in all; while the Otterton breccias must be separated from the lowest bed of the section here exposed by fully 150 feet.

That the Otterton breccias should form a basement for the Keuper in South Devon, I have no great objections to offer. These breccias, however, as the authors are well aware, are only a small portion of still lower beds of the same nature seen on the west side of that river, and extending along the Promenade until they are underlain by the red sandstones which in their turn overlie the Budleigh Salterton Pebble-bed.

These beds are of considerable thickness, 100 feet or more, and possess many distinguishing features. They are essentially different from any other beds in the Trias. Their dolomitic breccias or conglomerates, and the accompanying masses of concretionary limestone, would almost mark them off as a good representative of the missing Muschelkalk, if this formation has an equivalent in England.

It is the immediately overlying mottled or current-bedded sandstones seen between Otterton Point and the east side of the Sid, that I would regard as the base of the Keuper, in which have been found the remains of the *Hyperodapedon*. This is a point, however, that I would not by any means urge if it be considered that the missing Muschelkalk has no true equivalent or representative in our own country.

The chief object of my paper will have been attained if it is deemed that I have shown sufficient evidence for the conclusions that the Sidmouth section has been misread by Professor Hull and Dr. Irving, and that the Otterton breccias are on a far lower horizon than the alleged breccias (?) in the Sidmouth section.

NOTICES OF MEMOIRS, ETC.

British Association for the Advancement of Science. Seventy-third Annual Meeting, held at Southport, September 9–16, 1903.

List of Papers read in Section C, Geology.

Professor W. W. Watts, M.A., M.Sc., F.G.S., President.

The President's Address.—Geology in Education and Practical Life.

J. Lomas.—On the Geology of the Country around Southport.

Harold Brodrick.—On the Geology of Martin Mere.

A. Smith Woodward, LL.D., F.R.S.—Report of the Committee on the Registration of Type-Specimens of Fossils.

Professor H. A. Miers, F.R.S.—Report of the Committee on the Structure of Crystals.

André Delebecque.—On the Lakes of the Upper Engadine.

H. B. Muff and W. B. Wright.—On a Pre-Glacial or Early Glacial Raised Beach in County Cork.

G. W. Lamplugh.—On Land Shells in the Infra-Glacial Chalk Wash at Sewerby, Yorkshire.

Report of the Committee on the Estuarine Deposits at Kirmington, Lincolnshire.

Report of the Committee on Erratic Blocks.

Report of the Committee to Explore Irish Caves.

Report of the Committee on Underground Waters of North-West Yorkshire.

Report of the Committee on Geological Photographs.

Dr. Wheelton Hind.—On the Practical Value of certain Species of Molluscs in the Coal-measures.

Report of the Committee on Life Zones in the Carboniferous Rocks.

W. S. Boulton.—On the Igneous Rocks of Weston-super-Mare.

J. J. H. Teall, F.R.S.—On Dedolomitization.

A. C. Seward, F.R.S.—Notes on the Fossil Flora of South Africa.

A. Smith Woodward, LL.D., F.R.S.—On a Carboniferous Acanthodian Fish—*Gyracanthides.*

A. Smith Woodward, LL.D., F.R.S.—On the supposed evidence of an Anomodont Reptile from Brazil.

J. Lomas.—On Polyzoa as a Rock-cementing Organism.

T. H. Cope and J. Lomas.—On the Igneous Rocks of the Berwyns.

W. G. Fearnsides.—On the Lower Ordovician Rocks in the Neighbourhood of Snowdon and Llanberis.

E. A. Newell Arber.—On the Fossil Flora of the Ardwick Series of Manchester.

J. Lomas.—Report of the Committee on the Fauna and Flora of the Trias.

A. Somervail.—On the Base of the Keuper in South Devon. (p. 460.)

G. W. Lamplugh.—On the Disturbance of Junction Beds from Differential Shrinkage during Consolidation.

J. G. Goodchild.—On some Contorted Strata occurring on the Coast of Northumberland.

J. G. Goodchild.—Some facts bearing on the Origin of Eruptive Rocks.

J. G. Goodchild.—On a possible Cause of the Lethal Effect of the Dust ejected during the Recent Volcanic Eruptions in the West Indies.

J. G. Goodchild.—Notes on the Metalliferous Deposits of the South of Scotland.

J. Jowett.—Glacier Lakes and Overflow Valleys in the Neighbourhood of Rimington.

William MacKie.—On the Origin of Continents and Ocean Basins.

W. Whitaker, F.R.S.—Report of the Committee on Changes along the Coastline of the British Isles.

H. W. Monckton.—Notes on the Sarsen Stones of Stonehenge and on those found in the Bagshot District.

Llewellyn Treacher.—On the occurrence of Stone Implements in the Thames Valley, between Reading and Maidenhead.

J. Lomas.—On the Origin of certain Quartz Dykes at Foxdale, Isle of Man.

H. J. Seymour.—Supplementary List of Minerals known to occur in Ireland.

F. P. Mennell.—On the Average Composition of the Igneous Rocks.

Papers bearing on Geology read in other Sections:—

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

J. Milne, F.R.S.—Report of the Seismological Committee.

D. Burns.—Phenomena accompanying the Volcanic Eruptions in the West Indies.

SECTION E.—GEOGRAPHY.

Captain E. W. CREAK, C.B., R.N., F.R.S., President.

President's Address (refers to Terrestrial Magnetism and Geology).

Dr. Tempest Anderson, M.D., B.Sc. — The Recent West Indian Eruptions.

C. E. Moss.—Peat Moors of the Southern Pennines: their Age and Origin.

SECTION G.—ENGINEERING.

CHARLES HAWKSLEY, M. Inst. C. E., President.

President's Address (refers to Water Supply).

J. Campbell Brown.—On the Nature and Quality of some Potable Waters in South-West Lancashire.

J. Parry.—Water Supply and South-West Lancashire.

R. Pearson.—History of the Discovery of Natural Gas in Sussex.

SECTION H.—ANTHROPOLOGY.

J. G. Garson, M.D., and W. J. Lewis Abbott.—Some Recent Excavations at Hastings, and the Human Remains found.

Mrs. Stopes.—Palæolithic Implements from the Shelly Gravel Pit at Swanscombe, Kent.

Mrs. Stopes.—Saw-edges in Flints from Swanscombe, Kent.

Nelson Annandale, B.A.—The Survival of Primitive Implements in the Faroes and Iceland.

SECTION K.—BOTANY.

A. C. SEWARD, F.R.S., F.G.S., President.

President's Address.—Floras of the Past: their Composition and Distribution.

Dr. D. H. Scott, F.R.S., and Professor F. W. Oliver.—The Seed of *Lyginodendron.*

W. Wilson.—The Plants on the Serpentine Rocks in the North-East of Scotland considered with reference to the Soil Ingredients.

REVIEWS.

I.—Catalogue of the Madreporarian Corals in the British Museum (Natural History). Vol. IV: The Family Poritidæ. 1. The genus *Goniopora.* By HENRY M. BERNARD, M.A. 4to; pp. viii and 206, with 14 plates. London: printed by order of the Trustees, 1903. Dulau & Co., Soho Square.

THIS is the fourth volume on Corals issued by the Trustees of the British Museum (Natural History). Vol. i, by the late George Brook, on the genus *Madrepora*, appeared in 1893 (pp. xii and 212, with 35 quarto collotype plates of the genus *Madrepora*); there were at that time in the collection 1104 specimens, described

by Mr. Brook under 180 specific names, the total number of species of the genus amounting to 221. Vol. ii, embracing the genera *Turbinaria* and *Astræopora*, was, through the lamented death of that accomplished zoologist Mr. George Brook, undertaken by another excellent biologist, Mr. Henry M. Bernard, M.A., F.L.S., F.Z.S., and appeared in 1896 (pp. iv and 106, with 33 plates). Vol. iii, containing the corals of the genera *Montipora* and *Anacropora*, prepared by the same author, was issued in 1897 (pp. viii and 192, with 34 plates 4to). In 1897 the late Sir William Flower, then Director, writing in the Preface, said: "The three volumes now finished form together a very complete monograph of the Madreporidæ, which is one of the chief reef-building families of Stony Corals. . . . In 1878, when Brüggemann prepared his manuscript catalogue, there were only 41 specimens of Montipores, divisible into 16 species. There are now more than 400 specimens, classed under 116 species, about 80 of which are new."

In the preface to vol. ii Mr. Bernard refers (pp. 19–21) to the difficulties which beset the systematic naturalist in attempting to establish a standard upon which to divide Corals into groups—say according to their methods of growth. These methods of growth, which at first seem so convenient, are found to pass into one another, so that it is most perplexing to decide whether a specimen exhibits one or the other type of growth.

Again, the number of transitional forms observable in a long series of specimens, which, from their calices, are clearly related, renders it difficult to decide as to which group they properly belong. Still more serious is the fact that in Torres Straits we find Turbinarians widely differing in the character of their calices, yet revealing exactly the same methods of growth, which shows that in that case at least the form of the corallum is due to the environment. Often, too, special local forms of growth are confined entirely to limited areas.

A year later, writing at p. 17 in vol. iii, Mr. Bernard says: "While claiming that the chief divisions of the genus are natural divisions, I can only repeat what was said in the preface to vol. ii as to the real value of the specific divisions. The types represent merely the more marked variations presented by the specimens in the collection, and are therefore for the most part purely artificial groupings. Only in those cases in which the individual specimens are known to have been collected from the same locality, and might almost be fragments of one and the same colony, does the name imply the close blood-relationship which the word species should be taken to connote. In all other cases the types are, strictly speaking, only morphological groups united because of certain peculiarities of form or structure which they have in common. Their ultimate systematic value is thus problematical. How much this is the case, indeed, may be gathered from the fact that the differences presented by specimens which are undoubtedly specifically identical may be far more striking than those that separate many of the types."

"The influence on the mind of the puzzled worker by such a group of many individuals, showing great variations, yet undoubtedly specifically identical, leads him, as a rule, temporarily to a wholesale lumping of other specimens, until his courage fails him, when the more striking individual variations are once more separately described as new types."

The above extracts will serve to convey the feelings of the author in regard to the use and limitation of the term 'species.' Indeed, so far back as 1896 he wrote: "It seems to me certain that we are rapidly nearing the time when our ever-increasing collections, revealing as they do the infinite grades of variation presented by living organisms—especially by stock or colony-forming animals, such as corals, in which the varying factors are doubled,—will compel us to break loose from the restraint of the Linnean 'species.'"

We come now to the latest issue of Mr. Bernard's work on corals (vol. iv, August, 1903), issued under the favourable auspices of Professor E. Ray Lankester's administration as Director and Keeper of Zoology. By the Director's advice, the author has made a special study of the rich collection of fossil corals contained in the Geological Department, which has revealed the fact that an important Tertiary coral, *Litharæa*, is generically identical with *Goniopora*, and this genus can now be traced back to early Cretaceous times, and had its period of maximum development in the early Tertiary beds of South Europe. The fossils, moreover, throw much light upon the morphology of the genus.

"The variability of the corals" (writes Professor Lankester) "has, in previous volumes, been a good deal obscured by the establishment of a number of so-called species; the author has thought it right to cease establishing genetic groups without the necessary data for so doing. He regards his task as that of presenting the facts and what may legitimately be deduced from them in the way that will be most useful to future workers and to the officials of other museums. Experience alone can show whether the method he has adopted in order to attain this end, however faultless its logic may be, can be employed with advantage in dealing with any other group besides the corals, or even whether it is the best way of presenting the corals, having regard solely to the facts. The attempt is, however, a sign of the times, for it is clear that, whether the older school of systematists like it or not, the question of method is an increasingly serious one, and Mr. Bernard's attempt should stimulate inquiry outside the beaten paths." (Introduction, p. i.)

The first thing that will strike the reader is the change in the formula, the author having completely abandoned the old methods of naming in favour of geographical symbols.

"It must, of course" (writes Mr. Bernard, p. 190), "be at once admitted that names like those usually employed to indicate species might have been used instead of geographical symbols. But the objections to names seem to be many and serious.

"A 'specific name,' by long usage and almost universal agreement, implies a true genetic group, and my experience has been that no explanation as to the meaning assigned to the use of the name can change this. When we are not dealing with species, but with forms, from the ultimate grouping of which species may perhaps be discovered, the work is confusing if the method of designation for the forms is that used for species. Some special method is needed for this preliminary analytical stage of work. Only when the natural groups have been discovered should names be used.

"The use of some special symbol for this preliminary study becomes obvious if we picture to ourselves what must happen as soon as true genetic groups or species can be compounded from series of known forms. One of the names will be retained as the name of the species, others as the names of varieties, while the rest will have to be discarded as mere synonyms. Working symbols have this advantage over ordinary specific names, that they can be legitimately discarded if we so desire. But it seems to me that, while we would certainly desire to discard a wearisome and perfectly unintelligible list of synonymous *names*, there would be no desire to discard synonymies composed of geographical symbols, for they would give at a glance the geographical distributions of the species and of its several varieties.

"The attempt here made to record forms is being made in other groups besides corals, but so far only in such groups as have already been divided into species. The process involves the addition to the accepted specific name of one or more qualifying names, one of which invariably indicates the locality. In this way the old binominal designation of Linnæus is forming the basis for a multinominal system of recording the various forms which we now find embraced by the species. This system cannot be adopted in the corals, for the simple reasons that only a very small proportion of the corals have yet received any names at all, and only a few of those which have been named can now be identified. The process is, therefore, not one of designating the forms which make up established species, but of recording forms which may some day be grouped into species. We who are working with corals, then, are in a position favourable to the adoption of a new and more straightforward method of dealing with the species problem. In reality we are still in the throes of sorting out genera, and all the most solid work of the past is chiefly valuable in this respect. Even this stage is far from complete. The task, therefore, is complicated, and the new method should be technically simple, practical, and efficient.

"The question thus arises, whether names or symbols best fulfil these conditions. Names, when there are only a few of them, may be easier to remember, but long lists are a dead weight upon the work. While there may ultimately prove to be but few *groups* or *species* requiring names, the number of *forms* to be designated is bound to be very large. For example, the analytical tables which now give at a glance the geographical distribution of the different

structural divisions would have been far less useful if meaningless names had been given to the forms. It seems to me that we have no other alternative than that between 'trivial' names and symbols. It is not possible to invent a long list of short names, each one of which shall convey useful information, except on some fixed plan, and that, sooner or later, means the construction of symbols or of symbolic names." (p. 191.)

Notwithstanding this bold and determined attempt to reform zoological nomenclature, and to rid us of the long lists of synonyms which fill so many pages of every systematic work, the author has to admit that he has been warned again and again that there are rigid formalists who firmly believe they would be doing zoology a service by *naming*, that is, "*making species*" of, all the forms here recorded by geographical symbols. Mr. Bernard, from recent experience, finds he is compelled to respect this warning and to give a list of Latin equivalents for his geographical symbols which may stand instead of *specific names*, which the *rigid formalist* may catalogue and accept as such. One hundred and forty-four of these provisional names are listed, each preceded by the author's symbol, which he is warned will not be accepted in lieu of a name, so they read thus:—

GONIOPORA: (symbol) *G. New Guinea* 1 (which stands for, or is) = *Goniopora Nova-guineensis prima* [and in those cases in which the forms have been assumed by previous writers to represent separate and distinct *species*, the name of such species is given in brackets; thus to the above name we must add (*G. pedunculata*, Quoy & Gaimard)]; *G. New Guinea* 2 = *G. Nova-guineensis secunda*; *G. New Ireland* 1 = *G. Nova-hibernica prima*; *G. Solomon Islands* 1 = *G. Salomonis prima*; and so on.

Two objections present themselves to Mr. Bernard's admirable proposals—yea, three might be urged—(1) The symbol alone is insufficient. (2) The name in full in addition or in place of the symbol is *too long*.[1] (3) Is it not unfair to annex all the geographical names for one group? Furthermore, it involves the introduction of the *trinomial system* into zoology, which is certainly not a thing to be greatly desired. The symbols alone, we fear, will not meet with cordial acceptation in any case.

The main difficulty which will be felt by systematic zoologists in adopting Mr. Bernard's method of nomenclature in corals is that it is unlike that in use for similar natural divisions, so that this class of organisms must stand aloof from, and cannot conveniently be brought into line with pre-existing arrangements of other orders and families.

Whatever attitude we may adopt with regard to Mr. Bernard's system of nomenclature we must all be most grateful to him for one thing, namely, that he has taken in hand the long neglected

[1] Especially when we have so often to use some other name as well to qualify it, as pointed out above (viz. *G. pedunculata*, Q. & G.). There are 51 such additional recognised names which must be used and cannot be set aside.

fossil Zoantharia, and is tracing out their existing relationships with the same careful and philosophical attention which he has bestowed upon the living corals.

In the present volume the author writes (p. 28): "The Eupsammiidæ and *Goniopora* appear to have arisen in Mesozoic times, the earliest known Goniopore being from the Lower Cretaceous formation of the Crimea, since which time the perforate corals have flourished, belonging for the most part to the Tertiary period." (Earlier corals, claimed to belong to the Poritidæ, including *Calostylis*, of Lindström from the Silurian, have so far not borne the test of examination.) Mr. Bernard then proceeds to deduce the origin of *Goniopora* and *Porites* (forming the Poritidæ) and the Madreporidæ from the Eupsammiidæ.

These primitive relationships are illustrated in the following scheme. A primitive porous coral, that is, a parent form in which the epithecal cup, or the prototheca, is flattened out, and the secondary theca is built of septa joined by synapticulæ:—

Simple and simply branching forms.	Luxuriantly branching forms, owing to early budding and consequent dwarfing of the polyps, but with rapid growth in height of theca.	Astræform colonies, due to early budding while the skeleton is incomplete, basal and disk-shaped.
The Eupsammiidæ.	**The Madreporidæ.**	**The Poritidæ.**
[? Including TURBINARIA.]	[? Excluding TURBINARIA.]	GONIOPORA.
		By suppression of tertiary septa.
		PORITES.

The author inserts under "Geographical arrangement of forms" all the fossil genera and species where they appropriately belong.

Thus at p. 92. Group V, **India and Persia**, *containing descriptions or records of fossil Gonioporæ from Sind* (1–7), *Indus River* (1), *Persia* (1–4).

62. *Goniopora*, **Sind** (7) 1; and then in what we should consider the synonymy we find:—

Litharæa epithecata, Duncan: Sind Fossil Corals, Mem. Geol. Surv. India, 1880, p. 23, pl. ii, figs. 1–9; Geol. Dept. R. 13, presented Geol. Surv. India.

A full description follows, and of 11 other species (pp. 92–99). Under Red Sea and Egypt, 3 fossil forms are described (pp. 99–107). Under Italy, fossil *Gonioporæ* are described from Vicenza (1–13), Verona (1–2), Alexandria (1–3), Turin (1–3), Genoa (1–5), (pp. 107–122). Under Austria-Hungary we find Miocene corals from Vienna, Cretaceous from Bohemia, etc. Under France we have many forms from the Miocene of Dax, Gironde, Paris Basin, Coutances, etc. (pp. 128–146). Under England we find fossil

Gonioporæ from Bracklesham Bay and Brockenhurst (pp. 147–153). Russia furnishes a Lower Cretaceous form from the Crimea (pp. 153–154). There is also a form from the Eocene of Somaliland described by Gregory. In the analytical tables of results (pp. 162–168) the fossil forms have their appropriate places, as e.g. No. 46, Java Sea 2 and 3, Valley of the Tjilanang, Ronga, Upper Miocene, and 4, near Liotjitjangkang, also U. Miocene. Then Eocene, India; Miocene, Persia; Eocene, Egypt; and so on, down to Upper Cretaceous, Bohemia, and Lower Cretaceous, Crimea.

The last table gives us a summary of the whole of the known forms of *Goniopora*, with their geographical and geological distribution, showing Cretaceous 5, Eocene 35, Oligocene 20, Miocene 19, Pliocene 1, Pleistocene 1, Recent 70, giving a grand total of 151 forms, or *possible* species.

There is an interesting survey of growth-forms and their distribution (pp. 169–186), and the summary of results (pp. 187–189). "The only specimens" (of corals), says Mr. Bernard, "showing unmistakeable genetic affinities are those which have been gathered from the same spot and are obviously daughter-colonies of one and the same parent."

"The largest area over which such a genetic group is as yet known to spread is that of the Maldive Islands. One simple form of Gonioporan colony, with calicles which are those characteristic of its type of growth, has been discovered by Mr. Gardiner occurring at considerable depths round at least four of these islands," the evidence showing that they are all alike developed on a soft muddy bottom. "This determined *the growth-form*, and this is largely responsible for the type of the calices" (p. 188). Mr. Bernard thinks that "The Stony Corals are still too elementary in their organisation to be able to acquire any but transient stability, if such an expression can be admitted; they also respond very quickly to their environment."

"The chief results, then," says Mr. Bernard, "are practically all that could be expected from the relatively small amount of the material. They are almost exclusively morphological, phylogenetic, and biological. The systematic arrangement of the forms in the order of their evolution cannot yet be attempted."

We desire to record our admiration for the plates, especially those of the present volume, in particular plates i to x^b, giving enlarged views of portions of growth-forms from various examples (numbers and localities given in each case). These, which are enlarged five times natural size by photography, far exceed in beauty and accuracy of detail those of the previous volumes.

We heartily commend Mr. Bernard's work to the attentive consideration of all zoologists, and more especially of those who are interested in recent and fossil corals, although, if the author carries his point, all the *species* of corals must, in the near future, remain nameless, like the 'Masque de Fer,' or be represented only by a locality and a number!

II.—Memoirs of the Geological Survey of England and Wales.

1.—The Geology of the South Wales Coalfield. Part IV: The Country around Pontypridd and Maes-Têg, being an account of the region comprised in Sheet 248 of the Map. By Aubrey Strahan, M.A., F.G.S., R. H. Tiddeman, M.A., F.G.S., and Walcot Gibson, B.Sc., F.G.S. 8vo; pp. vi and 134, with plate of sections and 6 text illustrations. (Issued July, 1903; preface dated 28th February, 1903. Price 1*s.* 6*d.*) Illustrating Sheet 248 of the Geological Map of England and Wales (scale 1 inch to 1 mile), colour printed. (The map is sold separately, price 1*s.* 6*d.*)

2.—The Geology of the Cheadle Coalfield. By George Barrow, F.G.S. 8vo; pp. iv and 62, with 2 illustrations in the text and geologically coloured map of the Cheadle Coalfield. Price with map, 2*s.* (Preface dated 12th March, 1903.)

3.—Summary of Progress of the Geological Survey of the United Kingdom and Museum of Practical Geology for 1902, with *Introduction* by J. J. H. Teall, M.A., F.R.S., Director. 8vo; pp. iv and 240, with 9 illustrations in the text. London, 1903 (received 20th August, 1903). Printed for H.M. Stationery Office; sold by E. Stanford, London, etc. (or of Messrs. Dulau & Co., 37, Soho Square, W.). Price 1*s.*

THE Geological Survey memoirs recently published, whose titles we quote above, are of considerable interest.

1. The first of these is a continuation of "The Geology of the South Wales Coalfield,"[1] comprised in Sheet 248, and is the fourth part of the memoir descriptive of this region, including the important part of the coalfield extending from Pontypridd on the east to Cwmavan on the west, and from Aberaman and Glyn-corwg in the north to Llantrisant and Mynydd Margam in the south, embracing the greater part of the range of the best steam-coal.

Sir H. T. De la Beche, Sir W. E. Logan, and Mr. D. H. Williams made the first survey of this area on the old map; probably most of the work was by De la Beche himself, but the western part was surveyed by Logan before his connection with the Geological Survey. The original maps were exhibited by Logan in 1837 at the British Association in Liverpool, and attracted the attention of De la Beche, with the result that they were handed over to the Geological Survey and incorporated in the official maps, while Logan himself became a member of the staff. Sheet 36 was published in or before the year 1845.

The re-survey was made on the 6 inch scale, under the superintendence of Mr. Strahan, and published in 1899. The eastern part of Sheet 248 was surveyed by Mr. Strahan, the south-western part by Mr. Tiddeman, and the northern part by Mr. Gibson.

[1] See previous review, Geol. Mag., June, 1903, p. 269.

Each geologist contributes an account of the area surveyed by himself, and the whole memoir has been edited by Mr. Strahan.

Two subdivisions of the Coal-measures, namely, the Pennant series and the Lower Coal series, occupy nearly the whole area. In the latter occurs a group of seams which yield the well-known smokeless steam-coal. These seams are illustrated in the present memoir by a folding plate giving six vertical sections; various other sections are also given in the text, while sheets of vertical sections, Nos. 83–85, are published separately. The seams of the Lower Coal series vary greatly in thickness; thus, in the Aberaman Colliery in a section prepared by Mr. E. M. Hann (given in detail on pp. 12–14 of this memoir), in a depth of 283 yds. 1 ft., or 850 feet, no fewer than 28 seams are passed through having an aggregate thickness of 15 yds. 2 ft. 8 ins.; but of this amount only 4 seams are more than a yard in thickness, 5 are over 2 feet thick, 11 exceed one foot in thickness, and 8 are less than a foot; so that it is probable that not more than 9 out of the 15 yards in thickness of coal, if even so much, are won at this colliery. It may be of interest to notice that, though the seams can be recognized for long distances in an east and west direction, yet both these and the measures associated with them change so rapidly southwards that only a general correlation by groups is possible. In this part of the coalfield some massive sandstones, much resembling Pennant, develop in the upper part of the Lower Coal series.

The Pennant series shows a no less remarkable expansion both in a southward and westward direction. At the same time its upper part becomes split up by shales and coal-seams, which have yielded the bulk of the coal near Neath, Swansea, and Llanelly. Thus both the top and the bottom of the Pennant is less distinct than in Monmouthshire, where the subdivision consisted almost exclusively of sandstone.

The Upper or Llantwit Coal-measures occur in two small outliers only in the area comprised in Sheet 248.

In the South Crop, where the high dip usual in the southern margin of the coalfield prevails, the Millstone Grit and what may be the top of the Carboniferous Limestone come into view, but they are partly overspread by Triassic strata, which have been laid down unconformably upon their truncated edges. The Coal-measures themselves are partly thus covered, and it is worthy of note that the Triassic conglomerates consist, not of Coal-measure rocks, but of fragments of Carboniferous Limestone.

The Secondary rocks, which include Keuper, Rhætic, and Lias, are described in a separate chapter. They enter the map under description along its southern margin only.

The faults and disturbances are grouped into (1) the east and west folds and the Moel Gilan Fault, and (2) the north-north-westerly faults. They are discussed in detail in chapter viii.

Chapter ix, after giving a general account of the glacial deposits, deals with their occurrence in each valley. In chapter x the principal economic products of the region are enumerated.

The map (price 1*s.* 6*d.*), which is very carefully printed in colours, is published in two editions, on one of which (the Solid Edition) glacial deposits and the like are omitted, while on the other (the Superficial Edition) such deposits are indicated by colour, as well as those portions of the solid geology which are not concealed by Drift. The map of the solid geology, being nearly all covered by the Coal-measures, the symbol of which is an olive-green colour, has a sad and mournful effect, and renders it rather difficult to decipher the names of places upon it. We think it might be possible to use a somewhat paler colour with advantage. Manuscript six-inch maps geologically coloured are deposited in the Survey Office, Jermyn Street, where they can be consulted, and copies can be obtained at cost price.

2. "The Geology of the Cheadle Coalfield," by George Barrow, forms a small but excellent memoir, complete in itself, of an outlying portion of the North Staffordshire Coalfield, full particulars being given of the various seams of coal, with records of borings and remarks on the probable extent of the workable Coal-measures. A good diagram-section across the coalfield is given on p. 49, showing the various workable coal-seams. There are 17 seams of coal, two being 6 feet in thickness, three over 3 feet thick, seven of 2 feet and upwards, and the remainder only about one foot in thickness.

Details of the underlying Millstone Grit series and the overlying Bunter and Keuper formations are also furnished, and special reference is made to the water-bearing strata. The Glacial Drift and other superficial deposits are described, and the memoir is accompanied by a small but excellent colour-printed geological map, a plan we hope to see followed in the issue of every separate Survey memoir.

The area described in this small memoir is remarkable for the fact that its main features are of two widely different ages. What may be broadly called the northern portion, is composed of Carboniferous rocks, forming a sloping tableland essentially of pre-Triassic age, though modified of course by later denudation. Upon this older land-surface the Triassic rocks were deposited, but have since been denuded off all except a small portion of the northern area; thus restoring, as it were, the old pre-Triassic surface. In the southern area, however, these rocks have escaped denudation to a considerable extent, and now form a second and newer tableland, overlooking the first and older one. The true form of the older tableland is somewhat obscured locally by the hill of red sandstone at Cheadle, but from the summit of the hill it is at once seen that this isolated eminence is simply a detached portion of the newer Triassic plateau, and really serves to emphasize the fact that these rocks do form a tableland.

The highest ground occurs in the northern area, formed of Carboniferous rocks, attaining an elevation of 1,000 feet about Ipstones, and 800 feet in the neighbourhood of Wetley Rocks. The Triassic rocks do not attain so great an elevation; at the edge

of the plateau overlooking Cheadle the ground maintains a fairly uniform height of 700 feet above sea-level, and the top of the hill at Cheadle is at the same height.

The drainage of the area is effected by the two rivers the Churnet and the Tean and their branches. Of these the Churnet is much the larger, and flows for the most part in a deep valley, often almost a gorge; and so regular on the whole is the plateau on both sides of the river that it is often possible to look across the deep valley without realising its existence. The chief branches of the Churnet are three in number, and flow through the Consall Woods, the valley between Ipstones and Froghall, and the beautiful gorge of Dimmings Dale. The gorge is renowned for its steep, craggy, and densely wooded sides. It is cut in the Triassic rocks; the other two channels are in the Carboniferous. Though less gorge-like than Dimmings Dale they both have steep and craggy sides locally. The country about Cheadle is drained by small streams flowing in shallow hollows, which unite to form the Tean, and eventually flow into the Churnet to the south of this area.

Much of the ground is permanent pasture, and this is specially the case where the soil is formed of the heavy Carboniferous shales and clays. Of the lighter lands, formed of the sandstones and grits of this formation, a considerable portion is under the plough, and the same is true where the soil is formed of the dry Triassic sandstones. Even here, however, may be noted the same tendency to lay ground down in permanent pasture that is seen in many other parts of England.

Several minor industries are carried on in the district. Of these silk-spinning at Cheadle is mainly due to local cheapness of production; a manufacture of which the town of Leek may be taken as the centre. Brick-making is carried on to a considerable extent, the Coal-measure shales and clays being employed for this purpose. The bricks are of excellent quality.

There are large copper-works in the Churnet Valley close to the railway at Froghall and Oakamoor. The industry is still retained, although the original deposit of copper-ore at Ecton Hill which gave rise to it has been long since abandoned. There were also formerly brass-works near Cheadle which had a high reputation, but these have fallen into decay.

Coal-mining is the most important industry of the district, and gives employment to a considerable number of men. There are at present six collieries at work, but only two, the Foxfield and the Delphouse, are connected with a railway, so as to be able to send coal out of the district; the others can only supply local needs.

The coal-workings of this district are of great antiquity. They can be traced back as far at least as the reign of Richard III. The coal-seams outcrop at the surface, and, not being concealed beneath drift or Boulder-clay, were ploughed up in the fields, and so came to be early recognised and used as fuel. In the majority of cases the old workings for coal were started from the outcrop, and therefore required no great engineering skill to develop. They all appear

to have been arrested by the influx of water into the workings, although in one instance they evidently displayed some considerable intelligence in draining a particularly good seam between Belmont Hall and Ipstones by driving a level to carry off the mine water.

3. The SUMMARY OF PROGRESS for 1902 conveys an excellent idea of the vitality of the Geological Survey, under its present able Director, Mr. J. J. H. Teall, F.R.S., whose zealous activity in planning the work is only equalled by the energy displayed by his staff in carrying it into execution.

In England and Wales the field-work has mainly covered four areas—Devon and Cornwall, South Wales, the Midlands, and the London district. In Scotland the work has been distributed over six districts, four being in the unsurveyed portion of the Highlands and two in the Carboniferous areas of the Midland Valley. In Ireland the Drift Survey was continued in the neighbourhood of Belfast. A few of the more important features of the work of the year may be referred to here.

Highland Metamorphic Rocks.—Probably the oldest rocks with which the Survey has had to deal in the course of the year occur in the Highland metamorphic region. Previous work in the areas occupied by the Eastern Highland schists in the north of Scotland have demonstrated the existence of extensive tracts of country composed of rocks closely resembling certain portions of Lewisian gneiss, especially those which occur in zones of secondary shearing. Those varieties of gneiss to which reference is made consist of alternations of acid and basic material, with occasional lenticles of ultra-basic rock; but they differ from the unmodified gneisses in possessing a granulitic structure. Two belts composed of rocks of this type have been met with by Mr. Hinxman in Strathconan Forest, Ross-shire, where they are seen to be most intimately interfolded with siliceous granulites of the Moine type. Although the exact meaning of these facts is not apparent, it may safely be predicted that they will be found to have a most important bearing on the origin of the Eastern Highland schists of Sutherland and Ross.

Other facts bearing upon the same subject have been observed by Mr. Clough in central Ross-shire, a granitic rock at some early period having been intruded into sediments which have been converted into hornfels by contact-action. Zones of thrusting and shearing comparable to those which have been described in the Lewisian gneiss traverse both the granitic area and that occupied by the altered sediments, the hornfels having, as a result, been converted into mica-schists, and the granitic rocks into finely foliated augen-gneisses, with a granulitic matrix.

Important observations have been made in the Southern Highlands by Dr. Peach and the officers acting under his direction, both on the mainland and the islands of Argyllshire.

The great quartzite formation of Islay and Jura, which has been split up into several recognizable zones, in some of which flattened worm-casts (*annelide-burrows*) occur, has been followed into Scarba, and evidence obtained that the boulder-beds, so well developed in

the Isles of the Sea, form the natural base of this group of strata. These beds contain fragments, many of which are rounded, of the underlying Degnish and Shuna Limestones.

In the Eastern Highlands the characters and relative ages of the complex igneous intrusions have been studied, but this subject is still *sub judice*.

Torridonian.—The Torridonian rocks, as they are developed in Rum, have been described by Mr. Harker, who shows that they have been affected by the post-Cambrian thrust-movements. In the north-west of the island a prominent crush-breccia, composed of lenticles of Cambrian limestone and crushed sandstone, overlies the thrust-plane.

The detailed mapping of the *Lower Palæozoic rocks* on the north side of the Carboniferous area in South Wales has shown that the anticline in which the oldest rocks come to the surface follows the Towy Valley, and Messrs. Cantrill and Thomas have recognized an inversion which has had the effect of bringing the *Didymograptus bifidus* shales over the Llandeilo Beds.

Old Red Sandstone and Devonian.—Additional evidence of the fact that the lavas of Lorne plateau were poured out on an uneven surface formed of the Highland schists has been obtained in the course of mapping the southern margin of this plateau to the north of Loch Melfort, and definite proof of the Lower Old Red Sandstone age of the Glencoe volcanic rocks has been furnished by the discovery of *Psilophyton* in shales which are associated with the lavas.

In England the Old Red Sandstone rocks on the borders of the South Wales Coalfield have been examined, and evidence of a powerful strike fault, or rather series of faults, traversing the central portion of the northern band has been obtained. "The course of this disturbance," as Mr. Strahan says, "along the middle of the outcrop of the Old Red Sandstone for so many miles, its effect in throwing in patches of Carboniferous Limestone by what must be an enormous displacement, and lastly, the guiding influence which it has exerted upon the rivers, in common with other disturbances, of the east-north-east and west-south-west system, all combine to give it an unusual interest."

In North Cornwall the purple and green slates with *Pteraspis* which occur in Watergate Bay have engaged the attention of Mr. Reid. They are of special interest as indicating, both by their fossil contents and lithological characters, the existence of the Old Red Sandstone facies within the Devonian area.

The work of mapping the coalfields of England on the six-inch scale has been continued in South Wales and in the Midland counties, while in Scotland the work of revising the old six-inch maps has commenced. In South Wales the mapping of the coalfield proceeds steadily towards the west, and much information as to the correlation of the coal-seams and the nature of the disturbances will be found in this Summary of Progress. Three systems of faulting or folding exist. The steep uplift which determines the southern margin of the coal-basin and the Llanelly syncline belong to the

pre-Triassic system, which traverses the Vale of Glamorgan. A long series of north-north-west faults, the course of which across the pre-Triassic folds has been worked out in detail, belongs to the system which is certainly in part of post-Triassic, but probably in part also of pre-Triassic age. Lastly, a series of parallel disturbances of great magnitude, which traverse the northern part of the coalfield, the Old Red Sandstone and the Lower Palæozoic rocks, and which have determined the river drainage, may be assigned to the system of which the Neath disturbance is a well-known example. This third system, which is characterized by folding and overthrusting on a large scale, runs in a general west-south-west direction, and from its remarkable influence on the surface configuration is believed to be of later date than the others.

In the Midland district the work has been confined to the southern and western part of the Derbyshire and Nottinghamshire Coalfield. Mr. Wedd has mapped out the various beds of Millstone Grit which were not separated in the original survey, and one result of his work has been to relegate a considerable tract of country which was formerly regarded as Coal-measures to the Millstone Grit formation. Mr. Gibson has continued his researches on the higher measures of this coalfield, and has obtained additional evidence to prove that beds above the Top Hard, which have been brought to light in the Gelding shafts and in the Thurgarton boring, are palæontologically, lithologically, and stratigraphically comparable with the higher measures occurring in other Midland coalfields. As he points out, there seems no escape from the conclusion that the Pennine elevation, with the consequent breaking up of the syncline, was subsequent to their deposition. He has also obtained evidence of the existence of marine conditions during the deposition of the Coal-measures at several horizons, both low down and high up in the series, and in view of these facts he naturally asks whether a much larger proportion of our Coal-measures has not been formed under marine conditions than is generally supposed. In working out the palæontology of the coal Mr. Gibson has received valuable aid from Dr. Wheelton Hind, whose name frequently recurs in this Summary of Progress.

In Scotland the revision of the Carboniferous areas has been commenced in the eastern part of the Midland Valley. Mr. Wilson has re-examined the oil-shale field to the west of Edinburgh, and calls attention in his report to the fact that the shales in that region, with few exceptions, deteriorate both in the quantity and quality of the oil as they are followed downwards. If this should prove to be a general law, it will obviously have a very important bearing on estimates of the value of any area in which the oil-shale horizons exist, and raise an interesting problem as to the nature of the processes by which the oil-producing compounds have been concentrated near the existing surface.

The examination of the coast between Dunbar and Cockburnspath has enabled Mr. Clough to prepare a detailed section of the Carboniferous Limestone series, and to show that the beds which dip under the sea along a portion of the coast are probably very near

the base of the Edge coals of Midlothian. These coals may therefore exist beneath the sea under conditions which will enable them to be worked at some future time.

But the most striking addition to our knowledge of the Carboniferous rocks of Scotland is that furnished by Mr. Kidston's examination of a large suite of plants from the Canonbie Coalfield, in the collection of which he was assisted by Mr. Macconochie. This proves that Upper, Middle, and Lower Coal-measures are here present. According to Mr. Kidston the highest measures are on the horizon of the Radstock Beds, an horizon which is higher than any reached in the midland or northern coalfield so far as is at present known.

The Permian and Trias, the Jurassic and Tertiary deposits have also received attention during the past year, but we cannot now dwell with greater detail on the Summary before us, which deserves to be more fully studied by all who take an interest in the progress of geology in the British Isles.

CORRESPONDENCE.

COMMENTS ON A COMMENTATOR.

Sir,—As my name has been made prominent in more than one part of the last number of the Geological Magazine, permit me to say that I see no reason to modify what I said (1895, p. 75) about the Budleigh Salterton pebbles, and cannot admit that Mr. Shrubsole is right in asserting the oblate spheroidal form to have been acquired by rolling on the beach. To this point I paid particular attention, with what result may be seen in the following extract from my diary. After some notes on size, form, and colour, it goes on—"I think these peculiar, almost semicircular ellipsoids are rather commoner on the beach than in the cliffs, perhaps due to their being a little more worn and selected. Nevertheless, they are generally the dominant form in the sections, but are less conspicuous from being half buried." This flattened form could not be acquired by wave-action alone, but must be initiated by a certain original 'slabbiness' in the rock from which the pebbles have been derived. A parallel to this may be found in the flattened chalk pebbles on the beach in the Bridlington district. Thus the dominant quartzite pebbles at Budleigh Salterton must have come from a source different from that which has supplied most of those at Cannock Chase.

Reference is also made to a paper of mine on Luxulyanite. It is not easy to disentangle the writer's meaning from the mass of irrelevant matter, but I presume it is not meant to be complimentary, so I may say that though more than a quarter of a century has passed since I wrote this paper, and I have studied many tourmaline-bearing rocks in the interval, I have found no reason to alter the opinion then expressed as to the history and formation of this mineral in that case. I also am familiar with party-coloured crystals of tourmaline, but fail to see that their occurrence affects the accuracy of my original conclusions. I do not remember having