames*," in speaking of the Cotteswolds having been submerged beneath the sea, says, "The sea may have covered the highest hills, but proof fails at 750 feet, according to the careful researches of Mr. Hull and Mr. Lucy, which I am happy to confirm."

My extended observations, however, now shew that proof does *not* cease, as I formerly supposed, at 750 feet, but that the

whole Cotteswold range had ceased to be dry land at the time the Clays and N. D. passed over it.

Let us now turn our attention from the hills to the low ground of the valleys, where we shall see the same Boulder-clay we have been considering on the top of the Cotteswolds; also another Clay of very different character, formed at a later period by the action of land ice, out of the beds of the Lias of the district, and further undoubted evidence of ice action, as shewn in the planed-off surfaces of various formations upon which gravel and clay repose.

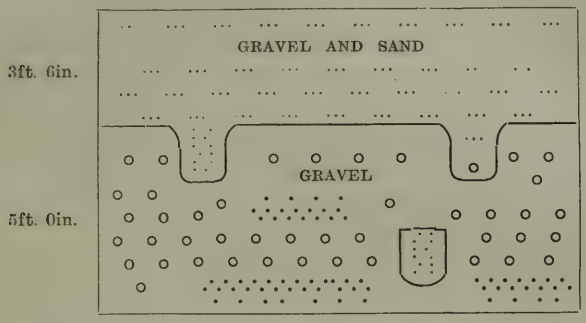
The Silica Clay of the Cotteswolds occurs in a gravel-pit at Todenham, near the Church, close to a small plantation on entering the village from Mitford bridge, of which the following is a section:—



Now in No. 2 there is a twisted layer of Boulder-clay varying from six inches to three feet in thickness, with large and small pebbles of N. D., and which I submitted to Professor Church, who wrote to me: "I see it contains silicious bodies well worn, including a fine quartzite lump, which I send you."

At Paxford, not far from Todenham, in a field which was being drained, I found fully four feet of Boulder-clay, with Flints, Quartzose Pebbles, Greenstone, Millstone Grit, Lias, and Syenite of the Charnwood type.

In the valley at Frampton, about four miles from the Cotteswolds, and not more than 60 feet above the sea level, are two remarkable pits, of which the following is a general section:—



The gravel is composed of Oolite, and Marlstone, with some Fossils from both, but Lower Lias Gryphites are most abundant. In the clay pockets rounded bits of Quartz are met with of exactly the same kind as those found in the clayey seams of the Oolite quarries on the tops of the Cotteswolds. The clay I submitted to Professor Church, who informed me that it is "full of brown Hæmatite fragments and colourless granules of Quartz, the total per centage of Silica being 69 · 60."

The following analysis of the various Clays I have mentioned shew an average of about 68 per cent of Silica, already proving they are not of local Oolite origin, and I believe they are mostly derived from the denudations of the New Red Sunstone.

ANALYSIS OF THE VARIOUS CLAYS REFERRED TO.

	Woodchester Park.	Cleeve Cloud.	Symonds' Hall Farm.	Painswick Hill.	Frampton Gravel Pit.
Silica ...	70.50	67.2	69.58	68.2	69.60

The close agreement of the quantity of Silica of the valley clays as shewn in the section at Frampton, and the Quartzite character of the Clay at Todenham, with the Clay of the Cotteswolds, points to a common origin: and the Clays now in the valley, which I believe were once on the high ground, suggest a vast amount of denudation by land ice, snow, and rain of the escarpment, to bring it into its present position.

We will now proceed to examine the second Boulder-clay, and I have to thank the Rev. Dr. SMITHE for calling my attention to a cutting on the Cheltenham and Banbury Railway, close to the Great Western conduit at Hatherley Road, Cheltenham, where, as the following section shews, the clays of the upper beds of the Lower Lias are waved, and resting upon them is a seam of small gravel, from two to twelve inches thick, containing Quartz pebbles, with Oolite and Marlstone Gravel, and capped with a Boulder-clay derived from the Jamesoni beds. *(See Section.)* In making a well at Dante Villa, Howard Street, Gloucester, Mr. EMBREY, of the School of Science supplied me with the following section :—

	ft.	in.
Alluvium	1	8
Yellowish Clay, with much Lime	4	6
Blue Clay	8	6
Gravel	2	3

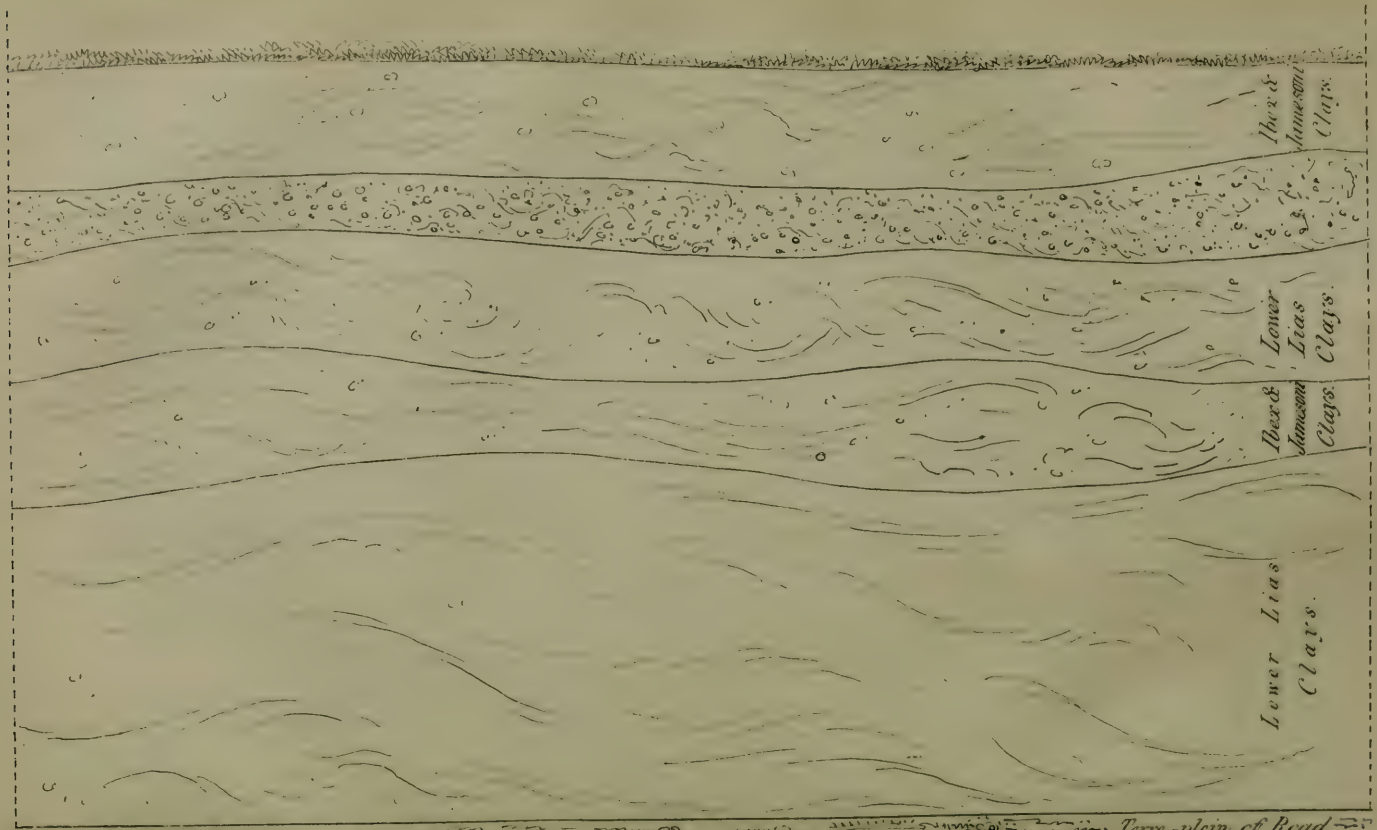
During the time the Park was being drained I had many opportunities of seeing the relative position of the gravel and clay, also in many parts of the district round Gloucester, and always found the gravel lying on an uneven planed-off surface of Lias. Very frequently the gravel itself is in waved lines, and I remember on one occasion taking our President to see a section when the foundations were being got out for the Whitfield Memorial Church at Gloucester.

At Brookthorpe, in sinking a well, I found under the vegetable soil :

	ft.	in.
A yellowish Clay, (Boulder-clay), so much worked up as to form an excellent puddle	4	4
Oolite and Marlstone Gravel	2	4
Then Clay, gradually becoming harder until it rested upon a floor of blue hard Marl of the Henleyi-Zone ...	4	0

This Clay, which had evidently not been subjected to the same attrition as the upper bed, appeared to have been formed by the percolation of water through the gravel.

Before proceeding to the last subject I wish to give some supplementary information on two important sections, *Hempstead* and *Limbury*, in my former paper, (Cotteswold transactions vol. V. page 79,) as they will have an intimate bearing on my concluding remarks.



Up-Hatherly, No. I - (Scale ½" to 1'.) -
(EAST)

(Page 79, Hempstead.) In the summer of 1870, the Rev. Samuel Lysons had a large reservoir made for some new water-works at a distance of about 200 yards from the section at the churchyard. Mr. Williams, the Engineer, informed me that, in making the preliminary boring the instrument used passed through clay to the depth of fourteen feet which induced him to believe the ground around was of like nature. However, in proceeding with the work he found what he had bored through was a pillar of clay, of a conical form, about four feet wide at the top, and ten feet at the base, surrounded by sand and gravel, much intermixed in places, folded over with seams of clay. The base rested on an eroded uneven clay. Mr. Williams said in all the works in which he had been engaged he had never seen such a peculiar condition of earth as this excavation presented. When I visited the works they were nearly completed, but I observed the clay, gravel, and sand were much contorted, apparently by some powerful lateral pressure, and the only agent that I am aware of, capable of producing such an effect is ice.

Among a considerable heap of N. D. pebbles I picked up a large block of Millstone grit, and tracing the cutting in a Southerly direction towards Elmore, underneath the surface soil was Boulder-clay with N. D. pebbles studded in it, and I found a piece of Felstone. The foundations for some cottages were being excavated near to the reservoir exhibiting a thickness of several feet of the Quartzose Sand, similar to the section in the Churchyard, and shewing how great is the change of soil within a few yards. The Sand is from the New Red Sandstone beds.

Since I made the section at Limbury, which is the finest in the district shewing Glacial Drift, the pit has been extensively worked for gravel, to form a new road, and shews a greater depth than when I first examined it, being now fully eight feet. Some of the Silurian transported blocks were remarkable in shape having a slab-like appearance resembling an elongated brick with a flat surface, and not more than an inch thick, apparently more water-worn than would be caused by a slow

running stream. The gravel is a mass of pebbles and flat slabs, mixed with sand, and near the bottom was found a large Silurian angular Boulder, probably Caradoc from the Malverns, 2 feet long, 1 ft. 6 in. wide, and 3 inches thick. This is now in the Museum at Gloucester.

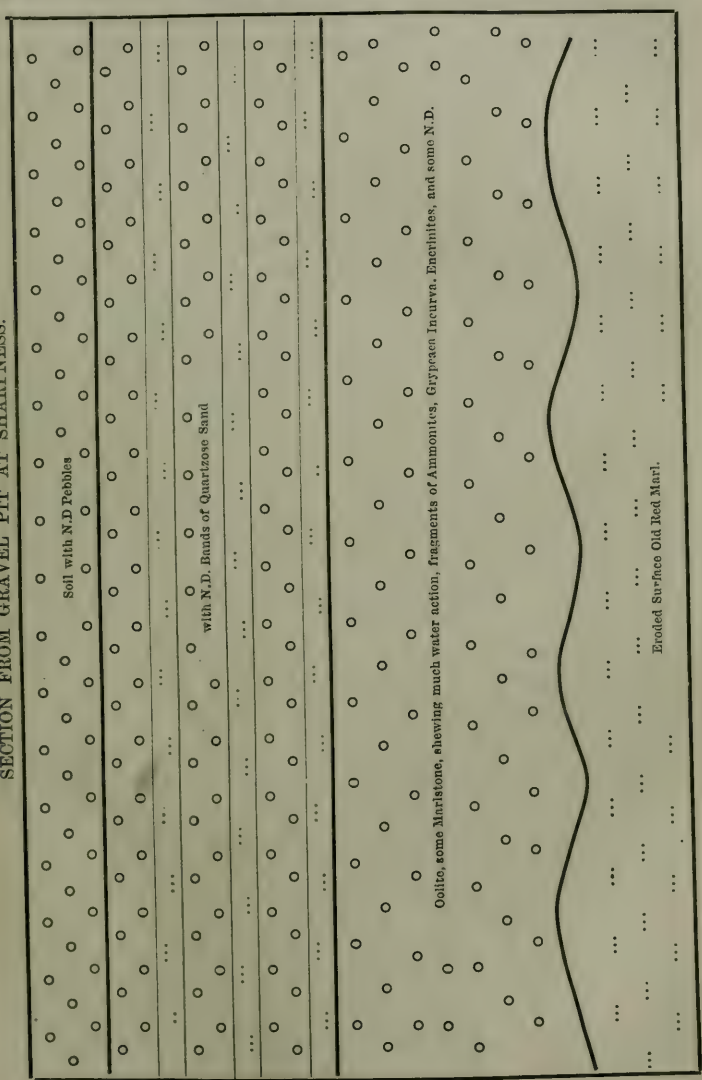
In addition to the long list of Silurian and other fossils, hard chalk, pieces of Syenite, Licky Quartz, Granite, and Carboniferous Limestone, which I gave in my paper, (vol. V. page 81,) I found Gryphæa incurva and Cardinia both from Lower Lias.

And now to the further evidence of ice action in the plain: commencing at Sharpness Point, where on the removal of the gravel for the works of the Midland Railway, the surface of the hard beds of the Old Red Sandstone was found to be eroded and furrowed, with no trace of mud left. At and around Gloucester, extending beyond Tewkesbury, I have seen many like examples of erosion in the Lower Lias Marls.

To shew this is not a mere local example I would mention that Mr. C. Moore in the *Quarterly Journal of the Geological Society*, December, 1867, says:—"In the neighbourhood of Bath wherever the Drifts are passed through they are found to lie on the Upper Blue Marls of the Lower Lias, which present long lines of furrows channelled out either by Glacial action or the effects of Post Pliocene erosion." Indeed, the same phenomenon holds good throughout the greater part of the low ground of this country, where gravel occurs: on the Chalk, in various parts of Norfolk, Suffolk, Kent, around Freshwater in the Isle of Wight, and on the great Western Railway between Didcot and Reading, as well as in the New Red, at Beeston in Nottinghamshire. I have noticed it also on the brecciated Oolite close to the Peterborough Railway Station.

For some years I have been occupied, as my limited leisure would admit, in attempting to correlate the Gravels of our district with those of the East Coast and other parts of England, and I may here remark that I believe in these planed-off surfaces I have found a starting point common to all areas, and which I may probably make the basement line of a future paper.

It is upon the eroded surface, whatever the formation is that gravel occurs often mixed up with a Till or Boulder-clay, as is so well shewn on the banks of the Severn at Sharpness Point, of which the following is a general section.



In sinking the cylinders at number 10 and 11 Piers in the river, for the Severn Bridge, at a depth of 25 feet below the sands, a piece of Boulder-clay (derived from Old Red) was brought up, containing N. D. pebbles and one small bit of Oolite. There were two feet of Gravel found lying on the top of the hard Marl Rock from which the unrolled flint, I hold in my hand, was taken. The spot would be about 1,400 feet from the shore on the Sharpness side.

The same Till as at Sharpness is seen on the other side of the Severn, rather lower down, in the cutting of the New Severn Bridge Railway to Lydney.

After the heavy gale some years ago when the *Royal Charter* was lost, Mr. Clegram directed my attention to the displacement of sand caused by the storm in the Severn at Purton which had uncovered a considerable quantity of Northern Drift pebbles, and some of large size. As to how they got there and on the presence of drift on both sides of the river, I hope to have something to say in discussing the formation of the Severn, on a future occasion.

To those of our members who have only examined the Gravels in our own district near to the Cotteswold range, from which they were derived, I am aware how difficult it is to realize *ice action.* But I do not think any one who has visited Limbury, an isolated hill, with transported blocks of Silurian, Granite, Mountain Limestone, and even Chalk, with some of the former bearing evidences of Glacial striations, or has witnessed ice marks on the slope of the Malverns, as seen by Mr. Etheridge and myself, can doubt there was a time when Glaciers passed down the valley of the Severn; and how could the Cotteswolds have escaped their action?

In the Northern Cotteswolds there are also unmistakable evidences of ice action. At Aston Magna I have taken out a piece of Chalk embedded in a large angular flint, fully a hundred weight not at all water worn, and with dendritic markings still on the Chalk; and when the cutting was made, Mr. Robert Tomes, a most trustworthy observer, found striations on large blocks of hard Chalk. This cutting at Aston is most remarkable, as it shews the N. D. with the Oolitic Gravel upon the top.

There are many Boulders of foreign origin within a few miles of this spot.

When we reflect that there is probably not a bed in the Inferior Oolite in our neighbourhood sufficiently hard to retain striæ, the explanation seems to me simple. Marks are rarely found except upon dense compact rocks, like the one I hold in my hand from the Carboniferous Limestone.

The numerous outliers of Oolite which remain shew clearly, that when the Glacial period set in, the Cotteswolds stretched much farther to the westward than they do now; and after the great submergence when the hills rose from beneath the water and the climate began to ameliorate, frozen snow rested in the form of land ice upon the slopes, which, when the summer sun began to melt it, would slide down into the valleys with large masses of the rock upon which it reposed. The rainfall was probably much greater than it is now, and floods would carry away the large masses of fallen rock still further into the valleys, reducing them by attrition; and subsequently owing to a depression of the land the sea water came up the Severn valley, washing and rubbing the rocks until they became reduced to gravel, and which I believe to be the origin of the beds we meet with some distance from the hills, as at Frampton, Barnwood, and, indeed, all gravels that are derived from our *local* rocks.

Observations on the Opercula of some Silurian Gastropoda, &c.
By Frederick Smithe, M.A., LL.D., F.G.S., *&c.*

The operculate Gastropoda possess a shelly or horny cover, called an operculum, with which they close the mouth of their shell. This separate portion is developed on the posterior part of the foot, and when the animal has entirely withdrawn into the shell it constitutes in some degree a sort of defence or protection to the soft creature. We would now urge that a study of the operculum, be it recent or fossil, ought not to be disregarded by the naturalist.

Agassiz, in his work on classification,* where treating of the succession and standing of animals, observes of the Gastropoda generally that—"Every palæontologist is aware how imperfectly their remains have been investigated in comparison with what has been done for the fossils of other classes." It is also the opinion of zoologists that not only the Gastropoda, but the whole of the Mollusca, need to be rearranged, as the present classification is only a disposition of so many artificial groups, and must be regarded as simply provisional until the Gastropoda are more thoroughly examined; wherefore, until that time arrive, we should studiously collect observations upon the subject, and even stray particles of information are not without value and significance. A collection of specimens of the operculate Gastropoda, whether land, fluviatile, or marine, without their opercula, loses much of its value, and avails little for the true purpose of natural classification. Such a collection is simply

* "Essay on Classification," L. Agassiz. Longmans, 1859. p. 163.

an assemblage of defective objects—beautiful they may be, but they are biologically incomplete without this member. Seeing that the shell of a Gastropod is its skeleton, and the operculum part of that skeleton, it is strange that in collections even of recent shells this integral part of the organism is so often absent. Unskilled and unscientific collectors are to blame; yet it is only fair to admit that such a deficiency is becoming less common, for a spirit of clearer scientific insight is animating those who study the Mollusca as the chief invertebrates of the Animal Kingdom, and the result is apparent in the fact that foreign specimens of Mollusca are at present generally accompanied, at least in museums, with this appendage, whilst examples of British species, from the facility of procuring specimens, are very rarely "put up" without the part. Of course the frequency of the occurrence of complete specimens is generally in proportion to the abundance of the species. But a different set of conditions altogether embarrasses the palæontologist in his researches, which is evident when we consider how the *fossil* Mollusca became entombed in their parent *rock*. The dissolution of the softer parts, such as the ligament in the Conchifera and in the Gastropoda, of the animal itself to which the operculum belonged, convinces us that the chance of preservation of such a delicate structure as an operculum must have been rare, and even when this was shelly, instead of horny, the chance of survival was inconsiderable, so that if the part became petrified at all, it must have owed its preservation to a shelly or calcareous nature. Accordingly, we must not veil the fact that we absolutely know next to nothing of the opercula of Gastropods in the fossilized state, so that cases which accident occasionally discloses are quite exceptional.

One or two of these rare instances it may be interesting to mention; and first, we would touch on the odd and singularly shaped operculum of that Lower Silurian genus Maclurea (Lesueur, 1818) allied to Bellerophon, but whose affinities are not clearly known, once thought to be confined to the Chazy Limestones of the United States of America, until it was detected in 1854, by Mr. Charles Peach, in the Highlands

of North Britain.* Two species of the genus Maclurea are known, together with their opercula—the *Maclurea Peachii* and the *Maclurea Logani*. These are so well drawn and described in the Proceedings of the Geological Society of London, that I will only give the reference—(see vol. xv., p. 379, and plate xiii.) The preservation of the opercula of these species of Maclurea evidently depended on their hard, coarse, shelly structure. In appearance they are not unlike a grotesque unrolled Pileopsis. Leaving palæozoic species on one side, an instructive illustration may be added of the use to which an acquaintance with the opercula of Gastropods may be turned; and the case will probably have additional interest for us from the situation being in Liassic strata. In the Upper Lias at May and Curcy, in Normandy, certain strange ellipsoid fossils were not unfrequently brought to light from the *Leptæna* band. These small peculiar things defied all the ingenuity of the MM. Eudes-Deslongchamps to decipher. All their palæontological friends to whom they submitted them were equally at fault. Not only could the Professors not refer them to any genus, but scarcely to their order in the Natural Kingdom. Wearied at length, and with exhausted patience, MM. Eudes-Deslongchamps thought it would be well to name and describe these fossils provisionally, in their treatise on the Upper Lias; so they gave them rank as a genus under the name of *Peltarion*, which next they divided into two species, standing as follows:—

Genus *PELTARION*.—Eudes-Deslongchamps.

Species . . .	*Peltarion unilobatum*, Eudes-Desl. *Peltarion bilobatum*, Eudes-Desl.	May and Curcy.

Of these quasi species full descriptions and figures and many

* It is a point of interest to note here a remarkable extension of the range of this peculiar Silurian genus that the Challenger Expedition naturalists have ascertained. Captain Feilden, R.N., has brought home *Maclurea* from Bessels Bay, a latitude as far north as 81° 6′. (*Quarterly Journal Geological Society*, vol. xxxiv. page 804.) This important addition swells the list of British fossils included in the Arctic Province; for though an "aberrant" form, it helps to conduct us to a more precise knowledge of glacial relations and periods.

interesting particulars are given by the authors in their works cited.* Their judgment, on the whole, inclined to the view that they were Rhyncholites or other parts of Cephalopods,—at least their words seem to imply this much—"*Il y a toutefois entre les Rhyncholites et les Peltarions une sorte d'air de famille.*" (p. 24.)

Fossils resembling these had also been discovered in the Coral Rag of Würtemberg (Jura Blanc) by Prof. QUENSTEDT, who was sorely exercised as to their real character, and who, after patiently casting about in every direction for their affinities, declared that there was scarcely a doubt, judging from their texture, that they belonged to the *Echinodermata.* He accordingly assigns them a place and notice at the end of his account of the *Crinoidea*, bestowing upon them the mystic name *Problematica*, though without going to the absurd length of forming them into species.†

Again, Mr. CHARLES MOORE, of Bath, F.G.S., met with fossils of the same character in the Leptæna clays of the Communis zone (Upper Lias) at Ilminster, in Somersetshire.‡ He immediately pronounced them to be the body-plates of a fossil Chiton—the *Chiton unilobatum*, EUDES-DESLONGCHAMPS—and constituted one of them the type of his *Chiton radiatum*, although, had all their characters been duly scrutinized, appearances would have told against such a determination, inasmuch as the convex edges of these fossils were thick, instead of being the reverse, which latter is invariably the case with the edges of the plates in the *Chitonidæ* where they overlap and articulate.

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* See "Mémoire sur la couche à *Leptæna*," par les MM. EUDES-DESLONGCHAMPS. IIIe vol. du Bulletin de la Soc. Linn. de Normandie. 1859. Plate 2, fig. 5-6; plate 7-8.

† Proceedings of the Somersetshire Archæolog. and Nat. Hist. Society. "On the Middle and Upper Lias of the S.W. of England." Vol. xiii., p. 56. Taunton: 1875-6.

‡ Handbuch der Petrefaktenkunde, QUENSTEDT. Auflage 2^e. Tübingen, 1867. T. 69; fig. 45.

And so it came to pass that these little fossils were bandied about from one class of the Animal Kingdom to another—sometimes a Chiton, sometimes a Barnacle, and then a Crinoid—until the mystery has at length been cleared up, and that quite recently. It was only within the past year that the reproach was taken from these strange diminutive objects. M. Bedouin had, it seems, in 1868 actually found two casts of a fossil shell, a *Neritopsis*, with the so-named *Peltarion* in their mouths; and besides this, the keen research of an ingenious conchologist, M. Hippolyte Crosse, editor of the *Journal de Conchyliologie*, Paris,* materially assisted to clench the matter, for, by a close study of the opercula of the recent Gastropoda, he has clearly proved that the fossil puzzles, *known* under the name of *Peltarion* of the MM. Eudes-Deslongchamps, *Problematica* of Dr. Quenstedt, and *Chiton radiatum* of Mr. Moore, are simply the opercula of certain Gastropods belonging to the genus *Neritopsis* of the family *Neritopsidæ*.

A discussion of the following particulars may now engage our attention. Two points—one, the scientific relation of the operculum to the rest of the shell; and the other, its relation to the class of operculated Gastropods generally. There was a view—first conceived, I believe, by Adanson, and firmly held by the late Dr. Gray, so many years keeper of the Zoological department of the British Museum,—that the shell of a Gastropod with its operculum complete is the analogue of a bivalve Mollusc; or, otherwise expressed, that the operculum is the equivalent, zoologically, of the dextral valve of the Conchifera. This figment, so purely an imagination, consisted in fancifully regarding the simple shell of the Gastropod as a single valve, and its companion operculum as the corresponding valve of a bivalved Mollusc; and it would, if only true, make our collections of the Gastropod Mollusca, for the most part, a mere array of single or odd valves.

From this palpable *reductio ad absurdum* we feel relieved by the knowledge that malacologists of the foremost rank totally

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* *Journal Conchyliol.* Paris, 1875. pp. 57-66.

reject Dr. GRAY's hypothesis. Our late excellent associate, Dr. S. P. WOODWARD, of the British Museum, always strenuously opposed this view of the subject. Nevertheless, in order to chase away all doubt, I have consulted Professor HUXLEY, whose account (see article "Mollusca") containing the history of the development of that sub-kingdom ought to be studied by every one who concerns himself about the matter. The Professor kindly writes to me in reply—"I have not the slightest doubt that Dr. GRAY was wrong and WOODWARD right about the operculum of Gastropods." And moreover, Professor HUXLEY considers "that the development of the part is conclusive upon the point."* We may therefore infer most safely from this departure that the correspondence of the operculum as to *function* would be like that of the plug in certain of the Byssoarca, which was the opinion of Professor FORBES; and that it corresponded in *position* to the byssus of other Conchifera, according to LOVEN, though of much more complex structure. (S. P. WOODWARD.)

A few words may be allowed on the position of the operculum. It is attached to the posterior part of the foot of the animal, and is there developed, and not secreted by the mantle like the rest of the shell. When the animal has withdrawn into the body-whorl of its shell, this part ingeniously forms a perfect shutter to the orifice, generally fitting it with a marvellous closeness,—though in some species it does not wholly close the aperture, but only serves as an imperfect defence to the animal, like the puny buckler of certain African savages; indeed, when the substance of the opercula, as in many species, is horny instead of shelly, the protection they afford can avail but little. For instance, the fine *Ampullaria insularum*, a large fluviatile Gastropod that flourishes in the muddy marshes of La Plata, is

* I would quote the Professor's expression of opinion in his lectures, which I did not happen to meet with until lately. Treating on the Branchiogastropoda (GREENE), he states that "as the operculum is developed from the foot, and not from the mantle, it can obviously have no homology with the valves of either a Brachiopod or a Lamellibranch."—HUXLEY, Lectures on Comparative Anatomy, p. 36. London, 1864.

"eaten by the rails and other water birds, who often break the operculum, the only vulnerable part, to get at the animal."*

From what I have said, we are now able to conclude pretty accurately that palæontologists have scarcely any knowledge of the subject of our discussion. Notwithstanding, its value in the classification of certain of the extinct species must unquestionably be of no slight aid. In one great class, for instance, of the fossil Cephalopoda, the *Ammonitidæ*, this appendage, known as the Aptychus and Anaptychus,† when taken in connection with the form of the mouth and other natural features, is now relied on with the utmost confidence as a trustworthy ground of new generic distinctions by such authorities as Wright, Suess, Zittel, Waagen, and Von Mojsisovics; so that the present classification of the Ammonites, which is a mass of confusion, based, it is true, upon a natural, though, taken alone, an insufficient character—that of the late Baron Leopold Von Buch's configuration of the sutures—is being superseded, having clearly had its day, since even now we see it begin to fade into the limbo of past failures. There is, however, no denying that the difficulty is to satisfactorily prove the connection between the valves referred to and their particular shells—precisely the same difficulty which obtains with the operculated Gastropoda.

When I purposed to offer some remarks on the opercula of certain species of fossil shells, I had under my eye four specimens which, a few years ago, came to my hand in the Wenlock Limestone beds on the Longhope side of May Hill. It is true that the first examples found explained themselves: they were, without a shade of doubt, the opercula of some marine Gastropod, but the question as to what species or even genus they could belong seemed a hopeless one to settle. The doubt was cleared up in a way unlooked for, and that speedily, by my happening

* Gray's Systematic Arrangement of the Mollusca in the British Museum. London, 1857. Part I., page 67.

† "Nidamentaldrüsendecke" is the word forged by our Teuton kinsmen, meaning literally "nidamentalglandcover."

I

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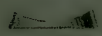

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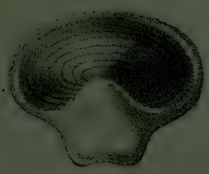

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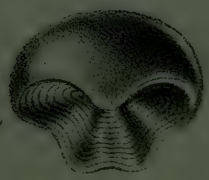

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FOSSIL OPERCULA.

(GASTROPODA.)

to dislodge a specimen which showed the operculum actually lying in, or close to, the mouth of its parent shell, which was the not unfamiliar *Euomphalus sculptus* of SOWERBY, one of the classic species of Wenlock age. I incline to the belief that such fossils cannot be so very rare as some may suppose. It is more likely that hitherto they have been misinterpreted—that is, regarded as Discina, or as portions of a coral, and so forth, for to the former it bears more than a passing resemblance. As giving some colour to this, I have, just before preparing this account, had sent me by a brother naturalist, Mr. G. F. WHIDBORNE, M.A., F.G.S., four specimens from his collection for examination. These he had labelled "Discina," but all of them proved on inspection to be the opercula of species of *Euomphalus*. They were obtained from near Malvern. In one specimen the operculum was deeply withdrawn into the body-whorl of the shell, and not merely reposing near the mouth like one of my own specimens. Mr. WHIDBORNE acutely suggests that the occurrence of opercula might be useful in measuring the rate of deposition of sediment, and that a bed containing a number of shells without their opercula might be an argument against sudden deposition of sediments. A proper discussion of such observations, though of service, would exceed the limits of this paper. The presence of the operculum in or near its shell would naturally point to a state of undisturbed ooze or mud, and the absence of drifting currents. Where, on the other hand, the shells are found without their opercula, we might reasonably infer that the causes of the separation of the parts might be sought in violent eddies, or even in the thrust of the shaly beds after deposition of the sediment.

In an additional specimen which I got from the May Hill beds, and which I thought was an operculum fixed in the mouth of a kindred species—the *Euomphalus rugosus*, I was not so fortunate, as Dr. H. WOODWARD, of the British Museum, on having the fossil cleared, found the object to be simply the hypostome of a trilobite—an *Illenœus*. This I mention by way of caution against similar illusions. However, even in the authentic examples—those of *Euomphalus sculptus*, the part in

question is so scarce that the Director of the British Museum informs me he has not yet seen an example. Nor is the part figured or even mentioned in the best text-books I have searched, such as those of CHENU, PICTET, or QUENSTEDT's last edition of the "Petrefaktenkunde;" so that an examination of the present character will have its use in directing attention to the subject. Fully admitting that a fanciful analogy may have misled some authors into a false homology of the operculum, still the subject is not without its special and distinct value. Even as a biological element it possesses a peculiar interest, having a character probably of subgeneric degree in importance, and so far must be accorded weight as a factor in any natural system of classification of the Mollusca. At least we would submit that, apart altogether from mere utility in that relation, a knowledge of the operculum should not be disregarded in any thorough study of the development and organogenesis of the order to which it belongs; because to such seemingly minor points the palæontologist has to defer in any sound research into the succession, rank, and genetic relations of the Mollusca, whether recent or fossil, if his systematized knowledge would aspire to a character at once vital, lasting, and suggestive, to say nothing of the demands made on him by what we sum up in the phrase—scientific truth—to which may we all look with various energy and renewed freshness.

THE OPERCULUM OF *EUOMPHALUS SCULPTUS*, (OF SOWERBY.)

PARTICULARS.

Position.—Wenlock Limestone, Upper Silurian. May Hill, Gloucester. Found by the author in 1867.

Description.—The operculum is shelly, ovately annular, a spiral of twelve whorls, the rings depressed, nodose, constricted, beadlike, and the substance probably horny towards the nucleus, which is concentric, concave within, plane without. Thin, with bevelled edge fitting closely into the mouth.

Measurement.—The transverse and conjugate axes... 11·25 mm. × 9·0 mm.
The thickness... ... ... 1·25
The angle of rim—circa. ... ... 20°

FOSSIL OPERCULA.

(GASTROPODA.)

EXPLANATION OF THE PLATE.

I.—SILURIAN.—The Operculum of *Euomphalus sculptus* (SOWERBY).

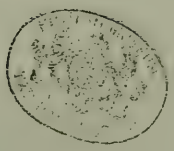
(Natural size).

1. The fossil with its operculum in place.
2. Exterior of the operculum.
3. Section on the diameter of the operculum.
4. Whorl of the operculum.

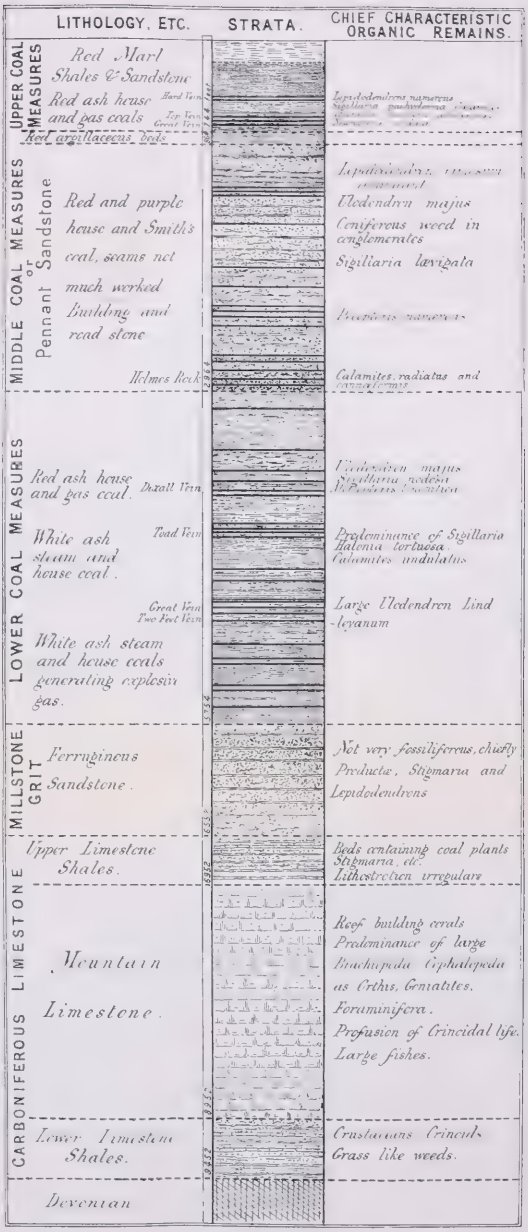
II.—LIASSIC.—The Opercula of *Neritopsis* (SP).

(Enlarged).

1. Exterior of the *quasi Peltarion unilobatum*, EUDES-DESLONGCHAMPS.
2. Interior of the same.
3. Exterior of the *quasi Peltarion bilobatum*, EUDES-DESLONGCHAMPS.
4. Interior of the above.



SECTION
OF THE
BRISTOL COALFIELD.



SCALE

150 Fathoms to one Inch

The Carboniferous Flora of the Bristol Coalfield.
By E. Wethered, F.G.S., F.C.S. *Read at Gloucester, (Winter Meeting), November* 14*th*, 1878.

The Bristol Coalfield has at various times, been described by many eminent Geologists but these descriptions have for the most part related to Physical conditions of the strata.

Mr. Stoddart, F.G.S., in his valuable papers on the Bristol Coalfield, communicated to the Bristol Naturalists' Society, has touched slightly on the Flora, but with this exception I am not aware that it has been in any way described. In fact, the Fossil Flora of most coal fields is generally passed over as being of little importance; the Fauna has been chiefly collected and adopted for the classification of strata or stratigraphical purposes.

* Professor Hull, in his classification of the Carboniferous series, states, that on principle he "rejected both fish and plants as furnishing data for classification."

Now, considering that plants as well as animals have their range in time also, does it seem reasonable to ignore them? That they should not be, is now contended by several geologists of distinction.

As an instance of the importance of recognising the Fossil Flora of any area I would point to the difference of opinion which has arisen as to whether the Lignite deposits of Colorado belong to the Tertiary or Cretaceous age. In these Lignites, Professor Lesquereux ("Age of N. American Lignites," U.S. survey of Colorado) describes 250 species of plants which are not known in the Cretaceous rocks, associated with a few types of Cretaceous Fauna. Now the question is, which shall deter-

* Quarterly Journal Geological Society, Vol. 33, page 651, 1878.

mine the age of the deposit, the 250 species of plants, or the isolated Cretaceous Fauna?

Another difficulty of this kind is the determination of the age of the Upper Series of the Bohemian Gas Coals. A Permian Fauna exists with Carboniferous species of *plants*, which is to determine? It appears to me that the deposits should be referred to one or the other period, according as to whether the Fauna or Flora is the most distinct and decisive.

A practical application of Professor Hull's remark is to be found in the Bristol Coalfield. Some years ago the base of the Pennant, locally termed the Holmes Rock, was said by certain geologists to be the Millstone grit, which would have led to error; in reading the structure of the Bristol Coalfield, this error was, however, pointed out by Mr. H. Cossham, F.G.S., at the British Association, held in Bath in the year 1864.

Now had those Gentlemen who examined and mapped this rock as Millstone grit, known the Flora found in it, and compared it with that of the Millstone grit, it is difficult to see how they could have made the mistake, allowing for its then obscure position.

In the *Geological Magazine* for August, 1878, page 34-5, Mr. H. E. Hippsley, C.E., contributes a paper on the "Correlation of the Somersetshire Coalfield," and shows that there are at least substantial reasons for questioning its correlation. This doubt, however, might be easily removed by a critical determination of the Fossil Flora.

The Carboniferous plants were most, if not all, Cryptogamic; some however possessed a higher degree of organization than is general with that division of the vegetable kingdom, hence they are considered by some writers to have belonged to the Gymnospermous Conifers.

The climatal and physical conditions which prevailed over the S.W. as well as the whole of England during the long Carboniferous period may be best judged by what we are able to gather of the surrounding circumstances.

There is unmistakeable evidence of slow and definite subsidence, and the accumulation of sedimentary matter; the

many subsidences to be followed by an equal number of pauses, which enabled fresh vegetation to grow, but only to be again submerged. Most Coalfields show by the Fauna that the Flora was submerged not always by salt or fresh water, but at one time it was fresh, at another salt, and again by a mixture of the two or estuarine.

This indicates that the plants grew in close proximity both to the sea and fresh water at different times. Of submergence by fresh water we have evidence in fresh water Limestones, composed for the most part of *Spirorbis carbonarius* in some parts of England.

In the Bristol Coalfield the indications of alternations of marine, fresh, and estuarine deposits are not indicated by any Fauna found up to the present time, though a diligent search has been made for Fossils.

If now we turn to our section of the Bristol Coalfield, we at once get a general view of it (see section). First comes the Carboniferous Limestone, divided into the Lower Shales, Mountain Limestone, and Upper Shales. The Lower Shales rest conformably on Devonian strata, the break being a palæontological one determined by the Fauna, but the Flora of the Mountain Limestone is more Devonian than Carboniferous. According to Goeppert,* the Mountain Limestone (Kohlenkalk) examined by him contained 47 species, of which 46 were terrestrial plants belonging to the same families as occur in the Upper Devonian.

We might naturally suppose this to be the case, as we have abundant evidence that during the deposition of the Limestone a Devonian land surface existed. Thus the Coal measures in some parts of the centre of England are defective at their base, the Limestone being absent. There must then have been land where this defect occurs, on which we can see no reason why a Devonian Flora should not have flourished and been carried by rivers to the sea in which the Limestone was forming.

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* On the Flora of the Siberian Devonian and lower Carboniferous formations, Geo. Soc., Vol. 16, p. 279, 1860.

The lower shales consist of alternations of clays, sandstones, shales, and dark blue bands of compact Limestone. We have, at least, one clear evidence of land surface in the beds which contain "Grass-like Weeds," as Mr. Stoddart calls them.*

This is the first appearance of plants in the Carboniferous rocks, but though it indicates land or close proximity to it, the surface was sinking so as to admit of the formation of Limestone, with its abundant life. From this life some writers draw conclusions as to the climate which prevailed during the whole of the Carboniferous epoch.

Where a Fauna is found associated with actual Coal Strata, considerable enlightenment is to be gathered as to the climate in which the vegetation flourished, but where none is found, as in in the case of the Bristol Coal measures, it appears to me very speculative to refer back to the Mountain Limestone for information. We must remember that a vast period of time elapsed between the beginning and the close of the Coal measures proper, and this lapse of time extended over the deposition of the Millstone grit, which in the Bristol district is upwards of 1000 ft. thick.

By referring to the Section of the Coalfield, the characteristic Fossils of the Limestone are seen on the left hand side, and from them we may conclude that the climate was tropical.

We must not neglect to notice that some of the Limestone beds yield bitumen, but it is not certain that it is of vegetable origin, for it may also be ascribed to the decomposition of animal substance.

At the close of the Mountain Limestone a similar condition prevailed in many respects as with the Lower Shales. There was more alternation of beds, some indicating deep water, others close proximity to land and actual land surfaces, on which plants grew, but still the conditions were not such as to allow of the formation of Coal; a vast time had yet to elapse before that store of wealth was accumulated in the South-west of England.

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* Proceedings of the Bristol Naturalists' Society, page 318, Vol. 1875-6.

Though there was similarity of conditions with the two Shales, there were also great differences. When the Lower Shales were in process of formation the general tendency of the sea bottom was to sink, with the Upper, it was to rise, and the Fauna brought in for the most part with the former, passed away with the latter.

On the Silurian and Devonian land surfaces which remained during the formation of the Mountain Limestone, great changes had been going on. At the close of the Upper Carboniferous Shales we have evidence that the Flora exhibits more of the Carboniferous than the Devonian type. By the denundation of this land surface the Upper Shales were gradually covered by a close grained ferruginous grit, the Millstone grit, and it is in this that we find the species of plants of a Carboniferous type.

In the Millstone grit there are a few seams of Coal that are worthless, and this fact, coupled with the general scantiness of Plant remains, indicates that the conditions were not favourable to their growth, or that they had been destroyed. This we think is characteristic of the Lower Carboniferous generally. Dr. Dawson states* that the "Flora of the St. Johns series of Devonian rocks excel in number of genera and species the Lower Carboniferous as it exists in British North America," indicating deterioration or destruction.

Now what is the composition of the Millstone grit, and what effect would its constituents have upon decomposing vegetation? Dr. Sterry Hunt states† "that the scantiness of Floral remains in some of the older rocks may be quite accounted for by the iron diffused in the soils and waters of those early times, which not only rendered possible the accumulation of such beds of ore, but oxidised and destroyed the organic matter, which in later ages appeared in coals, lignites, pyraschists and bitumers."

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* On the Flora of the Devonian Period in N.E. America. Quart. Jour. Geo. Society, Vol. 18, page 304, 1862.

† On the Origin of Metalliferous Deposits. Chemical and Geological Essays, page, 229.

Now the Millstone grit contains a considerable quantity of iron, and the effect of this would be, as Dr. Hunt has said, very destructive to organic substances, and will, we think, quite account for the few Fossils; for not only are the Plant remains scanty in the Millstone grit, but few fossils of any kind are found.

Mr. Stoddart remarks, in the paper before referred to, that in one of the Brandon Hill beds a large number of Productæ are seen where the lime has totally disappeared, having been dissolved out, leaving a hollow mould of the shell. There is only one agent that could do this, namely an acid, and we have not far to look for that, as a great amount of carbonic acid gas would be generated by the destruction of vegetable matter as above described. The circumstances seem to suggest that the grit was deposited in an inland sea, or lagoon, subject to an influx of the ocean, by which the Fauna was introduced, but upon the original condition being restored, they were destroyed by the gases generated by decomposing vegetation. I must not, however, enter upon a discussion of this subject now, my only object in referring to it is to show that the evidence is against a climate, unsuitable alike to vegetation and Fauna, and its scantiness is not to be accounted for by anything like an interglacial period.

The top of the Millstone grit gradually passes into the Lower Coal Measures, which as represented in the coalfield section, are between 2700 and 2800 feet thick. The lower series consists of more than one class of coals, and I hope to show that there are fossil plants characteristic of these groups, and sometimes of single seams of coal by which they may be determined, in the same way that a certain Fauna determines other strata. Seams of coal, and associated strata vary much in a short distance, and for the purpose of correlation, too much reliance must not be laid on the physical conditions, or on the lithology of the surrounding strata.

We first come to a series of seams generating explosive gas, the only ones which do so in the coalfield. I regret exceedingly that my knowledge of the Flora of these seams is very limited, as they have as yet been worked only at collieries with which I have no connection.

I have endeavoured to get information on the subject, but no collection appears to exist, and it is said that no Fossils are to be found, but this I must be pardoned for discrediting.

The same idea has prevailed with regard to the steam coal seams above; the reason was, that few specimens are found immediately over the coal, but a foot or two above, and there they had not been looked for.

From the examination of a Stone Quarry, at Kingswood, which lies in close proximity to the Ashton top seam, I have been able to get some light on the subject, but, as in the case of the Millstone grit, the chemical constituents of the stone have not been conducive to the preservation of organic remains; there are the indications of a very abundant Flora, now represented by moulds; they are chiefly those of a Calamite and Trigonocarpum.

It is important that a knowledge of this Flora should be obtained, seeing that these coal seams are the only ones in the Bristol district which generate explosive gas, and it would be, at least, interesting to compare them with those of the non-explosive gas seams which follow.

The first of these is the "Two Foot" seam, which is especially characterised by the occurrence of large *Ulodendron Lindleyanum*, also known as *Botherodendron punctatum*, but the latter name I think should be discontinued, as the tree is no doubt a species of *Ulodendron*, and the complication of names only tends to create confusion. Fine specimens of *Lepidodendron Sternbergii* also occur, but they are not so numerous as the last. The thin end of these trees point towards the south-east, a circumstance which appears to indicate that the current which brought them down came from the north-west.

Then there is *Calamites ramosus* tolerably abundant, and *Cordaites*. This latter has usually been considered to be foliage, but it appears to me to partake more of the nature of a reed. By glancing at the table of the Flora we see the range of this genus is great; it is found over every seam in the district, so far as I have been able to ascertain, and always in great abundance.

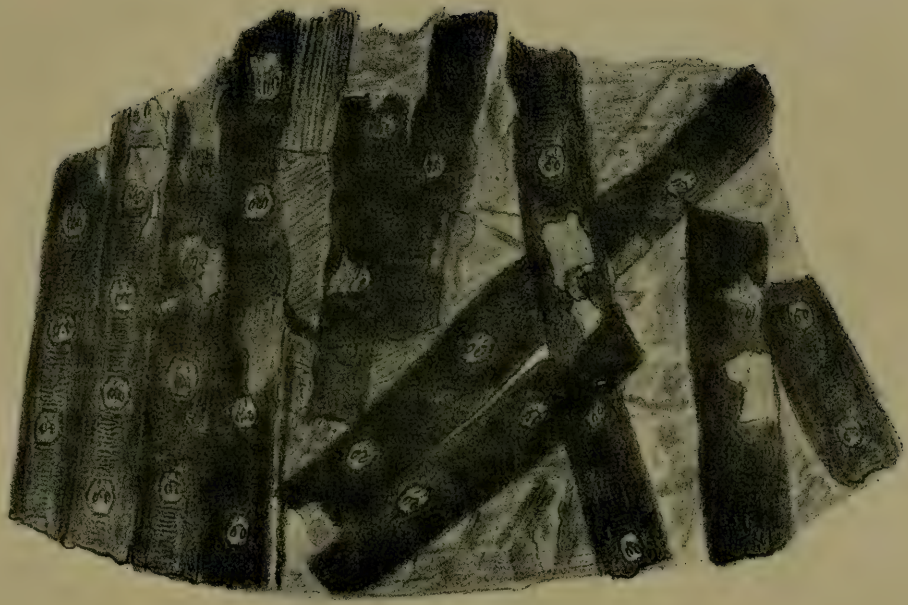
SECTION OF THE TWO-FOOT SEAM.

Lithological	Strata	Fossil Flora
Fine Duns 8 feet thick		Ulodendron Lindleyanum Lepidodendron Sternbergii Calamites ramosus Cordaites
Shale, 8 inches thick		Cordaites
Black Dun, 6 in. thick		Cordaites
Coal, 2 feet thick		
Underclay, 3 feet thick		Roots

Scale—¼ of an inch=1 foot.

The next seam of coal which I propose to notice is the Great Vein. It is, as the name implies, the thickest of any, averaging from four feet and a half to five feet, and is 58 yards above the "Two-foot" seam.

The greater number of genera and species of plants found here are similar to those over the latter. *Ulodendron Lindleyanum* is less abundant, and the specimens are not so large. The fructifications of *Lepidodendron Sternbergii* are in places numerous, but I have not yet found a main stem. *Calamites radiatus*, *Cordaites*, and *Alethopteris oreopteridis* occur for the first time. Owing to this seam of coal being thick, it is not necessary to get much of the overlying strata down for the construction of the underground roads ; therefore there are few opportunities for observing its Flora, because the fossils are usually found a few



I.—TRUE FORM OF SIGILLARIA MONSTACHYA.—(L. AND H.)

[HALF NATURAL SIZE.]

feet over the coal, the only chance of getting specimens is when a fall occurs, or when, for some special purpose, a portion of a road is required above the usual height.

Passing over several seams of coal as yet little worked, we come to the Toad Vein, 172 yards above the Great Vein, but the name, *Sigillaria* seam, would be more appropriate, from the great abundance of this genus in the roof, together with unusual quantities of *Cordaites*. Of the *Sigillaria*, 2 or 3 species are characteristic, and are not found out of it. The one most numerous is imperfectly figured by LINDLEY AND HUTTON, on p. 55 of their book as a variety of *pachyderma*, but it has peculiarities which entitle it to be described as a new species, and it will shortly be described as *Sigillaria Etheridgii*, after MR. ROBERT ETHERIDGE, F.R.S., being formerly one of his students. One feature of the Fossil is the detachment of the ribs in some specimens found, and the same is noticeable in the other characteristic, but much less numerous species, *S. Monostachya*. I had considered my specimens to be those of a new species, but MR. CARRUTHERS, who kindly examined them, considers them to be the true form of the above species, figured by LINDLEY AND HUTTON on page 72 loc. cit. These authors have only figured one rib, and remarking upon the peculiarity, they say, "this is so like a single rib or fluting of the *Sigillaria* that it is difficult to believe it can be anything else, and yet it is as difficult to understand how one longitudinal portion of *Sigillaria* should be separated from another in the way this one has been separated; for not only is there not the smallest trace of tearing, but the whole specimen stands out in very high relief."

The other species of Sigillaria found over the Toad Vein are *scutellata*, *tesselata*, and *Murchisonæ* and one other which I have been unable to determine; less numerous than the Sigillaria are *Halonia tortuosa*, *Lepidodendron rimosum*, *Calamites undulatus*, *Sphenopteris obtusiloba* and *irregularis*, *Neuropteris gigantea* and (strange as it may appear to some) *Stigmaria*. It will be observed that the Flora of this seam is very different from the two before. *Ulodendron Lindleyanum*, *Lepidodendron Sternbergii* and *Calamites ramosus* having now disappeared.

Following the Toad Vein are again three seams which have not been worked, and then the White-ash steam coals come to an end. They are followed by Red-ash gas and house coals.

The first of these is the Upper Five Coals, lying 131 yards above the Toad Vein, and 11 yards higher is the Doxall seam. The rich Flora of the Toad Vein has almost disappeared; the Sigillaria have only one representative, the other fossils, with the exception of *Cordaites*, have not as yet been found.

The roof of the Doxall seam is a hard calcareous blue-stone, the richness of the colour being due to the amount of ferrous compounds contained; on exposure to the air, the latter passes into the ferric state. Almost the only Fossil found is the cast of a small Calamite, the organic structure having been destroyed. There is, however, evidence of a rich Flora having existed; but the bulk of the vegetation has been in the main destroyed by the iron and sulphates, which the waters of that period contained and deposited.

Mr. Edward T. Hardman, F.G.S.,* demonstrates this decomposition of organic matter by referring to the Flax Pits of the North of Ireland, where he says, "the clay in which the pits are sunk contains nearly all the iron present in the ferric condition when not subject to the action of the plants, but in the mud from the bottom there are only parts compounds of iron mostly as Carbonate. Nor is there a trace of peroxide of iron in the flaxwater, but, on the contrary, plenty of ferrous iron."

Next follow numerous beds of fire-clay, shales and stone. These fire-clays are full of *Stigmaria*, but few vestiges of the Lepidodendroid or Sigillaroid plants, of which they were the roots, are met with, the only one I have found is *Ulodendron majus*, and two stems standing in situ† with Stigmaria attached.

This stratum is now being proved at the Kingswood Collieries by a branch from the Belgium Pit. Only one seam of coal up

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* The Atmosphere considered in its Geological relation. Quarterly Journal of Science, No. 56, October, 1877, page 460.

† The structure was not well enough preserved to determine them with certainty. They were 8 inches in diameter, and the underclay was compressed to an inch thick.

to the present time has been cut beyond the Doxall; its identity however at present is uncertain.* Over it is a tolerably rich Flora; *Cordaites*, with other reed-like plants, are almost as abundant as on the Toad Vein, but the characteristic forms are *Neuropteris Cistii*, very numerous, *Alethopteris lonchitica* and *Sigillaria nodosa*. This ends the lower series, and by referring to the table containing the list and range of the Fossils it will be seen that there are several in this division which have not been named in connection with the seams of coal, because of some uncertainty as to the seam from which they were collected.

We now enter upon a Sandstone deposit about 2100 feet thick, known as the Pennant. This formation is said to be alone confined to the South Wales, Bristol, Somersetshire, and Forest of Dean Coalfields, and though we speak of the Upper and Lower series divided by this Sandstone, it does not follow that these divisions correspond with those of other Coalfields. It strikes one as being singular that so thick a formation should be confined to so limited an area, and seeing that some parts of it so closely resembles the Millstone grit, it may be that in other districts it is mistaken for that formation, especially when the out-crops are not seen, if so, there are large deposits of coal yet to be discovered.

The Pennant is an alternation of sandstone and pebbly conglomerates with mud balls, and beds of clay. These latter were land surfaces on which a Flora had grown, and been submerged in water, highly charged with calcareous and quartzose sediments and ferric oxide. The vegetation decayed rapidly in its presence, the fibrous parts alone remaining, now forming black layers. The stone sometimes presents a very red appearance, which is only superficial where the iron has been re-oxidised, and clearly shows at a glance the amount of iron which some beds of this sandstone still contain, but the greater portion has been carried away in solution by water. We have here a recurrence of what we had in the Millstone grit, namely, conditions

* Since the above was written another seam has been cut which bids fair for a rich Flora.

very destructive to organic remains, so that we can form but a limited idea of the life which existed, nor can we tell to what extent coal forming vegetation has been destroyed, and the loss thereby sustained ; but in the pebbly conglomerates of the Upper Pennant specimens of wood are to be found wonderfully well preserved.

In the Pennant are a few seams of coal which constitute the middle series. They are chiefly used for smiths' work and house coals, but the uncertainty of their thickness is remarkable. This may in part perhaps, depend upon the amount of chemical decomposition to which the seam has been subject, during and after submergence ; the chemical character of the roof is very changeable and this would influence the decomposition, causing it to be unequal.

The Flora of the Pennant so far as can be ascertained up to the present time, consists of *Neuropteris flexuosa, heterophylla. Alethopteris Bucklandi, Pecopteris hemiteloides, Cistii, æqualis, cyatheites, Miltoni* ; *Sigillaria Candollei, organium, laevigata, tessellata ; Lepidodendron aculeatum, Veltheimiana, rimosum, Sternbergii* ; *Calamites radiatus, cannæformis ; Ulodendron majus, Trigonocarpum* and *Cordaites.*

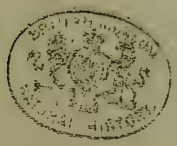
The Pennant was brought to a close by the sinking of the land, on which was deposited argillaceous beds of some 150ft. thick, coloured by iron in the ferric state. These form a sort of lithological passage between the Pennant and the base of local upper series of coal measures, but not a vestige of plant life has been obtained in these beds.

The lapse of time which extended over the deposition of these beds must have been considerable, as when land again appeared and vegetation grew, new genera and species had come into existence. The seams of the Upper Series are house and gas coals especially noted for the high illuminating power of the gas.

The lowest seam of coal is the Great Vein, at Parkfield Colliery, it is only divided from the Holly Bush seam above by about a foot of Duns, but to the south the distance between the two increases, and ground comes in characterised by the occurrence of *Neuropteris (Euneuropteris) cordata* in great numbers.

II.—CALAMITIES RADIATUS (BRONG.)—SHOWING ROOTS.

[HALF NATURAL SIZE.]



III.—ORDINARY FORM OF COAL STONE.

[HALF NATURAL SIZE.]

The Holly Bush seam and those above have over them fossils, common to all though not equally numerous; the top vein is especially characterised by well-preserved specimens of Calamites. Over the Top vein occurs the true type of *Sigillaria pachyderma* and some of the strata between the Top and Holly Bush seams are full of the foliage of *Lepidodendra.*

The following is a complete list of the Flora of the Upper Series:—*Lepidodendron Sternbergii, longifolium, aculeatum, elegans, decorticata, rimosum; Sigillaria pachyderma, scutellata, elongata, subrotunda, intermedia; Stigmaria; Calamites decoratus, radiatus,* of the latter we figure a specimen with roots attached (Fig. II), the rhizoma appears to have continued on and to have broken off; *Ulodendron commutatum; Alethopteris lonchitica, urophylla, Bucklandi; Pecopteris arborescens, nodosa; Neuropteris cordata, Soretii, flexuosa; Rhacophyllum lactuca; Carpolithes sulcata,* and *Cordaites,* with reeds and grasses.

The unfortunate feature by which the hard vein may be especially known is the occurrence of small coalstones, sometimes in such numbers as to make the coal almost worthless.

After an examination of these stones and some which occur in the great vein of the Lower Series, I have been unable to arrive at their origin. They consist of an inorganic nucleus (in which there is a considerable proportion of iron), surrounded by a covering of carbonaceous substance.

On this are the markings of *Stigmaria,* and of the other tree plants of the period; the one figured is that with the marks of *Stigmaria* (Fig. III).

Were these bodies found over or under the coal, they would be placed in cabinets as fossils, but because they occur in the coal they are simply stones. They are, however, as much fossils as those found under or below.

The shape suggests their origin, it is the same as those of the other fossils; they were probably the hollow branches and roots of trees filled with *debris,* somewhat in this way.

It is tolerably certain that at least some of our coal-fields have been formed near the deltas of great rivers; into these rivers we see no reason why trees should not have been carried by

streams and water torrents as at the present day. Once in the water the rate of decay would depend upon the nature of the *debris* in suspension and solution. The inner parts of the tree, with the outer bark, being more liable to decay than the epidermal layer, a cylinder would result, into which it may be naturally assumed the sediment would accumulate. The weight of this accumulation would, in time, cause the cylinder to sink, and this coming to rest in coal forming vegetation would result in a coalstone. Or it may be that the plants decayed and were filled, as described, while standing.

The question may be asked would the coal period trees decay as we say; a quotation from Professor WILLIAMSON, of Manchester, taken from his works on the classification of coal plants will go a long way to confirm what we have suggested. He says "It is the bast layer with its investment of thick walled epidermal cells which has furnished in nearly every case the carboniferous film that covers the stem of the Lepidodendroid plants so abundant in the shales and sandstones of the coal measures. The bast layer evidently gave to the bark the faculty of resisting the decay which so effectually cleared out all the more central tissue. It was the double layer that constituted the cylinder, the two sides of which were brought together and flattened by superimposed pressure when the stems were prostrated and which constituted the hollow mould into which mud and sand were poured when they remained standing."

A few feet above the lower series Great Vein there is a bed containing large ironstone nodules, some of which are tolerably rich. These have much the same origin as coalstones. The only difference between them is, that the water in which they were immersed contained in the case of the iron nodules, a larger proportion of iron; this rapidly attacked the parts most liable to decay, with the formation of carbonate of iron, and, with a proportion of Silica and other substances filled up the cylinder thus formed. The shape and the well-preserved markings on these stones is very suggestive of their origin.

In the ironstones the markings chiefly indicate branches and trunks of trees; with the coalstones *Stigmariæ* predominate.

The question now comes what kind of vegetation formed coal. The popular belief has always been that coal is formed from large trees: let us consider on what this belief is based. There is, under each seam of coal, a bed of clay termed the underclay; in this Stigmariæ are found, it is therefore argued that they were the roots of the trees which formed the coal, and that the underclay represents the old land surface.

Secondly, it is argued that we find fossil trees and other kinds of vegetation in the roof, which must be the same kind as formed the seam below.

Again, pieces of the film which attached to these trees, have been prepared and examined under the microscope and called sections of coal.

With regard to the first, the occurrence of *Stigmaria* in the underclay, there are other roots in this clay more numerous than Stigmaria, and we have found the latter as often in the roof as the floor, a foot or so over the coal, and some distance away from anything approaching coal above; a specimen so formed is in the Bristol Museum surrounded with *Cordaites*. We have seen in the case of the fireclays of the Red-ash house and gas coals of the lower series, that they contained Stigmaria, but there was no seam of coal above, not even a shale in some instances.

With regard to the occurrence of trees over the coal. By referring to the section of the Two Foot Seam, it will be observed that the coal is followed by 6 inches of black Duns containing *Cordaites*, then 8 inches of shale with *Cordaites*, but still no large tree fossils, then comes eight feet of fine Duns in which we find *Ulodendron Lindleyanum*, *Lepidodendron Sternbergii*, *Calamites ramosus*, and *Cordaites*. The argument based on the fossils in the roof then, so far as the large trees are concerned, falls to the ground, because if the trees in the roof were such as formed the coal below, one would expect to find them immediately over, they should be, so to speak, contemporaneous, but this, as before remarked, never is so; the black Duns and shale must have occupied a considerable time in deposition and represent a considerable lapse of time between the actual coal vegetation and the deposition of the trees in the fine

Duns. *Cordaites* or other reed-like plants are the only type of fossils found in situ immediately over the coal in the Bristol coalfield, the larger forms of vegetation in the roof have evidently been drifted into their position.

The finding of the coalstones, their origin being as stated, also goes far to support this view.

Again, coal seams have an even thickness often for miles, and it is not difficult to imagine a land surface being submerged on which were forests of large trees, that would subsequently form a seam of coal of uniform thickness.

These trees could not grow together in such close proximity as to form a compact mass, nor could they fall into such, yet it is difficult to imagine a seam of coal being formed by any other than a compact mass during submergence.

At Speedwell Colliery, near Bristol, a thin seam of coal was cut which contained *Sigillaria*, but it was worthless for fuel, as the following analysis will show:

Ash	29·40
Fixed carbon	55·48
Moisture	1·23
Volatile matter	13·89
	100·00

The great peat and lignite beds of more modern formations are not composed of large trees but of mosses and reeds. Professor O. Heer in his notes on fossil plants discovered in Grinnell Land, thus refers to the lignite bed.

"The thick Lignite bed of Grinnell Land would indicate a large peat moss in which most probably a small lake existed. On the shallow bottom of this lake the great rhizomes of the water-lilies might spread and from them the leaves would rise to the surface of the water. On the muddy shore stood the large reeds and the Sedges (carices), the Birches, and the Poplars, the Taxodia with their graceful foliage, and the rigid-leaved Torelliæ.

The dryer spots and neighbouring chains of hills were probably occupied by the Polar and Feilden pines, by the Firs, the Hemlocks, and the Hayes-spruce.

To these must be added the Elm and the Hazel Bushes, whose fresh green foliage will have served to break the gloomy garb of the Pine-forest."*

A bed of Lignite is coal in the process of forming; if then the origin of the Lignites of the Miocene (which is the age assigned to the deposits) coal was formed as above described, why should it not have been the same, or a modification of the same, during the carboniferous period, a delta perhaps being sometimes substituted for a lake?

It suggests itself to us that the occurrence of Stigmaria in the underclays may be accounted for in this way: there was a land surface gradually sinking, as it sank water advanced and the terrestrial vegetation was replaced by mosses and reeds, the big trees fell and drifted away, the ferns and other terrestrial vegetation also floated away or decayed, as we see the modern ferns at the present day when in water.

In conclusion I would urge attention to the study of the Fossil Flora; it has not hitherto, it is true, rendered much assistance to Geology, but the reason is it has not been asked; but if taken up and worked out upon the lines I have endeavoured to sketch out to-night, I think it would bear important fruit, and prove that Fossil plants, like Fossil animals, had each their prescribed limits in time and space.

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* Quarterly Journal Geological Society, page 69, 1878.

DISTRIBUTION OF THE FOSSIL FLORA IN THE BRISTOL COALFIELD.

	Carb. Limestone	Millstone Grit	Lower Coal Measures	Middle Coal Measures or Pennant	Upper Coal Measures
LEPIDODENDRON					
Sternbergii ... *Brong.*	...	*	*	*	*
longifolium ... *Brong.*	...	...	...	...	*
aculeatum ... *Presl.*	...	...	...	*	*
elegans ... ... *Brong.*	...	...	...	...	*
Veltheimiana ... *Sternb.*	...	*	*	*	...
polyphyllum ... *Ad. Rom.*	...	*	...	...	...
decorticatum	...	...	...	...	*
rimosum ... ... *Sternb.*	...	*	*	*	*
ULODENDRON					
majus ... ... *L. & H.*	...	...	*	*	...
commutatum ... *Schimp.*	...	...	...	...	*
Lindleyanum ... *Sternb.*	...	...	*	...	...
SIGILLARIA					
subrotunda ... *Brong.*	...	...	...	...	*
laevigata ... ... *Brong.*	...	...	*	*	...
pachyderma ... *Brong.*	...	...	...	...	*
scutellata ... *Brong.*	...	...	...	...	*
tesselata ... ... *Brong.*	...	...	*	*	...
elongata ... ... *Brong.*	...	...	...	...	*
intermedia ... *Brong.*	..	...	...	...	*
monostachya ... *L. & H.*	...	...	*	...	...
Murchisonæ ... *L. & H.*	...	...	*	...	...
Etheridgii ... *Wether.*	...	...	*	...	...

	Carb. Limestone	Millstone Grit	Lower Coal Measures	Middle Coal Measures or Pennant	Upper Coal Measures
SIGILLARIA—Continued.					
organum ... ... *Sternb.*	...	...	...	*	...
Candollei... ... *Brong.*	...	...	*	*	...
nodosa ... ... *L. & H.*	...	...	*	...	...
LEPIDOPHLOIOS					
Laricinum ... *Sternb.*	...	...	*	...	...
LEPIDOSTROBUS					
variabilis ... *L. & H.*	...	...	*	...	...
STIGMARIA *ficoides* *Brong.*	*	*	*	*	*
CALAMITES					
Suckovii ... ... *Brong.*	...	...	*	...	...
undulatus ... *Brong.*	...	...	*	...	...
radiatus	...	*	*	*	*
cannæformis ... *Schloth.*	...	...	...	*	...
Cistii ... ... *Brong.*	...	...	*	...	...
decoratus... ... *Eichw.*	...	...	...	...	*
ramosus ... ... *Artis.*	...	...	*	...	...
CALAMOCLADUS					
æquisetiformis *Sternb.*	...	...	*	...	...
HIPPURITES (*Asterophyllites*)					
giganteus... ... *L. & H.*	...	...	*	...	...
longifolius ... *L. & H.*	...	...	*	...	...
HALONIA					
tortuosa ... ... *Lindl.*	...	...	*	...	...
PECOPTERIS					
oreopterides ... *Brong.*	...	...	*	...	...
nervosa ... ... *Brong.*	...	...	*	...	...
arborescens ... *Schloth.*	...	...	...	...	*
nodosa ... ... *Göpp.*...	...	...	...	...	*

	Carb. Limestone	Millstone Grit	Lower Coal Measures	Middle Coal Measures or Pennant	Upper Coal Measures
PECOPTERIS—Continued					
hemiteloides ... *Brong.*	...	...	...	*	...
æqualis ... ... *Brong.*	...	...	...	*	...
Cistii ... ... *Brown.*	...	...	...	*	...
cyathea ... ... *Brong.*	...	...	...	*	...
Miltoni ... ... *Brong.*	...	...	...	*	...
NEUROPTERIS					
Soretii ... ... *Brong.*	...	...	...	...	*
cordata ... ... *Brong.*	...	...	...	...	*
gigantea ... ... *Sternb.*	...	...	*	...	...
elegans	...	...	...	...	*
flexuosa ... ... *Sternb.*	...	...	...	*	...
heterophylla ... *Brong.*	...	..	...	*	...
Cistii ... ... *Brong.*	...	...	*	...	...
SPHENOPTERIS					
obtusiloba ... *Brong.*	...	...	*	...	...
irregularis ... *Sternb.*	...	...	*	...	...
ALETHOPTERIS					
Serlii ... .. *Brong.*	...	...	*	...	...
lonchitica ... *Brong.*	...	...	...	...	*
Bucklandi ... *Brong.*	...	...	...	*	*
urophylla ... *Brong.*	...	...	...	...	*
CORDAITES	...	...	*	*	*
TRIGONOCARPUM	...	...	*	*	...
CARPOLITHES *sulcatus* ...	...	...	...	...	*
olivæforme	...	...	*	...	...

Address to the Cotteswold Naturalists' Field Club, read at the Annual Meeting, held at Gloucester, on the 3rd April, 1879, by the President, Sir W. V. Guise, Bart., F.L.S., F.G.S.

Gentlemen,—

In presenting my Annual Report, I have again the pleasure of congratulating members upon the continued prosperity of the Club. The evening meetings which were held during the winter, in accordance with a resolution come to at our Annual Meeting last year, have proved a great success, and have been the means of supplying valuable contributions to our published "Transactions."

In the matter of finance I am likewise enabled to report most favourably; our Treasurer's account showing a very considerable balance in our favour.

The number of our members has been somewhat lessened by death and retirement, but the deficiency will doubtless soon be restored by fresh accessions from without.

Amongst those of whom death has deprived us we have to lament John Garlic Ball, late Coroner for the County, and Sebastian Stewart Dickenson, late Chairman of Quarter Sessions,—both valuable public officers and early members of the Cotteswold Club; but a more than common loss has befallen us in the decease of George Frederick Playne, one of our oldest and most valued members, who expired suddenly, at Stuttgart, on the 11th of last month, and to whose memory more than a passing notice is due.

A memoir of our late lamented friend which appeared in the *Stroud Journal* of March 22nd has supplied me with some particulars of his scientific life and works, of which I have availed myself in the following biographical sketch:—

"To those who were so fortunate as to be on terms of intimacy with him he was known as a man of varied accomplishments and refined intelligence, and as a warm-hearted friend. By them his death will be deeply

lamented. Many years ago he was engaged on archæological studies, and numerous drawings of the architectural remains of old churches and ruins in his own neighbourhood remain to attest his artistic skill and industry. Long afterwards some of these supplied materials for an interesting paper on 'The incised grave-stones and coffins of Minchinhampton Church,' published in the 'Transactions of the Cotteswold Naturalists' Field Club.' At another period of his life, as a botanist, he made collections of mosses and ferns, and of species of rare trees and shrubs, many of which are still flourishing at Whitecroft; and his collection of British ferns was very complete. In later years geology and the study of the remains of pre-historic man chiefly occupied his attention, and in these branches of science, as in those of his earlier life, he was indefatigable in his researches. His untiring industry in these investigations will be evident from the careful elaboration of the papers read at the meetings of the Cotteswold Club, and published in their 'Transactions,' as well as from the fine collection of flint implements now in the Museum at Gloucester. In collecting materials for one of the last of his papers on 'The ancient Camps of Gloucestershire,' he visited, and, from measurements, made plans of nearly every camp in this county. Modest and unassuming in reference to his scientific acquirements, it was only those who had the advantage of his acquaintance who were really aware how industriously he laboured in those branches of science in which he took an interest, and with how much knowledge in these branches his mind was stored. Few men have drunk deeper of the delights which the study of nature gives to those who seek them; few men have led a more blameless and truly Christian life; and few men have left this world more deeply regretted by those who intimately knew him, than the truly Christian English gentleman whose death we all so deeply deplore."

In addition to the papers above referred to, the following by Mr. Playne have appeared in the volumes of the Cotteswold Club:—"On the Physical Geography of the district drained by the Frome and its Tributaries;" "On the Early Occupation of the Cotteswold Hills by Man;" "On recent Calcareous Deposits of the Cotteswolds." He had also just completed at Stuttgart a catalogue of the fossils of the Würtemberg Jura, many of which he had personally collected in his tour through Germany and Switzerland, and which, it is much to be wished, may yet be made available to Cotteswold Geologists.

I may add that Mr. Playne had, at my request, consented to contribute to our "Transactions" a paper—now I fear lost to us—on the Cloth Manufacture of our Cotteswold Valleys, for

which he possessed a very ample store of materials; in connexion with which subject none could supply fuller information than the brothers PLAYNE, whose firm has been honorably known in association with this important industry at least from the time of Queen ELIZABETH, whose Ministers made it one of the conditions on which the Charter was granted to the East India Company, that that corporation should export annually a large quantity of woollen cloth of a particular quality. A great deal of this cloth was made by the family of PLAYNE: sometimes in such quantity, in a single order, that the cloth would have run all the way from the manufactory near Stroud, to the East India House, in Leadenhall Street; and it is at once a proof of the honorable manner in which the brothers PLAYNE carried on their manufacture, and an interesting item in the history of British trade, that down till 1854, when the Charter of the East India Company lapsed, by the Government taking over its powers, the bolts of cloth made at Dunkirk Mills were received as a *standard* of sterling value, with their leaden seals attached, as a guarantee that no one had opened them since they left the mills; and this all over the north of China and the north-east of Tartary. In days like these, when Great Britain is beginning to lose the name she once had for the genuineness of her wares, it is well to know that there are bright and honorable exceptions to this state of things.

After this somewhat lengthy, but not, as I venture to think, uninteresting digression, I will proceed to give a summary of the work done at our various Field Meetings during the past season.

ANNUAL MEETING.

The Annual Meeting of the Club was held at the Bell Hotel, Gloucester, on Tuesday, 2nd of April, 1878, when the officials for the year were appointed. Sir WILLIAM GUISE was again chosen President, with Dr. WRIGHT and Mr. LUCY as Vice Presidents, and Dr. PAINE as Secretary. The President, in

proposing the re-election of Dr. Wright, made reference to the distinction lately conferred upon him by the presentation to him of the Wollaston Medal, in recognition of his long and laborious services to Geological Science, of which his splendid Monograph of the Fossil Echinodermata of the Chalk and Oolites must ever remain an enduring monument. The learned Doctor is now engaged on a Monograph of the Ammonites of the British Isles, which all lovers of Geological Science must wish him health and leisure to complete. The first part of this Monograph, with the introduction, has just been published by the Palæontographical Society. It first appeared as an introduction to the author's Monograph on the *Asteroidea* in the Vol. of the Palæontographical Society for the year 1861. It has just been issued in the Society's Vol. for 1878 as an introduction to a Monograph of the Lias Ammonites of the British Isles, by the same author. Being altogether re-cast, it now forms a practical compendium, of no small utility, embodying much important information, and is, of course, written up to date (1878). It contains a large amount of scientific matter, scientifically arranged, convenient for the eye, in the form of tables; and, by its ample references to the leading authorities, directs the student to lines of further research.

The Rev. Dr. Smythe was of opinion that this introductory chapter, giving, as it does, a complete historical view, in moderate compass, of the recognised sub-divisions of the Lias, noting their occurrence, characters, correlations, leading forms of life, &c., &c., would, if reprinted in our "Transactions," afford to many members, who could not readily resort to the bulky volumes in which it originally appeared, a summary of the subject both useful and convenient. Its appearance in our "Transactions" would, he submitted, confer an honour on the Club. It was, therefore, on the proposal of Dr. Smythe, resolved, that permission be sought to allow of its publication in the "Transactions" of the Cotteswold Club.

The President read his Annual Address, giving a comprehensive review of the work done by the Club during the past year.

A discussion then arose on the subject of more frequent meetings for the reading and discussion of papers, it being a cause of complaint that the reading of papers after dinner, as had been customary, left no time for discussion, indeed that frequently there was not time for the reading of papers at all. Upon the proposal of Dr. Wright it was resolved that three supplementary meetings should be held during the autumn and winter months, with a view to remedy the defect complained of.

Mr. John Bellows then read a paper "On the Burning of Bishop Hooper." In connexion with this deeply affecting tragedy he had searched the archives of the city of Gloucester, feeling assured that there must be some record of the event; in this search he had been greatly assisted by Mr. K. H. Fryer, the Town Clerk; and had been rewarded for his pains by finding the whole of the costs and charges incurred in carrying out the cruel sentence, duly entered in the accounts of the City Chamberlain as—"Allowance in money gevyn in rewarde to the Kyngs and Quenes servants at the bryngyng downe off Mast^r Hooper to be brent." A fac-simile of this page was exhibited. John Hooper suffered death at the stake in February, 1555; in the year 1826—nearly three centuries afterwards—some labourers, making excavations in St. Mary's Square, came upon the lower end of the stake at which Hooper was burnt, which, after passing through two or three hands, was secured for the city of Gloucester, in whose keeping it is now placed, with a metal label attached, on which its history is engraved.

About thirty sat down to dinner, at the Bell Hotel. After dinner a report was read by Professor Boulger, of the Agricultural College, Cirencester, on the progress towards completion of the Flora of Gloucestershire, in which he stated that his appeal for help towards the completion of the proposed county Flora had been amply responded to. As an associate in his work he had secured the co-operation of Mr. Allen Harker, of Gloucester, who had for some years been occupied in collecting materials for a Flora of the county; the result of

their combined work being that they then had records within the county of 1065 species of flowering plants, ferns, lycopods, and horse-tails, out of 1665 forms enumerated as species in the seventh edition of the "London Catalogue of British Plants." With such information, or prospects of it, the authors have commenced their work, of which a specimen page, beautifully printed, was exhibited to the Club.

FIRST FIELD MEETING.

The first Field Meeting for the season took place on Tuesday, 21st of May, when the Club visited the romantic district of Knightsford Bridge, on the Teme, a district described in their programme as "a country rich in picturesque scenery and historic lore, and full of interest to the botanist and geologist." The Rev. W. S. Symonds, of Pendock, met the Club at Worcester, and acted as guide throughout the day.

The Knightwich Station is between Worcester and Bromyard, and only distant about half a mile from the hamlet of Knightsford Bridge. Immediately opposite the Station is a very remarkable section of faulted Keuper rocks, and New Red Sandstone, interstratified with fragments of angular stones, forming a "breccia," which Geologists believe to have been derived from the Rosemary rock close by, when it formed a beach line to the Lower Keuper Sea. A little westward of the Station the Lower New Red Sandstones are seen resting unconformably against an old shore line of upheaved Upper Silurians, which belong to that elevated area which strikes southwards above the New Red vale to the Malverns, and northwards to Abberley. When examining the nearly vertical Silurian masses, the Geologists observed a dome of, apparently, Aymestry Limestone, which throws off the beds around the centre of elevation. The Upper Ludlow Shales, Downton Sandstone, and Passage Rocks of the Ledbury section were

determined, but the purple beds, against which the New Red Rocks abut, furnished no fossils whereby to determine their status. Ankerdine Hill was then ascended: the weather was most propitious, gleams of sunshine lighting up first one point of scenery, then another, as Mr. SYMONDS pointed out and described localities remarkable either for historic interest or geologic record. Northwards rose the grand old Malverns, famed for their ancient rocks and for the evidence they afford of occupation by pre-historic man. The wooded country to the north-west was that of the tradition of St. KATHERINE and her maid MABEL, fleeing from their pursuers to Ledbury, and the miraculously preserved footsteps of their steeds, still to be seen in the Old Red Sandstone of the Sapey brook. To the north-west rose the Titterstone Clee, at the base of which lies Cleobury Mortimer, the birth-place of ROBERT LANGLAND, who wrote the "Vision of PIERS PLOUGHMAN," in the days of WICKLIFFE, like him exposing the vices of the times. Abberley Hills lay due north—Silurian rock masses elevated nearly 1000 feet above the sea. They were once occupied by King HENRY the Fourth, a tyrant who began his reign by the murder of his cousin, RICHARD the Second, and was the first to establish torture and death in his dominions for religious differences. He and Archbishop ARUNDEL burnt SAWTRE, in 1401, an example which succeeding kings and priests have not been slow to follow. When HENRY the Fourth was on Abberley, OWEN GLENDWR with his Welshmen and French allies occupied Woodbury Camp opposite, an ancient British stronghold. In this neighbourhood, between Ankerdine and Ridge Hill, is a singular depression, where coal shales occur, between Old Red Sandstone and Permian "breccias." To the north-east rose the Clent Hills, and they, too, have their sections of Triassic rocks and Permian. At Hagley was the home of LYTTELTON, while at Hales Owen beyond was that of SHENSTONE. On Permian rock, too, stood the ancient church of St. KENELM, who was murdered through the devices of his false sister QUENDRED. The vale of Worcester eastward was even brighter in sunshine than the western side, the Lickey rose on the horizon, and even Edgehill was

distinguishable far away in Warwickshire, where CHARLES the First fought his first battle with his people. LAYAMON, the Anglo-Saxon poet, lived at Areley, near Bewdley; and THOMAS HABYNGDON, the historian, resided at Hindlip, so famous for its towers, turrets, winding passages, and secret chambers, which sheltered the conspiring Jesuits in the troublous times of JAMES the First. The grand old mansion with all its memories is gone, and its place is taken by a pretentious Georgian stucture. How the modern proprietor could have had the heart to do it must ever remain amongst those things which "no man can understand." The battle-field of Worcester afforded another subject for notice and observation, for with the help of a glass the slopes of Perrywood Hill were visible, and the ground traversed by the defeated CHARLES in his galop from Worcester city to the seclusion of Boscobel.

From Ankerdine the party again crossed the Teme to Rosemary Rocks, where some time was given to the examination of those strange conglomerates, and their large angular and re-cemented rock fragments.

After dinner, at the Talbot Inn, Knightsford Bridge, Mr. SYMONDS gave a recapitulation of what the party had seen and done, which led to a discussion, in which Mr. HANDEL COSSHAM and Mr. LONGE joined. The party then broke up, after a day of much enjoyment.

SECOND FIELD MEETING.

The second Field Meeting took place on Tuesday, 25th June—a fine sunny day—when between forty and fifty members of the Club assembled at the Gloucester Station, on their way to Symonds' Yat, in the Forest of Dean. At this point the party quitted the railway, and ascended the hill by the steep path to the summit of the rock, which towers precipitously above the Wye, and commands the extensive and well-known

prospect. Here the President called upon the Rev. W. S. Symonds to give some account of the geologic features of the surrounding country. The Malverns and May Hill were hidden in the summer haze; Mr. Symonds directed attention to their ancient geologic history, and told his hearers how their old stratified gneissic beds claim a like remote antiquity with the Laurentian rocks of America and the Hebrides, and how the volcanic masses which interlie the stratified rocks must have been erupted untold ages ago, when these ancient strata were accumulating in the Laurentian seas—that May Hill may be regarded as representing in its mass the whole of the Upper Silurian series of Murchison, and that a tunnel through its centre would probably reveal a nucleus of the ancient gneiss and volcanic rocks of Malvern. To the north-east rose the wooded ridges which mark the strange valley, or rather series of valleys, which circle round Haughwood and Woolhope; while far beyond could be seen the Titterstone Clee, a great outlier of "Old Red" rocks and Carboniferous deposits, which have been preserved from denudation by a volcanic outburst of jewstone or trap, an ancient lava, which has burst through Silurian, Old Red, and Carboniferous masses, and now furnishes the well-known Clee Hill road-stone. The Old Red Sandstone of Herefordshire was briefly described, and, turning westwards, Mr. Symonds pointed to the rim of the South Welsh coalfield, where it rises above the Usk, and told the history of the remarkable outlier of Pencerrig Calch, of the valley of the Usk, the "Old Red" masses of the Black Mountain, the Brecon Vans, the Scyrrid, and the Sugar-Loaf. He then spoke of the Wye caves and their wild inhabitants, the hyæna, the cave lion, and cave bear. He further called attention to the river gorge, the river masses of Carboniferous Limestone, and the river pebbles which were found in some of the caves nearly 500 feet above the present river bed. Under the shade of the green trees of the forest Sir John Maclean had provided a welcome luncheon, after partaking of which the Naturalists filled to overflowing the carriages sent to meet them, and the party trotted away merrily to the castle of St. Briavels.

Arrived at St. Briavels they were met by the Rector, the Rev. Taprell Allen, who conducted them over the church and the ruins of the castle. Alas! the church had been what is called "restored" in 1830, when the old Norman tower was pulled down, and a modern structure erected in its stead. The Warren tomb represented in Bigland was seen in ruins. Enough however remains of the earlier fabric to cause the beholder to regret that modern restorers had not withheld their hands from introducing their paltry windows among the stonework of better architects than themselves. Notwithstanding modern interpolations the Norman relics still left are very interesting. There are Norman piers and arches on the south side of the chancel, with the original Norman clerestory. The Early English arches of the side aisles still remain; and among a heap of architectural and monumental relics in the south transept is preserved a very remarkable early coffin-lid, of stone, engraved with stiff-leaved foliage, and having a female head, in wimple and mentonniére, inserted in a different kind of stone.

The castle of St. Briavels, or St. Brulais, was once of great importance in the Forest of Dean. It was never a large castle, as the moat which surrounded it is not more than 500 yards in circumference. The keep and the flanking towers fell in 1752 and 1754, but some interesting ruins are still left, to attract the wandering antiquary. The castle is remarkable for the number of its portcullises, a form of defence well adapted to keep out invaders, before the introduction of gunpowder; and an early chimney-piece, with brackets, rudely sculptured, is well deserving of attention.

The castle was founded by Milo Fitzwalter, in the days of Henry I. It was alike the seat of justice and a prison. Among its Constables we mark the names of De Clare and Beauchamp, Earl of Warwick. Another was Hugh Despenser, the unfortunate favorite of Edward the Second. Guido de Bryan, the standard-bearer at Cressy and Poitiers, whose effigy is in Tewkesbury Abbey, was Constable in the time of Edward III from whom he obtained for the inhabitants of St. Briavels exemption from "all toll, pontage, parage, and murage."

The "King-maker" was Constable in the days of EDWARD IV. A fine forest view expands from the castle heights, reminding the spectators rather of scenes in the Hartz Mountains or the Black Forest, than of those amongst the cultivated hills and dales of England.

So much time had been occupied in and around St. Briavels that none was to spare for the contemplated visit to Newland church, which had in consequence to be abandoned. The dinner hour summoned the party to Coleford, where an excellent repast awaited them at the Angel Inn.

After dinner the thanks of the Society were given to Sir JOHN MACLEAN for his hospitality; and on the call of the President, Mr. SYMONDS gave an account of his experiences in caves and cave-hunting. He led his hearers to the caves by the banks of the Lesse, in Belgium, where years ago, in company with the President, he had examined the habitations and the remains of pre-historic men and pre-historic animals. He reminded the President how they had together explored bone caves on the shores of the sunny Mediterranean in France and Italy, and had beheld the fossil skeletons of pre-historic men who had been buried there when the mammoth and the hyæna roamed where now are the orange and lemon groves of the sunny south; and how they had traced the track of the glacier as it swept over the Cols of the Maritime Alps right down to the waters of the Mediterranean. He referred to the bone caves of various parts of England; to those of Banwell and Wookey-Hole, near Wells, those at Gower, near Swansea, and those far away by Settle in Yorkshire. With reference to these latter, he entirely agreed with Mr. TIDDEMAN that a glacier from Ingleborough had passed over the entrance to the Victoria cave since it was occupied by hyænas, and wondered that Geologists could visit that district and escape seeing this important fact. He wound up the cave history with an account of King ARTHUR's cave on the Doward, and begged that some of the working Geologists of the Club would assist him in unravelling some of the more difficult problems which yet surround the Wye pebbles in the caves, and the excavation of the gorge of the river.

THIRD FIELD MEETING.

The third Field Meeting was held on Tuesday, 23rd July. The programme was attractive, the day was fine, and a large number of members of the Club assembled at the Stroud Station on the Great Western Railway, where two brakes with four horses each, and other carriages were in waiting.

The route, as described in the programme, traversed a very beautiful Cotteswold district, by way of Bisley to Miserden Park, where the proprietor, Mr. E. A. Leatham, the distinguished representative of Huddersfield, had offered to entertain the Club at dinner. Such a drive was well qualified to display to the eyes of valesmen and strangers the diversified beauties of Cotteswold scenery, which, for combined richness and variety, can scarcely be equalled by any other district of like extent, either in England or elsewhere.

Regarding the Cotteswold range as a grand old coast-line, its contour is indented by longitudinal valleys, which, like that of Stroud, cut deeply into its mass; and these again are intersected by transverse valleys and deep coombes, with rivulets trickling through them, whose sides are richly clothed with timber, shadowing green meadows, diversified with farms and villages and gentlemen's seats. The Cotteswolds, moreover, are interesting as being the seat of an ancient civilization, which dates from a time prior to the Norman conquest; for the Normans found this district so populous that traces of their architecture are to be found in almost every village Church, even in the most remote hamlets of the Cotteswold hills and valleys. The reason of this is not far to seek: these open hills afforded pasturage when the heavy clays of the vale presented a scene of woods and swamps. Later on, in the time of our Edwards and Henrys, the Cotteswolds became a great centre of the wool trade, which then constituted a principal source of wealth in these kingdoms. The proofs of this are everywhere visible in the superior quality of the buildings—not only in towns such as Bisley, where this feature is especially noticeable—but even in the rural villages, in which may be remarked

the prevalence of TUDOR architecture, with its gabled roofs and mullioned and transomed windows.

Through this lovely country ran the road of the travellers. The ascent from Stroud to the summit of the plateau involved a stiff pull, of a nature to try both horses and tackle, and, as the event proved, was too much for the apparatus of one of the vehicles, of which a splinter-bar snapped, causing no little delay before it could be replaced.

The first halt was made at a quarry near the Union Workhouse, where Mr. WITCHELL drew attention to the great development of the oyster bed *(Gryphæa sublobata)* as compared with the same beds at Rodborough Hill and other localities. The *Gryphæa* is here observed in separate layers at the partings of the beds, instead of being in one bed, as at Rodborough, and while at Rodborough the thickness of the bed is about two feet, at Stroud Hill it is from ten to twelve feet. It consists of a tough sandy grit, in which fossils are abundant, but impossible to extract.

A short distance beyond and lower down the hill the Geologists examined a quarry called "The Coneygre," where was shewn a fine section of the "Oolite Marl," about ten feet in thickness, containing the characteristic fossil *Rhynchonella fimbria* in abundance. Here Mr. WITCHELL drew attention to a good example in the building freestone of what is known as "*slickensides.*" The rock had fallen away, so that only a portion of the rubbed surface was visible, but in it were sections of fossils partly ground down. These smoothed surfaces are due to the unequal movement of the beds in course of upheaval or depression, by which the surfaces are ground against each other. This quarry was a perfect garden of wild flowers, ablaze with blossoms of every hue,—the rosy spikes of the Rose-bay, Willow-herb, (*Epilobium angustifolium*) Viper's Bugloss (*Echium vulgare*), Lady's Fingers (*Anthyllis vulneraria*), Musk Mallow (*Malva moschata*), Sweet Marjoram, the golden stars of the Ragwort, the ramping Clematis, and many others. The prospect, looking down the Stroud valley from this point, was extensive and singularly picturesque, the broken ground of the quarry forming an admirable and effective foreground.

Having reached the summit level, a wide undulating plateau succeeds, with charming peeps down well wooded coombes. Passing the beautiful demesne of Lyppiatt on a road bordered by noble sycamores, Bisley was presently reached, where a halt of some duration was made. In the churchyard is a 13th century cross, in good preservation, which has been figured by Lysons, and likewise by C. Pooley, in his "Old Crosses of Gloucestershire." Below the churchyard five perennial springs leap forth from the clay-beds of the "Fuller's Earth." These beds, which are a part of the "Great Oolite" series, are the prevalent source of water supply all along these Cotteswold coombes, where their position may be pretty accurately traced by the cottages scattered along this line of water-bearing strata.

After some homely refreshment at a small inn, the Red Lion, the party with their conveyances proceeded on towards Miserden. The road passed through Trougham or Druffham Field, where quarries were examined in the "Stonesfield Slate," and some traces of plant remains were found. Attention was directed to a tumulus which had been cut through many years before, in clearing the ground for the erection of a cottage, when many bones were said to have been found and removed.

Proceeding onwards they arrived at a spot marked in the Ordnance Survey as "The Camp." Here they halted to examine two round barrows by the side of the road, within an enclosure. Both have been cut into at some former period and thoroughly ransacked. Three or four large stones, which formed the entrance of a chambered tumulus, are all that now remain. There is now no trace of a "Camp," but the name of the hamlet, joined to the fact that a cluster of cottages in the valley below is called "The City," is very suggestive of the former existence of some place of importance, all traces of which have long since been swept away and forgotten. At Whishanger, the road to Miserden crosses a great line of "fault," by which the "Great Oolite" beds are thrown down 250 feet against the base of the "Inferior Oolite." The beds were searched for fossils, and examples were found of "*Hyboclypus Mülleri*" and "*Trigonia Painei.*"

Shortly after four o'clock Miserden Park was reached, where the party was most courteously received by Mr. and Mrs. Leatham, who have lately become the possessors, by purchase, of this beautiful demesne. The house, a handsome Tudor residence, which has of late undergone considerable alterations, was for more than two centuries the home of the Sandys family. It stands in a noble park, diversified with hill and dale, richly wooded. The place derives its name from the Norman family of the Musards, by whom the manor was held from the Conquest to the time of Edward the First, from whom its name "Musarden," now "Miserden," was derived. The castle of the Musards occupied an artificial mound now known as the "Castle Hill," to which the Club on their arrival paid a visit. Nothing of the Norman castle now remains, the materials of which it was constructed having been used, so tradition says, in building the more recent mansion; but the steep scarped mount on which was erected the keep of the original fortalice is still there, and will long remain to tell to future generations the tale of feudal domination, long since passed away.

On their return to the house the party was most hospitably entertained by Mr. and Mrs. Leatham. After dinner the President proposed the health of their kind host and hostess, and offered to them the hearty thanks of the Club for their generous hospitality.

Before leaving a short visit was paid to the church, where the beautiful monuments to members of the Sandys family attracted deserved admiration; as examples of the sculptor's art they are of rare excellence. The western doorway, too, is curious, showing a pointed arch inserted within one of Norman date—this latter being a remnant, no doubt, of the original church of the Musards.

This proved to be the last Field Meeting of the Club for the season. The fourth Field Meeting was indeed fixed for Tuesday, 27th August, at Bristol, but owing to the absence of the officers of the Club, as well as of many of the members, scarcely any of whom signified a desire to be present, it was judged most fitting and convenient to postpone the Meeting at

the proposed locality to another season. Thus our summer season terminated with the Meeting in July. But the active energies of the Club did not hybernate, as has been the custom in former years, after the termination of the Field Meetings; these were kept alive by the adoption, now for the first time put in practice, of Winter Meetings, for the reading and discussion of papers, in accordance with the resolution come to at the Annual Meeting of the Club in the previous April.

THE FIRST EVENING MEETING

Was held at the Lecture Theatre of the School of Science and Art, at Gloucester, on Tuesday, the 14th of November, at 4 p.m., when a paper was read by E. Wethered, Esq., F.G.S., on the Carboniferous Flora of the Bristol Coal-field. This paper was illustrated by some splendidly drawn diagrams, with lists of fossils. After a lengthened introduction Mr. Wethered referred to descriptions of the Bristol Coal-field by different Geologists, with a view to showing that, in the absence of fossil fauna, the Flora had not been availed of as it might have been for the classification of strata whereas he held that coal seams—or, where they lie close together, groups of coal seams—may be determined by their associated vegetable forms with the same certainty as strata generally are differentiated by their contained animal remains. Owing to the little value hitherto attached to fossil plants, as a means of classification, the subject is in a condition far from satisfactory; and until this is rectified the use to which it may be applied must necessarily be very limited. It was therefore with a hope to contribute something towards supplying this deficiency that the Lecturer had directed his attention to the classification of the beds of the Bristol Coal-field on the basis of their contained floral organisms.

Mr. Wethered referred to a section of the Coal-field drawn on a scale of sixty feet to an inch, and described the various divisions and floral horizons. Beginning with the Carboniferous Limestone, he showed that the Flora was rather Devonian than Carboniferous, as must be expected from the prevalence, during the deposition of the limestone, of Devonian land surfaces. At the close of the "Upper Limestone Shales" we have evidence that the Flora had begun to be more Carboniferous than Devonian. By denudation of the existing land surfaces the "Millstone Grit" was gradually formed over the "Shales." In this "grit" there are a few seams of coal, of no economical value—the "Millstone Grit" passes gradually into the "Lower Coal Measures," and here the first workable coal-seams occur. Passing over the explosive gas-seams, which are not present in the Bristol Coal-field, the Lecturer arrived at the "two-foot seam," which is especially characterised by the presence of "*Ulodendron Lindleyanum*," "*Calamites radiatus*," and large "*Lepidodendron Sternbergii*," together with vast quantities of "*Cordaites*," generally supposed to be the remains of foliage; but Mr. Wethered considers that he has proved it to be a reed. This fossil was found to be prevalent throughout every seam of coal in the coal-field of which Mr. W. had any knowledge. Following the lower series of coals comes the Pennant Sandstone, upwards of 1800 feet thick. This formation is said to be restricted to the Bristol, Somerset, and South Wales coal-fields; but there is reason to suppose that it has been confused with the "Millstone Grit," as was actually proved to be the case by Mr. Handel Cossham, in the Bristol coal-field; such mistake proving a serious source of error, which might be detected by the plant-life of the two formations, when their resemblance lithologically would render them otherwise undistinguishable.

The next question was as to the nature or kind of vegetation of which the mass of the coal is formed. This has been popularly ascribed to large trees of Lepidodendroide or Calamite type, which abound in the overlying shales, but the Lecturer showed good reasons for believing that the coal is formed, like peat bogs of the present day, from reeds and mosses and plants

of low organization, in which the great tree-like club-mosses grew and flourished.

An interesting discussion followed, in which Mr. F. Longe, Mr. Allen Harker, and Dr. Wright took part, the latter expressing himself as well satisfied with this first Evening Meeting, which he had been mainly instrumental in bringing about.

THE SECOND EVENING MEETING

Was held at the Lecture Theatre of the Science School, in Gloucester, on Thursday, 16th of January, 1879, when papers were read by Mr. John Sibree, M.A., and by Mr. E. Witchell, F.G.S. The subject of Mr. Sibree's paper was "The Extension of the scope and interest of Natural Science within the last twenty years." Having been asked to contribute some remarks on one of the general aspects of Natural Science, he thought he could not do better than endeavour to elicit opinion regarding the origin and development of organic forms—a question which, though it had scarcely engaged the serious attention of Naturalists prior to the publication of Darwin's "Origin of Species," in 1859, was of paramount importance. Previous to that date a teleological or a crudely speculative bias had characterized the treatment of the question. Indeed until palæontological data had been abundantly collected, compared, and sifted, hypotheses must have been framed in ignorance of by far the most important part of the evidence. Even if the existing fauna and flora could be supposed to represent all the ancient types, Naturalists would, apart from palæontology, have been examining the tree of evolution at the point where its branches most widely diverged. The demonstration of the sufficiency of existing causes to account for the aspects of nature in the past—a demonstration mainly due to Sir Charles Lyell—was also a necessary preliminary to the successful

investigation of the question. He noticed some suggestive generalizations in animal and vegetable physiology as accounting for individual forms, and VON BAER's law of embryonic development as pointing to genetic relations. It was not however till the publication of DARWIN's theory that a *vera causa* had been suggested for genetic relations in detail: and he maintained that the remarkable changes of form in pigeons, dogs, and horses, which breeders had realized, must have its analogy—probably on a much larger scale—in the operations of nature in the wild state. Since 1859 the opinions of competent observers had ranged themselves under three tolerably distinct classes;—first, that of those who advocated what might be called, by geological analogy, catastrophic views; secondly, that of evolution generally, without the preponderance of any particular agency: and thirdly, that of Darwinism, properly so called. He thought it very important to observe the limits which DARWIN himself assigned to the influence of Natural Selection, and to the distinction between that doctrine and evolution generally, which was not compromised by the rejection of Natural Selection, as a sufficient explanation of the aspects of nature.

Following the lead of Sir GEORGE MIVART, the writer of the paper gave a summary of the chief grounds on which the Darwinian doctrine was contended for, and of the very formidable difficulties in the way of its reception which the first of these writers (himself an Evolutionist) Mr. MURPHY and others had alleged. Some points of the discussion were illustrated by the persistence of genera and species in neighbouring geological horizons, and opinion was invited as to whether their rise or disappearance could in any way be associated with Natural Selection.

The reading of this paper was followed by a very lively discussion, in which Dr. WRIGHT, Mr. WITCHELL, Mr. LUCY, and the President took part; Dr. WRIGHT, in an eloquent speech declaring himself an opponent of evolution.

The general concurrence of all the modern leaders of scientific thought in favour of evolution in some form finds its

latest exponent in the eminent physiologist Professor O. C. Marsh, of Yale College, Connecticut, who, in his address read before the American Association for the Advancement of Science, on the "Introduction and Succession of Vertebrate Life in America," uses these words,—"I am sure I need offer here no argument for evolution; since to doubt evolution to-day is to doubt science, and science is only another name for truth."

Mr. Sibree's paper was followed by one by Mr. Witchell, entitled "Notes on a Section of Stroud Hill and the Upper Ragstone Beds of the Cotteswolds." The paper was accompanied by a Section of Stroud Hill, a portion of Cotteswold geology of which no complete section has hitherto been given. It comprised the series of strata from the Middle Lias to the Great Oolite, and the paper referred to the portion above the Upper Trigonia Grit, comprising the Ragstone beds described by Dr. Lycett in his "Geology of the Cotteswold Hills," as the "Pholadomya Grit," and by Professor Hull in the Geological Survey of East Gloucestershire as "Clypeus Grit."

The denudation of the escarpment of the Cotteswold range left the "Trigonia Grit" its uppermost bed; and the higher beds of the Inferior Oolite, not being much exposed in the escarpments of the river valleys, had not attracted so much attention as they deserved.

Mr. Witchell then described a series of beds, some of which were sterile, but one (the "Clypeus Grit" at Rodborough Hill) extremely fossiliferous—*Terebratula globata* being in the greatest abundance. Upwards of ninety species had been collected, of which fifteen were new. Most of the *testacea* appeared in the Trigonia beds below, but some were absent, hence the beds in their fossiliferous character were not identical. The sterile beds immediately succeeded the Coral formation of the Ragstones, which itself was formed upon the "Trigonia Grit;" and as the Trigonia beds are remarkably fossiliferous, it was suggested that the change of marine conditions which preceded the Coral formation also led to the withdrawal of a large proportion of the mollusca of the Oolite sea, to return

again, as shewn in the fossiliferous character of the "Clypeus Grit."

The upper bed of the Inferior Oolite is a bed of white freestone, only partially fossiliferous, and to this succeeds the "Fuller's Earth." A description of these beds was given, and their distinctive fossils were enumerated. To these succeed the laminated beds of the "Stonesfield Slate," containing numerous plant remains, but badly preserved.

The upper bed of the Section was described as consisting of four feet of thin-bedded Great Oolite. This formation appears to thin out towards the west; and it was suggested as probable that it never extended far beyond the present escarpment of the Cotteswolds.

THE THIRD EVENING MEETING

Was held in Gloucester, on Thursday, 20th of February, 1879.

Major Barnard read a paper on the subject of "Palms." He described the peculiarities and distinguishing features of this interesting tribe of plants, their geographic distribution, and the many economic purposes which they serve. His remarks were illustrated by a large number of diagrams, and by specimens of the wood, fruit, and leaves of the palms he described. He was accorded a hearty vote of thanks for his paper.

Mr. John Bellows then read a paper upon the "Etymology of the word 'Cotteswold.'" He set out by an examination of the Ordnance Map, which shows,—

1. That the rivers of the district nearly all retain their Celtic names.

2. That the rocks, sandbanks, creeks and passages of the Severn do so too.

3. That many of the towns and villages in the county are of Celtic foundation.

4. That the separate points all along the range of the Cotteswold hills—especially the more prominent ones—bear Welsh names still; and that the Roman roads do so.

And 5. That the neighbouring ranges of the Mendips and the Malverns are only known by British or aboriginal designations. The writer next referred to the evidence afforded by old chronicles and histories, quoting those of NENNIUS, HENRY of Huntingdon, and ASSER. He then turns to the present spoken dialect of the country (east of Severn) and shows not only that separate words have come down to us from the Welsh, but, what is of far more weight, that even some of the grammatical forms are unmistakably from the same stock.

To sum up then—with the evidence derived from

I. Names of places still Celtic;

II. The inference from documents; and

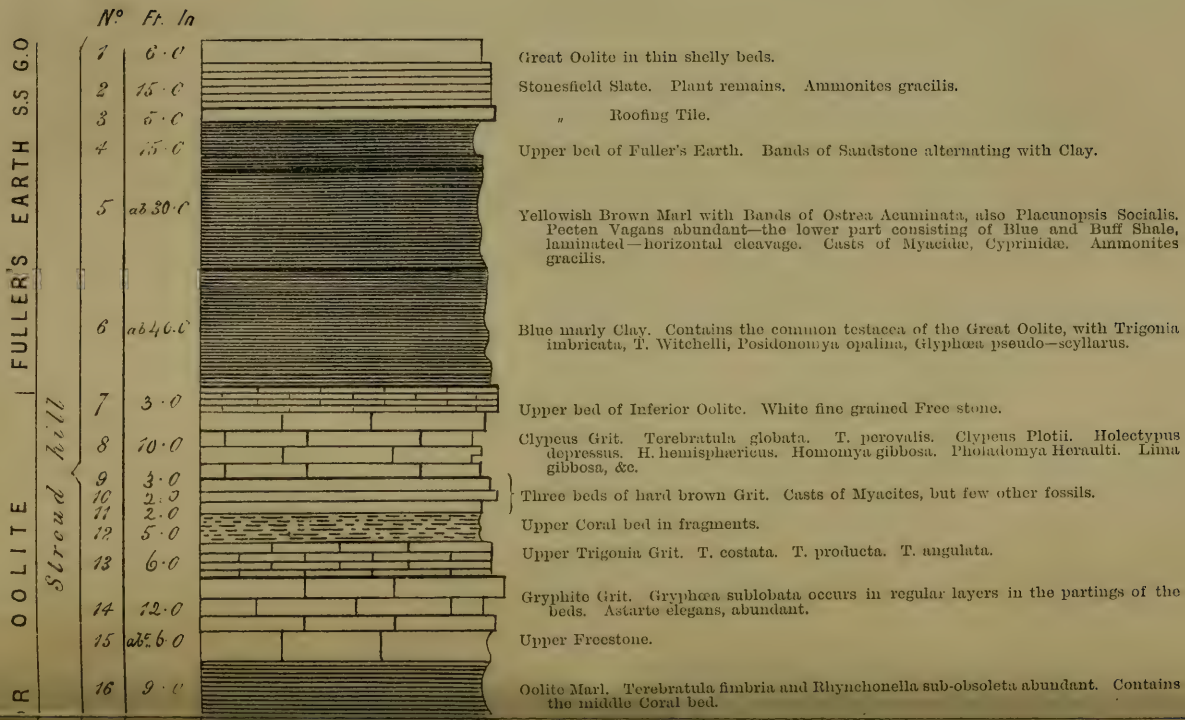
III. From the present dialect of the Vale of Severn, we must conclude that the British language held its own in this part far too long and too firmly for the name of a long line of hills to have passed away after the Saxon invasion. To imagine, as CAMDEN does, that "Cots" is from sheep cots, would require us to suppose that the hills were first farmed, and, after being covered with sheep pasturages, *named!* On the other hand, the very frequent occurrence of the syllable "cot," or "cote," in the names of places, both on the Cotteswolds and elsewhere, in places either wooded or once wooded, points pretty clearly to "coit," or "coet," the old Welsh word for wood, being the first syllable of that name.

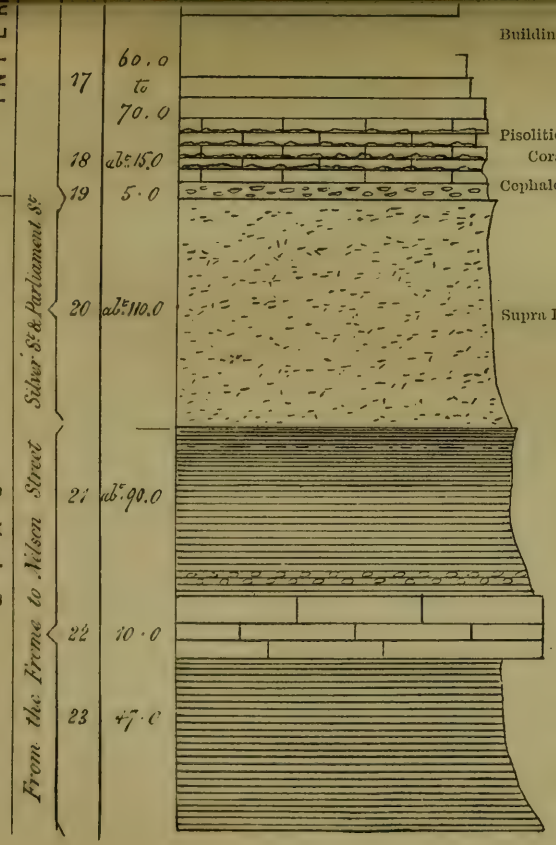
He took the original appellation to be "coet is gwêl"—the "woods under the plain," and that the Saxons altered the sound of the last syllable to "wold," a hill. As a matter of fact, at the present day the "w" is not sounded by the Cotteswold peasantry, who say "Cots'ells." The writer however attached no great weight to this, but considered the enquiry chiefly interesting from its bearing on the early state of this part of England, as regards the exodus or otherwise of the aboriginal populations on the approach of the Saxons.

The President, in thanking Mr. Bellows for his valuable paper, remarked upon the benefits which had accrued from these winter evening gatherings, and expressed a hope that they would next year meet with the same success as that which had thus far attended them.

This brings to a conclusion the Report which it was my duty to lay before you; and I can but express an earnest hope, in which you will all most cordially join, for the continued success and prosperity of the Cotteswold Naturalists' Field Club.

SECTION OF STROUD HILL.





Building Freestone—the lower beds becoming coarse, and passing into ragstones.

Pisolitic Ragstone, layers of Pisolite in the partings. Terebratula Plicata. The lower Coral bed not exposed.

Cephalopoda bed.

Supra Liassic Sands, the lower part occasionally concretionary, about 110 feet.

Upper Lias. Bands of Blue Shale, alternating with Buff Clay and Shale, about 90 feet; the lower portion containing

Fish remains. Ammonites serpentinus, A. Communis, &c.

Lias Marlstone

Middle Lias. Extends to a considerable depth below the bed of the Frome.

Bed of the Frome (120 feet above sea level.)

Notes on a Section of Stroud Hill, and the Upper Ragstone Beds of the Cotteswolds. *By* E. Witchell, F.G.S.

In the Transactions of the Club are Sections of Cleeve and Leckhampton Hills, which are regarded as typical of the Inferior Oolite formation, but there is no complete Section of the middle part of the Cotteswolds, comprising the district around Stroud: the Section of Stroud Hill which accompanies this paper is intended to supply the deficiency. It includes, with the exception of the beds between the Upper Freestones and the Gryphite Grit which are absent, portions of the whole of the strata of the Cotteswold Hills from the Middle Lias to the Great Oolite inclusive.

The higher beds of the Section, comprising the upper part of the Inferior Oolite and the Fuller's Earth, do not appear to have attracted the notice of the Geologists of the Club so much as the other beds of the formation; I have, therefore, made a few notes in reference to this part of the Section.

The Ragstone beds appear, in the Cleeve and Leckhampton Sections, as terminating with the Upper Trigonia Grit; and Dr. Wright, in his paper correlating the Inferior Oolite of Gloucestershire with that of the Cote d'Or, does not refer to any higher beds; but Dr. Lycett, in "The Geology of the Cotteswold Hills," describes a series of beds under the name of "Pholadomya Grit," which, he says, are 15 feet thick, and overlie the Trigonia Grit. Two or more of these beds are described by Professor Hull, in his Memoir of the Geological Survey of East Gloucestershire, as the "Clypeus Grit."

There are five distinct beds in the series, and their total thickness at Stroud Hill is about 20 feet. Their absence at Cleeve and Leckhampton may account for their having been,

as I think, somewhat overlooked; but as they constitute, in the north eastern and south western extremities of the Cotteswolds, the sole representatives of the Inferior Oolite, and extend over a large area, they appear to me to deserve closer examination.

The Inferior Oolite forms the escarpment of the Cotteswold range, but in consequence of the great denudation that has taken place, the higher beds of the formation are absent, and the top of the escarpment is either the Upper Trigonia Grit, as shown in the Cleeve and Leckhampton Sections, and at Painswick and Selsley Hills, or the Freestone beds, as at Birdlip, the Horsepools, Haresfield, Frocester, Uley, and Stinchcombe Hills. In the absence, therefore, of any beds along the line of the escarpment higher in position than the Upper Trigonia Grit, we have to look for these Upper Ragstones in the escarpments of the river valleys of the Cotteswolds; but even there some difficulty is experienced in finding Sections unless they are sought by a person locally acquainted with the district or the ground is systematically explored, as in the Geological Survey.

In his Memoir Professor Hull mentions a rubbly white Oolite as occurring at the top of the formation immediately below the Fuller's Earth, which he has named the "Clypeus Grit." This rubbly white Oolite occupies the same position in the Stroud district, but the "Grit" is, I think, the bed next below, and is described by Professor Hull as occurring throughout the north-eastern Cotteswolds—at Colesbourne, around Brimpsfield, at Stow, Rissington, the high land from Icomb Camp to Burford, Swinbrook, and the north and south sides of the Evenlode. In the neighbourhood of Stow it rests on the Midford Sands, and, where these are absent, upon the Upper Lias. Professor Hull has given only one detailed Section, viz., at Little Rissington; it is as follows:—

		ft.	in.
1.	Coarse white rubbly Oolite, with *Clypeus Plotii*, *Terebratula globata*, *Pholadomya*, &c.	4	0
2.	Coarse soft Marl	0	8

		ft.	in.
3.	Compact white Oolite	4	0
4.	Soft Marly Oolite, with *C. Plotii*, *C. clunicularis*	4	0
5.	Unseen, about	4	0

At Swinbrook the Section is described as 15 feet of exceedingly coarse-grained Oolite, containing *Clypeus Plotii*, *Terebratula globata*, and *Lima gibbosa;* and on the north side of the valley of the Evenlode the bed is of similar character, and about 10 feet thick.

The Pholadomya Grit of Dr. Lycett is described in the following Section at Scar Hill, Nailsworth:—

		ft.	in.
1.	Brown Oolite, partly disintegrated by atmospheric action ...	4	0
1a	Sandy concretionary Oolite, abounding with *Terebratula globata*	1	0
1b.	Four beds, the upper portion of each consisting of brown concretionary Rock, with *Myacites subelongatus*, *Gresslya abducta*, and *G. conformis*, in the state of casts	7	0
1c.	*Trigonia Grit*		

The rubbly condition of the upper beds was doubtless the reason why Dr. Lycett did not more fully describe the White Oolite, which Professor Hull mentions as occurring at the top of the formation.

Having observed in the excavations in making a reservoir on Stroud Hill, that this White Oolite was a compact bed, I was induced to look for it in other places in the district. On Rodborough Hill I found it a bed of fine-grained white Freestone, five feet thick, broken up into rubble where it forms the substratum, but regularly bedded at a greater depth.

At Rodborough the upper Ragstone series between the Fuller's Earth and the Trigonia Grit is as follows:—

Section No.		ft.	in.
7.	Compact white fine-grained Oolite, containing *Terebratula globata*, *Trigonia costata*, *Pecten arcuatus*, *P. demissus*, &c.	5	0
8.	Clypeus Grit, containing *Terebratula globata* in immense numbers	2	6
8*a*.	Clypeus Grit, containing *Terebratula globata*, also, in profusion, *Rhynchonella sub-tetrahedra*, *Holectypus depressus*, *H. hemisphericus*, *Nerinæa Guisei (n.s.)*, *Natica Hulliana*,		

		ft.	in.
	and a large assemblage of *Conchifera;* the more common forms are *Lima gibbosa*, *L. duplicata*, *Cardium cognatum? Sowerbya elongata (n.s.)*, *Pecten demissus*, *Myacites subelongatus*, *Pholadomya Heraulti*, *Gervillia* (several species), *Astarte* (several species), *Cyprina*, &c.	3	0
9.	Hard brown fine-grained Limestone, nearly destitute of Fossils	2	0
10.	Hard brown sandy Grit, with the surfaces partially dissolved, leaving the harder parts in the form of concretionary nodules, containing casts of *Myacites*, *Pholadomya*, &c. ...	2	0
11.	Upper Coral bed...	3	0
12.	Upper Trigonia Grit		

Dr. Holl (*Quarterly Journal of the Geolog. Soc.*, 1863, p. 306), has described the Upper Ragstone beds as running through the Lower Cotteswolds to Dundry, and along the whole belt of Oolite through Dorsetshire and Somersetshire. At Horton Rectory, near Hawkesbury, the Ragstone beds are as follows:—

		ft.	in.
A.	Upper Ragstone, white thin-bedded friable Oolite	12	0
B.	Lower Ragstone, massive hard brown Limestone in two or three beds, with many fossils, about	10	0

The hard brown Limestone appears to represent one or more beds of the Clypeus Grit of the Stroud district.

At Midford viaduct, near Bath, the White Oolite is described by the Rev. H. H. Winwood as immediately underlying the Fuller's Earth. It consists of four beds, altogether about 14 feet in thickness, becomes a brownish white in the lower portion, and contains casts of *Trigonia*, &c.

At Dundry the Section made by Mr. Stoddart shows,—

	ft.	in.
Freestone (White Oolite)	16	9
Ragstone	6	0
Coral bed	1	0

From these descriptions it will be observed that there is a gradual and regular development of the White Oolite as it extends through the Cotteswolds towards Dundry, where it attains its maximum thickness. The hard brown beds are absent in the north eastern area, and the soft marly Oolite in the middle and south western areas. A few more characteristic

fossils in the compact white Oolite and the soft marly Oolite in Professor HULL's Section would enable us to make a better correlation of the beds. It may be that the strata alluded to as unseen are the brown beds of the Stroud Section.

The Coral bed appears to have its limit southwards at Rodborough Hill. It occurs on the eastern escarpment in a broken up condition, but in the Ragstone quarry near the Fort, about 300 yards distant, it is absent, and it appears in the quarries on the south side of the Hill as a thin stratum only. Passing over beds 9 and 10 with the remark that No. 9, from its superior hardness, is less broken up than the beds above, and is, therefore, in the absence of fossils, a good guide to the examination of the series, we come to the Clypeus Grit, No. 8. This bed, which is of considerable thickness in Stroud Hill, is there comparatively unfossiliferous, *Terebratula globata* and *Pholadomya Heraulti*, being the prevailing Mollusca; but in Rodborough Hill it is charged with fossils, although the tough nature of the matrix and the circumstance of the test being extremely fragile, make it a work of patient labour to collect many specimens.

An oyster bed on the surface of the lower Clypeus bed at Rodborough indicates a pause in the deposits, and then follows a profusion of *Terebratula globata*. A stratum six inches thick is composed almost entirely of this shell; the next two feet of the deposits above are also largely composed of it.

About 12 per cent of the fossils of the Clypeus Grit are new, a large proportion belong to the Trigonia Grit, but nearly one half pass upwards into the Great Oolite. The assemblage of Testacea is considerable; I have collected upwards of 90 species, and many doubtless remain undiscovered.

The White Oolite—the uppermost of the series—has been already described. Its most abundant Fossil is *Terebratula globata:* in some places it is nearly destitute of fossils, but those which occur are well preserved. The bed at Stroud Hill is three feet thick, but at Rodborough it is five feet.

The change that ensued in the condition of the Oolitic Sea after the formation of the Coral bed is very striking. The

upper Trigonia Grit was a deposit of shells, covered up by a coarse grit, or occasionally a fine mud. In the latter condition the Shells are well preserved, and the walls and road-side stone heaps in the district attest their immense abundance. The Coral bed also contains a large number of fossils, but the deposition upon it of the brown Grit beds indicates a considerable change in the marine life of the Oolitic Sea. The Mollusca, so abundant in the Trigonia bed, for a time withdrew to other seas, and the brown sandy Grits are nearly destitute of organic remains.

The brown beds disclose a succession of strata differing somewhat in their lithological character. The lower bed is very tough, it contains large Oolite grains in clusters with few fossils. The bed next above is fine grained and nearly destitute of fossils. It is, perhaps, the hardest and most compact bed in the formation. It is succeeded by another tough Oolite bed, nearly the counterpart of the first in its lower portion, but becomes fossiliferous towards it upper surface.

The Coral bed separates the ragstone series into two divisions, between which there is considerable difference, both as regards the structure of the rocks and the fossils they contain. For reference it would be convenient to call the beds above the Coral bed the Upper, and those below, down to the Freestones, the Lower Ragstones.

The term "pisolitic ragstone" would apply to the beds near the base of the Inferior Oolite.

The upper Ragstones appear to have a wide range. In the Calcaire de Longwy, in the province of Luxembourg, they are represented, and Messrs. Chapuis and Dewalque have figured from that formation numerous species also found at Rodborough, including *Homomya gibbosa*, *Lima gibbosa*, *Lima duplicata*, *Modiola gibbosa*, and *Holectypus depressus*, the first of which does not occur in the Cotteswolds earlier than the beds I have described, and the others are some of the most abundant fossils of the Clypeus Grit.

In his correlation of the Jurassic Rocks, before alluded to, Dr. Wright mentions the stage Calcaire à *Collyrites ringens*

as the highest bed of the Inferior Oolite of the Cote d'Or. The list of fossils from that stage contains many of those found in the Clypeus Grit, including *Clypeus Plotii*, *Lima gibbosa*, and *Pholadomya Heraulti*, and I regard it as probable that the Clypeus Grit forms part of the stage.

The Fuller's Earth.—So few opportunities occur for examining the beds of the Fuller's Earth that no complete Section of them has yet been made, and it is probable that sections at any given localities would be found to vary considerably from each other. In Stroud Hill the lower portion of the formation (No. 6 in Section) consists of a blue Shale occasionally consolidated, and in this condition, when dry, having a conchoidal fracture. The shaley part is very fossiliferous, but the shells are, with one or two exceptions, reduced to a dark pigment, so that they cannot be identified without great difficulty; one of the exceptions is *Lima duplicata*, which is so well preserved that the shell appears in its original condition. *Posidonomya Opalina* Quen. occurs in great numbers.

One of the most abundant fossils in this part of the formation is that of a small crustacean, *Glyphœa pseudo-scyllarus*. It is very fragile, and when found it is constantly separated by the cleavage of the matrix into two parts, one part adhering to each side. I have also found a single claw of the genus *Magita*. Several specimens of a small but new *Trigonia (T. Witchelli Lyc.)* have been collected, and a few examples of *T. imbricata*, both of which species have been recently figured by Dr. Lycett in the Memoir of the British Fossil *Trigoniæ*, published by the Palæontographical Society.

In Stroud Hill the percolating water is thrown off by this bed, the more porous beds overlying it acting as a sponge, by which the water is held until gradually let out in the springs. Were it not for the faults which let a portion of the water escape down to the Upper Lias, a much larger quantity would be thrown off by the Fuller's Earth, and the slopes of the Cotteswolds would be exceedingly well watered. The retentive nature of the Fuller's Earth varies considerably even in short distances; thus at Stancombe Ash, near Bisley, the upper bed

of the formation throws off the water, and a well about six feet deep is amply supplied, and at Ferris Court, only a mile distant from Stroud Hill, the water level is stated by Mr. J. H. Taunton to be near the surface, while at Stroud Hill it is in the lower part of the formation.

The blue Marl is succeeded by a bed of blue and buff Shale, laminated, with horizontal cleavage, fossiliferous, the fossils being similar in character and condition to those in the bed below (No. 5 in Section). *Myacidæ* and *Cyprinidæ*, in the form of casts, are common, and the Fossils generally agree with those of the Great Oolite. Above this the Marl and Shale gradually assume a lighter colour, and become buff and brown; the upper part contains *Ostrea acuminata* in immense abundance; *Placunopsis socialis* and *Pecten vagans* are common. Bands of cemented valves of *Ostrea acuminata* occur, varying from one to nine inches in thickness, to the exclusion of other fossils. On the slopes these bands are found broken up and partially disintegrated. I have obtained from this part of the formation a single specimen of *Ammonites gracilis, Buck.*, a shell hitherto found in the Stonesfield Slate.

The upper portion of the formation consists of a sandy Clay alternating with beds of Sandstone, brown on the surface, blue internally, and closely resembling the Stonesfield Slate, except that it is less laminated. The passage from the Fuller's Earth to the Stonesfield Slate is shown in the disappearance of the Clay and the greater development of the Sandstone beds, which assume a more persistent character.

The Stonesfield Slate, as shown in the Section, represents the western edge of the formation. It is thin bedded, but it is too consolidated and irregular, and not sufficiently laminated for roofing tiles, and is used only for road making and field walling. It contains numerous pieces of wood and plant remains, but the impressions are badly preserved. A thin whitish stratum near the middle of the formation splits into thin flakes, the surfaces of which are covered with impressions of plant detritus. Among the fossils I have found part of a

Crinoid; another specimen has been figured as a plant (*Aroides Stutterdii,*) but Dr. WOODWARD has pronounced it to be the proboscis of a *Crinoid,* and will so describe it.

In a well sunk on Stroud Hill in connection with the Water Works the lower part of the Stonesfield Slate was found to be laminated, and split up on exposure like the true roofing tile. I estimate this part at 5 feet thick, but it may be more.

There is little variation in the lithological character of the Stonesfield Slate between Stroud Hill and Stancombe Ash, but eastwards from the latter place it becomes more sandy and fissile, and is worked for roofing tiles. The upper bed of the Section consists of thin bedded Great Oolite, about four feet thick, distinguishable from the underlying beds in being lighter in colour, softer in structure, and more fossiliferous. The Great Oolite appears to thin out as it extends westward, and it is probable that its limit was not far beyond the present escarpment of the Cotteswold range.

FOSSILS FROM THE CLYPEUS GRIT OF RODBOROUGH HILL.

Cephalopoda—

Ammonites subcontractus. M. & L.
" *Brocchii.* Sow.
Ammonites Parkinsoni. Sow.
Belemnites abbreviatus. Sow.

Brachiopoda—

Terebratula globata. Sow.
" *perovalis.* Sow.
" *Whitakeri.* Dav.
Rhynchonella angulata. Sow.
" *subtetrahedra.* Dav.
" *spinosa.* Schloth.

Gasteropoda—

Nerinæa Guisei. Nov. Sp.
" *undulata.* Do.
Natica Stricklandi. Lyc.
" *Hulliana.* Lyc.
Amberleya capitanea. Goldf.
Alaria armata. Lyc.
" Sp. undetermined.
Acteonina antiqua. Lyc.
Cerithium clypeatum. Nov. sp.
Trochus monilitectus. Phil.
" *clypeatus.* Nov. sp.
Monodonta Labadyei Archiac. (Qy.)
Pleurotomaria. Casts of.
Chemnitzia. Do.
Solarium disculum. M. and L.

Conchifera—

Opis Deshayesi. Lyc.
" *Painei.* Nov. sp.
Unicardium incertum. Phil.
" *parvulum.* M. and L.
Pecten arcuatus. Sow.
" *demissus.* Sow.
" *personatus.* Goldf.
" *clypeatus.* Nov. sp.
Avicula digitata. Desl.
Sowerbya Woodwardi. Lyc.
" *elongata.* Nov. sp.
Cypricardia cordiformis. Desl.
Neræa Ibbetsoni. Lyc. [Lyc.
Trigonia gemmata var. bifera. Nov. sp.
" *producta.* Lyc.
" *angulata.* Sow.
" *costata.* Sow.
" *duplicata.* Sow.
Astarte subtrigona. Goldf.
" *sub-angulata.* Nov. sp. [sp.
" *depressa var. Rodborensis.* Nov.
" " *var. depressior.* Nov. sp.
" *clypeata.* Nov. sp.
" *rhomboidalis.* Phil. sp.
" *minima.* M. and L.
Myacites compressiusculus. Lyc.
" *sub-elongatus.* Ag. sp.
" *æquatus.* Phil.
Corbis. Sp. und.
" Do.
Cardium cognatum. Var. clypeatum.
Cardium cognatum. Phil.
Gervillia acuta. Sow.
" *pernoides.* Desl. (Qy.)
" Sp. und.
Lima gibbosa. Sow.
" *duplicata.* Sow.
" *bellula.* Mor. & Lyc.
Hinnites velatus. Goldf.
Modiola gibbosa. Sow.
" *explanata.* Morris.
" *plicata.* Sow.
Ceromya striata. Sow. sp.
" *plicata.* Ag.
Homomya gibbosa. Sow.
Trichites undulatus. Lyc.
Pholadomya Heraulti. Ag.
" *Dewalquei.* Lyc.
Nucula nucleus. Desl.
Ostrea acuminata. Sow.
" *rugosa.* Goldf.
Cyprina Lucyi. Nov. sp.
" Sp. und.
Lucina clypeata. Nov. sp.
Cucullæa concinna. Phil. sp.
" *oblonga.* Goldf.
Gresslya abducta. Phil. casts of.
" *conformis.* Do.
Pteroperna clypeata. Nov. sp.
Isoarca clypeata. Nov. sp.

Echinodermata—

Holectypus depressus. Desor.
" *hemisphericus.* Ag.
Hyboclypus ovalis. Wr.
Clypeus Plotii. Klein.
Echinobrissus clunicularis. Lhwyd.

Pisces—

Strophodus magnus. Ag. teeth of.

I have to thank Dr. Lycett for his kind assistance in identifying the fossils, and in determining the new species.

DESCRIPTION OF SPECIES FIGURED.

TRICHITES UNDULATUS, LYCETT. Pl. I, fig. I.; Pl. II, figs. 1, 2.

The genus *Trichites* is fully described by Dr. LYCETT, Vol. I, p. 42, and by MORRIS and LYCETT in the Monograph of the Mollusca of the Great Oolite. *T. undulatus* is described in Vol. I, p. 46, as follows:—"Shell oblong, umbones ribs obscure, few, concentric, irregular, and undulated, sometimes obsolete in the larger valve. The smaller valve unknown." No figure is given.

It will be observed from the figures that there is great variability in the form of this shell. The figure on Plate I is much more convex and narrow than that on Plate II. It has also regular lines of growth, of which the latter is nearly destitute. Each shell is about 10 inches long, one is 8 inches wide, the other 6 inches.

TRICHITES NODOSUS. MOR. and LYC. Pl. III.

The figure in the Monograph of the Great Oolite is that of the left valve. The figure now given is the interior of the right valve. It is nearly flat. There is a long ligamental groove down the straight side of the shell. In other respects the shell is fully described in the Monograph.

PHASIANELLA COSTATA. Pl. IV, fig. 1.

Shell conical, spire elevated, acute, whorls six, their height equal to the half of their opposite diameters, convex, transversely costated, costæ regular, raised, longitudinally striated, the last whorl much inflated, aperture ovate, its height equal to half the length of the entire shell. The costæ on the anterior part of the last volution are wider apart than on the other portions of the shell, and in the interstitial spaces fine lines may be detected. The longitudinal striæ are only visible with the aid of a magnifier. Height, 1 inch.

Geological position and locality,—the Clypeus Grit of Rodborough Hill. Rare.

= Trichites undatus Lycett. Vol. 1. p. 46 non undulatus

Nerinæa Guisei. Pl. IV, fig. 2.

Shell slender, sub-cylindrical, volutions very numerous, much excavated, encircled with minute costæ, irregular and unequal, eight to ten to a volution, suture prominent, acutely carinated, columella solid, with one fold, outer wall with two folds near the middle of the volution; aperture unknown.

Fragments of this shell—and it has only been found in a fragmentary condition—indicate that it was of considerable length, not less than 9 inches.

The costæ and internal folds are observable only on the better preserved shells. The first costa is close to the suture, and is more prominent than the others, giving to the edge of the suture a furrowed appearance: the other costæ, except the three last, are rather wide apart, but these three are close together. Indications of a second fold on the columella, corresponding with the posterior fold on the outer wall are sometimes observable.

The prominence of the sutures, the great concavity of the whorls, the arrangement of the costæ, together with the internal folds, sufficiently distinguish this from other lengthened slender species; but, owing to the fragmentary condition of all the specimens, we are unable to compare sufficiently the volutions of the young form with those of the adult condition, and are therefore unable to judge of the figure of the entire shell.

Locality and position—the Clypeus Grit of Rodborough Hill. Common.

Trochus Clypeatus. Pl. IV, fig. 3.

Shell small turbinated, whorls angulated, encircled with a prominent rib near the suture, giving the shell a step-like appearance. There are two other small ribs on the side. The last whorl has three acute ribs nearly equidistant, two of which form the upper and lower angles of the whorl; all the angles are acute. Base smooth, entire; aperture nearly round.

This shell is sufficiently distinguished from other species by its turbinated form and the angularity of the whorls. Height, 5 lines.

Geological position and locality,—the Clypeus Grit of Rodborough Hill, where it is abundant.

NERINÆA UNDULATA. Pl. IV, figs. 4 and 4a.

Shell long, taper; whorls concave, but depressed and flattened near the sutures, giving to the profile the appearance of a series of undulations, costated, having four to five costæ on the larger part, and three to four on the smaller part of each whorl. Aperture unknown.

As only a fragment of this shell has been discovered, and being in a crystalline condition, its internal character cannot be ascertained. It is provisionally referred to the genus *Nerinœa*. Length of fragment one inch. It contains 8 whorls; diameter of the last whorl one eighth of an inch.

Locality,—Clypeus Grit, Rodborough Hill.

TRIGONIA GEMMATA. *Var. bifera.* LYC. Pl. IV, fig. 5.

This shell is described by Dr. LYCETT, in a foot-note in his Monograph of the British fossil *Trigoniæ*, p. 239, thus:—"It has seven rows of concentric costæ, which occupy more than half the height of the valve. The oblique or perpendicular costæ, nine in number, have three only which originate at the marginal carina; all the others proceed from the last formed concentric costa to the pallial border: the general figure is somewhat shorter than the typical form." No figure is given in the Monograph, the shell having been discovered after the plates were completed. Height 6 lines, length 7 lines.

Locality,—the Clypeus Grit, Rodborough Hill. Rare.

CYPRINA LUCYI. Pl. IV, fig. 6.

Shell ovately transverse, tumid, inequilateral, umbones rather small, not prominent, antero-mesial, hinge border slightly curved, lunule excavated, base regularly elliptically curved. The surface of this shell exhibits faint but regular concentric folds of growth, with indications of concentric striæ. Height 22 lines, length 2 inches.

Position and locality,—the Clypeus Grit of Rodborough Hill.

ASTARTE CLYPEATA. Pl. IV, fig. 7.

Shell ovately subtrigonal, sub-equilateral, moderately curved, anterior and posterior borders nearly straight, sharply rounded at their lower extremities, transverse diameter slightly greater

than the height; umbones moderately produced, lunule nearly obsolete; hinge margin straight, oblique, lengthened, the surface of the valves ornamented with a few rugæ round the umbones, which pass downwards into closely arranged irregular striæ. Height 7 lines, diameter 8 lines.

Position and locality,—the Clypeus Grit, Rodborough Hill.

ASTARTE SUB-ANGULATA. Pl. IV, figs. 9, 9a.

Shell small, convex, subtrigonal, tumid, inequilateral, umbones produced, large, incurved; anterior to the middle of the valves hinge border curved, lower border nearly straight, but sharply curved at the anterior and posterior extremites, lunule large ovate; the surface with concentric obtuse ribs (about 20) separated by somewhat narrower interstitial spaces.

The small subtrigonal tumid form of this shell separates and distinguishes it from contemporary species. Height and diameter, 6 lines.

Geological position and locality,—the Clypeus Grit of Rodborough Hill. Very common.

ASTARTE DEPRESSA, GOLDF. *Var. Rodborensis.* Pl. IV, figs. 10, 10a.

Shell suborbicular, rather depressed, umbones moderately prominent, nearly mesial, slightly incurved, lunule nearly obsolete; hinge border nearly straight, oblique, posterior border slightly produced; the surface has a few small closely arranged rugæ near the apex; the remainder of the surface is concentrically striated with several faintly marked plications of growth. Allied to *A. striato costata Munst.*, but is distinguishable from that species by its rounded and more depressed form, less incurved umbones, and smaller lunule. Height and lateral diameter, 10 lines.

QUENSTEDT has figured three examples of *Astarte depressa* (Der Jura Pl. LXVII, figs. 29, 30, and 33), each of which has a more elliptical form, and fig. 29 is more depressed than our shell. These shells, with *A. Striata costata*, and *A. clypeata*, fig. 7, form a group, having similar surface markings, but

varying in form and thickness, and more particularly in the shape and size of the lunule and curvature of the umbones. Perhaps they had better be regarded as varieties of one species.

Geological position and locality,—the Clypeus Grit of Rodborough Hill. Rare.

Lucina clypeata. Pl. IV, fig. 8.

Shell convex, suborbicular, sub-equilateral, lunule rather large, umbones small, mesial, hinge margin slightly curved, base rounded, concentric lines closely arranged, regular, interrupted by numerous folds of growth, which become rugose near the base. Anterior side produced. Height 12 lines, diameter 13 lines, diameter through both valves 6 lines.

Geological position and locality,—Clypeus Grit, Rodborough Hill.

Sowerbya elongata. Pl. IV, figs. 11, 11a.

Shell thick, smooth, shining, transversely lengthened, equilateral, convex, with a posteal subacute, oblique angle, and narrow flattened space posterior to it; anterior side produced, its lower extremity curved elliptically, posterior lower extremity angulated; umbones small, little elevated, surface ornamented with regular longitudinal striations, moderately separated, and passing over the posteal oblique angle and the surface posterior to it. There are two or three folds of growth, and much variability in the degree of convexity and in the obliquity of the posterior angle. Length 15 lines, height 9 lines.

Geological position and localitity,—Clypeus Grit of Rodborough Hill.

Pecten Clypeatus. Pl. 5, fig. 1.

Shell small, convex, sub-equilateral, with radiating costæ (about 60) closely arranged, slightly curved, but obsolete on the upper part of the shell; the whole surface concentrically striated, auricles ribbed, apex slightly curved.

This shell is allied to *P. Woodwardi*, M. and L., and *P. arcuatus*, but differs from them in its outline and convexity; the absence of punctuations in the interstitial spaces further separates it from *P. arcuatus*. Height and diameter, half an inch.

Geol. position and locality,—Clypeus Grit, Rodborough Hill.

Opis Painei. Pl. V, fig. 2.

Shell subtrigonal, convex, inequilateral. Umbones elevated angular and curved; the anterior side crossed by four well defined plications, three of which occur at regular distances, the fourth is somewhat nearer the third and is near the lower border. Between each plication the surface has closely arranged concentric lines. An elevated acute carina separates the anterior and posterior sides, parallel to which are slight depressions giving to the carina the appearance of a prominent thin ridge; the posterior side short, narrow; the anterior side much produced, Lunule very large, occupying the greater portion of the anterior border of the shell.

The outline of the figure bears some resemblance to *O. Luciensis* D'Orb, but the short and more curved carina, the oblique produced lower border of the anterior side, and the well marked plications across the surface distinguish it from that species.

Height 8 lines, lateral diameter 7 lines.

Geol. position and locality,—the Clypeus Grit of Rodborough Hill, where it is rare.

Pteroperna Clypeata. Pl. V, fig. 4, 4a, b, c.

Shell small, sub-æquivalve, contrentrically marked with nearly obsolete lines of growth, crossed by faint longitudinal striæ, umbones moderately large, the umbo of the left valve rising higher than the other, and above the hinge line; anterior wing produced, pointed; posterior wing rather small, transversely striated, its margin excavated by a longitudinal furrow, which becomes wider towards the lower extremity, and is longitudinally striated; a slight ridge forms the inner border of the furrow; the right valve more flattened than the left,

and its surface less marked; the right valve moderately convex. The aspect of this shell approaches that of *Gervillia*, especially in those instances where the posterior wing is shorter than usual. The right valve also resembles that of *Pteroperna pygmea*, *Dunker*, but the posterior wing is more produced than in *Gervillia*, and less than in *P. pygmea*. Length 15 lines.

Geological position and locality, the Clypeus Grit of Rodborough Hill, where it is common.

ISOARCA CLYPEATA. Pl. V, fig. 3, 3a, 3b.

Shell suborbicular, convex, sub-equilateral, umbones moderately large, slightly curved, sub-mesial. The surface has closely arranged concentric lines, with folds of growth; the latter become larger near the base of the shell. These are crossed by numerous regular lines radiating from the umbones.

Geological position and locality, the Clypeus Grit of Rodborough Hill, where it is very rare.

CARDIUM COGNATUM. Phil. *var. Clypeatum.* Pl. V, figs. 5, 6.

This is a variety of the Inferior Oolite shell described by Dr. LYCETT, in his Supplementary Monograph of the Great Oolite Mollusca Palæont. Soc. 1863, p. 54. Compared with the typical form it is distinguished by the greater thickness of the shell and prominence of the ornamentation. In the Cornbrash and Kelloway Rock of Scarborough the test is delicate, smooth, and shining.

Geological position and locality, the Clypeus grit of Rodborough Hill.

ASTARTE DEPRESSA, GOLDF. *Var. Depressior.* Pl. V, figs. 7, 7a, b.

Shell sub-orbicular, thin, greatly depressed, umbones anterior, small, obtuse, nearly flat, lunule obsolete, base regularly rounded, costæ (about 22) closely arranged, slightly angulated, the interstitial spaces with numerous minute concentric striæ.

This shell differs in several respects from *A. depressa* figured by Goldfuss T. 134 f. 14. The umbones are more anterior, and

more depressed, the lunule more obsolete, and the outline more ovate than in that shell. It bears no resemblance to *A. depressa* Quen., and is a different species.

Geological position and locality, the Clypeus Grit, Rodborough Hill, where it is moderately abundant.

Chemnitzia. (Qy.) Pl. V, fig. 8.

Shell large, whorls convex, costated anteriorly; costæ rather large. The fragment figured indicates a shell of considerable size, but as the external mould only has been discovered, a full description cannot be given, but it will suffice to call attention to a very fine species.

From the Clypeus Grit of Rodborough Hill.

Cerithium clypeatum. Pl. V, fig. 9, 9a.

Shell turrited, volutions numerous, narrow, about twice as wide as high, expanded posteriorly, nearly straight anteriorly, with numerous encircling lines; aperture oblique, narrow, canal produced; height of entire shell about 13 lines, diameter of last whorl 3 lines.

Geological position and locality, the Clypeus Grit of Rodborough Hill, where it is rare.

EXPLANATION OF PLATES.

Plate I.

1 *Trichites undulatus.* Lyc. (reduced).
2 " " Side view, (reduced).

Plate II.

Trichites undulatus. Another example, (reduced).

Plate III.

Trichites nodosus. M. & L. View of the interior of the right valve, (slightly reduced).

Plate IV.

1 *Phasianella costata.*
1a " " Whorl enlarged, showing costæ and longitudinal striæ.

2 *Nerinæa Guisei.*
2a " " Another example
2b " " Section showing internal folds.
2c " " Whorl enlarged.
3 *Trochus clypeatus.*
4 *Nerinæa undulata.*
4a " " Whorl enlarged.
5 *Trigonia gemmata.* *Var. bifera* LYC.
6 *Cyprina Lucyi.*
7 *Astarte clypeata.*
8 *Lucina clypeata.*
9, 9a } *Astarte sub-angulata.*
10 10a *Astarte depressa.* GOLDF. *Var. Rodborensis.*
11 *Sowerbya elongata.*
11 " " Enlarged view, showing encircling lines and striæ.

PLATE V.

1 1a 1b *Pecten clypeatus.*
2 *Opis Painei.*
3 *Isoarca clypeata.*
3a " " Magnified view of portion of internal mould.
3b " " Magnified view, showing encircling and radiating lines.
4b *Pteroperna clypeata.* Right valve.
4a " " Left valve.
4b 4c Other examples.
5 *Cardium cognatum.* LYC. *Var. Clypeatum.*
6 " " Another example.
7, 7a, 7b } *Astarte depressa.* GOLDF. *Var. depressior.*
8 *Chemnitzia.* (Qy.) Internal mould.
9 *Cerithium clypeatum.*
9a " " Whorl enlarged, showing transverse lines.

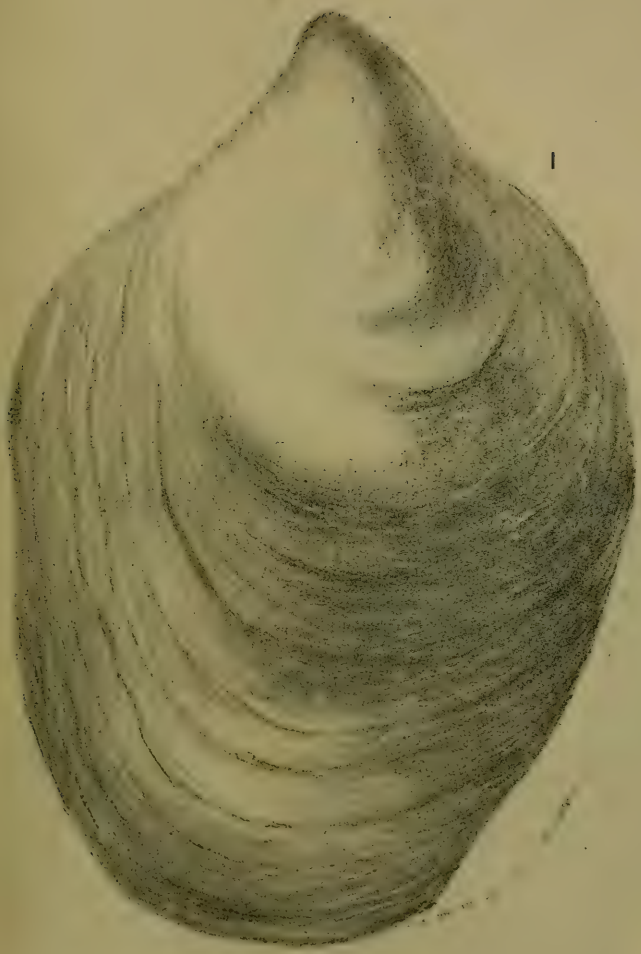

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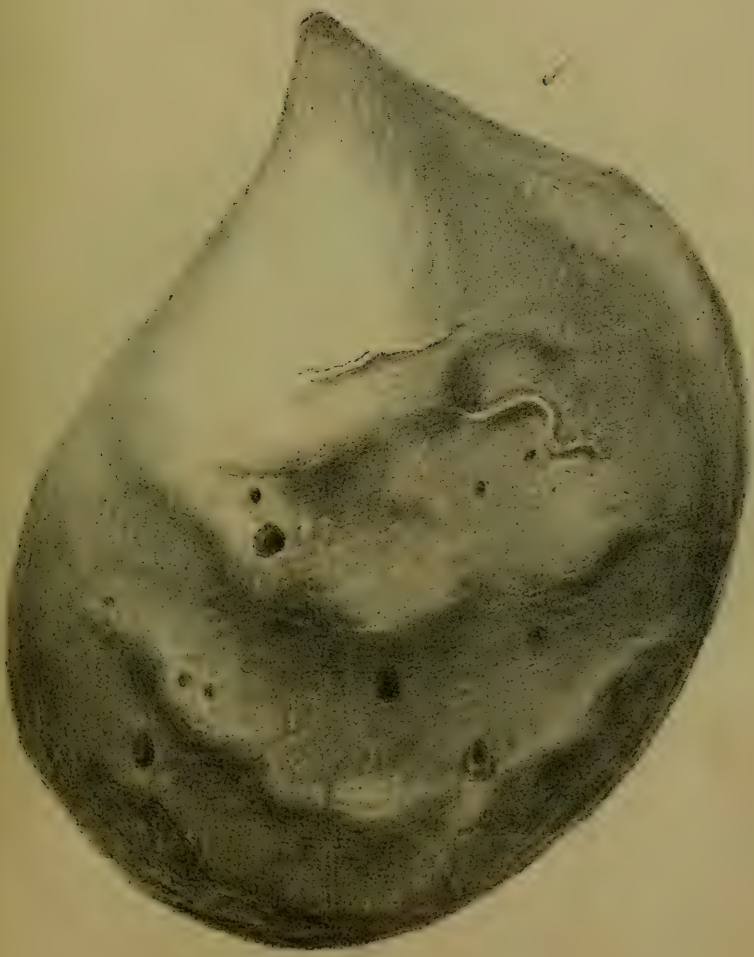
Plate 2



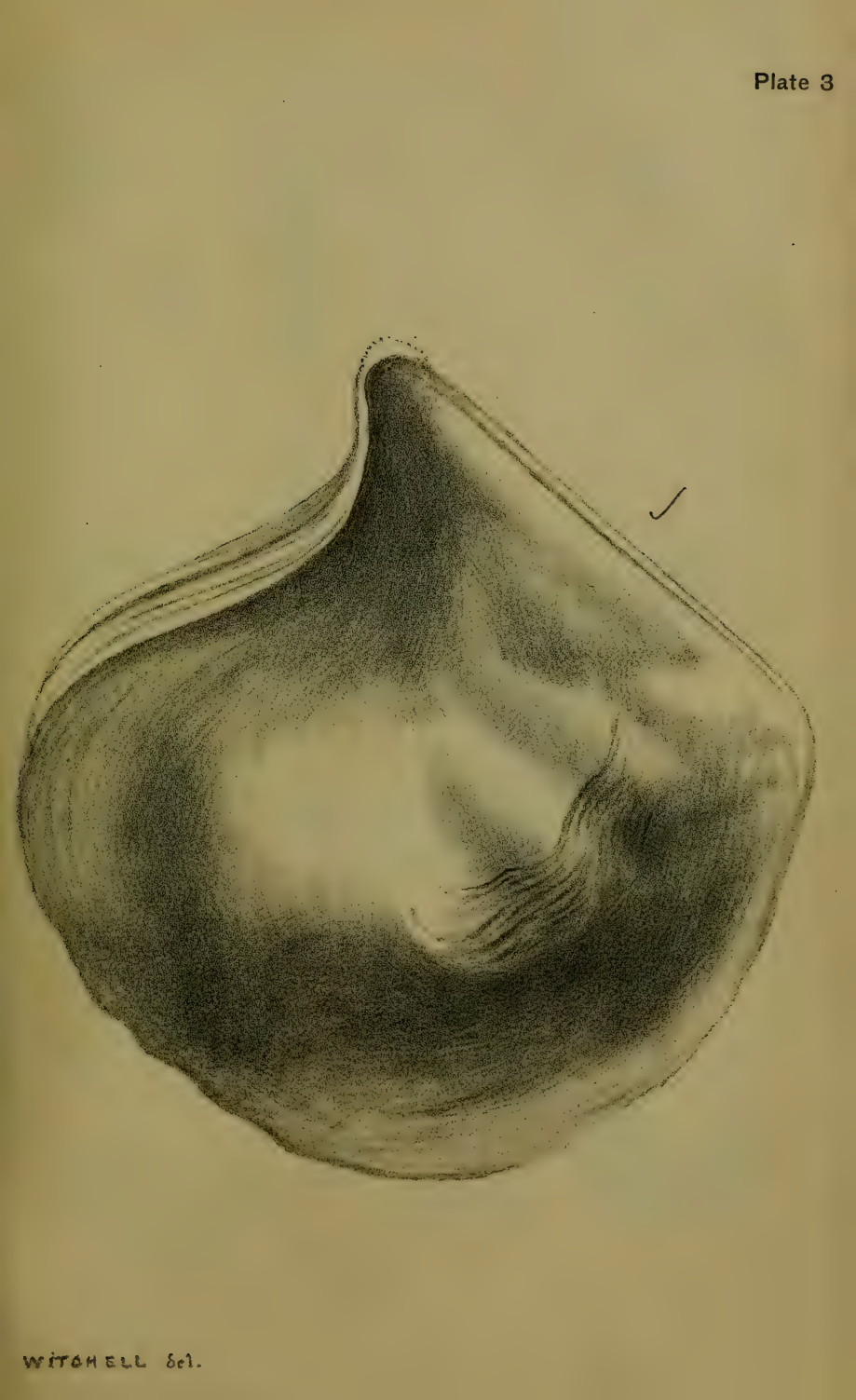


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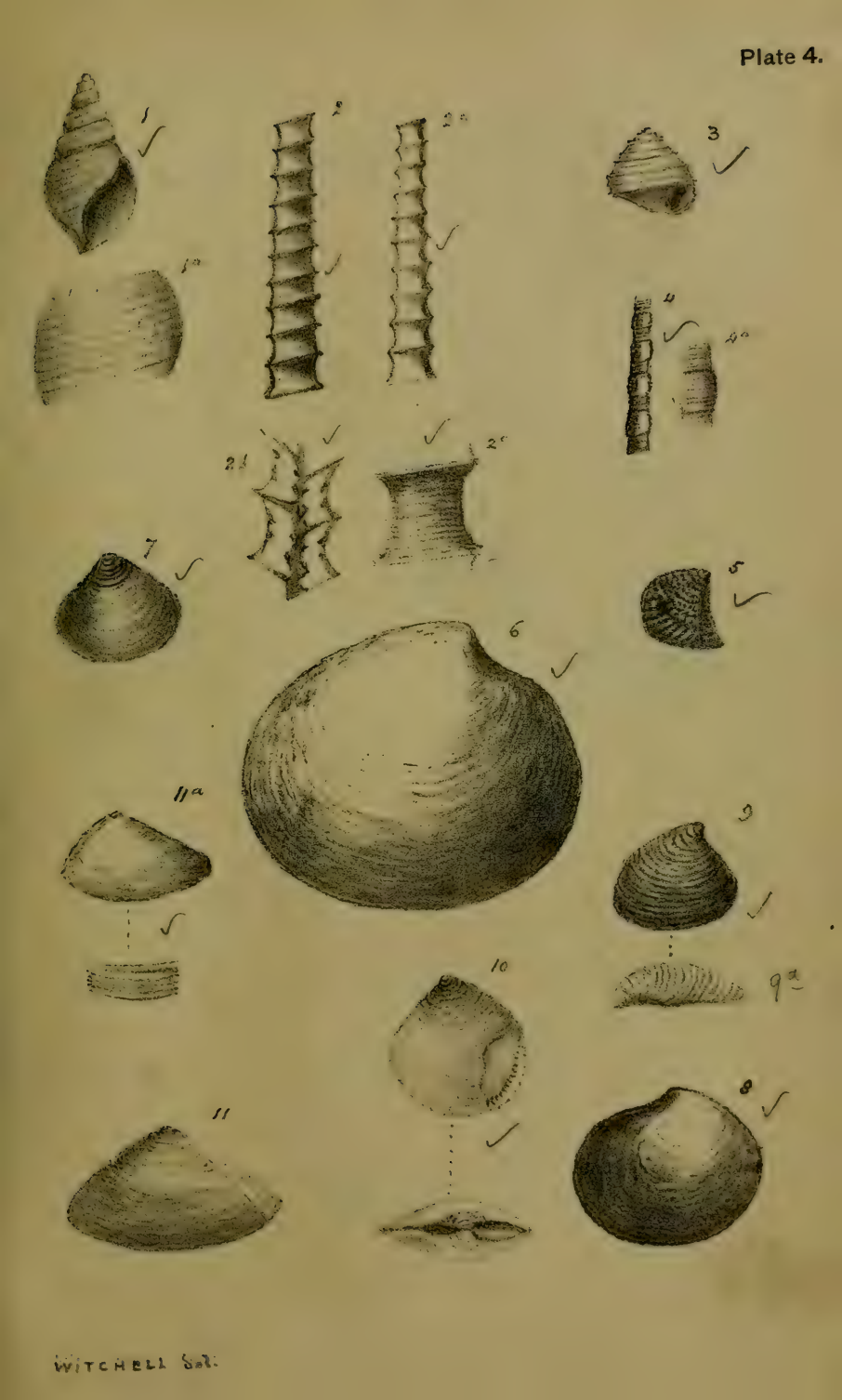
Plate 4.



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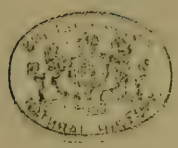
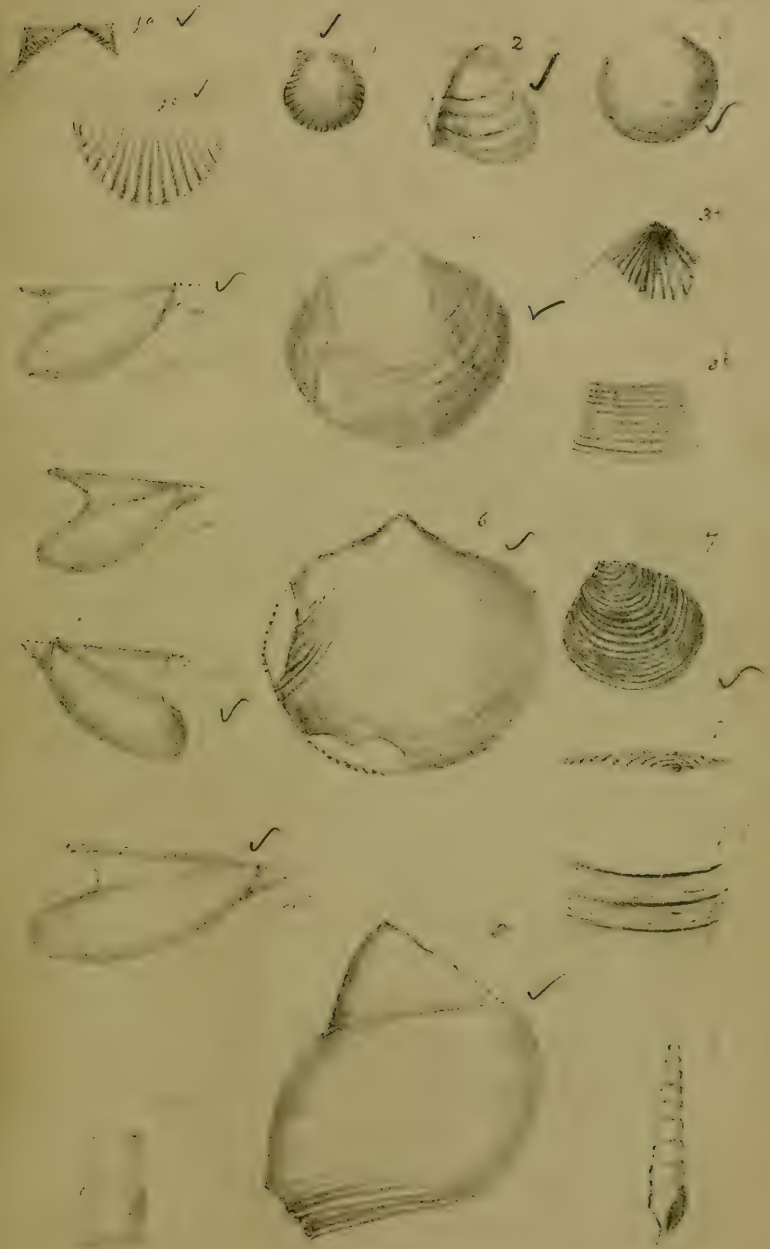


Plate 5.



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Address to the Cotteswold Naturalists' Field Club, by the President, Sir W. V. Guise, Bart., F.L.S., F.G.S. *Read April 20th, 1880.*

Gentlemen,

It is again my agreeable duty to report to you that the Cotteswold Club is in all respects in a satisfactory condition. Our numbers, in consequence of deaths and retirements, are somewhat lower than usual, but there need be no hurry to fill up vacancies: there is no lack of candidates for admission, and I am of opinion that we should look rather to keeping up a supply of working members, than, for the sake of filling up our ranks, to admit those to whom our field excursions are the sole attraction.

In the matter of finance, our excellent Treasurer makes a very favorable report. It has not been found possible to prepare a balance-sheet in time for the Annual Meeting, but I am assured that a printed statement will be in the hands of members within a few days.

The papers read before the Club during the past season are much above the average, both in numbers and importance; a result which is due to the Winter Evening Meetings, which have proved eminently successful.

Our Field Meetings last year were much marred by the wet season, which proved so disastrous to many interests more important than our own; but in spite of such drawbacks our Meetings were well attended, and many subjects of interest, novelty, and instruction were passed in review. Of these and of our Winter Meetings I will now proceed to give a detailed outline.

ANNUAL MEETING.

The Annual Meeting of the Club was held at Gloucester, on Thursday, the 3rd of April, 1879, when you did me the honor to re-elect me as your President, together with our former Vice-Presidents, and our old and well-tried Secretary and Treasurer.

The President having, according to custom, read his Annual Address to the Club, Dr. Wright, F.R.S., gave a "Sketch of the Palæontology of the Lias Formation, considered in reference to the theory of Animal Evolution." The Lecturer commenced by reminding his audience of the relative position of the Lias, as related to the Trias below and the lower Oolite above, and to the extent of the area which the Lias sea occupied in central Europe during the time its various beds were accumulating. With a well executed map he traced out the dry land and the seas of the period, and showed the shore line of the Lias sea in what was now England, France, Germany, Switzerland, the Austrian Alps, Italy, &c. The Lias stood conspicuous amongst the other Mesozoic strata in the completeness of its record, for the chapters of its life history were written in imperishable characters on its dark shales and limestones; and these could be deciphered with a certainty that was very remarkable, and it presented in this respect a favourable field for tracing the course of life during the long period of time through which the strata were accumulating. It was an exception therefore, to the general assertion that the geological record was imperfect, and consequently the results deduced from its study merited in an especial manner the thoughtful consideration of Cotteswoldians, seeing that along the slopes of the hills and the picturesque valleys of the range its beds were well developed.

Everyone who has discussed the theory of the transmutation of species with the disciples of Mr. Darwin has soon found himself in a difficulty to answer that philosopher's remarkable chapter on the imperfection of the geological record; for Mr. Darwin, in his graceful way, says: "Geology assuredly does

not reveal any such finely graduated chain, and this perhaps is the most obvious and serious objection which can be urged against my theory;" and again, "the geological record, viewed as a whole, is extremely imperfect; but if we confine our attention to any one formation, it becomes much more difficult to understand why we do not therein find closely graduated varieties between the allied species which lived at its commencement and at its close." These passages show at once Mr. Darwin's difficulty, for if there be such a thing in nature as the evolution of a lower form of animal life into another and higher condition, then assuredly we have a right to expect to meet with some transition form by which the links of the chain are united; but geology does not reveal any such nicely graduated scale, for if it did, none would have presented them better than the Lias. I am therefore (said the Doctor) anxious to show you the various forms of life which appeared for the first time in the Liassic age, and carefully to enquire into the ancestry of each of the groups which the Palæontologist has discovered in the Lias formation.

In the upper breccia of the Keuper at Degerloch, Würtemberg, the molar teeth of a small mammal were found thirty years ago, and since then teeth, probably belonging to the same genus, have been found in the Lias at Watchet, and near Vallis Vale, in Somerset. The animal was probably a small pouched quadruped, but anything beyond that is conjecture. It was however a true mammal, and the first and oldest known to Naturalists.

The next class to which I invite your attention is the reptiles; which, during the Lias age, were the most formidable of all, and presented forms of life the most remarkable that we know among all the vertebrata. We meet with three distinct groups of these in the Lias—the *Enaliosaurians*, or marine reptiles; the *Pterodactyles*, or aerial reptiles; and the *Teleosaurians*, or land and river reptiles. Now in each of these groups we discover an assembly of anatomical characters which are quite special to fit the organism to fulfil the special conditions of its existence. Among the first or marine reptiles the *Ichthyosaur*

will ever stand supreme. This marvellous animal had the spinal column of a fish, the skull and jaws of a crocodile, the sclerotic plates of the eye resembling a like structure in turtles, lizards, and birds; it had the paddles of a whale articulated to the scapular arch of the *Ornithorhyncus*. Whence did this creature trace its descent? What ancestors had it in the Triassic seas? But the rocks have not yet revealed from whence these complex structures were derived. Take again the *Plesiosaurus*, with its long neck united to the trunk of an ordinary quadruped, with the ribs of the chameleon, and the paddles of the whale. Several species are known, and their anatomy well understood.

There is another type of skeleton which makes its first appearance with the dawn of the Lias age; it has a history quite unique, and its skeleton such as is found in no other reptile, living or extinct. The *Pterodactyles* present us with an assemblage of structural characters especially adapted to an aerial life. They have some resemblance to birds and bats, but they differ from both. From birds they are distinguished by the form of their vertebral column, and by the presence of teeth set in sockets; from mammals, by their conical teeth, small brain case, and reptilian structure of the shoulder joint. The wings of these flying reptiles were constructed on mechanical principles different from the wings of bats or birds. In birds the fingers are united, and serve for the support of the wing pinions: in bats the thumb is rudimentary, and the joints of the four fingers are elongated, to sustain the membrane that serves the purpose of a wing. On the contrary, the hand of the *Pterodactyle* resembles that of a lizard, the thumb and three fingers retain their normal size, but the little finger has all its joints strengthened and elongated, to form a rod for supporting a wing. Their long bones are hollow, and are traversed by air tubes like those of birds, and the carpal and metacarpal bones of the hand gave to these animals the delicate power of feathering the wing, either in air or water, in a way similar to the webbed feet of the Gannet and other diving palmipeds. The first *Pterodactyle* appeared in the Lias age, under the form of the *Dimorphodon macronyx*, discovered in the Lower Lias of

Lyme Regis. This is another specialised type of structure of which no traces of ancestry are found in the Trias formation.

The Crocodiles make their first appearance in the Upper Lias, under the remarkable form of *Teleosaurus Chapmanni.* These reptiles resemble rather the Gavial of the Ganges than the Crocodile of the Nile.

Fishes played an important part in the Lias sea. The genera found therein are nearly all special to that formation. The species found in the Lower Lias are distinct from those found in the Upper Lias.

It would appear from all these anatomical facts that all the vertebrated animals found in the Lias beds are limited to that formation, since we cannot discover the ancestors of either the marine, aerial, terrestrial or fluviatile reptiles in any of the older formations.

Let us now turn to the invertebrated fossil animals included in the *Arthropoda*, *Mollusca*, and *Radiata.* Of the *Arthropoda* we have examples of *Crustacea* and *Insecta.* The *Crustacea* are represented by the genera *Glyphœa* and *Coleia*, both of which are special forms found only in the Lias beds. Insects are found in the "Insect Limestone" at Aust, and the order *Diptera* of which the house fly is typical, appear for the first time in the Lias beds. The Mollusca afford us a very interesting field for observation on the advent and exit of species in the several stages of life into which the Lias is divisible. The classes into which this sub-kingdom is grouped being not of equal interest, the Cephalopods are specially selected for demonstration. These animals form the highest type, and one section—to which the common cuttle-fish belongs—have no external shell, while another section is furnished with a many-chambered shell, like the Pearly Nautilus. Belonging to the naked section is that curious fossil the *Belemnite*, which first made its advent suddenly in the seas of the Lower Lias, and prevailed in such numbers during some of its periods that the strata containing them are called Belemnite beds. The Thunder-bolt (its common name) formed the internal skeleton of an extinct group composed

of many species; and these remarkable Molluscs must have swarmed in the seas of the Middle Lias. The history of their internal structure is curious and unique; and, beyond the belief that they formed the internal skeleton of a naked decapod, we know nothing of their ancestry or their relations in time. The chambered shells are well represented in the Lias. The Nautilus group has descended from the older formations, and retains its typical form in the shell of the *Nautilus striatus*, of which we have many fine specimens in our collections. It is Ammonites, however, which afford us so many subjects for study; and the number of species of this group—which extended from the Trias to the close of the Chalk era—is so great (amounting to 2000 species) that we may now consider them a distinct order, composed of several families, and each containing several genera. The Trias Ammonites all belong to specialised forms, which are limited to that formation. Amongst the earliest tenants of the Lias sea these beautiful chambered shells played an important part, and appeared under forms of a novel character. The great group of the *Areitites*, with their prominent keel and bisulcate siphonal area; to these succeeded the groups *Ægoceras*, *Lytoceras*, *Harpoceras*, &c.; each of these being characterised by special points in their anatomy, by which they are readily distinguished by experts in Palæontology. There is no pretence for saying that the newer forms of any of these groups have been evolved from pre-existing Ammonites; at all events, said the Doctor, I have never been able to trace out the anatomical character of such genetic relations.

The Doctor next passed on to the Radiate animals, of which he specially selected for illustration the *Echinodermata*. In this class, said he, we have a most marvellous piece of anatomical structure in the mechanism of their skeleton, which affords ample means for comparing one form with another, as a test of the theory of the evolution of forms of the Lias from those of the preceding Trias age. When we compare the *Lily Encrinite* of the *Muschelkalk* with the *Pentacrinidæ* of the Lias, we see at a glance how different the one form is from the other,

and how much more nearly allied in structure the Lias forms are with existing types than with any that are found in older formations. The same remark applies to the Star-fishes and Sea-urchins, which stand in very close affinity with newer forms of life.

The Doctor concluded his animated Address by stating that he had endeavoured to place before his hearers a few of the difficulties he had encountered in attempting to reconcile the Darwinian theory with his studies in comparative anatomy among the fossils of the Lias formation; and claimed the admission, on the part of believers in animal evolution, that he had shown abundant anatomical evidence for withholding his assent to the theory, on the immutable grounds of animal structure; and these, as Darwin himself admits, are "the most obvious and serious which can be urged against his theory."

The first Field Meeting for the Season was held at

BRISTOL,

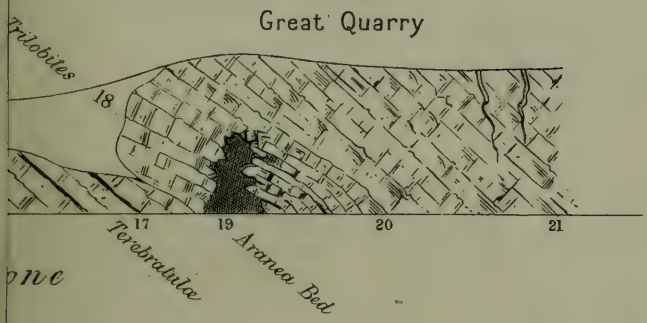
on Tuesday, 13th May; the weather was unfavourable, and storms of rain greatly interferred with the pleasure of the excursion. The Club was met by Dr. Burder, Vice-President of the Bristol Naturalists' Society, and by Mr. W. W. Stoddart, F.G.S., who acted as guide to the Geology of the district under review. This was the section at Clifton, so well known as a splendid epitome of the Carboniferous Strata lying between the Millstone Grit and the Devonian Beds of Sandstone, which are seen to dip under the Triassic Conglomerate.

This grand section, commencing with Devonian Strata 360 feet thick, passes gradually through 500 feet of Lower Limestone Shales, then through 2000 feet of Mountain Limestone, and terminates in upwards of 1000 feet of Millstone Grit.

Passing down the river side, beneath the suspension bridge, and a little below the Avonmouth Railway Station, Mr. Stoddart pointed out the position of the "Great Fault" which marks a great centre of disturbance in this area. Here, as Mr. Stoddart pointed out, the ground is greatly confused and broken up,

Millstone Grit and Coal-Measures being mixed together and all conformability destroyed. The beds have been displaced to the extent of 800 or 900 feet vertically, one side being upheaved the other depressed, while lateral pressure has completed the distortion. This fault may be easily traced on the opposite side of the river, past Stoneleigh Camp and Nightingale Valley. It is here that nearly all the best specimens of Corals have been obtained, especially several species of *Lithostrotion* and of the astreiform kinds of *Cyathophyllidæ*. The party now recommenced the massive mountain series, interrupted by the "Great Fault," and visited the "great" quarry in which good cubes of green and purple Fluor-spar are to be found. At the western end of this quarry are abundant examples of *Trilobites* and of "*Productus longispinosus*." Immediately after this, the "Black Rock" quarry was reached. It is from this quarry that most of the richest collections in Europe have obtained their *Icthyodorulites* and other remains of placoid fishes, mollusca, corals and polyzoa. This, the lowest series of the massive "Mountain Limestone," is terminated by a red bed of "encrinital" limestone. The Lower Limestone Shales are now reached which are excessively argillaceous and at "Cook's Folly" are richly clothed with woods. The lower shales are about 500 feet thick, every bed of which is very fossiliferous. Immediately above this deposit is a thin palate-bed from which have been obtained numerous examples of "*Helodus*", "*Conularia*," "*Lingula*," "*Bellerophon*," and other fossils. This is the locality referred to in the Report of the British Association of 1864, pp. 71 as containing undoubted Carboniferous Fossils which were formerly classed as Devonian, and found at Marwood, Pilton, &c. About 90 feet below this, two beds of Quartzose Conglomerate were pointed out as the remains of two old Devonian rivers. Beyond this occurs no Limestone, every bed being entirely made up of a Micaceous Sandstone for a distance of nearly 800 feet, when the beds are seen to dip below horizontal beds of "Dolomitic Conglomerate" containing numerous geodes of Calc Spar, Chalcedony, and crystallised Quartz.

DURDHAM DOWN



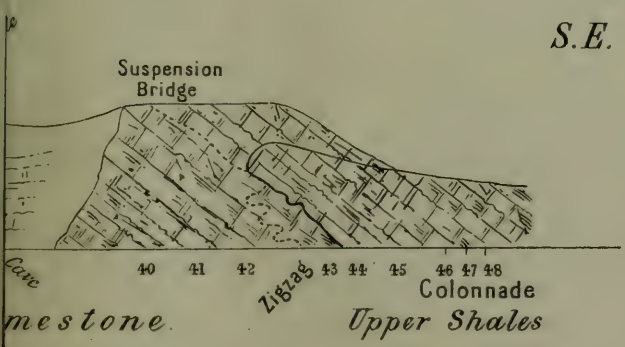
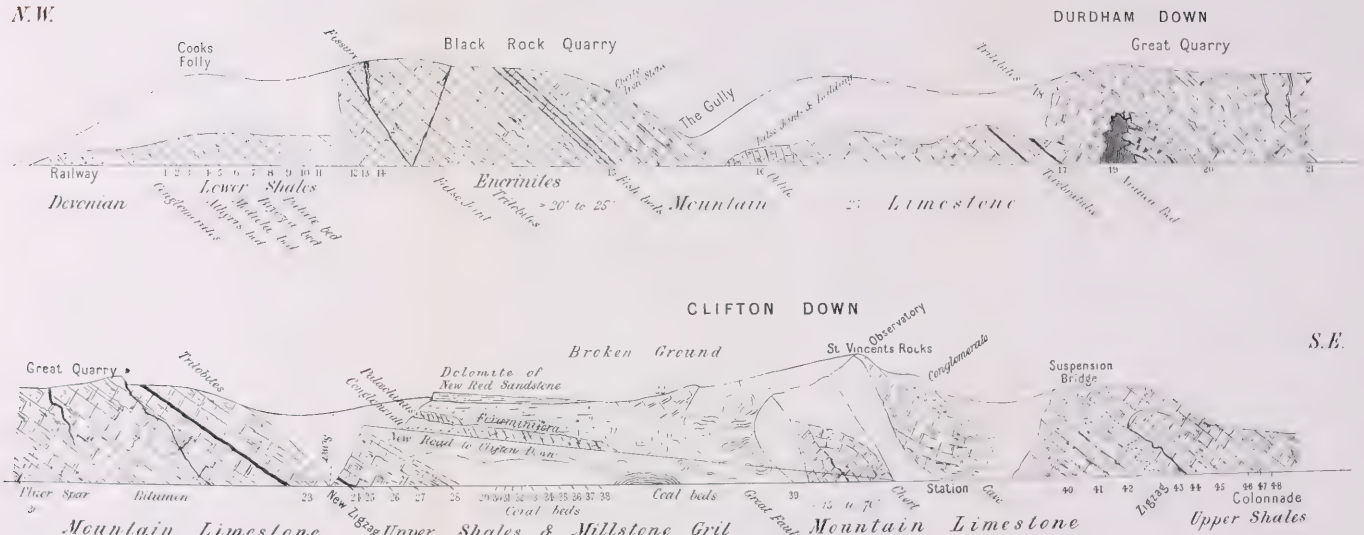


DIAGRAM OF THE AVON SECTION.



The party next proceeded up the Black Rock Gully to the summit of Durdham Down, from whence a good view is commanded of the surrounding scenery, made up of no less than 17 important geological formations.

The Avon gorge itself is a mile and a half long, comprising in the following order.—

Devonian Beds ...	about	800	feet
Lower Shales ...	"	500	"
Massive Limestone	"	2000	"
Upper Shales ...	"	400	"

All the beds dip easterly from 20° to 60°.

A good dinner at the Royal Hotel terminated a very enjoyable and instructive day, although somewhat marred by a rainy commencement.

The annexed diagram of the Avon Section was supplied by Mr. Stoddart.

The second Field Meeting of the Club was held on Tuesday, 24th June; the appointment being at

DUDLEY, FOR THE WREN'S NEST.

The unsettled state of the weather prevented many from being present and amongst the absentees must be numbered your President, who is indebted to our Vice-President, Dr. Wright, for a report of the day's proceedings.

The party left the train at Tipton, about a mile and a half from Dudley, and after a short walk reached the Claycroft Colliery, at the Foxyards, about two miles from Dudley. The remarkable feature in this Colliery is, that it is an open work, in which the different Coal Seams of the South Staffordshire Coal Measures have here come together with scarcely any of the intermediate Shales, so that they have here formed a great Cliff of Coal, thirty-nine feet in thickness, boldly exposed to day, and under which you may walk, lamp in hand, and inspect the black roof of Coal, adorned with stems of *Sigillaria*, *Lepidodendra*, and *Calamites*, closely packed with the Coal Plants, and all compressed together in the Carbonaceous Mass, which is hard, compact, and of a good quality throughout. The

face of Coal seen here, is known as the ten-yard or thick Coal of the district, but it is really about thirteen yards thick, and the divisions into which the entire Cliff is parted and by which the beds are technically known to the workmen, are as follows, taking the Beds in descending order:

Section of Claycroft Coal Cliff, Foxyards.—

		ft.	in.
1.	Roofs Coal	4	6
	Batt	0	9
2.	Top Slipper...	2	6
	Batt	0	7
3.	White Coal...	3	9
4.	Tow (Tough) Coal	4	6
5.	Brassils Coal	1	6
	Batt	0	3
6.	Foot Coal	2	0
	Batt	0	3
7.	Slips Coal	3	9
	Hard Stone	0	7
8.	Stone Coal	4	6
9.	Sawyer	2	9
10.	Slipper	3	9
	Batt	0	6
11.	Benches Coal	3	0
	Total with partings	39	5

Each of these Beds of Coal is known to the miners by a particular name, and has so much of a peculiar character about it that it can be recognized at once by an old "thick coal collier" and referred to its particular bed. A great fall of Coal had lately taken place here, amounting to about seven thousand tons, so that the Cotteswoldians had a fine opportunity for studying one of the most remarkable open workings of Coal in the British Islands.

After some time had been spent in examining the beds and obtaining some beautiful fern leaves from the iron-stone and inspecting an insect preserved in one of the nodules, the party mounted the hill to examine the remarkable dome of Silurian Rocks known as the Wren's Nest, which is similar in structure to the Castle Hill at Dudley, and like it is composed of two beds

of Limestone, with an intermediate bed of Shale. It is a dome-shaped oblong elevation, composed entirely of Silurian Rocks, which have been squeezed by lateral pressure into their present form. There is a central nucleus of lower Shale on which repose the Limestones dipping every way at considerable angles from the centre of the hill. On the south-west side the beds curve round very symmetrically, dipping west, south-west, and south, at an angle of about 40°. Similarly on the north-east side, the two Limestones are symmetrically curved, dipping east, and north-east, and finally almost north at about 45°. Along the east and south-east sides of the hill, the inclination is much steeper, rising from 50° to 60°, and in one part to upwards of 80°. At the south-east corner the beds are broken by a fault, so that the end of the upper Limestone on the west of the fault abuts against the lower Limestone on the east side of it. The upper Limestone measures 28 ft. 4 in., the intermediate Shale 90 ft., and the lower Limestone is 42 ft. 3 in. thick. The Limestone beds have been quarried for many years, and the hill has been mined in other parts. Buttresses of rock have been left to prevent the inclined strata from falling, so that arches and caverns are seen on the west side of the hill. One road passes under the arches of rock, and some charming bits of landscape were observed here to perfection; the high lights gleaming through the brilliant green foliage against the blue sky, as seen from the rocky arch below, had a marvellous effect for all those who delight in natural beauties.

The limestones belong to the Wenlock series and contain a large assemblage of fossils. Many corals were found as the party moved along; but all who desire to see what the Wenlock Limestone at the Castle Hill has produced, should visit the museum at Dudley. There are several large cases full of very fine specimens of "*crinoids*" or sea-lilies, with their expanded arms, and long many-jointed stems. The beauty and perfection of many of these specimens can only be appreciated by the palæontologist, but as natural objects, even to the unlearned, they are marvels of beauty. There is likewise a good collection of the "*Trilobites*" for which Dudley has long been famous,

and from whose rich Limestones nearly every museum in the world has derived specimens. The corals and shells too, are well represented in this collection, but it is much to be desired that the beautiful fossils contained in the cases were better arranged, and that the cases themselves were kept cleaner, for the better inspection of the rare fossil treasures they contain.

On leaving the Wren's Nest, the party returned through the beautiful grounds of E. F. Smith, Esq. to the ruins of Dudley Priory. Just at this moment, a flash of lightning and a clap of thunder, added solemnity to the scene, whilst under the old ruined arches of the Priory the naturalists sought protection from the passing storm. When it cleared up, one section ascended the hill to the court yard of Dudley Castle, whilst another proceeded to the restaurant at the station to enjoy a well earned meal after a long day's walk.

A vote of thanks was accorded to W. E. Hollier, of Dudley, who had kindly acted as director for the day, while all joined in expressing the great satisfaction they had derived from the many interesting subjects which had been brought under their notice, and the meet was pronounced to be one of the most instructive that had ever been undertaken by the Club.

The third Field Meeting was held at

ALDERTON,

on August 19th, having been unavoidably postponed from July 22nd.

The members assembled at the Cheltenham station of the Great Western Railway, and proceeded in a four-horsed brake to their destination, halting by the way to examine the small church of Little Washbourne. It was evident that the stream which runs hard by had lately overflowed the meadow in which the church stands of which it had invaded the very door sill. The church itself offered little of interest, but at the neighbouring manor house the proprietor Mr. Walker exhibited many objects of interest. The house itself with its massive oak beams and pannelled rooms told its story of the days when wood was plentiful and stone or brick scarce. Here was shown

the church plate, of old date, simple and plain. In the parlour were two small mediæval pictures of subjects quaint and mystical, which fairly puzzled the antiquaries.

Arrived at the foot of Alderton hill the party toiled up the slopes rendered wet, muddy and slippery by the late rains, to the quarry, the examination of which was the object of their pilgrimage; which on their arrival proved to be half full of water; but by the aid of a diagram, the joint work of the Rev. Dr. Smythe and Mr. Lucy, the section was made plain. It was as follows:—

		ft.	in.
1.	Surface soil	1	6
2.	Buff and Grey Clays (conchoidal)	6	0
3.	Paper Shales of "*Communis*" Beds ...		
	Course of Limestone		
	"Fish Bed" Geodes		
	Fish Scales and Crustacea		
	Zone of "*Am. Communis*," or "*Bifrons*" Zone	25	0
	Shales laminated and bituminous		
4.	"*Leptæna* Clays"	4	6
	resting on		
5.	Indurated Rock of "*Spinatus*" Zone		
	Divisional line of Upper and Middle Lias		

The thickness of the "*Spinatus*" Beds undetermined.

All these beds are rich in characteristic Fossils, but the bottom of the quarry was so full of water that the line of separation between the Upper and Middle Lias was covered, and less than 30 feet of the Upper Shales were alone visible. To atone for this deficiency, it chanced that large stacks of Middle Lias stone were available for examination, supplying an ample store of the very rock which was submerged, namely that of the "*Margaritatus* Zone," with Fossils in profusion. Here the Rev. Dr. Smythe explained the section, and pointed out the chief features, touching on the physical causes that had planed off the Oolite from Churchdown and from Alderton, and had left the underlying deposit of Upper Lias. He noticed

some of the leading characters and the fossil contents of these ancient sea-bottoms, and the causes which would govern the presence or absence of the Molluscan and other marine population of ancient shore margins. Eye and hammer were now brought to bear upon the slabs of stone lying before them in the stacks. Here in a few minutes were detected the fractured rib of a Saurian, with numbers of great and small *Cephalopoda*, including many species of *Ammonites*, *Nautili*, and *Belemnites;* swarms of *Terebratulæ* and *Rhynchonellæ*, and plentiful genera and species of Lamelli-branchiate Molluscs and of univalve shells. All tell of warm seas surrounding islands on which grew *Cycads*, *Zamias*, and other plants of tropical or subtropical growth. Such were the lessons to be learnt from the embedded organisms of the Alderton quarry.

Descending the hill to the village of Alderton the party found luncheon awaiting them at the Gardener's Arms, from whence according to the published programme they should have proceeded to Gretton where an exposition of the geology of the beds was promised by Dr. Wright; but the inexorable rain of that rainy season set in, and it was determined to postpone to a future day our visit to the quarries at Gretton and to return direct to Cheltenham where dinner was provided at the Plough Hotel, at the close of which a short account was communicated by the Rev. Dr. Smythe of some fossil remains of a Plesiosaur which had been obtained by Mr. Lucy at Tate's Hill, in the Middle Lias. These bones were to find a place in the Gloucester Museum, where I believe they have since been deposited.

The fourth and last Field Meeting of the season was held on Thursday, 4th September. The members and their friends, to the number of thirty or more, assembled at the Dudbridge Railway Station, and proceeded to carry out the programme of the day, which included an inspection of the woollen cloth mill of Messrs. Apperley, Curtis, and Co., an examination of the geological strata of the Middle Lias at Dudbridge, a walk thence to Minchinhampton Common, passing over the Inferior Oolite, the Fuller's Earth, and the Great Oolite, and the

exploration of a mound on the side of the Common, near Bownham House, which, from its appearance, was supposed to be a tumulus.

Before quitting Dudbridge the attention of the Geologists was arrested by an unusual appearance in an exposure of Middle Lias strata, in a vertical position; the explanation being that the Lias had at some period slipped from its position, and had caused a fold in the strata. These slips are a common feature of Cotteswold valleys, and to such the widening of many is largely due.

Passing over to the opposite side of the valley, under the guidance of Mr. Witchell, the excavations in the Dudbridge brick-pits were examined. This brick clay contains more iron than is found in the Upper Lias which overlies it, and produces a better kind of brick; while the Marlstone, which runs through the section, contains a per centage of iron so considerable as to make it available for smelting purposes were the quantity of rock greater. There are two bands of Marlstone in the section, separated by six feet of Shale; the upper band is about one foot thick, the lower band about three feet. Both are fossiliferous, and the Geologists had no difficulty in procuring specimens of the characteristic fossils, such as *Ammonites margaritatus, Unicardium cardioides, Avicula inæquivalvis, Cardium truncatum,* &c. The section is altogether about thirty feet deep.

Leaving Dudbridge, the party proceeded to Rodborough Hill, passing in ascending order over the Upper Lias, the Midford Sands, and the Cephalopoda beds, stopping at the foot of the Common to see the Pisolitic Ragstones, which have thin layers of Pisolite in the partings of the beds. The Pisolite of Birdlip and Leckhampton Hills is here represented only by these thin layers, and disappears entirely a few miles to the south-west.

The next halt was at a short distance above, in a disused quarry, the greater part of which having been sloped down, only a small section was exposed, but this section contains the Nerinæa bed in the Oolite Marl, which is the next fossiliferous zone above the Pisolite; the intermediate strata consisting of the

building Freestone. Here Mr. Witchell pointed out the difference between the Oolite Marl, as shewn in the section, and the corresponding bed on the Stroud side of the valley, which is seen here in a concretionary state, while at Stroud Hill it is disintegrated and Sandy; here the *Terebratula fimbria* is scarce, at Stroud Hill it is abundant, and the bed is also much thinner at Rodborough than at Stroud.

The Upper Freestones were passed over on the way to the large quarry near the Fort, on reaching which a halt took place while Mr. Witchell called attention to the succession of Ragstone beds known as Gryphite, Trigonia, and Clypeus Grits, the latter being in the condition of rubble. The Gryphite Grit, which at Stroud Hill is from ten to twelve feet thick, is here reduced to two feet, but fossils are abundant, and the softer condition of the rock makes their collection a much easier task than in other localities. In the Clypeus Grits, Mr. Witchell called attention to a fossiliferous zone, which he had recently discovered, but to get at the bed it was necessary to move into a neighbouring disused quarry, where several of the characteristic fossils were collected.

The next point of interest was the coral beds between the Trigonia and Clypeus Grits, at a short distance fron the disused quarries. It was found to be broken up; the *debris* was about three feet thick. Mr. Witchell here called attention to the circumstance that the beds immediately overlying the coral bed are comparatively unfossiliferous, and that a considerable change must have taken place in the fauna of the Oolitic sea at the close of the coral period.

A walk over Rodborough Hill to Minchinhampton Common brought the party to the section of the Clypeus Grit below the Bear Inn, where the lithological character of the beds is well shewn. The section having been examined, the walk to Minchinhampton Common was resumed, the members separating into two divisions, one of which proceeded to the quarries on the Common, the false bedding of the section attracting the particular attention of those Geologists who saw it for the first time, the shelly beds also giving full employment to those who

sought their treasures. The other division went to the scene of the excavations which had been going on during the morning, into a mound which, from its appearance, was supposed to be a tumulus, but which proved to be a natural formation. The denudation of the side of the hill had left a capping of Ragstone which in the course of ages had assumed the form of a long barrow, and the turf effectually concealed its true character until the excavators uncovered it. Some burnt stones and pieces of charcoal at one end, about two feet under the surface, showed that fires had at some time been made there, but whether ancient or modern there was nothing to indicate. It should be mentioned that a few flint flakes were likewise found on this site.

From this spot the party proceeded to Bownham House, the residence of Mr. Lancaster, who had invited the Club to luncheon, and who received them with a most kindly welcome. After luncheon the President proposed Mr. Lancaster's health, and, in the name of the Club, thanked him heartily for his generous hospitality. Thanks were likewise given to Mr. Witchell, who had guided them over the ground in the morning, and had so ably explained the series of beds examined during the day; and to Mr. Alfred Apperley for kindly conducting members over his manufactory in the morning, and for his instructive explanation of the various interesting processes they had been privileged to witness.

The party separated after spending a very agreeable and instructive day. The weather was fine, but the sky was overcast, and the day lacked the sunshine so necessary to bring out the beauty of the magnificent scenery through which the Club passed in the course of the day's excursion.

FIRST WINTER EVENING MEETING.

The First Winter Evening Meeting of the Club was held in the Science School, at Gloucester, on Tuesday, the 20th of January, 1880, at 4 p.m., when Mr. F. D. Longe read a paper on the Polyzoa of the Cotteswold Oolites. The paper was illustrated by a large number of carefully executed drawings, and by numerous fossil specimens collected by the author, chiefly

from the "Pea Grit" of the Cotteswold Hills, which he had compared with examples in foreign Museums, especially with those of the Museum of Caen, in Normandy.

After a brief reference to the existing species of Polyzoa, Mr. Longe spoke of those of the Oolites as having been very little studied, and not described at all by any English writer; the only systematic account of them being contained in a memoir by Jules Haimés, published in 1844, in the *Memoires de la Société Geologique de France.*

Mr. L. described the Zoids of the Polyzoa, and their relation to the compound structure of which they form part, illustrating his description by a copy from Professor Allman's figure of *Lophopus crystallinus*, a British fresh-water form. He pointed out that the Zoid of the Polyzoa differed from the Zoids of the Actinozoa and the Hydrozoa, more particularly in having an intestine and anus, the other Zoids having only one orifice and no intestinal canal. He held that Zoids of the Polyzoa, like the Polyps of other compound forms, could not properly be regarded as complete animals, but only as the feeding and digesting organisms by which the whole structure is nourished.

He next referred to the division of the Polyzoa into two orders, the "*Cheilostomata*" and the "*Cyclostomata*"—that this division is based on a difference in the cells, but more particularly on the presence of opercula in the orifices of the cells in the *Cheilostomata*, which are wanting in the *Cyclostomata.* He pointed out the confusions, discrepancies, and even self-contradictions in the way in which this division has been applied to the Cretaceous and Oolitic forms by D'Orbigny, Michelin, Hagenau, and Haimés, particularly in reference to the *Mesenteriporidæ* and the *Escharidæ*, which were supposed by all these writers, except Michelin, to belong to different orders, the *Mesenteriporidæ* to the *Cyclostomata*, and the *Escharidæ* to the *Cheilostomata.*

Mr. L. thought that the well-preserved specimens of *Mesenteroporidæ* which the Cotteswold beds furnished, showed that they were very intimately connected with the *Escharidæ* of later periods; and he held that the latter group were only

specific variations of the former; being in fact their lineal descendants *by evolution*,—that the only other explanation was, that the *Escharidæ*, or operculated forms of *Mesenteripora* were a new creation, introduced about the cretaceous period. Such a view Mr. L. could not entertain, as the two groups agreed so closely in all their characters, and even in their specific variations.

Mr. Longe gave a synopsis of the several genera of Oolitic Polyzoa described by Haimés. His list contained 19 genera, including several exceptional and perhaps doubtful groups. Those genera which appeared from Haimés' list to be prevalent groups and represented by several species, were well illustrated by specimens shown by Mr. L. from the Cotteswold beds.

The more abundant and best represented groups were—

Alecto—(Stomatopora.) *H.*		Cricopora—(Spiropora.) *H.*
Diastopora—(Berenicia. *H.*)		Apseudesia.
Mesenteripora	Diastopora *H.*	Theonoa.
	Elea, &c. *D'Orbigny.*	Lichenopora.
	Eschara and Diastopora. *Michelin.*	Terebellaria.
		Heteropora.
		Ceriopora.

These groups were represented by several enlarged illustrations, and by numerous specimens, which Mr. L. had gathered from the "Pea Grit" beds of Cleeve and Crickley hills, the Great Oolite beds on the hills near Bath, and from the French beds at Luc, Nauville, and Arromanches, near Caen.

In the discussion which ensued, Dr. Wright took exception to Mr. Longe specifying the genus *Eschara* as occurring in the Oolite, whereas it did not occur until the later formation of the Chalk.

Dr. Smythe remarked that much credit was due to Mr. Longe for his zeal and labour. He (Dr. S.) had taken part last year, in association with Professor Brauns, of the University of Halle, in working out the fossil Bryozoa of Metz, and comparing them with our English species. His share in this is acknowledged in the article on the Bryozoa of Metz, published last year in Berlin, by the German Geological Society. On the critical points now in question, he quite agreed with Dr. Wright.

SECOND WINTER MEETING.

The second Winter Meeting of the Club was held at the Lecture Theatre of the Science Schools, in Gloucester, on the afternoon of Tuesday, 17th February, when papers were read by Dr. Day on the "Burbot and Air-bladders of Fishes;" and by Dr. Wright F.R.S., on "The Modern Classification of Ammonites."

Dr. Day stated that the Burbot is a fresh-water fish, which is found throughout northern and central Europe, also in Canada and the adjacent portions of the United States, while in Great Britain it is restricted to Durham in the north, extending along the eastern and midland counties as far south as Cambridgeshire and Norfolk; while the belief is that its numbers are decreasing, and that the species is doomed to extinction at no very distant date. This fish possessing an air-bladder of the *Physoclistic*, or entirely closed form, and having no ossicles by which it is connected with the internal ear, leads one to examine into *what is the air-bladder in fishes?* and *what are its functions?*

In the embryo this organ is perceived originating as a bud or offshoot from the upper portion of the alimentary canal, or even from the stomach; this offshoot elongates into a blind tube, and then enlarges at its terminal extremity into what will eventually form the air-bladder; consequently at some time of a fish's life there exists an open tube connecting its air-bladder with the alimentary canal, into which latter it opens, usually on the upper, rarely on the lateral, and occasionally on the inferior wall.

Dr. Day traced the varied adaptations of the air-bladder in the Dipnoids or highest class of fishes, and the communication during life, by means of a duct and glottis, with the œsophagus. He spoke of the ducts in *Lepidosiren*, *Protopterus* and *Ceratodus* as homologous with the windpipe, while the functions of the air-bladder are analagous to those of lungs.

The Ganoids afford instances very similar to those which obtain amongst Dipnoids. That the air-bladder is homologous

with the lungs of Batrachians and other air-breathing vertebrates appears to be proved. Among the Teleostean fishes the air-bladder exists as a closed sack of diverse forms. These forms are termed *Physoclisti.* In such forms as swim near the surface the air-bladder is mostly of comparatively small size, while in those that live near the bottom, *Pleuronectidæ*, it is, as a rule, absent.

The chief uses of this organ in Teleostean fishes appear to be two. (1), for flotation, enabling its possessor to maintain a certain level in the water; and (2), for acoustic purposes, it being partially or entirely employed for hearing, by means of various modes of connection with the internal ear.

It seems to be the rule that the fresh-water *Physostomi* have a connection, by means of a chain of ossicles, between the air-bladder on one side and a process of the internal ear on the other. These auditory ossicles were first pointed out by WEBER. The chain of auditory ossicles connecting the air-bladder with the internal ear were, as far as known to the Doctor, confined to the fresh-water *Cyprinidæ*, *Characinidæ*, and *Siluridæ*, though he thought it probable that this chain of ossicles will be found in other fresh-water families which he had not had the opportunity of investigating.

In conclusion the Doctor affirmed his belief that the air-bladder of fishes is the homologue of the lung of the superior vertebrate forms; that in some of the higher sub-classes it serves as an accessory respiratory organ for depurating the blood, and that with the majority of the Teleostean fishes it serves both as a float and as an organ of hearing.

The next subject was "The Modern Classification of Ammonites," by Dr. WRIGHT, who is the author of the elaborate monograph "The Lias Ammonites," now in progress of publication by the Palæontographical Society of London.

Dr. WRIGHT, F.R.S., introduced his paper on the Modern Classification of Ammonites with a general outline of the anatomy of the structure of the *Nautilus pompilius*, and its polythalamous shell, and the relations subsisting between them, inasmuch as it is the only living representative of the group of

fossils on the study of which they were about to enter. The first author who attempted a better arrangement of Ammonites than existed in his time was Von Buch. That illustrious man saw in the ramifications of the lobe-line on the mould beneath the shell of the Ammonite a character which he found to be definite, and varied in different forms; and by grouping all the similar forms alike and separating the dissimilar ones therefrom, he divided the Ammonite group into many families. The same method was followed and enlarged by D'Orbigny and Quenstedt, and subsequently greatly improved by Professor Suess, who had begun to study the Ammonite shell from a new standpoint, derived from the great experience he had gained in the examination of many better specimens than had fallen to the lot of previous observers. Suess's paper *Ueber Ammoniten*, soon engaged the thoughts of several young Naturalists of the Vienna school, and it became the starting-point of a new investigation. Dr. W. Waagen led the way in two interesting papers, communicated to the *Palæontographica* and *Benecke's Beiträge*, and the result was that the new arrangement of Suess's genera and others proposed by Waagen assumed the form of a new classification. The characters upon which the genera were established were—1st, the structure of the lobes and saddles, with the various arrangements of the lobe-line, occupied a front rank; 2nd, the shape of the aperture of the shell and the development of the mouth-border were shewn to possess characters of importance in constructing the diagnosis of genera; 3rdly, the length of the body-chamber affords another character from which important deductions are made, seeing that the size of the animal must have been proportioned to that of its dwelling-chamber, as we see so well exemplified in the case of the *Nautilus pompilius;* and as sometimes the body-chamber in certain groups extends to a whorl and a half in length, in others to one whorl, in others to one half or two-thirds of a whorl, it follows that the shape and size and structure of the mollusc must likewise have varied in these different groups. The fourth feature is the amount of involution of the whorls, or in other words the extent to which the one

whorl overlaps a preceding whorl; for as all polythalamous shells are cones more or less rolled up upon the same plane, the amount of involution must depend upon the angle at which the shell bends round when enveloping the embryo, so that the bending angle is really a part of the life history of the animal, seeing that each true species appears to observe its own angle of involution. The fifth feature is the presence or absence of the *Aptychus* and its form and structure, when present, in the different genera. A very remarkable specimen of a large *Aptychus* from the Inferior Oolite of Leckhampton hill, belonging perhaps either to *A. Sowerbyi* or *A. Parkinsoni*, was exhibited. It was upon these characters that WAAGEN constructed his arrangement of the genera in the scheme he proposed in the memoirs referred to. As additional genera have been erected by subsequent authors, derived from certain groups of species originally put together by WAAGEN.

Another step in their classification was proposed by Professor NEUMAYR, of Vienna, in his memoir *Die Ammoniten der Kreide und die Systematik der Ammonitiden.* The Ammonites were here grouped in four families.

I. ARCESTIDÆ.

1. Arcestes, *Suess.*
2. Didymites, *Mojsisovics.*
3. Lobites, *Mojs..*
4. Ptychites, *Mojs:*
5. Pinnacoceras, *Mojs.*
6. Sageceras, *Mojs.*
7. Amaltheus, *Montfort.*
8. Schloenbachia, *Neumayr:*

II. TROPIDIDÆ.

9. Tropites, *Mojs.*
10. Trachyceras, *Laube.*
11. Choristoceras, *Mojs.*
12. Rhabdoceras, *Suess.*
13. Cochloceras, *Hauer.*

III. LYTOCERATIDÆ.

14. Lytoceras, *Suess.*
15. Hamites, *Parkinson.*
16. Turrilites, *Lamarck.*
17. Baculites, *Lam.*
18. Phylloceras, *Suess.*

IV. ÆGOCERATIDÆ.

19. Ægoceras, *Waagen.*
20. Arietites, *Waag.*
21. Harpoceras, *Waag.*
22. Oppelia, *Waag.*
23. Haploceras, *Zittel.*
24. Stephanoceras. *Waag.*
25. Cosmoceras, *Waag.*
26. Ancyloceras, *D'Orbigny.*
27. Baculina, *D'Orb.*
28. Simoceras, *Zitt.*
29. Perisplinctes, *Waag.*
30. Olcostephanus, *Neum.*
31. Scaphites, *Park.*
32. Hoplites, *Neum.*
33. Acanthoceras, *Neum.*
34. Stoliczkaia, *Neum.*
35. Crioceras, *Léveillé.*
36. Heteroceras, *D'Orb.*
37. Peltoceras, *Waag.*
38. Aspidoceras, *Zitt.*

The first family, *Arcestidæ,* includes all the remarkable forms found so abundantly in the Triassic strata of the eastern Alps, and especially in the Red Alpine Limestone of that age at Hallstadt. The singular form of the lobe-line in all the species of this family is very different from the lobe-line of the Ammonites of the Jurassic and Cretaceous rocks.

The second family, *Tropididæ,* have the shell more or less ornamented and provided with radial ribs, which almost always support tubercles or spiny processes on the border of the siphonal area. Like the former family all the species are Triassic.

The third family, *Lytoceratidæ,* includes several groups which differ from each other much as regards their external form, but which nevertheless appear to have close genetic relations in their internal structure; they all have a short body-chamber, about two-thirds of a whorl in length, a simple mouth-border, slightly produced on the columellar side, but in all the other features there is a wide differentiation of structure. This family includes the typical forms of *Lytoceras* and *Phylloceras,* and others which differ much from them in external form, as *Hamites, Turrilites,* and *Baculites.*

The fourth family, *Ægoceratidæ,* includes a considerable number of groups which are widely different in form and affinities, so that it is difficult to give a general description of the family which shall be correct and comprehensive at the same time. We divide them, therefore, into three sections,

taking the most typical forms of each, around which we group the others; but as all these divisions require illustrations to make their definitions clear, we must pass this part of the paper over, and refer to its text, which will be printed with the woodcuts in our "Proceedings."

Dr. Wright having pointed out the genera by demonstrating a number of type examples which he had named for the occasion, and shown how distinct the groups are from each other when tested by the generic characters he had pointed out at the commencement of the paper, he said the change was not greater among the Ammonites than had been found necessary with the *Trilobites*, *Brachiopods*, and *Echinodermata*, and other classes which had required revision and re-arrangement, in consequence of the discovery of so many new forms belonging respectively to them. The change proposed was one rendered necessary by the progress of Palæontology, and although it might meet with opposition for a time, the new names would replace the old ones, as had been the case among other groups which had undergone re-arrangement in modern times.

THIRD WINTER MEETING.

The third and last Meeting of the Club for the Winter season was held in the Lecture Theatre of the Science School, in Gloucester, on Wednesday, 17th March.

Previous to the reading of papers, the company examined with much interest a fine collection of Arthropoda (Insects, Spiders, and Crustacea) arranged as an educational guide, which was liberally presented to the Gloucester Museum by Mr. Allen Harker. Mr. Harker explained the system of arrangement, and said that instead of exhibiting, as was too commonly done in museums, a collection of the most handsome and striking forms of Arthropods, he had endeavoured to give such a typical collection that the student of that branch of Zoology might find in it a key and a guide to the study of the whole group. He had illustrated the microscopic genera by enlarged drawings, and, where possible, had indicated habits or developmental peculiarities.

A cordial vote of thanks was offered to Mr. HARKER for his valuable and instructive gift.

Dr. WRIGHT having concluded his paper on the Ammonites, which is included in the foregoing report, the Rev. Dr. SMYTHE proceeded to give an exposition of Microscopy as applied to the discrimination of Igneous rocks.

As the time was restricted, the author, instead of reading his paper, made a running comment on the general subject, his object being to enlist the attention of Geologists in a study which, strange to say, took its origin—as regards the newer methods of examination—in this country, yet had languished here, whilst in the United States of America and on the continent of Europe it had gone ahead of us, and we had to go to foreigners to learn. Not to speak of the continental workers, who could boast of quite a bibliography of results, he could point to FERDINAND ZIRKEL's fine work on the Igneous Rocks of the Western Territories of North America, published in 1876 at Washington, by the Engineer Department of the United States army. This book contains a digested account of the examination of 2500 thin sections of rocks scrutinized under the microscope. He also mentioned that the *Geological Record* for 1877 gave a list of 150 works upon Petrology published in Europe and America in the course of a single year. In England one elementary text-book had been published on the study of rocks—*Rutley's Petrology*, 1879—it was already bought up, and the author going to press with a new edition.

The old method of study of the Igneous rocks was confined to chemical analyses of constituent minerals, or to the dry method with the blow-pipe, and to crystallography; but how a rock was built up, or how a crystal was formed, observers could not tell us; in fact they held the erroneous notion that crystals were homogeneous, whereas the case is quite the contrary. The method of examining the Igneous rocks at present is microscopical. For this we begin by reducing a given portion of the rock to be examined under the microscope into thin sections, as thin as the fine inner skin of an onion, in some cases, so as to be capable of transmitting light, and then

bringing optical science to bear upon them, through such instruments as the stauroscope, polariscope, &c. The authors of this new and more excellent way were two Englishmen, Messrs. Nichols and Sorby. Zirkel took up the new study in 1862, at Vienna, and Vogelsang at Delft; but to Rosenbusch, of Friburg University, is due the credit of first testing the mineral constituents of rocks by the use of polarised light. He then gave an account of Durocher's theory of the two magmas of the fluid melted rocks, which is in the main undoubtedly correct, though little trace of the original magmas can be detected now. The magmas or layers are known as the Acidic and Basic series; the former containing on the average 70 per cent. and upwards of silica or silicic acid, and the latter, not so rich in silica, containing on an average not more than 50 per cent. or less. The two series are otherwise known to Petrologists as Orthoclastic and Plagioclastic; or again as the Felspathic and the Augitic series. The difference between crystalline and amorphous matter was described, and the embryonic forms on incipient crystals, called "crystallites," were passed under review. The terms assigned to the two main groups of Igneous rocks, viz., the Vitreous and Crystalline, were enumerated,—these terms, it must be noticed, were only names of typical groups. Following the arrangement given by Rutley, the "Vitreous" or "Glassy," are Obsidian, Pumice, Perlite, Pitchstone, and Tachylite; the "Crystalline" eruptive rocks are the Granite group, Felstone, Syenite, Trachyte, Phonolite, Andesite, Porphyrite, Diorite, Diabase, Gabbro and Basalt. The four last of these used to be called "Greenstone" by the field Geologist, but this is now a vague word, like the "Grauwacke" of earlier workers in the field.

A diagram here given by the author showed the two series, the Acidic and the Basic. The Acidic kinds of crystalline rocks were represented at the top of the scale by Granite, which passed by insensible gradations into those vitreous forms called Pitchstone and Obsidian, the former being well represented in Arran, specimens of which were exhibited. The highest crystalline example of the Basic series was Gabbro (or Euphotide),

an Italian term. The distinctive component of the Gabbros, also called Serpentinites, are the minerals Labradorite and Diallage. The occurrence of this beautiful rock at the Lizard Point, in Cornwall, together with masses of Serpentine Ophite) in contact, and their origin as an altered rock from the decomposition of Olivine (Peridot) was enlarged on. The whole subject has been examined diligently by Professor Bonney (Q. J. *Geol. Soc.* Vol. XXXIII), and more lately by Professor King and another, in a paper read before the Royal Society of London, in 1880. The precise reference is this—*On the Origin of the Mineral, Structural, and Chemical Characters of Ophites and Related Rocks, a Paper read at the Royal Society by Professors* W. King, Sc. D., *and* T. H. Rowney, Ph. D. (1880). Examples of these rocks were shown.

A short account was given of the eruptive rocks of Charfield; they are the same as those at Damory Bridge, amygdaloidal Diorites, having the cavities for the most part filled with Calcite, and many lined with a green zeolitic mineral, called Viridite. On a farm known as Crockley's, near Charfield, were found queer flinty circular bodies, flat on one side, about 8 inches in diameter by 3½ inches thick—the country people know them as "buns." They seem to weather out of the Igneous rock, and in fact they correspond to the so-called "slag-cakes" or "volcanic bombs" that are now ejected at times from active volcanic craters.

The correspondence of the volcanic areas of the Western Isles of Scotland, such as Mull and Rum, with that of the Schemnitz mining district in Hungary, both being contemporaneous Neogene (Upper Miocene of Lyell), was discussed and illustrated. It is a subject of surpassing interest to Petrologists. Professor Judd, of the School of Mines, went into Hungary—fresh from the Hebridean volcanoes—at the instance of the late Sir Charles Lyell and Col. Scrope, to study the old Schemnitz volcano, whose heart is now blown out.

Over an area of about fifty square miles, now covered with volcanic rocks, can be studied the internal economy of an exhausted fiery reservoir, the ruins in fact of a huge Etna of

later miocene age. Strangely enough ZIRKEL came over to this country to study our British Eruptives, while JUDD went into Hungary to examine the Igneous rocks in that country of the same age. Their published descriptions are of rare interest and value to Petrologists, and should be carefully read.

VON HAUER's map of the Geology of Hungary, to demonstrate the eruptions over the ancient Schemnitz region, and a large collection of Igneous rocks from the Himalayan range, were displayed, but a scanty modicum of time could be afforded for examination, as members had to hurry off to catch their trains.

Annexed hereto I append ZIRKEL's tabular arrangement of the Igneous rocks, as drawn up by Dr. SMYTHE, with a view of assisting workers who may not have at command the original to consult.

FERDINAND ZIRKEL's arrangement of the Felspar bearing Igneous Rocks, with the Geological age of their outflow, tabulated. 1876.

I ORTHOCLASE ROCKS.

(1) QUARTZOSE OR WITH EXCESS OF SIÖ

Ante Tertiary	Tertiary and post Tertiary equivalents
(A) CRYSTALLINE	(A) CRYSTALLINE.
Granite	Rhyolite (Liparite)
Granite-porphyrites	
Felspar-porphyrites	
	(B) GLASSY or semivitreous
	Obsidian
	Pearlite
	Pumice
	Pitchstone

(2) QUARTZLESS WITH PLAGIOCLASE.

Syenite	Trachyte
Augite-syenite	Augite-trachyte
Quartzless orthoclase-porphyries	

(3) QUARTZLESS WITH NEPHELINE OR LEUCITE.

Foyaite	Phonolite
Miascite	Leucite
Liebenerite	Sanidine
Orthoclase-porphyrites ...	

II PLAGIOCLASE ROCKS.

(1) WITH HORNBLENDE.

Quartz-diorite	Quartz propylite
Diorite	Propylite
Porphyrite	Dactite
Hornblende-porphyrite ...	Hornblende-andesite

(2) WITH AUGITE.

Diabase	Augite-andesite
Augite-porphyrites	Felspar-basalt (with Dolerite and Anamesite)
Melaphyre	Tachylite

(3) WITH BIOTITE.

Mica-diorite ... ...

(4) WITH DIALLAGE.

Gabbro (Serpentinite) ... ...

(5) WITH HYPERSTHENE.

Hypersthenite ... ...

(6) WITH OLIVINE.

Serpentine (Ophite) ... ...
Forellenstein

III NEPHELINE ROCKS.

Nephelinite
Nepheline-basalt

IV LEUCITE ROCKS.

Leucite Sanidine
Leucite-basalt

This completes the review of the work done during the past season, and I think it will be admitted that it will compare favourably with former years, not only in respect of quantity, but that the quality of the papers are of a high order of excellence, and such as cannot fail to sustain and extend the acknowledged high reputation of the Cotteswold Club.

POSTSCRIPT.

I must not close these notes of a year's contributions to local natural science without putting on record the re-discovery on our Cotteswold hills of the rare Orchid *Cephalanthera rubra,*

which, after having been lost for more than eighty years, was found last summer in a wood near Stroud, by the Rev. Mr. Reader, one of the brothers of the Monastery at Woodchester. The discovery was announced to me through a lady residing in the neighbourhood, and I had the happiness of seeing the lovely plant growing in full beauty, and of sending blooms of it to many botanical friends. I refrain from naming the exact locality, with the view of protecting it from the ravages of greedy exterminators.

The plant, then called *Serapias rubra*, was first noticed by the Rev. Wm. Lloyd Baker, of Stout's Hill, grandfather to our present respected Vice-President, Thomas Barwick Lloyd Baker, the first President and founder of the Cotteswold Field Club. There is no record of the date, but it was probably near the latter end of the last century, and since that time, though often sought for, the plant has never been found until last summer, when it was re-discovered by the Rev. Mr. Reader. *Cephalanthera rubra* is not uncommon in many parts of the continent of Europe: I have gathered it in France and Italy, but nowhere have I seen it so luxuriant in form and colour as in these Cotteswold examples, which would almost seem to point to the Cotteswold Hills as its most congenial habitat.

Modern Classification of the Ammonitidæ. Read before the Winter Meetings of the Cotteswold Naturalists Field Club, held at the Science School, Gloucester, on the 17th February, and 17th March, 1880. By Dr. Thomas Wright, F.R.S., F.G.S.

The essential characters on which Von Buch and D'Orbigny based their Ammonite groups were derived—1st, from the greater or lesser complication in the ramifications of the suture-line, and the character of the lobes and saddles formed therefrom; 2nd, the position and structure of the siphuncle; and 3rd, the form of the spiral of the shell.

The first character Von Buch considered of primary importance, and on this alone proposed the families, as he called them, in his classical memoir, "*Die Ammoniten in den älteren Gibirgs-Schichten*, 1830." Subsequent observations, however, made by many independent students have taught them that this character, although an important one, is not so stable as the great naturalist believed—a fact which we have ascertained by noting the changes from simplicity to complexity in the morphology of *Goniatites*, *Ceratites*, and *Ammonites*. In adult life, however, the form of the suture-line is a valuable character, and ought to be accurately drawn from careful tracings made on the specimens themselves over the natural lines, and not given as mere sketches by the artist, as is often the case; in tracing the lines we have a natural impress, by the other mode a mere ideal representation; so that, whenever suture-lines are exposed and can be traced on the specimen, they should be carefully noted and recorded.

In all the Ammonitidæ the position of the siphuncle is invariably in the centre of the abdomen, and in the outer margin of the greater curvature of the spiral of the shell, opposite to the columella or dorsal border, the presence or absence of a keel in which it is sometimes lodged, and the roundness or flatness of the siphonal or abdominal areas, all afford specific characters which it is important to note.

The form of the spiral described by the growth of the shell has been taken as the basis for the establishment of several genera by PARKINSON, LAMARCK, D'ORBIGNY, HAUER, and LÉVEILLE, and from this character alone we have the following sixteen genera.

Ancyloceras, D'ORB.	*Hamulina*, D'ORB.
Anisoceras, D'ORB.	*Helicoceras*, D'ORB.
Baculina, D'ORB.	*Heteroceras*, D'ORB.
Baculites, LAM.	*Ptychoceras*, D'ORB.
Choristoceras, HAU.	*Rhabdoceras*, HAU.
Cochloceras, HAU.	*Scaphites*, PARK.
Crioceras, LÉV.	*Toxoceras*, D'ORB.
Hamites, PARK.	*Turrilites*, LAM.

This character, derived from the spiral of the shell, is only valuable when taken in connection with others, to which it becomes subordinate.

The careful study of the immense collections of Ammonites that have been slowly accumulating during the last twenty-five years from the Triassic, Jurassic, and Cretaceous rocks, have disclosed the fact that the earlier Palæontologists established many of their species on characters which were often derived from young specimens, or from fragments belonging to different phases of growth of the same species. This fact has helped to explain the hopeless nature of the task which the practical Palæontologist had to encounter some years ago, when he attempted to correlate species found in strata of the same age in different regions of Europe, so that an analysis of the synonyms of several forms disclosed the fact that many species had been described under different names by the same author, from his having unwittingly studied different stages of growth of the same shell, an error which was only detected several years afterwards, when more perfect specimens of the fossil had been discovered, so that much confusion resulted from premature attempts to generalise when the necessary details were absent. Having often lost my way in these specific labyrinths, and discovered that one cause of the difficulty arose from the fragmentary nature of the materials at the disposal of the

earlier observers, and likewise from the fact, unknown to them at the time, that most Ammonites change their form during growth, so that it became imperative on the Palæontologist to examine the morphology of every species, in order to place its history on a scientific basis. Having for many years pursued this method in the study of Liassic and Oolitic forms, and learned therefrom the numerous sources of error and perplexity which beset my early studies. I have discovered likewise that many species pass through important morphological changes of structure between youth, maturity, and old age, and that the amount of change varies considerably in the different generic groups; so that this character forms an important element in their diagnosis.

After Leopold von Buch, the first great reform in the classification of the Ammonitidæ was made by my learned and esteemed friend Professor Edward Suess, of Vienna, who, in a memoir,* "Ueber Ammoniten," communicated to the Vienna Academy, pointed out some important characters in the structure of the Ammonite shell which had been overlooked or underestimated by former observers, such as the form of the aperture and the structure of the central and lateral processes, which were often developed from its margin; and, secondly, the size of the dwelling chamber, considered in relation to the length of the last whorl. The study of these characters of course necessitated the discovery and study of perfect specimens, and the whole anatomy of the shell received more attention from him than it had done in the hands of his predecessors, and by an application of the facts obtained therefrom Suess established three new genera, *Arcestes*, *Lytoceras*, and *Phylloceras* on a very solid foundation. Five years later he extended his studies on the spiral of the Ammonite shell,† "Die zusammensetzung der Spiralen Schale." The reform so well inaugurated

* "Ueber Ammoniten," erste Abth., Sitzungsber. der Nat.-wiss. Classe der Wiener Akademie, 1865, Band 52. Abth. 1.

† "Ueber Ammoniten," 2 Abth., Sitzungsber, der Mathemat. Classe der Mathemat. Classe der Wiener Akademie, 1870, Band 61, Abth. 1.

by Professor SUESS was ably followed up by Dr. W. WAAGEN,* who directed attention to the importance of the study of the *Aptychus* and *Anaptychus*, and the presence or absence of this body in the Ammonite shell. The observations made by WAAGEN on the *Aptychus* he described and applied in the diagnosis of the genera proposed for several Jurassic species. In the following figures the *Aptychus carinatus* (fig. 3) is seen apart from the shell. In figure 1 it is seen lying in the dwelling chamber of an Ammonite, and in figure 2 the *Aptychus* is vertical, as if closing the aperture of the shell.

FIG. 1.

FIG. 3.

FIG. 2.

The following organic features are considered as elements of primary importance in studying the Ammonite shell, and their combination constitute characters for the diagnosis of the generic groups.

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* "Die Formenreihe des *Ammonites subradiatus*," Benecke's "Geogr.-Palæont. Beitrage," Bd. ii, 1869.

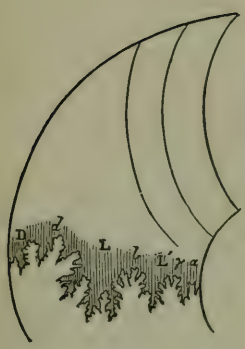

FIG. 4.—Disposition of the lobes in *Amaltheus margaritatus*, Montf.

FIG. 5.—Disposition of the lobes in *Phylloceras heterophyllum*.

FIG. 6.—Disposition of the lobes in *Phylloceras heterophyllum*, Sow.

Firstly.—The structure of the lobes and their suture-line have been fully studied by VON BUCH, D'ORBIGNY, QUENSTEDT, and OPPEL. I have given a *résumé* of the descriptions of the lobes and ramifications of the margin of the septa in treating

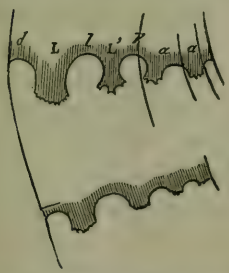

FIG. 7.—Disposition of the lobes in *Ceratites nodosus*, De Haan.

FIG. 8.—Form of the sub-divisions of the lobes in *Ammonitidæ*.

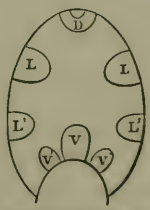

FIG. 9.—Mould of the disposition of the lobes of *Phylloceras*.

of the classification of the AMMONITIDÆ, and have shown that the points of the foliations are all directed backwards towards the winding of the spire, and the concavities all look forward towards the aperture (as seen in figs. 5, 6) in the ramified foliations of the suture-line; when they are folded the elevations are called saddles, and the intervening depressions lobes. In the *Ceratites* these parts are very simple, as shown in *Ceratites nodosus* (fig. 10), where the dentated saddles are seen to point backwards and the rounded lobes look forwards. Those parts are more complicated in *Amaltheus margaritatus* (fig. 4), and still more so in *Phylloceras heterophyllum* (fig. 6), in which the auxiliary lobes are numerous and well developed. Figs. 5, 6 show the disposition of the lobes of this beautiful Ammonite from the Upper Lias.

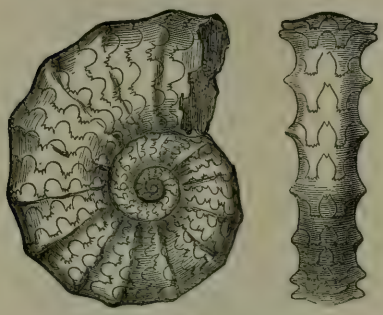

FIG. 10.—Side view. FIG. 11.—Back view. *Ceratites nodosus*, De Haan.

Secondly.—The shape of the aperture and the structure and development of the mouth-border of the shell vary very much in the different groups, and the special form which the border presents in different Ammonites affords an element of importance in constructing the diagnosis of genera. The difficulty which the Palæontologist experiences in obtaining Ammonite shells, or moulds of such, in which the mouth aperture with its border is preserved, has long prevented this anatomical character from being used in constructing the diagnosis of the different groups; at length, however, many specimens have been found, and we have ascertained that important differences do exist, and, perhaps, many more will be discovered by continued researches made along the same line of investigation.

In *Arietites*, as seen in *Arietites rotiformis* (fig. 12), and *Arietites obtusus* (fig. 13), the sides of the mouth-border are simple, and the ventral portion is more or less produced, as

indicated by the forward direction of the ribs in this region, these folds of the shell being formed in fact by the secretion from the mantle during the stages of growth. We note likewise in *A. obtusus* (figs. 13, 14), and in its allied form *A. stellaris*, that in these species the structure of the shell itself

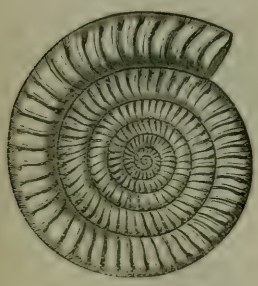

FIG. 12.—*Arietes rotiformis*, Sow. Side view.

FIG. 13.—*Arietes obtusus*, Sow. Side view.

FIG. 14, Back view.

presents remarkable transverse and longitudinal lines, which form pits or punctations at the angles of their insection, a character not observed in other allied species.

In *Aegoceras* the form of the shell varies much, the mouth-border is simple, without lateral processes, sometimes with a ringed contraction near the aperture, and a projecting ventral fold. The shell of *Aeg. planorbis*, Sow., shows this structure well, in one of the oldest Liassic forms of this group, and we see the same repeated in the young condition of *Aeg. Henleyi*=*A. capricornum* of SCHLOTH (fig. 15).

FIG. 15.—*Aegoceras capricornum*, Schloth.

FIG. 16.—*Amaltheus cordatus*, Sow.

In *Amaltheus* the siphonal or abdominal side of the shell forms, in general, a more or less sharp keel, often with an imbricated edge, and which projects forward in a long pointed process. This is very well seen in *Amaltheus cordatus* (fig. 16), where the lateral ribs are observed bending obliquely forwards towards the aperture, and the keel projecting onward in a long spear-shaped process. In *Amal. margaritatus* the keel is beaded and prominent, the ribs bending forward in graceful sweeps towards the aperture. In *Amal. oxynotus* (fig. 17) the shell is discoidal, and the siphonal area is almost as sharp as a currier's knife (fig. 18); the sides are undulated, with falciform ribs derived from the original form of the aperture, and with a projecting ventral process.

FIG. 17.—*Amaltheus oxynotus*, Quenst.

FIG. 18.

In *Harpoceras*, which embraces the true Falcifers (VON BUCH), the sickle-shaped ribs announce a complicated structure of the mouth-border, with a projecting siphonal or abdominal area, and with lateral lappets of greater or less extent; they are small in *Harpoceras serpentinum* (fig. 19), in *Harp. bifrons*, and *Harp. Levisoni*, and long and projecting in *Harp. opalinum*. I

must refer to the plates of these species, and the descriptive text thereof in my monograph, for many important details concerning the mouth-borders of *Harpoceras*.

FIG. 19.—*Harpoceras serpentinum*, Schloth.

FIG. 20.—*Stephanoceras Deslongchampsii.*

FIG. 21.

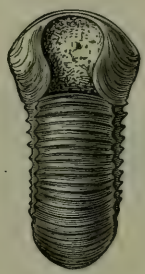

FIG. 22.

Stephanoceras Braikenridgii, showing labial prolongations.

In *Stephanoceras* the shell varies in form; the siphonal or abdominal area is, in general, rounded and without a keel or furrow, and the lateral ribs terminate in tubercles on the sides, from whence numerous folds branch out and extend over the abdomen to join their fellows from the opposite side. The mouth-border in *Stephanoceras Deslongchampsii* consists of a round band which encircles the aperture, as in fig. 20, and, by its prominence and inflexion on the sides, forms the thick lateral portion of the ribs up to the tubercles, which are prominent in this species. In *Stephan. Humphriesianum* the oral band is more voluminous, and in like manner as the mouth was developed onwards, the receding band formed the ribs and tubercles so well shown in that Ammonite. In *Stephan. Braikenridgii* the sides of the border develop long, inflected, lateral lappets, which

bend over the aperture, as seen in figs. 21 and 22. A like form of mouth-border is seen in the shells of *Stephan. Sauzei* and *Stephan. linguiferum*, and a still more marked variation of the lateral lappets is found in *Stephan. Gervillii*, *Stephan. Brongniartum*, all derived from the Humphriesanum zone of the Inferior Oolite, and *Stephan. Bullatum*, from the Great Oolite.

In *Cosmoceras* the sides are often highly ornamented with ribs and tubercles, which bespeak a corresponding development in the mouth-border of the shell. In *Cosmoceras Jason* (fig. 23), the lateral processes are very long, equalling two-thirds the diameter of the last whorl. Many years ago a large number of this species was collected from the Oxford Clay, near Chippenham, in a very perfect state of preservation, with the body-chamber and mouth-border complete. In other species of this group I have not been fortunate in finding the termination of the shell.

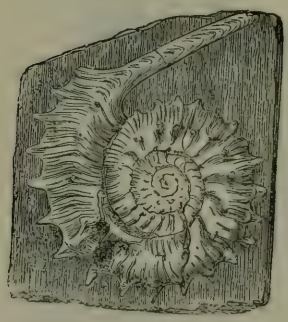

FIG. 23.—*Cosmoceras Jason*, Reinecke.

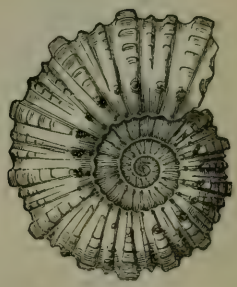

FIG. 24.—*Hoplites mammillaris*, Schloth.

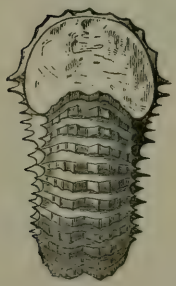

FIG. 25.—*Hoplites mammillaris*, Schloth.

FIG. 26.—*Hoplites Martini*, d'Orb.

In *Hoplites mammillaris* (figs. 24, 25) we have another example, showing how the remarkable ornamentation of some of the shells of this group depends on the development of the mouth-border. Here the ridges with their spines and the valleys with their smooth surface succeed each other, owing to the advance of the calcareous oral band and its temporary cessation of growth, producing the remarkable form of shell this species assumes (fig. 24). A similar condition of the mouth-border has formed the ornamented shell of *Hoplites Martini* (fig. 26), which I have collected in the Lower Greensand (Neocomian) from the Atherfield section, Isle of Wight.

In *Lytoceras* the mouth is circular and without lateral processes, the shell is distinguished, especially among its Liassic forms, for the reticulate structure of the test and the prominent frills that are developed at intervals, as in *Lytoceras fimbriatum* (fig. 27). These fimbriæ originated from a periodic activity in the secreting power of the mantle around the mouth-border of the species possessing these fimbriated projections. A similar structure is likewise found in *Lyt. hircinum*, from the Jurense zone.

FIG. 27.—*Lytoceras fimbriatum*, Sow.

FIG. 28.—*Phylloceras heterophyllum*, Sow.

In *Phylloceras* the involute shell of this group is marked with true forward inclined lines of growth, indicating the presence of a ventral process at the abdominal side of the mouth-border, and this appears to have been the case in the only specimen with a fan-shaped dwelling-chamber, *Phylloceras heterophyllum* (fig. 28),

which I obtained from the Upper Lias at Whitby, of this I have given a figure in my Plate two-thirds natural size.

A remarkable form of mouth-border has been figured by Count Münster, under the name *Scaphites refractus* (fig. 29). In this species the abdominal or siphonal area forms a beak-shaped process, curved downwards towards the aperture, and the lateral processes rise into angular projections, producing a curious pentagonal-shaped oral aperture in this shell.

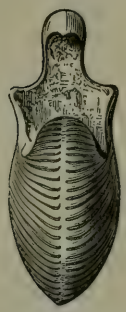

Fig. 29.
Scaphites refractus, Münst.

Fig. 30.

Fig. 31.
Ammonites Aon. Münst.

A still more remarkable mouth-border is seen in the curious Ammonite figured by Von Hauer as *Am. delphinocephalus*, in which the siphonal area becomes inflated, and projects forward like a Scaphite in a remarkable peak-shaped prominence. Münster has figured a remarkable fossil, *Amm. Aon.* (figs. 30, 31,) in which the ornamentation of the shell indicates a singular structure of the mouth-border.

Thirdly.—If the structure of the mouth-border shows that Ammonites varied much in the anatomy of their head, mantle, and arms, the length of the body-chamber affords another character from which important deductions may be made, as the capacity of this chamber was doubtless proportioned to the size of the contained animal, as seen in the *Nautilus pompilius* (fig. 32) of our seas, where the Mollusc is represented occupying the entire body-chamber, the outer margin corresponding to the ventral surface, and the columellar side to the dorsal surface

of the animal. We have here likewise to note the position of the tentacules and the place of the hood, which may probably be the homologue of the *Aptychus*. The septa are likewise seen to be concave towards the aperture, and convex towards the spire of the shell, and they all are perforated at the centre by the siphuncular tube, which proceeds from the posterior side of the Cephalopod to traverse the septa up to the last air-chamber.

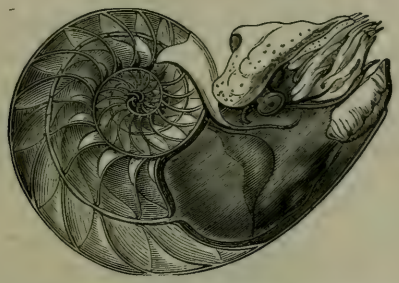

FIG. 32.—Vertical section of the shell of *Nautilus pompilius*, showing the siphuncle and the situation of the animal in the last chamber.

FIG. 33.—*Nautilus umblicatus*, Lam.

FIG. 34.—Section of the shell of *Nautilus pompilius*, Linn.

In fig. 34 we have a vertical section of the Nautilus shell (fig. 33). The chamber in the section is seen to extend to one half of a whorl, and from the inner side of each septum we observe a short funnel-shaped process projecting backwards, which affords attachment to the membranous siphuncle seen

fully *in situ* in fig. 32. The length and capacity of the body-chamber varies considerably in the different genera, which is found to have proportionate dimensions to that of the outer whorl; this appears to be constant in several of the groups on which careful observations have been made; the difficulty experienced in obtaining specimens in which the body-chamber is preserved is, however, a sufficient reason why more has not hitherto been done in this line of inquiry.

In *Arietites* (fig. 35) it will be observed that the septa are convex towards the aperture and concave towards the spire, whilst in *Nautilus* we have seen that the opposite condition prevails. The body chamber in *Arietites* is likewise very long, extending from one whorl to one whorl and a half in length.

FIG. 35.—Section of *Arietites obtusus*, Sow.
Showing the size of the dwelling-chamber and outward convexity of the septa.

In *Aegoceras* the length of the body-chamber varies from two thirds of a whorl to an entire whorl.

In *Amaltheus* the body-chamber is short, and varies from one half to two thirds of a whorl.

In *Harpoceras* it is about two thirds of a whorl.

In *Stephanoceras* it is from one whorl to one whorl and a quarter in length. In *Perisphinctes* from two thirds to a whole whorl, and in *Cosmosceras* it is about half a whorl in length. In *Phylloceras* it is short and wide, and in *Lytoceras* it is round and two thirds of a whorl long.

Fourthly.—The shell of the AMMONITIDÆ is a cone, which is more or less rolled up upon the same plane or in a spiral, and

the various turns of the shell or the whorls, as they are called, in general cover to a greater or less extent the preceding whorl; this is called the amount of involution of the whorls, a feature in the diagnosis of the shell which requires consideration when taken in connection with the other features I have described, as the extent of the involution is found to be generally the same in the different species of different groups. Some shells, for example, as those of *Lytoceras* (fig. 27), are only slightly involute; and others, like *Arietites* (fig. 12), have a wide umbilicus, with their inner whorls largely exposed; in others, as *Amaltheus* and *Harpoceras*, the whorls are much covered by the preceding whorl; in some species of *Phylloceras* they are entirely enveloped; and in others the umbilicus is completely closed. This character, the amount of whorl involution, appears to depend on the angle at which the shell bends round in the process of growth, and as it appears to be a very constant feature, it is of value in forming a diagnosis of generic characters. On this subject the Rev. J. F. Blake observes,* "If we take any fixed point in relation to the shell—say, a point in its surface or in the centre of its apertures—that point will describe a curve with the growth of the shell; and if this curve be projected on a plane, it nearly forms the well-known 'equiangular spiral.' Not exactly, however, because the growth does not begin from a point, as it should, but from the circumference of the embryo; and it has, therefore, been proposed by Mr. Naumann to call it a 'concho-spiral.' Taking, however, the former curve as an approximation to the form produced, we know that this depends for its shape entirely on the angle at which it is bent; and this depends on the law of the growth of the shell. Now, since this law is the same for all the parts of the shell, it follows that the curve described by every point in the same plane is the same, only representing earlier or later portions of one and the same curve. If, therefore, in an Ammonite which is coiled on one plane it is necessary to go back an exact revolution of 360° to reach the part of the

* "The Yorkshire Lias," p. 262.

curve corresponding to the inner edge of the whorl, it is plain that this will be just in contact with the outside of the preceding whorl, which is an exact revolution behind. If we must go back further the inner edge of the last whorl will lie within the outer edge of the preceding, or the shell will be more or less involute; if, on the contrary, we have to go back less, it will be uncoiled. The shape, then, of any shell coiled in one plane depends on the magnitude of the two angles, viz., the angle of the spiral and the angle of retardation of the inner edge."

Fifthly.—The presence or absence of the Aptychus is the fifth character in the anatomy of the shell which requires our consideration. In several extensive groups the Aptychus is supposed to be absent, as *Phylloceras*, *Lytoceras*, *Arcestes*, *Trachyceras;* at all events it has not yet been found in some of these. It is present as a horny undivided body in *Arietites*, *Aegoceras*, and *Amaltheus*. It is divided or bivalved and calcareous in *Harpoceras*, *Oppelia*, and *Haploceras*. It is thin, bivalved, and granulated externally in *Stephanoceras*, *Perisphinctes*, and *Cosmoceras*. It is thick, smooth, and punctated externally in *Simoceras* and *Aspidoceras*, and greatly resembles the large flat grinding teeth of certain genera of fishes from the Carboniferous Limestone; these thick calcareous *Aptychi* consist of two layers, an inner and outer, the inner alone exhibits lines of growth concentric with the angle of each plate, which is situated on that side of its broad end which is applied to its fellow of the opposite side. The outer layer is composed of many laminæ, which in some forms has a porous structure with a punctated and polished surface; there is a remarkable contrast between the thick porous *Aptychi* of the Kimmeridgian Clay, and Upper Jurassic rocks of Germany, and the thin shelly *Aptychi* of the Ammonites from the Inferior Oolite, or the horny *Anaptychi* of the Lias formation. When found undisturbed they occupy the lateral wall about the middle of the dwelling-chamber, having their base in general turned towards the mouth, as seen in figs. 1 and 3. The Solenhofen Lithographic Limestones contain several species of Ammonites, with

the dwelling-chamber of the shell, its mouth-border and lateral processes all complete, and in these specimens the relative position of the *Aptychi* agrees with what I have stated.

Having described in detail the five characters upon which Palæontologists have based the diagnosis of genera, I now proceed to give the classification proposed by Dr. WAAGEN, as it exhibits, in an analytical form, the results of modern investigations on the different groups of the AMMONITIDÆ.

The difficulty of finding the Aptychus *in situ* in the shells to which it belongs will long render this important anatomical character of little practical value as a factor in the diagnosis of the different groups, and for this reason it has not been employed by Dr. E. MOJSISOVICS or by Professor NEUMAYR in the classifications given by them.

The following classification of the new Ammonite genera was proposed by Dr. W. WAAGEN,* and a like grouping has since been published by M. E. FAVRE.†

GENERA OF AMMONITES.

A. *Aptychus*, ABSENT.

Dwelling-chamber short; appendage ventral.	PHYLLOCERAS, *Suess.* *Triassic* and *Cretaceous.*
Chamber short, appendage dorsal.	LYTOCERAS, *Suess.* *Trias.*, *Juras.*, *Cretaceous.*
Chamber very long, one and a half to two whorls, mouth-border dissimilar.	ARCESTES, *Suess.* *Triassic.*
Chamber short, mouth-border falciform, appendage ventral, sculpture Argonautiform.	TRACHYCERAS, *Laube.* *Triassic.*

B. *Aptychus* PRESENT.

I *Aptychus* undivided.

1 Horny *(Anaptychus)*—

Chamber long, one to one and a half whorls, mouth-border with pointed ventral appendage.	ARIETITES, *Waagen.* *Triassic* and *Liassic.*

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* "Ueber die Ansatzstelle der Haftmuskeln beim Nautilus und den Ammoniden. Palæontographica," Band xvii, 5, p. 197. 1867—1870.

† "Sur la Classification des Ammonites," M. E. FAVRE, "Bulletin de Soc. Geol. de France, 3e serie, tom i. p. 353. 1873.

Chamber from two thirds to an entire whorl, mouth-border with rounded ventral appendage.	AEGOCERAS, *Waagen.* *Triassic* and *Liassic.*
Chamber short, one half to two thirds of a whorl, mouth-border with long ventral appendage.	AMALTHEUS, *Montfort.* *Trias.*, *Juras.*, *Cretaceous.*
2 Calcareous,—*Aptychus Numida*, Coquand. Shell unknown (Sidetes?) Cretaceous.	
II *Aptychus* divided (bivalved) calcareous.	
1 *Aptychus* externally furrowed.	
Aptychus thin, chamber short, mouth-border falciform, with pointed ventral process.	HARPOCERAS, *Waagen.* *Jurassic.*
Aptychus thick, chamber short, mouth-border falciform, appendage rounded ventral.	OPPELIA, *Waagen*, *Jurassic*, *Cretaceous.*
Chamber short, mouth-border with a groove or enlargement near the aperture, mouth-border with lateral auricles, and rounded ventral appendage.	HAPLOCERAS, *Zittel*, *Jurassic* and *Cretaceous.*
2 *Aptychus* thin, granulated externally. Chamber long, mouth-border simple, or furnished with bands or auricles.	STEPHANOCERAS, *Waagen.* *Jurassic* and *Cretaceous.*
Chamber long, aperture narrowed by a furrow, simple, or provided with auricles.	PERISPHINCTES, *Waagen*, *Jurassic* and *Cretaceous.*
Chamber short, aperture simple, or furnished with auricles.	COSMOCERAS, *Waagen.* *Jurassic* and *Cretaceous.*
3 *Aptychus* thick, smooth, and punctated externally.	
Chamber long, umbilicus wide; shell with furrows, aperture with a ventral nasiform appendage.	SIMOCERAS, *Zittel*, *Tithonic.*
Chamber short, mouth-border in general simple.	ASPIDOCERAS, *Zittel.* *Jurassic* and *Cretaceous.*

Since the above scheme was proposed many important additions have been made to the number of genera. Dr. E. MOJSISOVICS has revised the family *Arcestidæ*, and grouped therein several new generic forms he had discovered in the Zlambach und Hallstatter-Schichten, and which he has figured in detail in his splendid Monograph.*

Professor M. NEUMAYR, of Vienna, has proposed the genera *Olcostephanus*, *Hoplites*, *Acanthoceras* and *Stoliczkaia* for certain

* "Das Gebirge um Hallstadt," Wien, 1875.

forms which have been detached from other genera owing to the discovery of new characters in these special forms; and Dr. WAAGEN has proposed the genus *Peltoceras* in his work on the Cephalopoda of the Jura of Kutch, for certain forms which he has described in his great work on the Indian Jurassic Ammonitidæ. As new discoveries are made in the structure of these Polythalamous shells many errors will be corrected, omissions supplied, and new genera erected for the reception of the corrected types of this wonderful assemblage of Cephalopoda which have been collected from the secondary formations (Mesozoic rocks) of Europe, and from beds of the same age in Asia. The Cephalopoda of the Cretaceous rocks of Southern India have been admirably figured and described, *Belemnitidæ* and *Nautilidæ* by HENRY F. BLANFORD, Esq., F.R.S.; *Ammonitidæ*, with revision of the *Nautilidæ*, by the late Dr. FERD. STOLICZKA; the Jurassic Fauna of Kutch, the Cephalopoda *Belemnitidæ Nautilidæ*, and *Ammonitidæ* by Dr. W. WAAGEN. All these works are contained in the *Palæontologia Indica*, part of the Memoirs of the Geological Survey of India.

Professor ALPHEUS HYATT published in the *Bulletin* of the Museum of Comparative Zoology, Harvard College, Cambridge, Mass., U. S.*, a memoir on the Fossil Cephalopods of the Lias contained in the Museum of that College, in which he gave an outline of a new classification and nomenclature of these fossils. He states that the Ammonoids, including all the Cephalopods with serrated or foliated septa, the *Clymeniæ*, *Goniatitis*, *Ceratites* and *Ammonites* proper were separated by the late Professor L. AGASSIZ from the Nautiloids and Dibranchiate Cephalopods as a distinct order. For many years past AGASSIZ considered some of these groups as natural families, and deemed them capable of a division into subordinate groups of generic importance. He imparted this fundamental idea to Professor HYATT, at the beginning of his studies on these interesting fossils, and selected the five genera which are referred to his authority as examples of the manner in which the subject

* "Bulletin of the Museum of Comparative Zoology, Harvard College, Cambridge, Mass., vol. i. No. 5, p. 71. 1866.

should be treated at the time AGASSIZ recommended the investigation to his pupil.

Professor M. NEUMAYR, of Vienna, has contributed an important memoir, *Die Ammoniten der Kreide und die Systematik der Ammoniteden*,* in which is brought into a continuous and connected form the progressive stages which the systematic study of Ammonites has made in the hands of the younger Palæontologists of the German school since the time Professor SUESS called their attention to the subject, in his classical memoir *Ueber Ammoniten*, already cited in these pages. The works of WAAGEN, MOJSISOVICS, HAUER, ZITTEL, LAUBE, and his own important papers have all been put under contribution to bring the subject up to our present stand-point of knowledge. The Ammonites are grouped into four families :—

I ARCESTIDÆ.

1 ARCESTES, *Suess.*
2 DIDYMITES, *Mojsisovics.*
3 LOBITES, *Mojs.*
4 PTYCHITES, *Mojs.*
5 PINACOCERAS, *Mojs.*
6 SAGECERAS, *Mojs.*
7 AMALTHEUS, *Montfort.*
8 SCHLOENBACHIA, *Neumayr.*

II TROPITIDÆ.

9 TROPITES, *Mojs.*
10 TRACHYCERAS, *Laube.*
11 CHORISTOCERAS, *Mojs.*
12 RHABDOCERAS, *Suess.*
13 COCHLOCERAS, *Hauer.*

III LYTOCERATIDÆ.

14 LYTOCERAS, *Suess.*
15 HAMITES, *Parkinson.*
16 TURRILITES, *Lamarck.*
17 BACULITES, *Lam.*
18 PHYLLOCERAS, *Suess.*

IV. AEGOCERATIDÆ.

19 AEGOCERAS, *Waagen.*
20 ARIETITES, *Waag.*
21 HARPOCERAS, *Waag.*
22 OPPELIA, *Waag.*
23 HAPLOCERAS, *Zittel.*
24 STEPHANOCERAS, *Waag.*
25 COSMOCERAS, *Waag.*
26 ANCYLOCERAS, *d'Orbigny.*
27 BACULINA, *d'Orbig.*
28 SIMOCERAS, *Zitt.*
29 PERISPHINCTES, *Waag.*
30 OLCOSTEPHANUS, *Neumayr.*
31 SCAPHITES, *Park.*
32 HOPLITES, *Neum.*
33 ACANTHOCERAS, *Neum.*
34 STOLICZKAIA, *Neum.*
35 CRIOCERAS, *Léveillé.*
36 HETEROCERAS, *d'Orbig.*
37 PELTOCERAS, *Waag.*
38 ASPIDOCERAS, *Zitt.*

* "Zeitschrift der Deutschen geologischen Gesellschaft," p. 854, Jahrgang. 1875.

I *Family.*—Arcestidæ, *E. v. Mojsisovics.*

Shell smooth or provided with transverse folds, ribs or longitudinal lines. Runzelschicht (wrinkled layer)* present in the older geological forms, the lobes consist mostly of short, abruptly interrupted lines, seldom (only in *Sageceras*) granular. Mantle impression in the forms from the Trias, with or without contraction of the mouth, always on the mould of the body-chamber, seldom visible on the cellular portion of the shell. Horny Aptychus probably present in *Arcestes*, certainly in *Amaltheus*, for the other forms doubtful.

Genus Arcestes, *Suess.*—Shell in general smooth, seldom with longitudinal lines; body-chamber long, from one to one and a half whorls. Spiral growth slow, strongly involute, mouth-opening contracted, either by an inversion of the shell, or through a thickening of its inner lamina around the border. Lobes strongly incised, so that the saddles consist of a small stem, with numerous approximated horizontal branches, from which other bifurcations proceed. The umbilicus is often closed by shelly eversion.

Dr. Ed. *v.* Mojsisovics divides the genus into the following groups:—Extra-labiati, Sub-labiati, Bi-carinati, Coloni, Intus-labiati, Galeati, and Sub-umbilicati, all of them characterised by more or less modified body-chambers of the full-grown individuals, and by a contraction of the umbilicus frequently entirely occluded by a callosity. All these forms are accurately figured from perfect specimens in his splendid monograph.

The typical *Arcestes* belong to the Trias. The species number about 130, and the Muschelkalk contains some highly developed forms. I cite three well-known species as types of this genus: *Arcestes, sub-umbilicatus*, Bronn, *Arcestes Gaytani*, Klipstein, *Arcestes Johannis Austriæ*, Klipstein.

Genus Didymites, *v. Mojs.*—General form and length of chamber as in the preceding; shell with well-defined lines of

* This word has no equivalent in the English language, but it clearly means the wrinkled marginal layer of the mantle of the mollusc that formed the lobe lines of the septa, and which imparted such an important character to the shells of the Ammonitidæ.

growth. Runzeln present; through the whole length of the body-chamber up to the mouth-border there rises upon the inner side of the shell, upon its convex part, a median ridge (normal line.) The whorl is contracted near the mouth. The lobe-line is formed by a few pairs of small incised saddles, which sometimes alternate with single saddles. The radial lines of growth on the shell, the median ridge on the ventral surface, and the peculiar arrangement of the lobe-line distinguish *Didymites* from *Arcestes*. All are collected from the Norische Stufe of the Trias, near Hallstatt.

Genus Lobites, *v. Mojs.*—In the general form and length of the body-chamber it agrees with *Arcestes* and *Didymites*. Shell with transverse folds, which are abundantly intersected with longitudinal lines. The last whorl developes a remarkable inflation, and subsequent contraction, and has the mouth-border much thickened, and the umbilicus occluded. Most of the species are found in the Triassic beds.

Genus Ptychites, *v. Mojs.*—In its general form and length of the chamber it resembles *Arcestes*, but differs from that group in the structure of the lobes.

Genus Pinacoceras, *v. Mojs.*—Shell small, with a high mouth-opening, surface smooth, rarely with any elevations thereon; body-chamber from one half to two thirds of a whorl long. Mouth-border with short lappet-formed processes on the ventral side. Lobe-line distinguished by the presence of an additional external lobe. The species are all Triassic. Ex. *Pinacoeras imperator*, Hau., *Pinacoc. Daonacum*, Mojs.

Genus Sageceras, *v. Mojs.*—In the form of the shell and length of the body-chamber this genus is nearly related to *Pinacoceras*. It is distinguished from it by the structure of the Runzelschicht, the form of the lobes, and the direction of the lines of growth on the concave part of the shell. The Runzelschicht is granular, as in *Nautilus*, and does not consist of long lines and threads, as in other *Arcestidæ*. The saddles are small, rounded, or linguiform; the lobes symmetrical, through simple conical indentations, single or divided; there are three lobe groups, as in *Pinacoceras*, three species belong to the Permian

formation, *Sag. Hauerinum*, Kon., *Sag. Orbignyanum*, Vern., *Sag. primas*, Waag., the others are found in the Triassic rocks, *Sag. Gabbi*, Mojs., *Sag. Haidengeri*, Hau., *Sag. Walteri*, Mojs., *Sag. Zigmondyi*, Mojs.

Genus Amaltheus, *Montfort.*—Siphonal side of the shell sharpened or keeled; ribs, when present, flexed forward, and ending in a scaly (fig. 37) or articulated ridge or keel (fig. 38); the external shelly lamina in some species developes fine spiral

Fig. 36.—*Amaltheus margaritatus*, Mont.

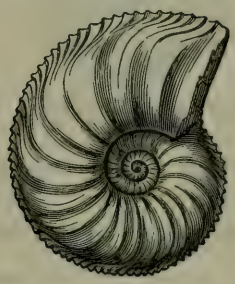

Fig. 37.—*Amaltheus cordatus*, Sow.

lines; body-chamber short; one half to two thirds of a whorl. Mouth-border simple, ventral portion ending in a long projecting process. Lobe-line extremely ramified, the siphonal lobe shorter than the principal lateral lobe, which is mostly broad and wedge-shaped. A divided horny *Anaptychus* has been found in this genus.

The genus *Amaltheus* has an extensive geological range; it is found in the Trias, *Amal. megalodiscus*, Beyr., *Amal. floridus*, Wulf; it is largely developed in the Jurassic strata, commencing with *Amal. Guibalianus*, d'Orb., *Amal. margaritatus*, Brug. (fig. 38,) and *Amal. spinatus*, in the Lias, and many forms are found in the higher Oolitic beds, as *Amal. cordatus*, Sow., Coral Rag (fig. 37); numerous species are likewise discovered in the Cretaceous rocks, as *Amal. Gevrilianus*, d'Orb., *Amal. Vibrayeanus*, d'Orb.

Genus Schloenbachia, *Neum.*—Shell keeled, with strong forward bent ribs on the sides, sometimes developing lateral

tubercles. Body-chamber two-thirds of a whorl long. Mouth-border falciform, ventral side with a forward directed process.

FIG. 38.—*Schloenbachia Roissyana*, d'Orb.

FIG. 39.—*Schloenbachia cristata*, Deluc.

FIG. 40.—*Schloenbachia Goupilanus*, d'Orb.

Siphon large, mostly lodged in the high keel (fig. 38); this genus is entirely limited to the Cretaceous rocks, and figs. 41 and 42 represent typical forms of the group.

II. *Family* TROPITIDÆ, *v. Mojs.*

"Shell more or less richly ornamented, and provided with radial ribs, which almost always support tubercles or spiny processes on the border of the siphonal area. Runzelschicht and impression on the surface of the mantle entirely wanting."

Genus TROPITES, *v. Mojs.*—"Body-chamber from one and a half to one and three quarters of a whorl in length. The strong-ribbed sculpture is interrupted upon the ventral surface, and rises as a median keel on the same. The ventral side of the mouth-border projects forward in a short broad lappet; the last whorl seldom loses the form and sculpture of the inner whorls. The lobes are characterised by a broad saddle stem, with transverse incised branches, a transverse placing of the lobe points, great development of the chief lobes, and a remarkable diminution of the auxiliaries" (MOJS). All the species are Triassic. Ex. *Tropites Pamphagus*, Dittm., *Trop. Saturnus*, Dittm.

Genus TRACHYCERAS, *Laube.*—Body-chamber short, from one half to two thirds of a whorl in length. The sculpture interrupted on the ventral surface (fig. 42). In some species there

is a deep median furrow, at which the ribs with their tubercles end. The mouth-border has a short ventral process. All the

FIG. 41.

FIG. 42.

Trachyceras Aon. Münst.

species are Triassic. Ex. *Trachyceras Aon.* MÜNST. (figs. 41, 42,) *Trach. binodosum,* HAU., *Trach. Attila,* MOJS.

Genus CHORISTOCERAS, *Hauer.*—This genus is nearly allied to the preceding. The body-chamber is short; the lobes are very slightly incised. The inner whorls have their sculpture interrupted on the ventral surface, whilst on the last whorl it extends uninterruptedly across the abdomen. The structure of the lobes shows a persistent relation to an older type, whilst in the sculpture on the ribs there is an evident inclination towards the *Trachyceras* type. All the species belong to the Trias formation. Ex. *Choristoceras decoratum,* HAUER, *Chor. noricum,* MOJS., *Chor. nasturtium,* Dittm.

Genus RHABDOCERAS, *Hauer.*—Staff-shaped and tubular, with a transverse ring-like sculpture and simple bent lobes; they are still very little known, and are probably connected with the *Choristoceras,* to which they stand very near. *Rhabd. Suessi,* HAU.

Genus COCHLOCERAS, *Hauer.*—The whorls are screw-shaped, with continuous ribs and simple bent lobes. This form stands also near to *Choristoceras;* it is found in the Trias beds at Zamblach and Salzkammergut. *Cochl. Fischeri,* HAU.

III *Family* Lytoceratidæ, *Neumayr.*

This family includes several groups which differ from each other much as regards their external form, but which nevertheless appear to have close genetic relations in their internal structure. They are characterised by having a short body-chamber, about two thirds of a whorl in length, a simple mouth-border slightly produced on the columellar side; but in all the other features there is a wide difference of structure.

This family includes the typical groups *Lytoceras* and *Phylloceras*, and others which differ much from them in external form, as *Hamites*, *Turrilites*, and *Baculites*.

The *Aptychus* appears to be absent in this family; at least, at present it has not been found.

Genus Lytoceras, *Suess.*—Shell discoidal, more or less flat; umbilicus large and open; involution slight, whorls round, only slightly embracing each other around the spire. Body-chamber two thirds of a whorl in length; mouth-border simple, with intermittent contractions, and prominent fimbriæ; columellar side with a lappet, which rests on the preceding whorl; the ventral and lateral sides without any prolongation. The sculpture and lines of growth parallel with the mouth-border; near the spiral suture they bend a little forward. Sculpture feeble, consisting mostly of small radial lines, and intermittent contractions of the shell, with corresponding fimbriæ or prominent fringed ribs at certain intervals of growth (fig. 43). Suture line very complicated. Lobes few, much branched; lateral lobes and saddles divided into small uniform symmetrical digitations; only two lateral lobes; and a large columellar lobe covered by the former whorl. No *Aptychus* has as yet been found.

Fig. 43.—*Lytoceras fimbriatum*, Sow.

This genus commences in the Trias. *Lyt. Morloti*, Hau.; *Lyt. sphærophyllum*, Hau.; *Lyt. patens*, Mojs.

It is represented in the Lias formation

by *Lytoceras fimbriatum*, Sow. (fig. 43). *Lyt. Cornucopiæ*, Young; *Lyt. Jurense*, Zitt.; *Lyt. hircinum*, Schloth; and *Lyt. torulosum*, Schübl.; *Lyt. Eudesianum*, d'Orb., Inferior Oolite; *Lyt. Adelæ*, d'Orb., Kelloway. In the Cretaceous rocks by *Lyt. Duvalianum*, d'Orb.; *Lyt. Honoratianum* d'Orb.; *Lyt. subfimbriatum*, d'Orb.

Dr. Waagen* has figured and described *Lytoceras rex.*, Waag., from the Middle Oolite of Kutch, Western India, which is nearly allied to *Lytoceras Eudesianum*, d'Orb.; it is a magnificent specimen, 11¾ inches in diameter, with thirty fimbriæ on its last whorl.

Genus Hamites, *Parkinson.*—With reference to the Cretaceous forms having a conical shell bent in one plane or more without the bends being in contact, Professor Neumayr remarks that a spiral curve of a particular curvature does not give sufficient data for the establishment of a distinct genus. With this view the recognised genera *Anisoceras*, *Ancyloceras*, *Baculina*, *Hamulina*, *Helicoceras*, *Ptychoceras*, and *Toxoceras*, where the curvature receives many modifications, and exists in some of the examples in more than one plane, are all suppressed, and the whole series reduced to the single genus *Hamites*, which, in the primary significance of the word, implied a conical straight shell, as *Hamites elegans*, d'Orb. (fig. 44), bent in one plane,

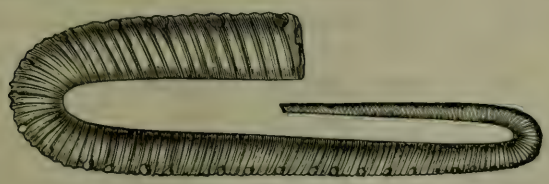

Fig. 44.—*Hamites elegans*, d'Orb.

without the bends being in contact. The suture-line is divided into six lobes, the principal lobe always the under lateral mostly, divided into pairs of branches.

* "Palæontologia Indica Jurassic Fauna of Kutch," pl. viii. p. 36. 1875.

Genus TURRILITES, *Lamarck.*—Under this genus Professor NEUMAYR classes *Helicoceras* (fig. 46), with an open spiral, not in one plane, and *Heteroceras*, with a closed spiral only in the earlier stage of growth. In *Turrilites* (fig. 45), the suture-line

FIG. 45.—*Turrilites catenatus*, d'Orb.

FIG. 46.—*Helicoceras Robertsoni*, d'Orb.

is divided into six lobes, each formed of a single pair of digitations. The ventral lobe formed of a pair which are a little longer or shorter than the lateral. The principal lateral and under lateral are formed of pairs of digitations and the columellar of single ones; the mouth is simple, and provided with bands on an anterior prominent process.

Genus BACULITES, *Lamarck.*—This genus connects, according to Professor NEUMAYR, *Lytoceras* with *Hamites* in the structure of the principal lateral lobe. *Baculites* (fig. 47) has a straight conical shell. Mouth oval or compressed, provided on the

FIG. 47.—*Baculites anceps*, Lamarck.

ventral side with a projecting linguiform process and two lateral grooves, which extend to the opposite side of the shell. Septa symmetrical, divided into four or six lobes, each formed of a pair of digitations. The ventral lobe equals in length the

adjoining principal lateral, which is longer than the lower lateral, and the columellar is small or absent.

Genus PHYLLOCERAS, *Suess.*—Shell discoidal, highly involute, covered with very fine striæ, which describe graceful forward bent lines (fig. 49). Body-chamber short, mouth-border simple, with lateral forward directed lappets. Lobes numerous, and very complicated, as many as eight or nine on each side. Saddles bladder-shaped and well rounded (fig. 50); body-chamber widely expanded and fan-shaped, with undulating radiations in *Phylloceras heterophyllum*. Ex. (see Plate of this species in my monograph on the Lias Ammonites).

FIG. 48.—Disposition of the lobes (D, L, L′, *a*) in *Phylloceras heterophyllum.*

FIG. 49.—*Phylloceras heterophyllum*, Sow. Side view, showing the lines of growth.

FIG. 50.—Disposition of the lobes and saddles (D, L, L′, *a*) in *Phyll. heterophyllum*, Sow.

Professor NEUMAYR* distinguishes from the Dogger and Malm four groups in this genus, of which the following are types:—I. *Phyll. heterophyllum*, SOW.; II. *Phyll. tatricum*, PUSCH; III. *Phyll. Capitanei*, CATULLO; IV. *Phyll. ultramontanum*, ZITT.

This genus commences in the Trias *Phyll. debile*, HAUER; and *Phyll. Neojurense*, QUENST. *Phyll. despectum*, MOJS.; *Phyll. occultum*, MOJS. In the Middle Lias, *Phyll. Loscombi*, SOW.; *Phyll. Zetes*, D'ORB. In the Upper Lias, *Phyll. heterophyllum*, SOW.; *Phyll. subcarinatum*, YOUNG. In the Oxford *Phyll. tatricum*, PUSCH.; *Phyll. viator*, D'ORB.; *Phyll. Hommairei*, D'ORB.; *Phyll. Zignoanum*, D'ORB. In the Cretaceous rocks, *Phyll. Velledæ*, D'ORB., and several other immature shells. In the Jurassic rocks of Kutch, Western India, Dr. W. WAAGEN has figured and described† several interesting species, closely allied to European forms, collected by the Geological Survey of India from the Upper Jurassic formations.

IV *Family* AEGOCERATIDÆ, *Neumayr.*

This family includes a considerable number of Ammonite groups, which have widely different forms and affinities, so that it is almost impossible to give a general description of the family which shall be correct and comprehensive at the same time.

The lobes present a great variety of ramified figures; the suture-line is in general complicated; the siphonal lobe large, and the principal lateral and secondary laterals attain considerable dimensions.

The siphonal or ventral area is in general round and well developed; in some there is a keel with lateral channels more or less deeply grooved; in others the shell is flattened and discoidal, with a wide open umbilicus; or is round and inflated, with highly involute whorls and a small umbilicus, sometimes

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* Neumayr, "Phylloceratten des Dogger und Malm," "Jahrbuch der Geol. Reichsanstalt," 1871, bd. xxi.

† "Palæontologia Indica, pls. v, vi, vii, p. 25.

nearly occluded by the last. In the presence of so much diversity in form and structure this family is subdivided into three sections :—

I Aegoceratites. *Arietites* and *Aegoceras*.

II Harpoceratites.—*Harpoceras, Oppelia, Haploceras.*

III Stephanoceratites.—*Stephanoceras, Cosmoceras, Ancyloceras, Baculina, Simoceras, Perisphinctes, Olcostephanus Scaphites, Hoplites, Acanthoceras, Stoliczkaia, Crioceras, Heteroceras, Peltoceras, Aspidoceras.*

Genus Aegoceras, *Waag.*—The form of the shell in this genus is very variable; it is flat and discoidal, with a wide umbilicus, or round and involute with a small umbilicus; in some shells the ventral side is convex and enlarged, and the sides highly ornamented with ribs, tubercles, or elongated spines; in other species the sides have simple folds or undulations, as *Aeg. Jamesoni*, Sow., and some are smooth, as *Aeg. planorbis*, Sow.

Fig. 51.—*Aegoceras capricornum*, Schloth.

Fig. 52.—*Aegoceras Davæi*, Sow.

The ventral side is in general round, as *Aeg. capricornum*, Schl., fig. 51, and *Aeg. Davæi*, Sow., fig. 52; sometimes it is grooved by a median channel, which interrupts the passage of the ribs from the right to the left side of the shell, as is especially the case in *Aeg. angulatum*, Schl., and *Aeg. Charmassei*, d'Orb. In all the species a keel is absent, and there are no lateral longitudinal channels in the siphonal or ventral area.

The body-chamber varies in length from two thirds to an entire whorl. The mouth-border is simple; the edge has

sometimes a thickened withdrawn lip and a ventral prolongation, and in *Aeg. planorbis* there is a contraction near the aperture, with no lateral auricles. The *Anaptychus* is horny, thin, and bivalved.

The lobe-line is much ramified, and the lobes in general are very complicated. There is a highly branched principal lateral, a smaller lower lateral, and a siphonal lobe, less than the principal lateral, ends in two divergent branches. There are several small auxiliary lobes near the suture, which are concealed by the involution of the spire, as in *Aeg. Charmassei*, D'ORB. This genus may be naturally divided into four sections :—

First Section—PSILONOTI.

Sides smooth, or with undulated folds or straight ribs; suture-line simple ; ventral area round and smooth. *Aeg. planorbis*, SOW.; *Aeg. Johnstoni*, SOW.; *Aeg. torus*, D'ORB.; *Aeg. intermedium*, PORTLOCK ; *Aeg. Belcheri*, SIMP.; *Aeg. liassicum*, D'ORB.

All these forms are found in the Planorbis zone of the Lower Lias.

Second Section—ANGULATI.

Sides covered with sharp flexed ribs, interrupted on the ventral area by a channel more or less developed. *Aeg. angulatum*, SCHL.; *Aeg. Charmassei*, D'ORB.; *Aeg. catenatum*, SOW.; *Aeg. lacunatum*, BUCK.; *Aeg. Boucaultianum*, D'ORB.

All these forms, the two last excepted, are from the Angulatum zone of the Lower Lias.

Third Section—ARMATI.

Sides with numerous ribs, many of which develop tubercles or elongated spines; in some forms they are absent. *Aeg. Davœi*, SOW.; *Aeg. planicosta*, SOW.; *Aeg. Birchii*, SOW.; *Aeg. armatum*, SOW.; *Aeg. Taylori*, SOW.; *Aeg. densinodum*, QUENST.; *Aeg. brevispinum*, SOW.; *Aeg. Valdani*, D'ORB.; *Aeg. Maugenesti*, D'ORB.

Aeg. planicosta and *Aeg. Birchii* are from the Upper Bucklandi beds of the Lower, and all the others are from the Jamesoni zone of the Middle Lias.

Fourth Section—INVOLUTI.

Shell highly involute; inner whorls sometimes almost entirely concealed. Shell during middle age undergoes a great change of form; in others the involution is less, and the umbilicus becomes wider. *Aeg. Henleyi*, SOW.; *Aeg. striatum*, REINECKE; *Aeg. Bechei*, SOW.; *Aeg. curvicornum*, SCHLOENB.; *Aeg. pettos*, QUENST.; *Aeg. heterogenes*, YOUNG.

All the forms of this section are from the Henleyi zone of the Middle Lias.

This genus begins in the Muschelkalk zone of *Arcestes Studeri* with *A. incultum*, BEYR., *A. Palmai*, MOJS., *A. Buonarottii*, MOJS., and became extinct in the Middle Lias.

Genus ARIETITES, *Waag.*—Shell discoidal, with a wide umbilicus; the sides of the whorls covered with straight simple ribs, which often have tubercles developed on them near the

FIG. 53.—*Arietites rotiformis*, SOW.

FIG. 54.—*Arietites obtusus*, SOW. Side.

FIG. 55.—*Arietites obtusus*; SOW. Front.

FIG. 56.—Section of *Arietites obtusus*, SOW.

ventral angle, as seen in *Arietites rotiformis*, fig. 53. In all the species the keel is large and prominent, and accompanied by two lateral channels (fig. 55). The mouth-border is simple, scooped away on the sides, with a long, projecting, ventral process. The body-chamber is from one to one whorl and a quarter in length.

The lobes are very characteristic, (*Arietites bisulcatus*, Brug.) The siphonal lobe is nearly as deep as it is broad, and the union of its wall with the siphon is nearly in the middle of its depth. The principal lateral does not reach to half its depth, and is sometimes as broad as it is deep. The lateral saddle rises above all the others, and stands upon the ground of the principal lateral; in general double the height of the outer saddle. The lower lateral is likewise much broader than deep, and the columellar is so small that it does not reach to half the height or breadth of the saddle, and ends in two branches.

The *Anaptychus* is thin, horny, and undivided; in some species it has a bell-shaped form. I have found it so in *Arietites semicosatus*, Young, and *Arietites stellaris*, Sow.

The genus *Arietites*, as long ago remarked by Leopold von Buch, is very characteristic of the Lower Lias, in which we find the following species:—

Arietites Bucklandi, *Sow.*	Arietites rotiformis, *Sow.*
" Bonnardi, *d'Orb.*	" Sauzeanus, *d'Orb.*
" Crossii, *Wright.*	" stellaris, *Sow.*
" obtusus, *Sow.*	" Scipionianus, *d'Orb.*
" semicostatus, *Simp.*	" Conybeari, *Sow.*
" bisulcatus, *Brug.*	" Brooki, *Sow.*
" raricostatus, *Ziet.*	" Turneri, *Sow.*

Genus Harpoceras, *Waag.*—The external outline of the shell of various forms, the ventral area always keeled with a round or angular border; the sides of the whorls ornamented with elegant falciform ribs of various degrees of thickness. Mouth-border sickle-shaped, with lateral auricles, and a long, pointed, ventral process (fig. 57). Body-chamber from

Fig. 57.—*Harpoceras serpentinum*, Schloth.

one half to two thirds of a whorl in length. Suture-line moderately ramified. Siphonal lobe short and bifurcate, with divergent branches always shorter than the principal lateral, which is largely ramified. The second lateral much smaller than the principal, and passing inwards into several auxiliaries.

The *Aptychus* bivalved, thin, and calcareous, with a shelly covering and several longitudinal folds, as seen in *Harp. Levisoni*, Simp.

Harpoceras first appears in the Middle Lias, in the zone of *Aeg. Jamesoni;* it attains its highest development in the Upper Lias, and is found in the Lower and Middle Jurassic rocks, disappearing in the Upper Kimmeridgian with *Harp. Zio.* Opp., collected from the zone of *Pteroceras oceani*, at Mahringen, near Ulm, Württemberg.

Middle Lias.

Harpoceras, nov. sp.	Harpoceras impendens, *Young & Bird.*
" Normanianum, *d'Orb.*	" arietiforme, *Opp.*

Upper Lias.

Harpoceras serpentinum, *Rein.*	Harpoceras insigne, *Schübl.*
" Levisoni, *Simp.*	" opalinum, *Rein.*
" bifrons, *Brüg.*	" radians, *Rein.*
" falciferum, *Sow.*	" striatulum, *Sow.*
" Lythense, *Young.*	" Aalense, *Ziet.*
" ovatum, *Young.*	" Thouarsense. *d'Orb.*
" variabile, *d'Orb.*	" primordiale, *Schloth.*

Inferior Oolite.

Harpoceras Murchisonæ, *Sow.*	Harpoceras Sowerbyii, *Mill.*
" Tessonianum, *d'Orb.*	" Edwardianum, *d'Orb.*

Genus Oppelia, *Waag.*—Shell discoidal and highly involuted; umbilicus very small; whorls much elevated. Ventral side either upon the chamber or upon all the whorls more or less acute and rounded. Sculpture slightly falciform, with a double set of ribs on the sides. Body-chamber sometimes ribbed, neither keeled or angular; from one half to two thirds of a whorl in length. Mouth-border falciform, sometimes with auricles, always having round external lappets. Siphon large,

with a calcareous sheath. *Aptychus* thick, calcareous, bivalved, and folded. Adductor muscles situated near the border of the shell in the lower half of the whorl. Suture-line extremely ramified. Siphonal lobe mostly shorter than the principal lateral, which is large and much branched. The second lateral is in like manner well developed, and there are several large auxiliaries between the second lateral and the umbilicus. Lobe bodies small, with almost parallel borders; lateral lobes unequally branched. The genus *Oppelia* appears first in the Lower Oolite, zone of *CosmocerasP arkinsoni*, as *Oppelia subradiata*, Sow., and the last representative of the group, as far as our knowledge at present extends, is in the Upper Jura of Stamberg, where a considerable number of different forms are found.

The English species of this genus are not numerous. *Oppelia subradiata*, Sow., from the Inferior Oolite, is a good example. Dr. Waagen has figured a number of beautiful forms of *Oppelia*, amounting to twelve species, from the Golden Oolite of Keera Hill, near Charee, Kutch, and other higher Oolitic beds. "*Oppelia subcostaria*, Opp., closely resembles the European *Opp. subradiata*, not only in the same form, but even in the same varieties as in Europe in the same layer." (Waagen.)

Genus Haploceras, *Zittel.*—The forms included in this group have been separated from the genus *Oppelia*, as they present certain characters in common by which they differ from the typical lines of that genus; they are all distinguished by a narrow umbilicus, a smooth surface, marked with fine lines of growth, like *Hapl. ooliticum.* d'Orb., from the Inferior Oolite, with its thin undivided falciform sculpture which passes round the shell. Sometimes there are a series of straight parallel ribs at intervals, as in *Hapl. ligatum*, d'Orb., between which a number of very fine, undivided, smaller and thinner folds are placed. The ribs are not bifurcated in this genus, and

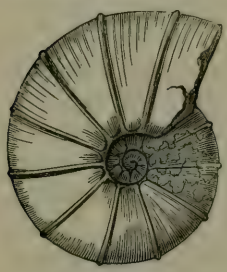


Fig. 58.—*Haploceras ligatum*, d'Orb.

there is neither a keel or a channel in the siphonal area. The body-chamber is short, and the structure of the *Aptychus* is unknown. The number of the lobes is variable. In addition to the siphonal lobe and the principal and smaller laterals there are from two to four auxiliaries present. The ramifications of the principal laterals are not symmetrically divided, and in the forms from the Neocomian strata the lobes have a more simple structure than those found in the Upper Cretaceous beds. This genus has a very wide stratigraphical range from the Lower to the Uppermost stages of the Jurassic series, and likewise in the Neocomian and upper Cretaceous formations.

Genus STEPHANOCERAS, *Waag.*—The general form of the shell is very variable in this genus; the ventral side is in general large and round, without keel, border, or channels. The sculpture is often highly ornamental. From the suture rises a short, stout rib, which often ends in a tubercle at the middle of the side. From the tubercles two or three smaller ribs arise, which pass over the ventral surface, and unite with their fellows on the opposite side. Sometimes the tubercles are wanting, and a number of fine encircling ribs make up the entire sculpture.

The mouth-border is often provided with broad lateral lappets, which are produced and inflected, as in *Stephanoceras Brackenridgii*, fig. 62, where they are very conspicuous, and often well preserved in this species.

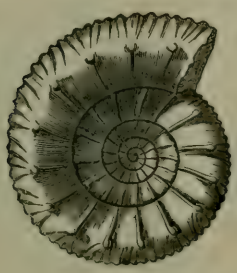


FIG. 59.

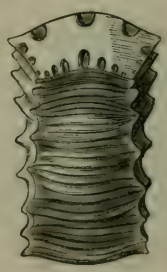


FIG. 60.

Stephanoceras Blagdeni. Sow.

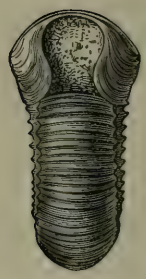


FIG. 61. FIG. 62.
Stephanoceras Brackenridgii, showing labial prolongations.

In *Steph. Blagdeni*, fig. 59, and *Steph. Humphriesianum*, the mouth is encircled by a thick band, from whence the strong ribs in these species is derived. The dwelling-chamber is from one to one and a quarter whorls in length. The suture-line is much ramified. The siphonal and principal lateral lobes are nearly of equal length; the lower lateral is much smaller, and there are several branched auxiliaries. There is considerable diversity among the species. The genus *Stephanoceras* appears to have certain genetic relations with group *Involuti* of the genus *Aegoceras* of the Middle Lias. Many characteristic species appear for the first time in the Upper Lias, as *Steph. annulatum*, Sow. fig. 63, and *Steph. commune*, fig. 64, with *Steph. crassum*, *Steph. fibulatum*, and *Steph. Hollandrei*, all from the same beds. The zone of *Steph. Humphriesianum*, Inferior Oolite, is one great depository of the species both in France and England. We have the following list therefrom :—

FIG. 63.—*Stephanoceras annulatum*, Sow.

FIG. 64.—*Stephanoceras commune*, Sow.

Stephanoceras	Brackenridgii, *Sow.*	Stephan.	Deslongchampsii, *d'Orb.*
"	Brocchi, *Sow.*	"	Gervillii, *Sow.*
"	Brongniarti, *Sow.*	"	Humphriesianum, *Sow.*
"	coronatum, *Brong.*	"	Sauzei, *d'Orb.*

The group which *Stephanoceras macrocephalum*, SCHLOTH, represents, appears to stand apart from the preceding forms, for all these shells are characterised by their globose figure, arising from the extreme involution of the shell, the narrowness of the umbilicus, with its steeply-inclined walls, and a remarkable lobe-line. The siphonal lobe is extremely long, and much broader, but not longer nor downward extending than the principal lateral; the second lateral is smaller, and reaches to the umbilical border. Such is the condition of the lobes in *Stephan. modiolare*, LUID. This group has very few species in the European rocks. They all occupy a very limited horizon, commencing with *Stephan. macrocephalum* in the Cornbrash in England, and in the same horizon in Germany. They are found likewise in the Kelloway Rock, and in the dark clay bed which lies above the Kelloway, and belongs to it.

The Indian species are numerous and well-preserved, twenty-three species have been figured and described from the Kacch Jura, by Dr. W. WAAGEN.* "Of these species those identical with European forms occupy also in Kacch, as in Europe, the true 'Macrocephalus-beds.' The other species, however, range from the uppermost beds of the Pachum group up to the Kuntkote sandstone, *i.e.*, from the highest beds of the Bath to the uppermost beds of the Oxford group, each of them keeping in the meantime strictly to its own layer."

"Long since it was apparent that the group of the *Macrocephali* was one of the most important among all the Jurassic Ammonites, not only because they characterised a well-defined horizon in the European Jurassic series, but also very nearly allied forms had been found over the whole world, and it was to a certain degree supposed that these also ought to signify about the same geological time, indicating for the beds in

* "Jurassic Cephalopoda Palæontologia Indica," p. 108.

which they were enclosed a nearly Callovian age. Dr. WAAGEN has found, however, that some of the Indian species range through the larger part of the Jurassic series, and even re-appear in the upper cretaceous beds."

Genus COSMOCERAS, *Waag.*—Shell flat, discoidal; sides provided with ribs of various forms, which are all bent forward, and impart a highly ornamental character to the shell; spines and tubercles are often developed therefrom. The ventral side has sometimes a smooth channel in the middle, which interrupts the course of the ribs across the siphonal area, as in *Cosm. Parkinsoni*, Sow., and *Cosm. Garantianum*, D'ORB. The body-

FIG. 65.—*Cosmoceras Duncani*, Sow.

FIG. 66.—*Cosmoceras radiatus*, Brugière.

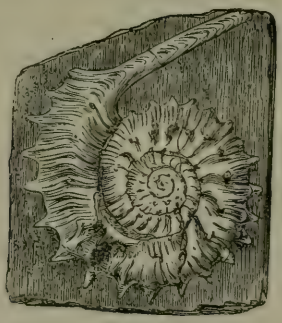


FIG. 67.—*Cosmoceras Jason*, Reinecke.

chamber is about half the length of a whorl. The mouth-border develops lateral auricles in youth, which disappear in old age. The suture line is very much ramified. The siphonal

lobe often equals, but is sometimes shorter, than the principal lateral, which is large and branched; the second lateral is small, and there are several auxiliaries. The *Aptychus* is the same as in *Stephanoceras.*

This genus appears first in the upper beds of the Inferior Oolite with *Cosm. Parkinsoni*, Sow., and *Cosm. Garantianum*, D'ORB. In the Kelloway Rock and Oxford Clay are several other species, as *Cosm. Calloviense*, Sow., *Cosm. Duncani*, Sow., fig. 65. *Cosm. Königi*, Sow., *Cosm. Gowerianum*, Sow., *Cosm. Jason*, REIN., fig. 67, *Cosm. Julii*, D'ORB., and in the chalk it is represented by *Cosm. verrucosum*, D'ORB.

Genus ANCYLOCERAS, *d'Orbig.*—Shell spiral, rolled on the same plane, with few whorls, all of which are disjointed and separate from each other; the last projected outwards in a horizontal line, and then turned upwards and inwards, forming an arch opposed to the turns of the spire. The recurved portion without septa is the body-chamber. The mouth-border is simple, round, and thickened by a shelly inversion. The septa are transverse and symmetrical, divided into six lobes, which are very unequal in size, and formed of very ramified, elongated digitations.

This genus first appeared in the Jurassic seas; in the Upper beds of the Inferior Oolite of France and England, we find *Ancycloceras annulatum*, D'ORB.; in Germany *Ancyl. baculatum*, QUENST.; and in the Kelloway Rock of England we have a third species, *Ancyl. Calloviense*, MORR. It is in the Cretaceous rocks where this genus attains its chief development.

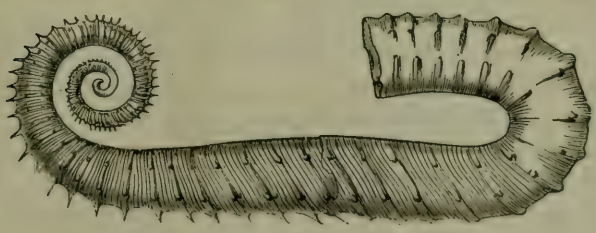


FIG. 68.—*Ancyloceras Matheronianum*, d'Orb.

Ancyloceras Matheronianum, D'ORB., (fig. 68,) is from the Upper

Neocomian, and *Ancylcoeras Puzosianum*, D'ORB., is from the Lower Neocomian, (fig. 69).

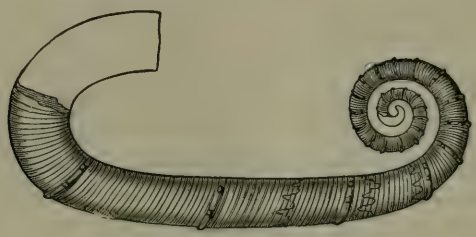


FIG. 69.—*Ancyloceras Puzosianum*, d'Orb.

Genus BACULINA, *d'Orbigny.*

Genus PERISPHINCTES, *Waag.*—Shell in general discoidal, with a wide umbilicus and a round ventral side. The scuplture consists of straight or oblique, forward directed ribs, in

FIG. 70.—*Perisphinctes Martinsii*, d'Orb.

general polytomate, and without tubercles. Mouth-border simple or with auricles, and a circular contraction visible on the shell, near the outlet, at certain intervals of growth. Body-chamber from two thirds to an entire whorl. Lobes similar to those in *Stephanoceras*, differing, however, in being more ramified, and having pendant columellar lobes. *Aptychus* bivalved, calcareous, very thin, and externally granular. *Perisphinctes Martinsii*, D'ORB, fig. 70, from the Inferior Oolite of France and England, is geologically the oldest of this group, which is largely developed in the Middle and Upper Jurassic strata of Europe, and a few species are found in the chalk.

The genus *Perisphinctes* is represented in the Kacch Jura (Kutch)* by more than fifty-six species, which can be distributed, according to Dr. W. Waagen, into six large sections, most of which comprise several groups embedded in strata, that find their equivalents in the Middle and Upper Jurassic rocks of Europe, between the Kelloway, Oxford, Corallian, Kimmeridgian, and Portlandian stages.

Genus Olcostephanus, *Neum.*—This genus was erected to receive a certain number of species that were formerly grouped with the preceding, but which are now separated from *Perisphinctes*. The type of this group is *Olcos. Cautleyii*, Opp., from the Indian Jura. *Olcostephanus*, in contrast with *Perisphinctes*, consists in a shorter body-chamber, two thirds of a whorl in length. Mouth-border in some has a simple smooth band, and in others lateral auricles are developed. The ribs project broadly from the border of the umbilicus, and separate on the sides into many smaller branches.

Genus Scaphites, *Park.*—Shell spiral, rolled on the same plane. Whorls at first contiguous and united, then separated from the others and projected outwards in nearly a straight

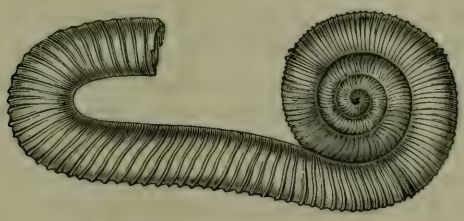


Fig. 71.—*Scaphites Ivanii*, Puzos.

line, afterwards turned upwards, bent round, and curved inwards, forming a kind of horse-shoe shape. The septa transverse, symmetrically divided regularly into more than six very unequal-sized lobes, invariably composed of short bilateral ramifications; the saddles formed of pairs of cells. The siphonal lobe is as

* "Palæontologia Indica," "Jurassic Fauna of Kutch," p. 143.

long as the principal lateral. The form of the inner whorls of *Scaphites* corresponds with those of *Olcostephanus*. Mouth-border round or oval, provided with large protuberant bands, more or less prominent. All the species are found in the Cretaceous rocks. *Scaphites gigas*, Sow., fig. 72. I have collected magnificent examples of this grand form in nodules, from eighteen inches to two feet long, in the Lower Greensand

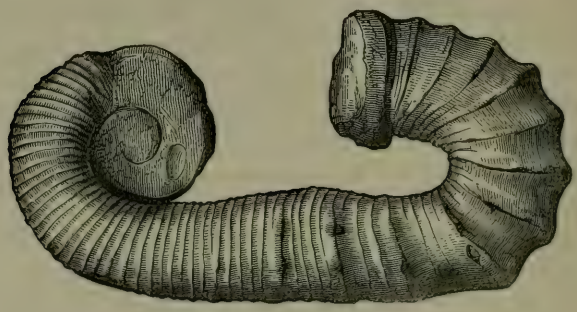


FIG. 72.—*Scaphites gigas*, Sowerby.

at Whales Chine, near Black-Gang, Isle of Wight. *Scaphites Ivanii*, Puzos, fig. 71, is from the Lower Neocomian, and *Scaphites, æqualis*, Sow., I have found in the Lower Chalk at Lewes, Sussex, and Chardstock, Somerset. This species is very abundant in the "Craie chloritées inférieures" of France.

Genus HOPLITES, *Neum.*—This genus is composed of a group of species which were formerly classed with *Perisphinctes*, and now separated therefrom, and characterised by having the shell closely involute with high whorls and a narrow umbilicus. The sculpture consists of numerous small undulating ribs, often polytomate (fig. 73), which arise, by a thickened stem or tubercle, from near the umbilical suture, and soon split up into smaller divisions; sometimes the ribs encircle the siphonal area, or are interrupted here either by their vanishing away at the border of the area or by a median channel, which breaks their continuity, or by a kind of crest formed by the abrupt termination of the lateral ribs, as in *Hopl. splendens*, Sow., or the

FIG. 73.—*Hoplites falcatus*, Mantell.

FIG. 74.—*A. Beaumontianus*, d'Orb.

lateral ribs may be folded and angular, as in *Hopl. falcatus*, MANT., fig. 73, or large and powerful, as in *Hopl. interruptus*, BRÜG. There is a considerable variety in the style of the rib sculpture and the form it assumes in this genus. The mouth-border and the length of the body-chamber are at present unknown.

The suture-line is much ramified in *Hoplites interruptus*, BRÜG. The siphonal lobe and two principal laterals are about the same length, with numerous branches, having a symmetrical arrangement; the second lateral is much smaller, and there are several auxiliaries. In general the lobe bodies are slender, the saddles broader than the lobes, the principal lateral is often longer than the siphonal, the second lateral very short, and there are several horizontal or oblique auxiliaries.

This genus is very characteristic of the Cretaceous period, and its highly ornamented shells form conspicuous groups in the different stages of the Chalk age.

Genus ACANTHOCERAS, *Neum.*—This new group has been proposed to receive several remarkable Ammonites which were included in the genus *Hoplites*, a more extended study of them having induced Prof. NEUMAYR to separate them into a distinct genus, of which the following is a diagnosis:—"The shell is wider and more massive; the umbilicus more open; the whorls moderately high; mouth-border and body-chamber both unknown." The sculpture consists of strong straight ribs, which proceed from the suture-line along the sides, or strong

constantly increasing ribs, with a number of tubercles, which adorn the sides and border. The siphonal area presents many differences; sometimes the median line is channelled, with rows of tubercles on the border, so that the ribs are interrupted

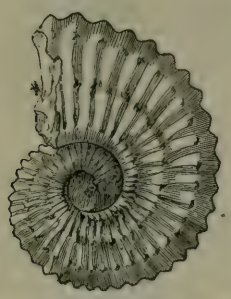


FIG. 75.—*Acantho. laticlavium*, Sharpe.

FIG. 76.—*Acantho. Brottianum*, d'Orb

from crossing; in other species the channel is wanting, and the ribs pass across. Sometimes the tubercles arrange themselves in a series of rows, or pass along the median line and form a kind of knotted keel. The suture line presents considerable variety in these highly ornamental shells. The siphonal and principal lateral lobes are about the same size, sometimes the former is much larger than the latter; and the second lateral is much smaller than the first, both terminate in single fronds, and there are several auxiliaries.

All the species are Cretaceous.

Acanthoceras Brottianum, *d'Orb.*	Acanthoceras Mantelli, *Sow.*
" Deverianum, *d'Orb.*	" Rhotomagense, *Brong.*
" mammillare, *Schl.*	" Sussexiense, *Sharp.*
" Martinii, *d'Orb.*	" Woolgarei, *Mant.*

All these species have been separated from *Hoplites*, and some of them have appeared under that generic name in the earlier part of this Monograph. They are, however, now placed as indicated by the author in his latest work on this subject.

Genus STOLICZKAIA, *Neum.*—Has been erected to receive a small group of remarkable Ammonites figured and described by Dr. FERD. STOLICZKA in his great work on the Ammonitidæ from the chalk rocks of Southern India, some of which were

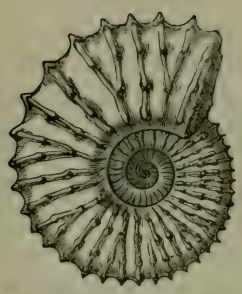


FIG. 77.—*Acanth. Deverianum*, d'Orb.

FIG 78.—*Acanth. Martinii*, d'Orb.

compared with *Arcestes* from Hallstatt. *Stoliczkaia Telinga*, STOL., in its external form, certainly resembles some of the gigantic *Arcestes* from the Alpine Triassic strata of Hallstatt in the form and smoothness of the shell, and in the constriction of the mouth-border; but the shortness of the body-chamber, and the structure of the suture line, has not the most remote resemblance to the very characteristic suture line of the Triassic forms from the Austrian Alps.

The shell is massive, highly involuted, sometimes discoidal, and with a wider umbilicus. Body-chamber about three fourths of a whorl in length. Mouth-border undulated, produced in the middle of the lateral wall, and slightly excised towards the siphonal or ventral area. The inner whorls provided with radii, which are not interrupted on the ventral area; the ribs attain here their greatest development; the body-chamber has a smooth shell, or some species has thickened ribs; the ventral side has neither a keel nor channels. The lobe line is much ramified, consisting of a siphonal lobe and a principal and lower lateral on each side, with a more or less developed columellar lobe having pendant digitations.

I refer the reader to Dr. FERD. STOLICZKA'S magnificent volume on the Ammonitidæ from the Cretaceous formations of Southern India for remarkable types of this genus, such as:—

Stoliczkaia argonautiformis, *Stol.*	Stoliczkaia Telinga, *Stol.*
" crataloides, *Stol.*	" Rudra, *Stol.*
" dispar, *d'Orb.*	" Xetra, *Stol.*

Genus CRIOCERAS, *Léveillé.*—Shell discoidal rolled on the same plane, whorls round, spine regular, in all ages composed of turns of the cone, which are disjoined and entirely separate. Mouth round, oval, or compressed, forming a slight thickening of the inner lamina of the shell. Body-chamber about two thirds the length of a whorl.

The sculpture consists of small encircling ribs, among which larger ribs or rows of tubercles are introduced at intervals (fig. 78). As seen in *Crioceras Emerici* the tubercles are usually two smaller on the sides, and two larger and more thorn-like arise from the border of the siphonal area, the disjunction of the whorls extends up to first formed coil. The lobe-line is highly ramified, and consists of a large siphonal lobe, with long symmetrical branches, a principal lateral on each side, with long, wide, spreading digitations, which are nearly but not quite symmetrical, a lower lateral on each side, much smaller than the principal, and a columellar lobe which is well developed. Such is the structure of the lobes in *Crioceras Duvalli*, LÉVEILLÉ. The large Crioceras shells are found chiefly in the Neocomian strata. I have collected *Crioceras Bowerbankii*, Sow., from the lower Greensand, in the Walpen and Ladder Sands of the Atherfield section, Isle of Wight, some of which were nearly two feet in diameter; some forms are found in the Gault of France, and the Speeton clay of Yorkshire, so that this genus is limited to the lower Cretaceous rocks.

FIG. 79.—*Crioceras Emerici*, Léveillé.

FIG. 80.—*Heteroceras Emerici*, d'Orb.

Genus HETEROCERAS, *d'Orb.*—Shell spiral turreted, whorls in growth contiguous and joined together in age, the last whorl separates itself from the others and becomes (fig. 80,) produced and re-curved, forming an arch with septa, and which was doubtless the body-chamber. *Heteroceras* is therefore a turrilite, with the body in age detached, produced, and re-curved. The most typical example is *Heteroceras Emerici*, D'ORB, fig. 80.

Genus TOXOCERAS, *d'Orb.*—Shell conical, subcylindrical, or compressed symmetrical, elongated, more or less arched, but never forming a spiral. Sides of the shell ornamented with encircling ribs, in some forms having stronger ribs at intervals developed. The sculpture consists of two rows of tubercles developed upon each side of the large ribs, and two rows of larger tubercles on the borders of the siphonal area, as shown in *Toxoceras Honnoratianum*, fig. 81. The mouth is round, oval, or compressed, with a prominent internal border, and the large ribs on the sides and ventral surfaces represent the different stages of growth of this bent cone. The lobe-line is very much ramified; the siphonal lobe is symmetrical, the stem is short, and the bifurcate branches are long; the superior lateral is very large, and composed of nearly symmetrical branches; the lower lateral is small, the columellar lobe has considerable dimensions, and is nearly symmetrical in its structure. The affinities of this genus regarding the structure of its lobes is with the preceding genus *Crioceras*, and, like it, is found in the lower stages of the Cretaceous rocks; all the larger specimens are obtained from the lower and upper Neocomian strata.

FIG. 81.—*Toxoceras Honnoratianum*, d'Orb.

FIG. 82.—*Aspidoceras longispinum*, Sow.

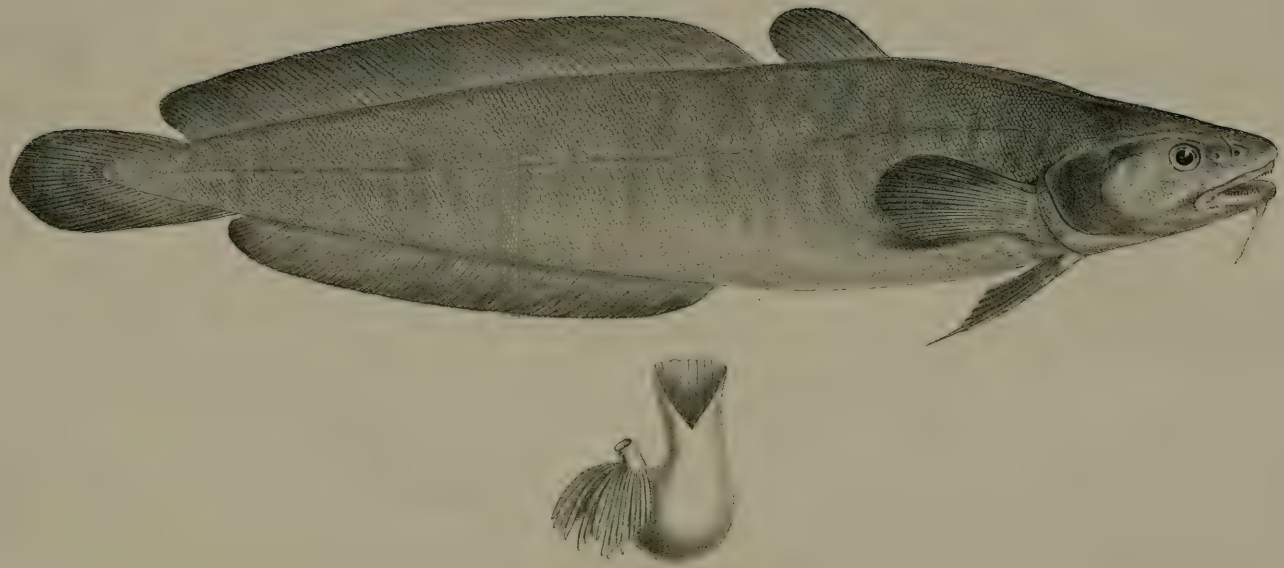
Genus Aspidoceras, *Zittel.*—The form of the shell in this genus is very variable: sometimes it is flat and discoidal with a wide umbilicus, or it is large, inflated, and highly involute. The siphonal or ventral area is rounded or flattened, the sides are adorned with fine ribs, and the sculpture consists of two rows of tubercles developed at intervals among the finer folds of the shell in its early age, which appear to disappear and are undeveloped in later years. The lobe-line ramifications are simple in *Aspid. perarmatum*, Sow. The siphonal lobe is large with symmetrical branches, the principal lateral is large, and composed of numerous unequal parts, and the lower lateral is much smaller. The body of the lobes and saddles is broad, and the lobes are much slit up into branches. *Aspid. longispinum*, Sow., from the Oxfordian of Weymouth, has a thick, discoidal, smooth shell, with two concentric rows of short spines growing upon the sides of the whorls, which are few and more than one half involute (fig. 82.) This forms a very good type of the group. The large section of the *Perarmati*, with a double row of tubercles on the sides of the whorls, appears to want auxiliary lobes. In the group which has *Aspid. altenense*, d'Orb., for its type, from the corallian, one row of tubercles grows near the umbilicus, and the sides and ventral area are encircled by small fine undivided lines of growth.

Genus Peltoceras, *Waag.*—Shell flat, discoidal, with a very large umbilicus; whorls with straight ribs, which, in adult specimens, are mostly provided with two or three rows of spines, siphonal side more or less flattened, or even excavated, the ribs passing over or disappearing before they reach it. Inner whorls with strong, sharp, mostly dichotomate ribs, sometimes undivided, outer whorls with strong, blunt, bi-tuberculous ribs, which pass over the siphonal area. Lobe-line highly ramified; siphonal lobe large, with symmetrical divergent branches; superior lateral widely separated from the siphonal, and forming a broad external saddle; lower lateral small, and imperfectly developed, or even wanting; sometimes the ribs are in part replaced by spines; amount of involution small; length of body-chamber unknown; mouth-border with large lateral auricles developed

from its sides. In England *Peltoceras athleta*, PHIL., and *Peltoceras Williamsoni*, PHIL. represent this genus; both species are limited to the Oxfordian strata.

Genus SIMOCERAS, *Zitt.*—Shell flat, discoidal, with a wide umbilicus, ventral side rounded or channelled. Sculpture seldom absent, and consisting for the most part of straight simple or divergent ribs, which in general, during the entire life of the species, or at any rate during youth, are unbroken on the ventral side, and abundantly provided with tubercles. They have the last whorl much swollen out; body-chamber three-fourths of a whorl; mouth-border in geologically youngest forms with upward bent external auricles, in older forms unknown. The lobe-line is not complex; siphonal lobe the largest; external saddle broad, and much developed. Suteral lobes very small, and single pointed. This genus is found only in the uppermost division of the Jurassic rocks, commencing in the upper part of the Middle Jura, and extending upwards into the lower Tithonian or uppermost Jura. *Simoceras anceps*, REIN., and *Simoceras Frassi*, OPP., are types of this genus.

The Author desires to return his best thanks to his old friend, the Rev. THOS. WILTSHIRE, F.G.S., the Secretary, and the Council of the Palæontographical Society for their kind permission to use the wood-cuts out of his Monograph published by them for the purpose of illustrating this memoir.



F. Day del.

Mintern Bros. imp.

LOTA VULGARIS.

The Burbot (Lota vulgaris) and air-bladders of Fishes, by Francis Day, F.L.S., and F.Z.S. *Read at Gloucester (Winter Meeting) 17th February, 1880.*

Mustela, Pliny, Hist. Nat., ix, c. 16: *Strinsias s. Botarissas*, Bellonius, De. Aquat., 1551, p. 302, &c., and *Clarias fluviatilis*, l. c. p. 304: *Lota*, Rondeletius, 1554, ii, p. 164, and *Barbota*, p. 165: *Botlatriæ, triseus*, Salviani, 1554, p. 213: *Mustela fluviatilis*, Gesner, p. 599, and ed. 1598, fol. 172 *b*, c. fig.: *Quappen*, Schonevelde, 1624, p. 49: *Lota Gallorum*, Aldrovandus, 1638, v. c. 46, p. 648; Jonston, 1649, iii, tit. 3, c. 11, p. 168, t. xxix, f. 10: *Mustela fluviatilis*, Willughby, 1686, p. 125, t. H 3, f. 4: Ray, Syn. Pisc., 1713, pp. 67, 68: *Gadus barbatus*, Müller, Prod. Zool. Dan. 1776, p. 41: Koelreuter, Nov. Com. Petroph. 19, p. 424: *Gadus*, sp. Artedi, Synon. p. 38, No. 13, and Genera p. 22, No. 10, and *Silurus cirro in mento unico*, Species, p. 107: *Rutten*, Marsigli, Danub. 1744, iv, p. 71, t. xxiv: *Burbot*, Pennant, Brit. Zool., (ed. 1.) 1776, iii, p. 199, (ed. 2) 1812, iii, p. 265: *Barbolt*, Bowdich, British Fresh-water Fishes, 1828, No. xxx: *Burbolt*, Couch, British Fishes, iii, p. 93, pl. cxlvi.

Gadus lota, Linn. Faun. Suec. 315 and Syst. Nat. 1766, ed. 12, p. 440: Bonnaterre, Ich., 1788, p. 49, pl, xxx, f. 110: Bloch, Fische Deuts. 1782—88, ii, p. 177, t. lxx: Gmel. Linn., 1788, p. 1172: Lacépède, 1798—1803, ii, p. 435: Donovan, British Fishes, 1802, iv, pl. xcii: Shaw, Gen. Zool. 1803, iv, p, 154, pl. xxiii, f. 2: Turton, Brit. Fauna, 1807, p. 91: Pallas, Zoogr. 1811, iii, p. 201: Hartman, Helvet. Ich. 1827, p. 50: Ekström, Vet. Akad. Handl. 1831, p. 43, and Fische Mörkö, 1835, p. 235: Brandt and Rat. i. p. 52, t. vii, f. 2: Cuv. Règne Anim.

Enchelyopus lota, Bloch, Schn. 1801, p. 52: Gronov. ed. Gray, 1854, p. 101.

Lota vulgaris, Cuv. Règne Anim.: Jurine, Poiss. Lac. Leman, 1825, pl. ii: Niloson, Skand. Fauna, 1832, iv, p. 580: Jenyns, Manual Brit. Vert. 1835, p. 448: Yarrell, Brit. Fishes, (ed. 1)

1836, ii, p. 183, c. fig. (ed. 2) ii, p. 267, (ed. 3) i, p. 572: Fries och Ekström, Skand. Fisk. 1836, p. 170, t. xli: Nordm. in Damid. Voy. Russ. Mérid. 1840, iii, p. 350: White, Catalogue British Fish, 1851, p. 93: Günther, Fische Neckar, 1859, p. 124, and Catal. 1862, iv, p. 359: Heckel and Kner, Suss. w. fis. ost. Mon. 1858, p. 313: Blanchard, Poiss. Eau. dou. France, 1866, p. 272, c. fig: Malm, Wiegm. Arch. 1864, p. 297: Steindachner, Verh. z. b. Ges. Wien. 1866, p. 387: Collett, Norges Fiske, 1875, p. 115: Houghton, British Fresh-water Fishes, 1879, p. 165, c. fig.

Molva lota, Flemming, Brit. Anim. 1828, p. 192.

Lota communis, Rapp, Fische Bodensee's, 1854, p. 36.

SYNONYMY OF AMERICAN EXAMPLES.

Gadus lota, Schöpf, Schrift. Gesell. Nat. Freund. Berlin, 1788, viii, p. 141: Pennant, Arctic Zool. 1792, Introd. p. cxci.

Gadus lacustris, Mitchell, Amer. Month. Mag., ii, p. 244.

Lota maculosa, Leseur, Journ. Acad. Nat. Sc. i, p. 83: Richardson, Fauna Bor.-Amer. Fish, 1831—37, p. 248: Kirtland, Boston Journ. Nat. Hist. 1842, iv, p. 24, pl. iii, f. 1: Dekay, New York Fauna, Fish, 1842, p. 284, pl. lii, f. 168: Agassiz, Lake Superior, 1850, p. 325.

Molva maculosa, and *M. huntia*, Leseur, Mém. Mus. v. 1819, pp. 159, 161, pl. xvi.

Lota compressa, Leseur, Journ. Ac. Nat. Sc. i, p. 84: Storer, Fish. Mass. p. 134: ? Dekay, l. c. p, 285, pl. lxxviii, f. 244, 245.

Lota inornata, Dekay, l. c. p. 283, pl. xlv, f. 145.

Lota brosmiana, Storer, Boston Journal, iv, pl. v, t. 1.

Burbot, *Coney-fish*, *Eel-pout*. *Mustèle*, *Barbotte*, and *La Loche*, French. *Butte* and *Quappe*, German.

B. viii, D. 13, 67—76, P. 19, V. 7, A, 66—71, C. 30, Cœc. pyl. 25—30, Vert. 21/38.

Length of head $5\frac{1}{4}$ to $5\frac{1}{2}$, of caudal fin $12\frac{1}{2}$, height of body $5\frac{1}{2}$ to $6\frac{1}{2}$ in the total length. *Eyes*, diameter 8 to 9 in the length of the head, $2\frac{1}{2}$ diameters from the end of the snout, and $2\frac{3}{4}$ apart. Body subcylindrical anteriorly,

becoming compressed in its posterior half. Head broad, its greatest width equalling its length, excluding the snout. Gape of mouth wide; jaws of equal length anteriorly; the posterior extremity of the maxilla reaches to beneath the middle of the eyes. A single barbel beneath the symphysis of the lower jaw; the anterior nasal valve with a short barbel-like prolongation. *Teeth* villiform, and of equal size in the jaws and on the vomer, none on the tongue.

Fins.—First dorsal somewhat lower than the second; caudal rather wedge-shaped, its lower portion commencing somewhat anterior to its upper: second ventral ray the longest in the fin. *Air-bladder*—destitute of a pneumatic duct, equalling one-third of the entire length of the fish, narrow, and terminating anteriorly in two rounded, horn-like processes; superiorly it is closely attached to the vertebral column in its entire length. *Cœcal appendages*, from 25 to 30, and of moderate length. *Scales*—small, mostly concealed in a thick mucus, which covers the body. *Lateral-line*—at first slightly descends, and then continues direct to the centre of the base of the caudal fin. *Colours.*—Body of a dull yellow or brown, variegated or banded with darker bands or blotches, sometimes studded with pale or else black spots; fins marked similarly to the body. Iris golden, pupils bluish. The colours vary with the waters these fish inhabit.

Names.—Pliny alludes to the *Mustela*, or "Weasel Fish" of Lake Constance, which he considered rivalled marine forms of fish. In England its local names are various: *Burbot*, or *Burbotte* is probably a corruption of its French designation *Barbotte*, "a bearded fish." *Eel-pout*, according to Gesner, is derived from its Dutch name *Ael-putt*, or *Putael*, a compound word, signifying *Ael*, "an eel," and *Purt*, or *Pud*, "a frog."* *Coney-fish* appears to be derived from its habit of lurking in holes of rivers' banks, as a *coney* or "rabbit" does on land.

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* Mr. Houghton would derive the term *Eel-pout* from the fact of the fish resembling an eel, but being more full-bellied or pouting. Its Anglo-Saxon name was *Aelepûta.*

Habits.—The Burbot prefers clear and still rivers and lakes, at the bottom or sides of which it lurks in holes or crevices among the stones. One was kept alive some months last year in one of the tanks in the Royal Westminster Aquarium: it selected the darkest corners, and appeared very unwilling to be seen; when compelled to change its situation, it did so with great deliberation, and never hurried itself. While moving, its ventral fins appeared to be used to a considerable extent as feelers; in fact outwardly it much resembled some American fresh-water Siluroids which previously resided in the same tank. This fish lives for a considerable period after its removal from the water, and, being very tenacious of life, can be kept alive for some time in cold and damp situations by feeding it on small fishes and pieces of raw meat. It is reputed to grow rapidly when well fed, is very voracious, feeding at night time, when it consumes a great quantity of small fish, worms, and aquatic insects. Although it has been stated to agitate its barbel in order to decoy little fish to its vicinity, such would appear to be improbable, as that appendage is situated beneath its chin. In suitable localities the Burbot is said to attain to a good old age. Its greatest enemy is perhaps the perch, which seems invariably to attack it: the pike likewise esteems it as food.

It is taken by nets, baited hooks, trimmers, or night lines.

Breeding.—The example figured was a female, captured in March, 1879, in the river Thet, in Norfolk; its ova at that period were not fully matured, but it will be remembered that the season was unexceptionally cold. Some authors observe that it deposits its ova in December and January; Yarrell states February or March: while they may breed rather later in England than on the Continent. Leon Baltner found 128,000 eggs in one example. At spawning time they leave the deeper waters, and seek smooth localities in streams, where they deposit their eggs.

Uses.—In the Oder these fishes were formerly much sought after, the fattest of those not disposed of being cut into slips, dried, and employed as candles. Oil from their livers was

likewise used as an external remedy for swellings; while the gall, in common with that of some other fishes, was recommended for its supposed efficacy in affections of the eyes. Glue (isinglass) was manufactured from its air-vessel. It is stated in the *Encyclopædia Londinensis* that "in Siberia and many parts of Russia, especially among the country people, they use the skin of this fish instead of glass, and it is as clear as oiled paper: the Ostides and Tschulymch Tarters use the skins for their summer dress, and make bags of it to preserve their pelfry." This may be erroneous, and the fish alluded to be eels, or perhaps both, for Mr. EDEN* observes "some members of this race (the Ostiaks) use fish-skin clothing in place of furs, the eels, which abound throughout the country, furnishing the material. These skins are very strong, and quite air-tight, excluding an immense deal of cold when well rubbed with fat. They are also used as windows to their yurts."

As food.—The Burbot has long been esteemed as a great luxury, but more so on the Continent than in this country; its flesh is white and delicate, while its liver is its most delicious morsel. ALDROVANDUS has recorded how a German Countess carried her epicurism so far as to expend the greatest portion of her income in the purchase of this dish. Its eggs however are unwholesome, and occasionally even poisonous.

Habitat.—This fish, although distributed throughout northern and central Europe, also Canada and the adjacent portions of the United States, is still rather local in its habits. Prior to the time when the geographical distribution of animals began to be attended to, it was asserted that the Burbot was found in India, a locality which was very properly discarded until the error was re-introduced by LACÉPÈDE at the end of the last century, and which has been copied by DONOVAN, YARRELL and COUCH. No fresh-water species of the Cod family, *Gadidæ*, exist in India, while in the sea is the single and aberrant genus of *Bregmăceros*.

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* Eden, *Frozen Asia*, 1879, p. 142.

In Continental Europe the Burbot is found in Norway, Sweden, and rivers flowing into the Baltic and Black seas; Siberia, through central Europe from Hungary to Switzerland, Germany, and as far south as France. GESNER's Ichthyology (A.D. 1598) is said to contain "the complete description and life history of all and every fish which may be seen and caught not only in the great high sea, but also in lakes, rivers, brooks, and all ship-bearing waters. Together with their uses and value, both for food and for medicine of the apothecaries. Very serviceable and useful to all physicians, maid-servants, cooks, and also to scientific painters." The figure of this fish adorns the title-page, while it is observed in the text that they used to be found in Bohemia and Prague, and were kept for the king in a large pool, on account of their beautiful appearance.

An interesting fable exists respecting the introduction of this fish into the Lake of Geneva. JURINE asserted that, according to popular tradition, the Burbot was brought there from Neuchatel, while BLANCHAT, in his *Natural History* of the environs of this latter place, attributes their introduction to the monks of St. Prex, in the fourteenth century. In support of this opinion, LUNEL, author of the *Fishes of Lake Leman* or Geneva, cites a map of the Lake engraved at Geneva, in 1588, by JEAN DU VILLARD, who has given in the margin figures of the fish, with their local names. All are recognizable, but the Burbot and eel are not represented, and due to the impassable barrier of the "Perte du Rhône," at Bellegarde, migrations of the latter to or from the sea are impossible. The absence of the Burbot was held to coincide with the local tradition, but, as observed by Professor FOREL at the "Vaudois Natural History Society," the following facts refute such a belief. RONDELET, a learned Naturalist of Montpellier, in France, published in 1555, at Lyons, as a continuation of his *History of Marine Fishes*, descriptions of the *Fresh-water Fishes of Europe*. He observed of the Burbot or Lotte, "the fish which the Lyonese call the Lotte, is named by the Genevese Motelle or Mustele." Now Motaile is at this day the popular name of this fish, and, having a local name, it must have been common or well known.

Rondelet's work was published thirty-three years prior to du Villard's map, and he gives a figure by which this fish can be recognized. Irrespective of this, the monks of St. Prex in the fourteenth century had neither a convent nor any of their order attached to the Chapter at Lusanne.

In England it is found in the rivers and some lakes in the counties of Durham and Yorkshire, in the Trent and its affluents in Nottinghamshire and Staffordshire,* where the largest examples have also been obtained: in the great east fen in Lincolnshire, although it is not generally distributed over that county; it is also found in Cambridgeshire, and in some of the Norfolk rivers. The belief however is prevalent that the species is decreasing in numbers, and perhaps doomed to extinction.

In Scotland the Burbot is unknown. In the *Catalogue of the Fishes in the British Museum* we find seven skins of *Lota vulgaris* thus recorded—"adult: skins, Frith of Forth. From Dr. Parnell's collection." Were this record unimpeachable it would conclusively prove their existence north of the Border; but even at first sight it would seem strange that this fresh-water fish should be captured in the locality referred to, more especially as Dr. Parnell himself does not allude to its existence there in his prize essay on the Fishes of the Frith of Forth. I find in the British Museum Registry that when Dr. Parnell's collection of 1636 specimens of fish obtained from all parts of the world, was recorded, no locality was given as to from whence these seven skins came. I conclude they were obtained from elsewhere, and are certainly unreliable as Scotch examples. Here however I would remark that it is placed among the *Siluridæ* by Artedi, showing how minute or concealed the scaling is to have been overlooked by such an excellent Ichthyologist. This would lead us to consider whether others may not have been equally mistaken when examining

* Plot, in his *Natural History of Staffordshire*, 1686, alluded to its existence, but even then it was rare; Mr. Heath observes that it is still found in the river Penk in that county.

specimens, supposing such to be scaleless Siluroids. FLEMMING found recorded at the end of SIBBALD's list* of Scottish Fishes *Silurus sive glanis*, and on this authority introduced the *Silurus glanis* of Continental Europe into his catalogue of British animals, although WILLUGHBY, who mentions *Silurus glanis*, does not refer to great Britain as one of the localities which it inhabits. It may be that the Burbot was alluded to by SIBBALD, or it may be that his authority was no better than the one I have alluded to respecting PARNELL's examples.

As regards Ireland a unique example of a fish which some have considered may be the *Silurus glanis* is stated to have been captured about 1827 or 1828 from a tributary of the Shannon, near its source, about three miles above Lough Allen. A fisherman asserted that a fish at least 2½ feet long, and 8 lbs. or 9lbs. weight, was seen struggling in a pool in the river as a flood subsided; that it had worm-like feelers to its mouth, while its appearance was so hideous that those who first saw it were afraid of touching it. The mouth in the figure of *Silurus glanis* in YARRELL's British Fishes was not considered large enough for that of the Irish specimen, but it must be observed that enquiries were only instituted in 1840. The captured fish was not eaten, but adorned a bush for two or three years, until the skeleton fell to pieces, and with it all evidence to connect *Silurus glanis* with Ireland.† Some have surmised that the fish may have been a Burbot, but it is manifestly impossible to connect any species with the evidence adduced.

The Burbot attains to about two or three lbs. weight in this country, but PENNANT records an example of eight lbs. captured in the Trent by Sir JERVASE CLIFTON. On the Continent they are taken up to ten or twelve lbs.

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* SIBBALD gives in his Scot. Illus. *Ealpout* as one of the Fishes of that country, but he employs the name for the viviparous Blenny, see pl. xix, fig. 3.

† One or more, fortunately unsuccessful, attempts have been made during the last few years to introduce this hideous monster into British rivers. The *Silurus glanis* has a voracious appetite, is a foul feeder, inferior as food, and almost rank when of a large size, whose presence would be of more than questionable advantage.

The example figured is 11·2 inches in length, and was procured by Dr. Lombe, of Torquay, for the Rev. W. Symonds, of Pendock, who kindly sent it to me, and subsequently a black spotted male from the same source. Inside the stomach of the figured fish was an almost entire Loach, *Nemacheilus barbatulus*, 2·5 inches in length.

I observed that the Burbot possesses an air-bladder, which is of the Physoclisti type, and destitute of any chain of ossicles connecting it with the internal ear, and I propose offering some general remarks upon the situation and functions of this organ as commonly observed. The uses of the air- or swim-bladder, likewise termed the air-sac or air-vessel, have long been subjects of speculation and formed material for discussion. It is a single or variously sub-divided sac, or it may be two sacs, partially or completely separated one from the other. Situated above the centre of gravity,* it lies beneath the vertebral column or back-bone, from which it is more or less divided by the kidneys, while inferiorly it is separated from the intestines by the peritoneum. As the air-bladder is entirely absent, or ceases to be developed in many fishes, and is frequently present or wanting in species belonging to the same genus, it would appear that it is not indispensable to their existence, its functions being accessory or supplemental, under certain conditions, to those of other organs of the body.

Investigating the origin of this organ in the embryonic stage, we find it originating as a bud or offshoot from the upper portion of the alimentary canal, or even from the stomach; this offshoot elongates into a blind tube, and then enlarges at its terminal extremity into what will eventually form the air-bladder. Consequently at some period of a fishes existence there must be a tube connecting the air-bladder (when one exists) with the alimentary canal, into which it

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* Were the air-bladder below the centre of gravity, or its contents evacuated into the abdominal cavity, the fish (unless its fins were very greatly developed) would roll over on its back, as we see occurs in *Tetrodons* and *Diodons*, when they inflate their large œsophageal sac.

opens usually on its superior or dorsal, rarely on its lateral, and occasionally on its inferior or ventral wall.

The air-bladder is present in the sub-classes Dipnoids, all the members of which are fresh-water; also in the Ganoids, all of which are entirely or partially fresh-water forms. It is absent in the Chondropterygii, except in a rudimentary form as a diverticulum opening on the dorsal wall of the pharynx in some genera. While in the lowly developed Pharyngobranchii and the Marsipobranchii it is entirely wanting.

In the large sub-class *Teleostei* it is present in the Orders *Plectognathi*, *Lophobranchii*, and *Acanthopterygii*, in the form of a closed sac *(Physoclisti)* the majority of which are marine. Whereas in the *Physostomi* it generally exists as a sac, having a connecting tube opening from it into the alimentary canal; the largest proportion of these fishes live in fresh water. As a general rule the air-bladder is found existing more constantly in the fresh-water than in the marine classes.

If we briefly trace out this organ we find it much as follows. Among the Dipnoids it is distinctly or indistinctly double, lung-like, and communicating throughout life, by means of a duct and glottis, with the œsophagus or pharynx. It is thus in the *Lepidosiren* of the Brazils, in South America; *Protopterus* of tropical Africa; and *Ceratodus* of Queensland, South Australia. All these fishes, for the purposes of respiration, have been observed to ascend to the surface of the water, and take in atmospheric air direct; a mode of breathing, however, not confined solely to these forms.

In a fish of the Gambia, *Lepidosiren annecteus*, the air-vessel forms a most interesting connecting link between what is usually observed in Fishes and Amphibians. During the rains the African river referred to overflows its banks, and numbers of *Lepidosirens* are carried away into what become vast watery tracts. These inundated places, as the hot season occurs, dry up under the rays of a tropical sun, and as a consequence all connection with the river first ceases, subsequently the watery tracts become converted into dry plains. As the water commences to evaporate the fish burrow into the

mud, but maintain a communication with the atmosphere by means of a small aperture. Here in their muddy chamber they await the return of the rains, when they emerge from the retreat where they have been æstivating. Of course in this chamber they are unable, owing to the absence of water, to employ their gills for respiration, but they are able to use their cellular lung, formed by the partition of the air-bladder into two chambers, for this purpose. They have a wide duct or trachea opening into the œsophagus on its ventral surface, where there is a distinct glottis. In short their lung or air-bladder is employed in depurating their blood during such time as they pass a torpid existence.

Ceratodus, or the Queensland mud-fish, is possessed of gills for respiration, and likewise an air-bladder modified into a respiratory organ, to be employed under certain circumstances. This latter organ occupies the whole length of the abdominal cavity, and is more or less divided into two halves. The right half contracts anteriorly, and opens by a short duct, with a glottis at its termination, on to the left side of the œsophagus, but not quite so far forwards as its ventral wall. The structure of this organ is that of a lung, where at times blood is decarbonised, and the oxygenated stream is conveyed by pulmonary veins to the atrium of the heart.

The Ganoids likewise afford instances very analogous to what obtains among the Dipnoids. I shall allude to *Amia* as an example of the Heleostei possessing cycloid scales; and *Polypterus* with Ganoid scales; and subsequently offer a few remarks on the *Acipenser* or sturgeon.

Amia, a fresh-water fish of the United States, respires atmospheric air as Ceratodus is observed to do, as proved by Wilder. Its air-bladder is a median sac, extending the entire length of the abdomen. Its posterior extremity is rounded, while anteriorly it bifurcates with two short horns, between which is the connecting communication between it and the dorsal surface of the alimentary canal, an opening which is guarded by a longitudinal glottis. The interior of this air-bladder is cellular, and it is traversed by fine ramifications of

blood-vessels. *Polypterus* is another fresh-water GANOID, found in South Africa. It possesses a double air-bladder, which opens into the pharynx on its ventral surface. The *Acipenser* or Sturgeon is the last of this sub-class to which I propose referring. It is provided with an air-bladder, but not similarly cellular to those already remarked upon; it does not appear to be employed in respiration, but its functions seem to be restricted to acting as a float. The opening from the air-bladder into the alimentary canal is that of a lower type, being on the dorsal surface, and it is not guarded by a glottis.

Thus far I have alluded to the higher classes of fishes; and among the DIPNOIDS we see an air-bladder, having a lung-like function, opening on the ventral wall of the pharynx, and protected by a glottis. But among the GANOIDS there is a divergence from the DIPNOID organisation. Although *Amia* has a respiratory air-sac, opening into the pharynx by a glottis, the communicating orifice is on the upper or dorsal, and not on the lower or ventral aspect, as occurring in the higher forms. *Polypterus* it is true opens on the ventral wall, but in *Acipenser* the respiratory function has not been developed, and the pneumatic opening is upon the dorsal wall of the pharynx.

Air-bladders in fishes, as might be expected in organs appearing in the lowest class of vertebrates, are of diverse forms and sizes, as well as differently protected. Existing in the abdominal cavity, as already described, they have usually two coats—an external, fibrous, tough, and glistening, and an internal, vascular, and mucous one. Between these two coats is often seen (especially in the physoclisti) a red glandular body, most frequently in its inferior region, and compared by some anatomists to the thymus. This gland seems to have the character of a rete mirabile, consisting of a double plexus of arteries and veins.

It has long been known that the gas contained in the air-bladder is a mixture of oxygen, azote and carbonic acid, in variable proportions, in accordance with species, and even in accordance with individuals. M. ARMAND MOREAU has proved among the fishes in which the air-bladder is closed, *(Physoclisti)*

that this organ always contains a greater part of oxygen whenever the animal is in a normal condition, that this oxygen disappears little by little if the animal cannot any longer derive it in the midst of its surroundings, and it perishes asphyxiated.

The air-bladder, excluding those forms which respire air, is generally found after death tightly distended with gas, and this consists chiefly of nitrogen in the fresh-water forms, and oxygen in marine genera, this latter substance augmenting in proportion in sea fishes in accordance with the depth at which the fish is captured. It has formed a subject of considerable discussion as to how this gas is generated, but, as in those classes in which the air-bladder is a closed sac, *(Physoclisti)* it is as well seen as in others possessing a pneumatic tube, *(Physostomi)* one cannot resist believing that the gas must be eliminated from the blood-vessels lining the interior of the organ. Probably the gland serves the special purpose of removing superfluous gas or any deleterious substance, while the pneumatic tube is not employed to admit the ingress of air, but acts as a safety-valve when the organ is too tightly distended.

But the reason why the air-bladder is refused the title of "lung" in most fishes is because it is usually supplied with blood from the adjacent arteries of the body not direct from the heart, and returns venous blood into the general circulation. In *Ceratodus*, however, although there is no special vessel employed to convey blood to the air-bladder, still we observe this organ possessing a higher functional development than exists in *Acipenser* for instance, as the returned blood is purified and subsequently conveyed direct to the heart, which arrangement does not obtain in *Amia* or *Lepidosteus*, both of which fish evidently use their air-bladders for respiratory purposes. *Lepidosiren* is doubtless the highest known form of living fish, forming a transitional link between *Amphibia* and Fishes. It is allied to Amphibia, as it possesses a heart composed of three chambers, two auricles and a ventricle; it has lungs (the air-bladder) which receives venous blood direct from the heart, to which it returns it arterialised; it likewise has rudimentary external

branchiæ on the side of its neck. It is, however, more closely related to fishes than Amphibians, especially in its form, its being covered with cycloid scales, and a fin surrounding the posterior portion of its body; while, although it has no branchiostegous rays, it has free branchiæ situated inside a branchial cavity, which opens into the pharynx by slits, while externally it communicates by a single orifice.

Ceratodus in many respects, especially externally, is closely related to the foregoing, although, as previously observed, its opening from the air-bladder into the pharynx is lateral, not ventral, as seen in Lepidosiren and the higher vertebrata. But the heart now becomes of rather a lower type, having a single auricle and ventricle, while its blood is not derived from the heart or large vessel springing from that organ, but from branches of the abdominal aorta or cæliac artery. Still its air-sac has the function of a lung, discharging at times arterialised blood into the atrium of the heart.* Thus transitional grades in the position and functions of this organ can be traced from *Lepidosiren* and *Ceratodus* to *Polypterus* and *Acipenser* downwards through the whole class of Teleostean fishes.

This leads us on to see that the air-bladder is homologous with the lung in its position and function in some of the higher orders; and if a gradation can be traced, it becomes no less clear that this homology (whatever its functions may be) exists throughout every variety and condition of air-bladder in the piscine tribes. The arteries which supply the air-bladder in Teleosteans are offshoots direct from the abdominal aorta, cæliac artery, or last branchial vein; the blood is returned to the portal, hepatic, or great cardiac vein. In the highest class of fishes we find this organ differently supplied, as it is not only the homologue but likewise the analogue of the lung,†

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* "The air-sac is supplied with branches from the pneumogastric nerve, like the lungs of the higher vertebrata." GRANT, *Comparative Anatomy*, p. 546.

† QUEKETT, who injected a small portion of the air-bladder of this fish, found the arrangement of the vessels was precisely similar to that existing in the lungs of reptiles.

thus in Lepidosiren venous blood is distributed to the organ and arterial conveyed away, the two efferent veins having coalesced, pierce the large post-caval, then pass forwards through the sinus and auricle, and thus discharge the blood into the ventricle. Consequently we find that in this organ there are two distinct modes of sanguification, in the lower division arterial blood goes to it and venous is returned from it; whereas in the higher forms venous is carried to it, oxygenated at it, and returned as arterial blood into the heart. *Polypterus*, as already remarked, closely resembles *Lepidosiren*, in both, as observed by Owen, the arteries of the air-bladders are derived from the returning dorsal portions of the branchial vascular arches before their union to join the aorta. In the *Polypterus* the artery of each air-sac is formed by the union of the efferent vessels of the last gill; the blood is, therefore, arterialised before entering the artery of the air-sac. In the *Lepidosiren* (by reason of the non-development of the gills on the two lowest of the branchial arches) the blood transmitted to the air-sac is venous.

If we examine into the condition and uses of the air-bladder in the bony or Teleostean fishes we find that they possess them in two distinct forms. I have already observed that in the embryo this organ is found to be an offshoot from the alimentary canal. This communication may become entirely obliterated, when such forms are termed *Physoclisti;* or else the canal may remain pervious throughout life, in the form of a pneumatic tube, connecting the air-bladder with some portion of the alimentary canal, in which case they go under the designation of *Physostomi.* This pneumatic tube may be with or without any distinct valve precluding the inlet and exit of air.

In short in the Teleosteans the air-bladder exists in the form of a closed sac, *Physoclisti*, as in the spiny-rayed *Acanthopterygians*, the spineless *Anacanthini*, the tufted-gilled *Lophobranchii*, and the hard-jawed *Plectognathi.* While in the remaining orders a connecting duct remains pervious, as in the *Physostomi*, excluding the family *Scombresocidæ.*

The air-bladder, however, is not only absent in many families, but it may be present or deficient among species of the same genus. One form of British mackerel, *Scomber colias*, possesses this organ, while the *S. scomber* has none. This is by no means peculiar to European genera. Thus among the Asiatic species of the marine *Polynemus* the *P. paradiseus* and *P. tetradactylus* are without air-bladders, while such exist in *P. indicus* and *P. plebejus*.

In such forms as swim near the surface the air-bladder is generally of a comparatively small size; while in those which live near the bottom, as the flat fishes, *Pleuronectidæ*, it is as a rule absent. In species possessing this organ, should it become ruptured from any cause, permitting the contained gas to escape, the fish has by some authors been stated to sink to the bottom, and unable to re-ascend, a conclusion some experiments have failed to establish. On the other hand some forms which have been hooked or netted at great depths and suddenly brought to the surface, without having time to compress or partially empty their air-bladders, the contained gas being no longer weighted down by a mass of superimposed water, expands rapidly, causing the organ to burst, or else forcing the stomach and upper portion of the alimentary canal into the fishes mouth.*

The chief use of this organ† in Teleostean fishes are two—(1). A *hydrostatic*, or for flotation, which serves, by contracting or distending its capacity, to condense or rarify the contained gases, giving it the mechanical function of enabling its possessor to maintain a desired level in the water, and which is accompanied with the power of renewing, expelling, compressing, or dilating its gaseous contents, so that it can rise or fall as necessity occurs. (2). The second use is *acoustic*, it being partially or entirely employed for hearing, by means of various

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* "A fish may remain at the bottom of the water due to the very fact of the pressure of the column of water on the air contained in the bladder." MÜLLER.

† I purposely omit such instances in which it might be employed, for respiration or in the production of sounds, constituting what has been termed "fishes voices."

modes of connection with the internal ear, mostly by tubular prolongations of the air-bladder, or a connecting chain of auditory ossicles.

Among the *Physoclisti*, the majority of which are marine, we find the air-bladder as a closed sac, having a single cavity, as observed in many of the Percidæ, wherein its greatest length is in its longitudinal axis. In some forms, as *Holocentrum* and *Sargus*, cæcal processes of the air-bladder diverge to attach themselves to the membrane, closing the part of the otocrane containing the sac of the great otolite:" (Owen). It has likewise been remarked that in the scad or horse-mackerel, *Caranx trachurus*, a canal passes from the air-bladder to the bronchial cavity, permitting the escape of air, although it does not serve to admit it.—(A. Moreau, Compt. Rend. lxxx. pp. 1247—1250.) Kner observed that in several fishes provided with pectoral pores, the thymus gland is absent, and the air-bladder communicates with the œsophagus by an open duct, in some Acanthopterygians, as *Holocentrum*, *Priacanthus*, *Cœsio*, &c.—(Sitz. Ak. Wiss. Wien. 1864, xlix, May, pp. 455—459). The air-bladder may have lateral attachments, as in *Sciæna*, or blind appendages, as in *Polynemus*. The interior of the air-bladder of physoclisti, as the cod, is lined with a thin membrane of silvery whiteness, composed of a series of fibres, covered with a basement membrane, provided with scales of epithelium; beneath this is a layer of vessels, while inside is situated a highly vascular body, receiving blood direct from the aorta: capillaries exist, and here veins commence. In the perch the glandular body is not in one compact mass, but scattered about its interior.—(Quekett, Trans. Microp. Soc., i, 1844, p. 100).

If we examine the *Physostomi*, or those families in which a pneumatic duct exists throughout life, forming a communication between the interior of the air-bladder and the upper portion of the alimentary canal, we find the majority of such are fresh-water forms,* situated between the Physoclisti on one hand

* The majority of marine Physostomi are littoral, or surface swimmers, often weak forms, which have to escape pursuit of enemies while rapidly rising to the surface.

and the Dipnoids and Ganoids on the other. This pneumatic tube possesses the same coats as the air-bladder, is of various lengths, and said to be occasionally tortuous. As a rule it opens upon the dorsal surface of the alimentary canal, but in some of the herring family directly into the stomach. The glandular body observed upon as existing inside the air-bladders of the Physoclisti, is not so well developed, as a rule* in the Physostomi.

As this pneumatic tube has no muscular coat it can hardly alter in its diameter except when acted upon by other forces, it would therefore be useless for inspiration.

If we examine a carp we find its air-bladder is generally a simple sac, with a constriction between its anterior third and posterior two-thirds, but not sufficient to close the communication. From the posterior portion of the air-bladder† springs the pneumatic tube, as already described; or else this organ may be in the form of two rounded portions placed side by side beneath the bodies of some of the anterior vertebræ, and not communicating with each other: but the two pneumatic tubes coalesce previous to entering the dorsal wall of the alimentary canal. Not only in the *Cyprinidæ* but also in the *Characinidæ* and *Siluridæ* a chain of auditory ossicles connects the air-bladder with the internal ear, instead of a tube filled with gas, as remarked upon in the Physoclisti. Three ossicles on either side pass forwards along the under surface of the body of the first vertebra, connecting the outer wall of the air-bladder with the atria of the vestibule. These ossicles were first pointed out by Weber; and since his time it has been shown that they belong, like the capsules of the special organs of sense, to the Splanchnoskeleton.

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* In the eel there are two, placed one on each side of the duct communicating between its two portions: the distribution of its vessels in the upper compartment of its air-bladder Quekett likened to the cellular lung of reptiles.

† In carps the anterior portion of the air-bladder is very elastic, the posterior but slightly so. Müller observed that "in proportion as the fish rises in the water the anterior bladder, which is the most elastic, must considerably increase in volume, and thus keep the head of the animal up, while the contrary must be the case when the fish descends."

In the same family, or that of carps, we find a curious form of loach, *Botia*, in the East Indies, that can scarcely be said to be entirely a ground feeder, but seems intermediate in habits between the true carp and the grovelling loaches. It has the anterior portion of its air-bladder, or what may be termed the acoustic part, more or less enclosed in bone, this being formed from the parapophyses of some of the anterior cervical vertebræ. All fish with the air-vessel enclosed in bone are bottom feeders, and very few are destitute of barbels. In the true ground feeding loaches, as the *Nemacheilus* and *Cobitis*, it almost appears as if the posterior two-thirds of the air-bladder, in its hydrostatic portion, were deficient; the organ being in the form of two rounded lobes, placed side by side, below the bodies of some of the anterior cervical vertebræ, where they are almost entirely enclosed in bone. The pneumatic tube, however, is still found to exist. In another exclusively ground feeding form of carp, *Homalopterina*, in the East Indies, and in which the lower surface of its body appears flat, and its general conformation refers to its habit of clinging close to stones at the bottom of streams, we find the air-bladder entirely wanting.

Another fresh-water family of Physostomi, the *Characinidæ*, residents of tropical Africa and America, are exceedingly interesting, as regards how this organ is modified in respect to hearing; a chain of auditory ossicles extending from it to the internal ear, as observed in the Cyprinidæ. While in *Erythrinus* we perceive a most interesting link between the Physostomous Teleosteans on one hand and the air-breathing Ganoids on the other, for in this genus although the air-bladder is above the alimentary canal, the pneumatic tube pierces the left side of the throat. The air-bladder is likewise sub-divided by fibrous partitions, but whether such are exceedingly vascular or not, whether this organ is used for respiration or simply for flotation, there does not appear at present to be evidence upon which to decide.

The extensive fresh-water Physostomous family (which has likewise some marine representatives) of *Siluridæ*, or sheat fishes, is very abundant in the tropics. Among them the air-bladder is remarkably modified, in the majority of instances

being apparently more useful for auditory than for hydrostatic functions, and as a general rule being smaller in fresh-water than in marine species. These fishes are evidently closely allied to the Cyprinidæ, and in one respect, the air-bladder, shows a somewhat similar modification. I have remarked how in the grovelling loach and some allied forms it is more or less enveloped in a bony capsule, and this is seen both in European and Asiatic forms, all of which, however, may be said to be ground feeders. The *Siluridæ* of Asia likewise live the life of ground feeders, and the power of employing their air-bladder as a float appears to be subservient to that of hearing. In the marine forms it has thickened walls, and the parapophyses of the first vertebræ (ex. *Arius subrostratus*) form expanded plates, to the under surface of which this organ is attached. As we go inland, especially towards the Himalayas, this organ becomes more and more enveloped in bone until it is as we find it in the loaches, while, like the Cyprinidæ, a chain of ossicles passes forwards to the internal ear. In the marine forms the broad plate on its upper surface and bony stays to its partitions would appear to exist for the purpose of counteracting superincumbent pressure; while in the fresh-water forms this bony covering, being greatly increased, would seem to be due to some fresh-water physical cause, not to a tropical climate, as I have observed the same phenomenon is seen in European loaches. The number of fresh-water genera existing among the Dipnoids of India and Burmah is twenty-five, out of which fourteen have the air-bladder more or less enclosed in bone; and, as all are ground feeders, one reason at least must be to prevent undue pressure on that organ when at great depths, and to preclude any abnormal interference with the function of hearing.

The chain of auditory ossicles which connect the air-bladder with the internal ear is confined, so far as I am aware,* to the

* Most probably this chain of ossicles will be found in some other fresh-water families, but which I have not yet had the opportunity of investigating. Since this paper was read I have discovered that auditory ossicles are present in the fresh-water family *Gymnarchidæ* of the Nile: a fish which possesses a cellular air-bladder that appears to have a lung-like function.

fresh-water Cyprinidæ, Characinidæ, and Siluridæ, all of which are physostomous, while that having the lowest organization, its opercular pieces being incomplete, is the Siluridæ, and which alone has marine representatives. Whether further investigations will confirm this time alone must show, but if such should prove to be the rule, it would seem that this family forms a connecting link between such as are marine with those which exclusively belong to the fresh-water.

Among the marine Physostomous forms all that have been examined, I believe, and in which communications exist between the air-bladder and internal ear, have such by means of cœcal prolongations from the air-bladder, and not by a chain of auditory ossicles, which appear to be absent in marine fishes. This leads one to enquire whether there are any fresh-water fishes that have this connection, as observed in sea forms. The perch has no auditory ossicles, and I should think his origin may be given as marine; and the same conclusion may be come to of the trout and anadromous salmon. I have frequently thought over which theory is most probable among the Salmonidæ, whether they were originally marine forms, some of which have taken to a fresh-water life? or whether they were originally fresh-water, and some had chosen the sea to live in, but returned to breed in their original homes? The great number of cœcal appendages, which are most developed in the marine forms, has always led me to consider that these fishes were originally inhabitants of the ocean; and now that I find the connecting link between the air-bladder and internal ear is not formed by a chain of auditory ossicles, still further probability seems to be added to this view.

In conclusion, I think it may be affirmed that the air-bladder in fishes is the homologue of the lungs of the superior vertebrate forms; that in some of the higher sub-classes it serves as a lung, depurating the blood; that in the majority of true or Teleostean fishes it is employed for one or both of the following purposes,—as a float, enabling its owner, by compressing or dilating it, to sink or rise to any desired level in the water; or, secondly, that it assists hearing, by communicating with the

internal ear: that in those forms in which it has an auditory function, we perceive two very distinct modifications, in marine Physoclisti a prolongation of the air-bladder itself passes forwards to the interior of the skull, while in fresh-water Physostomi the connection is by means of a string of auditory ossicles; that in such fishes as live the life of ground feeders a still further modification may take place, in the air-bladder itself being more or less completely surrounded by osseous walls, formed by the growth of the parapophyses of some of the anterior vetebræ.