with that of the Bunter, which was formed by a river coming from North-West Scotland.

21. There is a correspondence between the characteristics of the micropetrography of the Bunter, Keuper, and modern delta formations. The Leicestershire Trias shows signs of chemical action, the Nile delta of mechanical. The chemical composition of volcanic and metamorphic rocks locally argues a local as well as a distant source for the heavier minerals of the Keuper.

22. The evidence of the flora and fauna shows that there were provinces, and these were so arranged as to allow for the prevalence of delta conditions. The climate was moist and equable.

Finally, we conclude that there is nothing to prove that desert conditions did anything more than locally act upon the rocks mechanically, and to some extent chemically. *They had no part whatever in the work of deposition;* that is to say, they disintegrated the previous rocks (pre-Triassic). There is positive, direct, and accumulative evidence to prove that the Trias as a whole (and not the Bunter only) was the work of rivers which had continued to bring sediment in one form or another from the north-west of Britain or the north more or less continuously, under one condition or another, from the close of the marine phase of Lower Carboniferous (Mountain Limestone) times.

NOTICES OF MEMOIRS.

I.—British Association for the Advancement of Science. Sheffield, 1910. Address by the Rev. Professor T. G. Bonney, Sc.D., LL.D., F.R.S., President.[1]

. . . .

I DO not propose, as you might naturally expect, to discuss some branch of petrology; though for this no place could be more appropriate than Sheffield, since it was the birthplace and the lifelong home of Henry Clifton Sorby, who may truly be called the father of that science. This title he won when, a little more than sixty years ago, he began to study the structure and mineral composition of rocks by examining thin sections of them under the microscope. A rare combination of a singularly versatile and active intellect with accurate thought and sound judgment, shrewd in nature, as became a Yorkshireman, yet gentle, kindly, and unselfish, he was one whom his friends loved and of whom this city may well be proud. Sorby's name will be kept alive among you by the Professorship of Geology which he has endowed in your University; but, as the funds will not be available for some time, and as that science is so intimately connected with metallurgy, coal-mining, and engineering, I venture to express a hope that some of your wealthier citizens will provide for the temporary deficiency, and thus worthily commemorate one so distinguished.

[1] We regret that our limited space prevents the insertion of the full text of Professor Bonney's Address. Thus the statement of facts relating to the Drifts of Britain have been omitted, but the main arguments relating to the interpretation of the phenomena have been retained.

But to return. I have not selected petrology as my subject, partly because I think that the great attention which its more minute details have of late received has tended to limit rather than to broaden our views, while for a survey of our present position it is enough to refer to the suggestive and comprehensive volume published last year by Mr. A. Harker;[1] partly, also, because the discussion of any branch of petrology would involve so many technicalities that I fear it would be found tedious by a large majority of my audience. . . . I purpose, then, to ask your attention this evening to some aspects of the glacial history of Western Europe.

. . . Much light will be thrown on this complex problem by endeavouring to ascertain what snow and ice have done in some region which, during the Glacial Epoch, was never submerged, and none better can be found for this purpose than the European Alps.

. . . .

In certain mountain regions, especially those where strong limestones, granites, and other massive rocks are dominant, the valleys are often trench-like, with precipitous sides, having cirques or corries at their heads, and with rather wide and gently sloping floors, which occasionally descend in steps, the distance between these increasing with that from the watershed. Glaciers have unquestionably occupied many of these valleys, but of late years they have been supposed to have taken a large share in excavating them. In order to appreciate their action we must imagine the glens to be filled up and the district restored to its former condition of a more or less undulating upland. As the mean temperature[2] declined snow would begin to accumulate in inequalities on the upper slopes. This, by melting and freezing, would soften and corrode the underlying material, which would then be removed by rain and wind, gravitation, and avalanche. In course of time the hollow thus formed would assume more and more the outlines of a corrie or a cirque by eating into the hillside. With an increasing diameter it would be occupied, as the temperature fell, first by a permanent snow-field, then by the *névé* of a glacier. Another process now becomes important, that called 'sapping'. While ordinary glacier-scour tends, as we are told, to produce "sweeping curves and eventually a graded slope", 'sapping' produces "benches and cliffs, its action being horizontal and backwards", and often dominant over scour. The author of this hypothesis[3] convinced himself of its truth in the Sierra Nevada. . . . Beneath the *névé* the temperature would be uniform, so its action would be protective, except where it set up another kind of erosion, presently to be noticed; but in the chasm, we are informed, there would be, at any rate for a considerable part of the year, a daily alternation of freezing and thawing. Thus the cliff would be rapidly undermined and be carried back into the mountain slope, so that before long the glacier would nestle in a shelter of its own making. Farther down the valley the

[1] *The Natural History of Igneous Rocks*, 1909.

[2] In the remainder of this Address 'temperature' is to be understood as mean temperature. The Fahrenheit scale is used.

[3] W. D. Johnson, *Science*, N.S., vol. ix, pp. 106, 112, 1899.

moving ice would become more effective than sub-glacial streams in deepening its bed; but since the *névé*-flow is almost imperceptible near the head, another agency must be invoked, that of 'plucking'. The ice grips, like a forceps, any loose or projecting fragment in its rocky bed, wrenches that from its place, and carries it away. The extraction of one tooth weakens the hold of its neighbours, and thus the glen is deepened by 'plucking', while it is carried back by 'sapping'. Streams from melting snows on the slopes above the amphitheatre might have been expected to co-operate vigorously in making it, but of them little account seems to be taken, and we are even told that in some cases the winds probably prevented snow from resting on the rounded surface between two cirque-heads.[1] As these receded, only a narrow neck would be left between them, which would be ultimately cut down into a gap or 'col'. Thus a region of deep valleys with precipitous sides and heads, of sharp ridges, and of more or less isolated peaks is substituted for a rather monotonous, if lofty, highland.

The hypothesis is ingenious, but some students of Alpine scenery think more proof desirable before they can accept it as an axiom.

. . . .

But even if 'sapping and plucking' were assigned a comparatively unimportant position in the cutting out of cirques and corries, it might still be maintained that the glaciers of the Ice Age had greatly deepened the valleys of mountain regions. That view is adopted by Professors Penck and Brückner in their work on the glaciation of the Alps,[2] the value of which even those who cannot accept some of their conclusions will thankfully admit. On one point all parties agree—that a valley cut by a fairly rapid stream in a durable rock is V-like in section. . . . It is also agreed that a valley excavated or greatly enlarged by a glacier should be U-like in section. But an Alpine valley, especially as we approach its head, very commonly takes the following form. For some hundreds of feet up from the torrent it is a distinct V; above this the slopes become less rapid, changing, say, from 45° to not more than 30°, and that rather suddenly. Still higher comes a region of stone-strewn upland valleys and rugged crags, terminating in ridges and peaks of splintered rock, projecting from a mantle of ice and snow. The V-like part is often from 800 to 1000 feet in depth, and the above-named authors maintain that this, with perhaps as much of the more open trough above, was excavated during the Glacial Epoch. Thus the floor of any one of these valleys prior to the Ice Age must often have been at least 1800 feet above its present level. As a rough estimate we may fix the deepening of one of the larger Pennine valleys, tributary to the Rhone, to have been, during the Ice Age, at least 1600 feet in their lower parts. Most of them are now hanging valleys; the stream issuing, on the level of the main river, from a deep gorge. Their tributaries are rather variable in form; the larger as a rule being more or less V-shaped; the shorter, and especially the smaller, corresponding more with the upper part

[1] This does not appear to have occurred in the Alps.
[2] *Die Alpen in Eiszeitalter*, 1909.

of the larger valleys; but their lips generally are less deeply notched. Whatever may have been the cause, this rapid change in slope must indicate a corresponding change of action in the erosive agent. Here and there the apex of the V may be slightly flattened, but any approach to a real U is extremely rare. The retention of the more open form in many small, elevated recesses, from which at the present day but little water descends, suggests that where one of them soon became buried under snow, but was insignificant as a feeder of a glacier, erosion has been for ages almost at a standstill.

The V-like lower portion in the section of one of the principal valleys, which is all that some other observers have claimed for the work of a glacier, cannot be ascribed to subsequent modification by water, because ice-worn rock can be seen in many places, not only high up its sides, but also down to within a yard or two of the present torrent.

Thus valley after valley in the Alps seems to leave no escape from the following dilemma: Either a valley cut by a glacier does not differ in form from one made by running water, or one which has been excavated by the latter, if subsequently occupied, is but superficially modified by ice.

. . . .

Many lake-basins have been ascribed to the erosive action of glaciers. Since the late Sir A. Ramsay advanced this hypothesis numbers of lakes in various countries have been carefully investigated and the results published, the most recent of which is the splendid work on the Scottish lochs by Sir J. Murray and Mr. L. Pullar.[1] . . . Even these latest researches have not driven me from the position which I have maintained from the first—namely, that while many tarns in corries and lakelets in other favourable situations are probably due to excavation by ice, as in the mountainous districts of Britain, in Scandinavia, or in the higher parts of the Alps, the difficulty of invoking this agency increases with the size of the basin—as, for example, in the case of Loch Maree or the Lake of Annecy—till it becomes insuperable. Even if Glas Llyn and Llyn Llydaw were the work of a glacier, the rock-basins of Gennesaret and the Dead Sea, still more those of the great lakes in North America and in Central Africa, must be assigned to other causes.

I pass on, therefore, to mention another difficulty in this hypothesis—that the Alpine valleys were greatly deepened during the Glacial Epoch—which has not yet, I think, received sufficient attention. From three to four hundred thousand years have elapsed, according to Penck and Brückner, since the first great advance of the Alpine ice. One of the latest estimates of the thickness of the several geological formations assigns 4000 feet[2] to the Pleistocene and Recent, 13,000 to the Pliocene, and 14,000 to the Miocene. If we assume the times of deposit to be proportional to the thicknesses, and adopt the larger figure for the first-named period, the duration of the Pliocene would

[1] *Bathymetrical Survey of the Scottish Freshwater Lochs*, by Sir J. Murray and Mr. L. Pullar, 1910.

[2] I have doubts whether this is not too great.

be 1,300,000 years, and of the Miocene 1,400,000 years. To estimate the total vertical thickness of rock which has been removed from the Alps by denudation is far from easy, but I think 14,000 feet would be a liberal allowance, of which about one-seventh is assigned to the Ice Age. But during that age, according to a curve given by Penck and Brückner, the temperature was below its present amount for rather less than half (·47) the time. Hence it follows that, since the sculpture of the Alps must have begun at least as far back as the Miocene period, one-seventh of the work has been done by ice in not quite one-fifteenth of the time, or its action must be very potent. Such data as are at our command make it probable that a Norway glacier at the present day lowers its basin by only about 80 millimetres in 1000 years, a Greenland glacier may remove some 421 millimetres in the same time, while the Vatnajökul in Iceland attains to 647 millimetres. If Alpine glaciers had been as effective as the last-named, they would not have removed, during their 188,000 years of occupation of the Alpine valleys, more than 121·6 metres, or just over 397 feet; and as this is not half the amount demanded by the more moderate advocates of erosion, we must either ascribe an abnormal activity to the vanished Alpine glaciers, or admit that water was much more effective as an excavator.

We must not forget that glaciers cannot have been important agents in the sculpture of the Alps during more than part of Pleistocene times. That sculpture probably began in the Oligocene period; for rather early in the next one the great masses of conglomerate, called *Nagelfluh*, show that powerful rivers had already carved for themselves valleys corresponding generally with and nearly as deep as those still in existence. Temperature during much of the Miocene period was not less than 12° F. above its present average. This would place the snow-line at about 12,000 feet.[1] In that case, if we assume the altitudes unchanged, not a snow-field would be left between the Simplon and the Maloja, the glaciers of the Pennines would shrivel into insignificance, Monte Rosa would exchange its drapery of ice for little more than a tippet of frozen snow. As the temperature fell the white robes would steal down the mountain-sides, the glaciers grow, the torrents be swollen during all the warmer months, and the work of sculpture increase in activity. Yet with a temperature even 6° higher than it now is, as it might well be at the beginning of the Pliocene period, the snow-line would be at 10,000 feet; numbers of glaciers would have disappeared, and those around the Jungfrau and the Finster Aarhorn would be hardly more important than they now are in the Western Oberland.

But denudation would begin so soon as the ground rose above the sea. Water, which cannot run off the sand exposed by the retreating tide without carving a miniature system of valleys, would never leave the nascent range intact. The Miocene Alps, even before a patch of

[1] I take the fall of temperature for a rise in altitude as 1° F. for 300 feet, or, when the differences in the latter are large, 3° per 1000 feet. These estimates will, I think, be sufficiently accurate. The figures given by Hann (see for a discussion of the question, Report of Brit. Assoc., 1909, p. 93) work out to 1° F. for each 318 feet of ascent (up to about 10,000 feet).

snow could remain through the summer months, would be carved into glens and valleys. Towards the end of that period the Alps were affected by a new set of movements, which produced their most marked effects in the northern zone from the Inn to the Durance. The Oberland rose to greater importance; Mont Blanc attained its primacy; the massif of Dauphiné was probably developed. That, and still more the falling temperature, would increase the snow-fields, glaciers, and torrents. The first would be, in the main, protective; the second, locally abrasive; the third, for the greater part of their course, erosive. No sooner had the drainage system been developed on both sides of the Alps than the valleys on the Italian side (unless we assume a very different distribution of rainfall) would work backwards more rapidly than those on the northern. Cases of trespass, such as that recorded by the long level trough on the north side of the Maloja Kulm and the precipitous descent on the southern, would become frequent. In the Interglacial episodes—three in number, according to Penck and Brückner, and occupying rather more than half the epoch—the snow and ice would dwindle to something like its present amount, so that the water would resume its work. Thus I think it far more probable that the V-like portions of the Alpine valleys were in the main excavated during Pliocene ages, their upper and more open parts being largely the results of Miocene and yet earlier sculpture.

During the great advances of the ice, four in number, according to Penck and Brückner,[1] when the Rhone glacier covered the lowlands of Vaud and Geneva, welling on one occasion over the gaps in the Jura, and leaving its erratics in the neighbourhood of Lyons, it ought to have given signs of its erosive no less than of its transporting power. But what are the facts? In these lowlands we can see where the ice has passed over the Molasse (a Miocene sandstone); but here, instead of having crushed, torn, and uprooted the comparatively soft rock, it has produced hardly any effect. The huge glacier from the Linth Valley crept for not a few miles over a floor of stratified gravels, on which, some 8 miles below Zurich, one of its moraines, formed during the last retreat, can be seen resting, without having produced more than a slight superficial disturbance. We are asked to credit glaciers with the erosion of deep valleys and the excavation of great lakes, and yet, wherever we pass from hypotheses to facts, we find them to have been singularly inefficient workmen!

I have dwelt at considerable, some may think undue, length on the Alps, because we are sure that this region from before the close of the Miocene period has been above the sea-level. It accordingly demonstrates what effects ice can produce when working on land.

In America also, to which I must now make only a passing reference, great ice-sheets formerly existed: one occupying the district west of the Rocky Mountains, another spreading from that on the north-west of Hudson's Bay, and a third from the Laurentian hill-country. These two became confluent, and their united ice-flow covered the region of the Great Lakes, halting near the eastern coast a little south

[1] On the exact number I have not had the opportunity of forming an opinion.

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of New York, but in Ohio, Indiana, and Illinois occasionally leaving moraines only a little north of the 39th parallel of latitude. Of these relics my first-hand knowledge is very small, but the admirably illustrated reports and other writings of American geologists indicate that, if we make due allowance for the differences in environment, the tills and associated deposits on their continent are similar in character to those of the Alps.

In our own country and in corresponding parts of Northern Europe we must take into account the possible co-operation of the sea. In these, however, geologists agree that, for at least a portion of the Ice Age, glaciers occupied the mountain districts. Here ice-worn rocks, moraines and perched blocks, tarns in corries, and perhaps lakelets in valleys, demonstrate the former presence of a mantle of snow and ice. Glaciers radiated outwards from more than one focus in Ireland, Scotland, the English Lake District, and Wales, and trespassed, at the time of their greatest development, upon the adjacent lowlands. They are generally believed to have advanced and retreated more than once, and their movements have been correlated by Professor J. Geikie with those already mentioned in the Alps. Into that very difficult question I must not enter; for my present purpose it is enough to say that in early Pleistocene times glaciers undoubtedly existed in the mountain districts of Britain and even formed piedmont ice-sheets on the lowlands. On the west side of England, smoothed and striated rocks have been observed near Liverpool, which can hardly be due to the movements of shore-ice. . . . On the eastern side of England similar markings have been found down to the coast of Durham, but a more southern extension of land ice cannot be taken for granted. In this direction, however, so far as the tidal valley of the Thames, and in corresponding parts of the central and western lowlands, certain deposits occur which, though to a great extent of glacial origin, are in many respects different from those left by land ice in the Alpine regions and in Northern America.

They present us with problems the nature of which may be inferred from a brief statement of the facts.[1]

. . . .

(*To be concluded in our next Number.*)

II.—British Association for the Advancement of Science, Eightieth Annual Meeting, held at Sheffield, September 1–7, 1910. List of Titles of Papers read in Section C (Geology) and in other Sections bearing upon Geology.

Presidential Address by *Dr. A. P. Coleman, F.R.S.*

Cosmo Johns.—The Yoredale Series and its equivalents elsewhere.

Dr. J. E. Marr, F.R.S., & W. G. Fearnsides, M.A.—The Palæozoic Rocks of Cautley (Sedbergh).

Miss G. R. Watney & Miss E. G. Welch.—The Graptolitic Zones of the Salopian Rocks of the Cautley Area (Sedbergh).

Professor J. Joly, D.Sc., F.R.S.—Pleochroic Halos.

[1] See footnote on p. 463, at the commencement of the President's Address.

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Dr. J. D. Falconer.—Outlines of the Geology of Northern Nigeria.
Dr. F. H. Hatch.—The Geology of Natal.
Cosmo Johns.—The Geology of the Sheffield District.
Professor A. McWilliam.—The Metallurgical Industries in relation to the Rocks of the District.
T. Sheppard.—The Humber during the Human Period.
Dr. Tempest Anderson.—Matavanu, a new Volcano in Savaii (German Samoa).
Rev. E. C. Spicer, M.A.—On present Trias Conditions in Australia.
Dr. Wm. H. Hobbs.—Some considerations concerning the Alimentation and the Losses of existing Continental Glaciers.
Dr. J. Milne, F.R.S.—Seismological Report.
Mrs. M. M. Ogilvie Gordon, D.Sc.—Thrust Masses in the Western District of the Dolomites.
Professor J. W. Gregory, D.Sc., F.R.S.—On the Geology of Cyrenaica.
Marmaduke Odling.—An Undescribed Fossil from the Chipping Norton Limestone.
Professor Edward Hull, LL.D., F.R.S.—The Glacial Rocks of Ambleside.
Dr. C. H. Lees, F.R.S.—Mountain Temperatures and Radium.
John Parkinson.—Notes on the Geology of the Gold Coast.
A. D. Hall, F.R.S., & Dr. E. J. Russell.—The Objects and Scope of Soil Surveys.
L. F. Newman.—Drift Soils of Norfolk.
C. T. Cimingham.—The Teart Land of Somerset.
Sir T. H. Holland, F.R.S.—The Cause of Gravity Variations in Northern India.
Discussion on the concealed Coal-field of Notts, Derbyshire, and Yorkshire. Opened by *Professor P. F. Kendall, M.Sc., & Dr. Walcot Gibson.*
H. Culpin.—The Marine Bands in the Coal-measures of South Yorkshire.
W. H. Dyson.—The Maltby Deep Boring.
Miss M. C. Stopes, D.Sc., Ph.D.—Structural Petrifactions from the Mesozoic, and their bearing on Fossil Plant Impressions.
Dr. L. Moysey.—On some Rare Fossils from the Derbyshire and Notts Coal-field.
A. R. Horwood.—The Origin of the British Trias.
Rev. A. Irving, D.Sc., B.A.—On a Buried Tertiary Valley through the Mercian Chalk Range, and its later "Rubble Drift", etc.
Cosmo Johns.—The Geological Significance of the Nickel-Iron Meteorites.
Ernest Dixon, B.Sc.—The Geology of the Titterstone Clee Hills.
Reports on—
Erratic Blocks.
Crystalline Rocks of Anglesey.
Faunal Succession in the Carboniferous Limestone.
Critical Sections in the Palæozoic Rocks.
Charnwood Rocks.
Rocks of Glensaul.
Correlation and Age of South African Strata.

Geological Photographs.
Fossil Flora and Fauna of the Midland Coal-fields.
Topographical and Geological Terms used locally in South Africa.
Dr. A. Irving, D.Sc., B.A.—The pre-Oceanic Stage of Planetary Development.

List of Titles of papers read in other Sections bearing upon Geology:—

SECTION A.—PHYSICAL SCIENCE.

Sir Norman Lockyer, K.C.B.—Chemistry of the Stars.

SECTION E.—GEOGRAPHY.

O. G. S. Crawford.—A Regional Survey of the Andover District.
J. Cossar.—A Regional Survey of Midlothian.
H. Brodrick.—The Underground Waters of the Castleton District.
Dr. C. A. Hill.—Further Exploration in the Mitchelstown Cave.

SECTION H.—ANTHROPOLOGY.

Presidential Address by *W. Crooke, B.A.*
A. M. Woodward & H. A. Ormerod.—A Primitive Site in South-West Asia Minor.
A. J. B. Wace & M. S. Thompson.—Excavations in Thessaly.
Professor R. C. Bosanquet.—The work of the Liverpool Committee for Excavation and Research in Wales and the Marches.
Professor W. M. Flinders Petrie.—The Excavations at Memphis.
Dr. C. G. Seligmann.—On a Neolithic Site in the Southern Sudan.
Dr. T. Ashby.—Excavations at Hagiar Kim and Mnaidra, Malta.
H. D. Acland.—Prehistoric Monuments in the Scilly Isles.
Alexander Sutherland.—On the Excavation of the Broch of Cogle, Watten, Caithness.
G. Clinch.—Unexplored Fields in British Archæology.
Report of a Committee to investigate the Lake Villages in the neighbourhood of Glastonbury.
Report of a Committee to ascertain the Age of Stone Circles.
Rev. Dr. Irving.—On a Prehistoric Horse found at Bishop's Stortford.

SECTION K.—BOTANY.

Professor F. O. Bower.—Semi-popular lecture on Sand-dunes and Golf-links.
Professor F. O. Bower.—On two Synthetic Genera of Filicales.
Professor D. T. Gwynne-Vaughan.—On the Fossil genus *Tempskya.*
Dr. M. C. Stopes.—Further Observations on the Fossil Flower.

ABSTRACTS OF PAPERS READ IN SECTION C (GEOLOGY) AT THE MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, SHEFFIELD, SEPTEMBER 1, 1910.

III.—THE COAL-MEASURES OF THE CONCEALED YORKSHIRE, NOTTINGHAMSHIRE, AND DERBYSHIRE COAL-FIELD. By WALCOT GIBSON, D.Sc.

ON the map accompanying Mr. Currer Brigg's Report on District D in the Final Report of the Royal Commission on Coal Supplies for 1905 a triangular area having its apex at the Haxey (South Carr) boring is marked off as the proved extent of the concealed coal-field. The area thus defined amounts to about 460 square miles. To this, as the result of information obtained from several borings for coal completed since 1905, there can be added about 200 square miles situated north-east of Haxey and about 200 square miles lying south-east of Haxey. Much information has also been collected in the proved coal-field. The new material, so far as it relates to the Coal-measures, may be considered under (1) shape of the Palæozoic floor, (2) character of the measures, (3) the workable seams that are likely to occur within 4000 feet depth, and (4) their probable extension beyond the limits considered as proved in the Report of 1905.

1. *Palæozoic Floor.*—Between the outcrop of the Magnesian Limestone and the River Trent, north of Nottingham, the Permian rests on a uniform plain with a slope not exceeding two degrees and having a general direction to the east or a little north of east. Over the faulted area, south of Nottingham, the uniformity of slope has been broken; but outside the faulted belt the same even surface is maintained between Ruddington, Edwalton, and Owthorpe.

2. *Character of the Measures.*—The Barlow (Selby) boring in the north, the Thorne boring in the east, and that of Owthorpe in the south show that the Coal-measures immediately beneath the newer formations belong to an horizon several hundred feet above the Top Hard or Barnsley Coal, which is a high and most valuable seam in the coal-field. In these measures a marine band (20 to 50 feet thick) lies between 520 feet (Oxton boring) and 629 feet (Mansfield Colliery) above the Top Hard Coal in Nottinghamshire, and, as ascertained by Mr. Culpin at Brodsworth and Bentley and by Mr. Dyson at Maltby, between 670 and 705 feet above the Barnsley Coal in Yorkshire. The fauna, exclusively marine, is represented by fifty species distributed among thirty-seven genera. Many of the forms occur in the shales below the Millstone Grits, and a few represent survivors from the Carboniferous Limestone. The persistence, thickness, and fauna of the bed indicate a general and a fairly prolonged incursion of the open sea during late Middle Coal-measures. Minor incursions are represented by a few thin beds occurring above and below this horizon in Nottinghamshire and Yorkshire. The thickness of the measures as a whole increases to the north and diminishes to the east.

3. *The Workable Seams.*—All the borings and sinkings strike Coal-measures above the chief marine bed; but, except at Oxton and Maltby, both situated in the proved coal-field, the Upper Coal-measures have been completely removed by pre-Permian denudation. The seams above the Top Hard Coal and Barnsley Coal are irregular in their occurrence and of uncertain quality. In the Doncaster and Thorne area the Dunsil Coal 50 feet below the Barnsley bed appears to be a valuable seam, but it deteriorates south of Doncaster. Most of the lower coals over the recently proved extension of the coal-field lie beyond the limit of profitable working. The future resources of the coal-field therefore mainly depend upon the thickness, quality, and depth of the Top Hard or Barnsley Coal.

4. *Extension.*—As a result of the explorations made since the Report of 1905 the proved limit of the concealed coal-field may with some

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confidence be extended to a line joining Selby, Thorne, Haxey, and Owthorpe, but the quality and thickness of the coal cannot be foretold. There is no conclusive evidence to show whether, north of Thorne, the Barnsley Coal will take on the inferior character which it assumes north-east and east of Wakefield under the name of the Warren House Coal, and whether the thinning out of the Top Hard Coal observable in some of the collieries south of Mansfield will continue to the east.

A further extension north of the Ouse, east of the Trent, and south-east of Owthorpe is probable, but it is important to bear in mind how much there must be of conjecture in any conclusions arrived at from the slender evidence at present available.

IV.—The Graptolitic Zones of the Salopian Rocks of the Cautley Area near Sedbergh, Yorkshire. By Miss G. R. Watney and Miss E. G. Welch.

We have obtained the following zones in the Ludlow Rocks in descending order:—

1. *Monograptus leintwardinensis* (Hopk.)	Lower Bannisdale Slates.
2. *Monograptus Nilssoni* (Barr.)	Coniston Grits. U. Coldwell Beds.
3. *Monograptus vulgaris* (Wood)	M. Coldwell Beds.

In the Wenlock the following zones have been found in descending order:—

1. *Cyrtograptus Lundgreni* (Tullb.)	L. Coldwell Beds. Brathay Flags.
2. *Cyrtograptus Linnarssoni* (Lapw.) *Cyrtograptus symmetricus* (Elles)	Brathay Flags.
3. *Monograptus riccartonensis* (Lapw.)	Brathay Flags.
4. *Cyrtograptus Murchisoni* (Carr)	Brathay Flags.

These zones are comparable with those discovered by Miss Elles[1] and Mrs. Shakespear[1] in Wales and the Welsh Borderland[1]; though we have not yet succeeded in finding all the zones which they record we hope shortly to establish them in this area.

V.—Structural Petrifactions from the Mesozoic, and their bearing on Fossil Plant Impressions. By Miss M. C. Stopes, D.Sc., Ph.D., F.L.S.

The paper dealt with the importance of the structural petrifactions in the Carboniferous, e.g. exposure of the true nature of so many supposed 'ferns'; with the need of similar petrifactions from beds of Mesozoic age; and the danger of inferences drawn from plant *impressions*, e.g. untrustworthiness of many of Heer's and Ettingshausen's systematic determinations.

The discovery of true petrifactions in the Cretaceous, the nature of the flora contained in the nodules, and unusual points in its composition were considered. Special illustrations of its interest are: *Yezonia*, a new type of which the external appearance gives no clue to its nature; the discovery of the first-known flower with its anatomy petrified; and of the internal anatomy of the leaves of *Nilssonia*, long well known as impressions.

[1] Q.J.G.S., 1900.

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VI.—Notes on the Lower Palæozoic Rocks of the Cautley District, Sedbergh, Yorks. By J. E. Marr, Sc.D., F.R.S., and W. G. Fearnsides, M.A., F.G.S.

THE general succession is well known. The following additions to our knowledge of the various divisions have been recently obtained by us:—

Salopian.—Divisible into Lower Ludlow Rocks (Bannisdale Slates, Coniston Grits, and Coldwell Beds) above, and Wenlock Rocks (Brathay Flags) below. The calcareous gritty flags with *Phacops obtusicaudatus* are found here at the base of the Coldwell Beds, and form a ready line of separation between the Ludlow and Wenlock graptolitiferous strata. The Salopian graptolitic zones are being worked out by Miss G. R. Watney and Miss E. G. Welch.

Valentian.—The succession as described by one of us with the late Professor Nicholson was incomplete. We have now found a section in Watley Gill which nearly completes the sequence. In that beck the *Monograptus argenteus*, *M. fimbriatus*, and *Dimorphograptus* zones of the Skelgill Beds are found with their intercalated Trilobite beds, the higher graptolitic zones being absent owing to a fault which repeats the *Dimorphograptus* beds. The *argenteus* zone contains the type fossil and its usual associates, and exhibits the 'green streak' seen in the Lake District and in North Wales.

Ashgillian.—The Ashgill Shales have long been known here. The basal *Staurocephalus* Limestone appears to be represented by a greyish argillaceous limestone in Taith's Gill, which succeeds the Caradocian rocks with perfect conformity, and yields abundance of *Remopleurides radians* and other fossils; also by a similar limestone in the same position in Backside Beck, with badly preserved Trilobites, etc.

Caradocian.—Black calcareous shales with their argillaceous limestones containing a very rich Caradocian fauna, recalling that of the Trinucleus Shales of Sweden. The fauna is being worked at and separated from that of the Ashgillian Beds.

VII.—On some Rare Fossils from the Derbyshire and Nottinghamshire Coal-field. By L. Moysey, B.A., M.B., B.C., F.G.S.

IN the temporary museum in connexion with this section there will be found a collection of fossils illustrating some of the rarer forms of the Coal-measure fauna obtained during the last eight years from this district. From these it has been thought desirable to select some, mainly fragmentary specimens, for more detailed description, in the hope that they may be of assistance in the identification of other more perfect specimens, should such be obtained, and that a discussion on their many perplexing features may lead to a more definite idea as to their affinities.

Specimen 1, from Shipley, near Ilkeston, Derbyshire. These minute bodies, about 3 mm. long, are evidently the valves of the carapace of a Phyllopod. A similar fossil was described by Lea[1] from Pennsylvania under the name of *Cypricardia leidyi*. Professor T.

[1] Proc. Acad. Nat. Sc. Philadelphia, vol. vii, pt. iv, p. 341, 1855.

Rupert Jones[1] gave it the name of *Leaia leidyi*, and described two varieties, one *L. leidyi* var. *Williamsoniana*, from Ardwick, near Manchester, and the other *L. leidyi* var. *Salteriana*, from Cottage Row, Crail, Fifeshire. The present example agrees fairly closely with the Fifeshire specimen; but, on the whole, it seems best to create a new species for it, *Leaia trigonoides*, sp. nov., rather than risk confusion by adding a varietal appellation.

Specimen 2, from Shipley, is of interest, owing to the great difficulty of its interpretation. Possibly the best explanation is that it is the glabellar region of a *Prestwichia*. The presence of two minute crescentic dots, one on each side of the median line, is in favour of this theory, on the assumption that they are the larval eyes of the animal. Dr. Henry Woodward, however, who has examined this specimen, is very doubtful as to its limuloid origin.

Specimen 3, from the Kilburn Coal, Trowell Colliery, Notts. The curious feature in this specimen is the presence of crescentic openings on each segment similar to the 'stigmata' found in scorpions and other Arachnids, suggesting that it may be a fragment of an air-breathing animal.

Specimen 4, from Shipley, is probably one of the first abdominal segments of *Eoscorpius* sp., two specimens of which genus have been found in this district—one from near Chesterfield, and another, at present undescribed, found by the author in the Digby Claypit, Kimberley, Notts.

Specimen 5, from Brindsley, Notts, is a single segment of an Arthropod, and possibly referable to *Eurypterus*.

Specimen 6, from Shipley, is the wing of an insect probably belonging to the order Palæodictyoptera of Scudder.

Specimens 7 and 8, also from Shipley, are a fragment of a much smaller insect's wing, which, in its incomplete state, would be impossible to assign to any definite order.

Insects' wings are very uncommon in the Coal-measures of this district, only one having been found near Chesterfield, and described by S. H. Scudder[2] under the name *Archæoptilus ingens*.

REVIEWS.

I.—A Great Catalogue of Books on the Natural Sciences.

British Museum (Natural History).—Catalogue of the Books, Manuscripts, Maps, and Drawings in the British Museum (Natural History). Vol. III. L–O. By Bernard Barham Woodward. 4to. London, 1910. pp. 1039–1494. Price £1 per volume.

IN September, 1903, we had the pleasure to announce the publication of the first volume of this work from A–D. Volume II (E–K) followed in 1904, and progress since then has been seriously hampered

[1] Mon. Pal. Soc., 1862, Appendix, p. 115, pl. i, fig. 21, etc.
[2] S. H. Scudder, "Haxapod Insects of Great Britain": Mem. Boston Nat. Hist. Soc., vol. iii, pp. 217–18, 1873–94.