noted). The fragments in the crucible are then taken one by one and carefully placed in the burette, care being taken at the same time that nothing is lost in the transference. The finer débris may be left in the crucible. During the transference the burette may be smartly tapped from time to time to detach air bubbles from the fragments. The crucible is again weighed—say the weight is now W'. The height of the water in the burette is now taken. Say it is X' c.c. When we have $W - W'$ = weight of substance taken, $X - X'$ = number of c.c. occupied by quantity of substance taken, whence $\frac{W-W'}{X-X'}$ = specific gravity required.

I append the first ten determinations which were made by this method. Some of them were checked by other methods. From these the general accuracy of the method will readily be inferred.

Rocks, Minerals, Sands, etc.	Quantity taken. Grams.	No. of c.c. displaced.	Calculated Specific Gravity.
Granite	10·822 ...	4·1 ...	2·64
Porphyritic Olivine Basalt	8·483 ...	2·9 ...	2·925
Fine Sandstone	11·47 ...	4·4 ...	2·6
Sandstone cemented with Ba O SO_4 [1]	14·062 ...	4·4 ...	3·2 nearly
,, ,, ,, Ca F_2 [1] ...	13·447 ...	4·85 ...	2·77
Calcite...	10·17 ...	3·7 ...	2·75 nearly
Basic Rock (altered)	13·452 ...	4·9 ...	2·74
Garnet and Iron Sand	14·88 ...	3·8 ...	3·92 }
Same by Sp.g. bottle ...	6·813 ...	— ...	3·936 }
Shot in large pellets	79·328 ...	7·1 ...	11·17 }
(again)	103·754 ...	9·3 ...	11·16 }
Epidiorite	13·953 ...	4·9 ...	2·85 }
By Sp.g. bottle	4·84 ...	— ...	2·84 }

NOTICES OF MEMOIRS, ETC.

I.—Floras of the Past: their Composition and Distribution.[2] By A. C. Seward, F.R.S., Fellow and Tutor of Emmanuel College, Lecturer on Botany in the University of Cambridge.

After speaking of the important work accomplished by Professor Williamson, of Manchester, as a palæobotanist, and referring to his methods of microscopic investigation of the Carboniferous plants, Professor Seward said:—My aim is to put before you in this address one aspect of palæobotany which has not received its due share of attention: I mean the geographical distribution of the floras of the past. I recognise the futility of expecting conclusions of fundamental importance from such an incomplete examination of the available evidence as I have been able to undertake; but a hasty sketch may serve to indicate the impressions likely to be conveyed by a more elaborate picture.

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[1] Brit. Assoc. Rep. 1901, p. 649.

[2] Being the Presidential Address to the Botanical Section of the British Association for the Advancement of Science, Southport, September, 1903.

In endeavouring to take a comprehensive survey of the records of plant-life, we should aim at a wider view of the limits of species, and look for evidence of close relationship rather than for slight differences, which might justify the adoption of a distinctive name. Our object, in short, is not only to reduce to a common language the diverse designations founded on personal idiosyncrasies, but to group closely allied forms under one central type. We must boldly class together plants that we believe to be nearly allied, and resist the undue influence of considerations based on supposed specific distinctions.

As a preliminary consideration, we must decide upon the most convenient means of expressing the facts of geographical distribution in a concise form. The recognised botanical regions of the world do not serve our purpose; we are not concerned with the present position of mountain-chains or wide-stretching plains that constitute natural boundaries between one existing flora and another, but simply with the relative geographical position of localities from which records of ancient floras have been obtained. I have divided the surface of the earth into six belts, from west to east. The most northerly or *Arctic Belt* includes the existing land-areas as far south as latitude 60°, comprising—1, Northern Canada; 2, Greenland and Iceland; 3, Northern Europe; 4, Bear Island and Spitzbergen; 5, Franz Josef's Land; 6, Northern Asia. The *North Temperate Belt,* extending from latitude 60° to 40°, includes—7, South Canada and the northern United States; 8, Central and Southern Europe; 9, Central Asia. The *North Subtropical Belt* comprises the land between latitude 40° and the Tropic of Cancer, including—10, the Southern States of North America; 11, Northern Africa, part of Arabia and Persia; 12, Thibet, and part of China; 13, Japan. The *Tropical Belt,* embracing the land-areas between the Tropics of Cancer and Capricorn, includes—14, Central America and the northern part of South America; 15, Central Africa and Madagascar; 16, India, the Malay Archipelago, and Northern Australia. The *South Subtropical Belt,* extending from the Tropic of Capricorn to latitude 40° South, includes—17, Central South America; 18, South Africa; 19, Central and Southern Australia. The *South Temperate Belt* includes—20, the extreme south of South America; 21, Tasmania; 22, New Zealand.

Pre-Devonian Floras.—The scanty records from pre-Devonian rocks afford but little information as to the nature of the vegetation that existed during the period in which were deposited the Cambrian, Ordovician, and Silurian strata that now form the greater portion of the Welsh and Cumberland hills.

The genus *Nematophycus,* originally described by Dawson as *Prototaxites,* and afterwards referred by Carruthers to the Algæ, constitutes the most satisfactory example of a Silurian plant. This genus, which has fortunately been preserved in such a manner as to admit of minute microscopical examination, represents a widely spread algal type in Silurian and Devonian seas. The tubular elements composing the stems of some species of *Nematophycus*—

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which reached a diameter of 2 or 3 feet—exhibit a regular variation in width, giving the appearance of concentric rings of growth, as in the stems of the tree-like *Lessonia*, an existing genus of Antarctic seaweeds. This structural feature presents an impressive image in stone of a plant's rhythmical response to some periodically recurring conditions of growth in the waters of Palæozoic seas.

Devonian and Lower Carboniferous Floras.—The earliest plants that have been found in sufficient number, and in a state of preservation which renders their identification possible, are those from Devonian rocks.

What do we know as to the composition of the floras that flourished in the later stages of the Devonian and in the lower part of the Carboniferous era? The following list, which is by no means exhaustive, represents some of the more important generic types which may be very briefly described:—

1. Equisetales.
   Archæocalamites.
2. Sphenophyllales.
   Sphenophyllum.
   Cheirostrobus.
   [*Pseudoboronia* ?]
3. Lycopodiales.
   Lepidodendron.
   Bothrodendron.
4. Filicales.
   Archæopteris.
   Adiantites.
   Rhodea.
   Cardiopteris.
   Todeopsis.
   Cephalotheca.
   Rhacopteris.
5. Cycadofilices.
   Calamopitys.
   Heterangium.
   Lyginodendron.
6. Gymnospermæ.
   (Cordaitales.)
   Cordaites.
   Pitys.

In *Archæocalamites* we have the oldest example of an undoubted Equisetaceous genus. The structure of its comparatively thick and woody stem is practically identical with that of our common British type of *Calamites*, one of the most abundant of the Coal-period genera, while the strobilus differed in no essential feature from that of a modern Horsetail. The genus *Cheirostrobus*, founded in 1897 by Dr. D. H. Scott on a single specimen of a petrified cone, affords a striking illustration of a Palæozoic plant exhibiting a structure far more complex than that of any known type among existing Vascular Cryptogams. In this Scotch cone, about 3·5 cm. in diameter, we recognise Equisetaceous and Lycopodinous characters combined with morphological features typical of the extinct genus *Sphenophyllum*. Both Devonian and Culm rocks have furnished many examples of Lycopodinous plants. The genus *Bothrodendron*, closely allied in habit to *Lepidodendron*, has been recorded from Bear Island, Ireland, and Australia, and the cuticles of a Lower Carboniferous species form the greater portion of the so-called paper-coal of Tula in Russia. *Lepidodendron* itself had already attained to the size of a forest tree, with anatomical features precisely similar to those of the succeeding Coal-period species.

Our knowledge of the ferns is not very extensive. The genus *Archæopteris* from Ireland, Belgium, Bear Island, and North America

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has always been regarded as a fern, but we must admit the impossibility of accurately determining its systematic position until we possess a fuller knowledge of the reproductive organs and of its anatomical structure. Similarly, the genera *Rhacopteris*, *Adiantites*, and *Rhodea* may be provisionally retained among the oldest known ferns. The genus *Cardiopteris*—a plant with large oblong or orbicular pinnules borne in two rows on a stout rachis—is known only in a sterile condition, and it is quite as likely that its reproductive organs may have been of the Gymnospermous as of the Filicinean type.

The petrified remains of stems and leaves of such plants as *Heterangium*, *Lyginodendron*, *Calamopitys*, and others which demonstrate the existence of a class of synthetic genera combining Filicinean and Cycadean characters, are of exceptional interest as showing beyond doubt that Ferns and Cycads trace their descent from a common ancestry. The announcement made a few months ago by Professor Oliver and Dr. Scott that they had obtained good evidence as to the connection of the gymnospermous seed known as *Lagenostoma* with the genus *Lyginodendron* is one of the most important contributions to botany published in recent years; if, as I firmly believe, the evidence adduced is convincing, it gives satisfactory confirmation to suspicions that previous discoveries led us to entertain. The fact demonstrated is this: the genus *Lyginodendron*, a plant known to have existed during the greater part of the Carboniferous epoch, possessed a stem of which the primary structure was almost identical with that which characterises some recent species of Osmundaceæ, while the secondary wood produced by the activity of a cambium is hardly distinguishable from the corresponding tissue in the stem of a recent cycad. The fronds were those of a fern, both in the anatomy of their vascular tissue and in their external form; as far, therefore, as the vegetative characters are concerned, we have a combination of ferns and cycads. We still lack complete knowledge of the nature of the reproductive organs, but it seems clear that *Lyginodendron* bore seeds constructed on the Gymnospermous plan, but characterised by an architectural complexity far beyond that represented in the seeds of any modern Conifer or Cycad.

In such genera of Gymnosperms as *Cordaites*, *Pitys*, and others, we have examples of forest trees possessing wood almost identical with that of existing species of *Araucaria*, but distinguished by certain peculiarities which point to a relationship with members of the Cycadofilices, and suggest that Conifers as well as Cycads may have sprung from a filicinean stock.

Two facts stand out prominently as the result of a general survey of what are practically the oldest records of plant-life. One is the abundance of types which cannot be accommodated in our existing classification, founded solely on living plants.

The Devonian and Lower Carboniferous plants lead us away from the present along converging lines of evolution to a remote stage in the history of life; they bring us face to face with proofs of common origins, which enable us to recognise community of descent in existing groups between which a direct alliance is either dimly suggested or absolutely unsuspected if we confine our investigations to modern forms.

Another fact that seems to stand out clearly is the almost world-wide distribution of several characteristic Lower Carboniferous plants. We are, as yet, unable to follow these Devonian plants to an earlier stage in their evolution. We are left in amazement at their specialised structure and extended geographical distribution, without the means of perusing the opening chapters of their history.

Upper Carboniferous (Coal-measures) and Permian Floras.—The vast forests of the Coal age occupied an extensive area of land on the site of the present United States of North America, stretching across Europe into Eastern Asia; under the shade of their trees lived "the stupid, salamander-like Labyrinthodonts, which pottered with much belly and little leg, like Falstaff in his old age." The plants of these Palæozoic forests seem to be revivified, as we subject their petrified fragments to microscopical examination. Robert Louis Stevenson has referred to a venerable oak which has been growing since the Reformation and is yet a living thing, liable to sickness and death, as a speaking lesson in history. How much more impressive is the conception of age suggested by the contemplation of a group of Palæozoic tree-stumps exposed in a Carboniferous quarry and rooted where they grew! An examination of their minute anatomy carries us beyond the mere knowledge of the internal architecture of their stems, leaves, and seeds; it brings us into contact with the actual working of their complex machinery. As we look at the stomata on the lamina of a leaf of one of those strange trees, and recognise a type of structure in the mesophyll-tissues which has been rendered familiar by its occurrence in modern leaves, it requires but little imagination to see the green blade spreading its surface to the light to obtain a supply of solar energy with which to extract carbon from the air. We can almost hear the murmur of plant-life and the sighing of the branches in the wind as the sap courses through the wood, and the leaves build up material from the products of earth and air; products that are to be sealed up by subsequent geological changes, till after the lapse of countless ages the store of energy accumulated in coal is dissipated through the agency of man.

Time does not admit of more than the most cursory glance at the leading types of the Permo-Carboniferous floras. The general character of the preceding vegetation is retained with numerous additions. *Archæocalamites* is replaced by a host of representatives of the genus *Calamites*, an Equisetaceous type with stout woody stems and several forms of cones of greater complexity than those of modern Horsetails. Side by side with the Calamites there appear to have existed plants which, from their still closer agreement with *Equisetum*, have been described by Zeiller, Kidston, and others as species of *Equisetites*. The genus *Sphenophyllum*, a solitary type of an extinct family, was represented by several forms which, like the *Galium* of our hedgerows, may have supported their slender branches

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against the stems of stronger plants. Lycopods, with trunks as thick and tall as forest trees, were among the most vigorous members of the later Palæozoic forests. Although recent research has shown that several of the supposed ferns must be assigned to the Cycad-fern alliance, there can be no doubt that true ferns had reached an advanced state of evolution during the Permo-Carboniferous epoch. The abundance of petrified stems of the genus *Psaronius*, of which the nearest living representatives are probably to be found among the tropical Marattiaceæ, demonstrates the existence of true ferns. The most striking fact as regards the Permo-Carboniferous ferns is the abundance of fertile fronds bearing sporangia which exhibit a more or less close agreement with those of the few surviving genera of Marattiaceæ. The more familiar type of sporangium met with in our existing fern-vegetation is also represented, and we have recently become familiar with several genera bearing sporangia exhibiting a close resemblance to those of modern Gleicheniaceæ, Schizæaceæ, and Osmundaceæ. The sporangial characteristics of the different families of living ferns are many of them to be found among Palæozoic types, but there is a frequent commingling of structural features showing that the ferns had not as yet become differentiated into so many or such distinct families as have since been evolved.

Prominent among the Gymnosperms of the Palæozoic forests must have been the genus *Cordaites*: tall handsome trees, with long strap-shaped leaves. This genus, which has been made the type of a distinct group of Gymnosperms, combined the anatomy of an *Araucaria* with reproductive organs more nearly allied to the flowers of Cycads, and exhibiting points of resemblance with those of the Maidenhair-tree. It is not until the later stages of the Permo-Carboniferous epoch that more definite coniferous types made their appearance. The Maidenhair-tree of the Far East, one of the most venerable survivors in our modern vegetation, is foreshadowed in certain features exhibited by *Cordaites* and, as regards the form of its leaves, by *Psygmophyllum, Whittleseya*, and other genera. Leaves have been found in Permian rocks of Russia, Siberia, Western and Central Europe, referred to the genus *Baiera*, a typical Mesozoic type closely allied to *Ginkgo*. In the Upper Coal-measures and Lower Permian rocks a few pinnate fronds have been discovered, which bear a striking likeness to modern Cycadean leaves. Throughout the Permo-Carboniferous era the Cycadofilices formed a dominant group; *Lyginodendron, Medullosa, Poroxylon*, and many other genera flourished in abundance as vigorous members of an ancient class which belongs exclusively to the past.

One distinctive characteristic of the vegetation of later Permo-Carboniferous days is the occurrence of the Cycad-like fronds already referred to; also the appearance of *Voltzia* and other conifers with species of *Equisetites*, pioneer genera of a succeeding era that constitute connecting links between the Palæozoic and Mesozoic floras.

What we may call the typical vegetation of the Coal-measures, which continued, with comparatively minor changes, into the

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succeeding era, flourished over a wide area in the northern hemisphere, suggesting, as White points out, an almost incredible uniformity of climate. We have already noticed the existence in the southern hemisphere of Lower Carboniferous and Devonian genera identical with plants found in rocks of corresponding age within the Arctic circle. This agreement between the northern and southern floras was, however, not maintained in the later stages of the Palæozoic epoch. Australian plant-bearing strata, homotaxial with Permo-Carboniferous rocks of Europe, have so far afforded no examples of *Sigillaria*, *Lepidodendron*, or of several other characteristic northern forms; in place of these genera we find an enormous abundance of a fern known as *Glossopteris*. With *Glossopteris* was associated a fern bearing similar leaves, known as *Gangamopteris*, and with these grew *Schizoneura* and *Phyllotheca*, members of the Equisetales. In addition to these genera there are others which bear a close resemblance to northern hemisphere types, such as *Noeggerathiopsis*, a member of the Cordaitales, and several species of *Sphenopteris*. Similarly, in many parts of India, *Glossopteris* has been found in extraordinary abundance in the same company with which it occurs in Australia. In South Africa an identical flora is met with which extends to the Argentine and to other regions of South America. It is clear that from South America, through South Africa and India to Australia, there existed a vegetation of uniform character which flourished over a vast southern continent at approximately the same period as that which, in the northern hemisphere and in China, witnessed the growth of the forests whose trees formed the source of our coal-supply.

Since attention was drawn by Dr. Blanford and other writers to the facts of plant-distribution revealed by a study of the later Palæozoic floras, it has been generally admitted that during the Permo-Carboniferous era there existed two fairly well-marked botanical provinces. The more familiar and far richer flora occupied a province stretching from the western states of North America across Europe into China and reaching as far as the Zambesi; the other province was occupied by a less varied assemblage of plants, characterised by the abundance of *Glossopteris*, *Gangamopteris*, *Neuropteridium*, *Noeggerathiopsis*, *Schizoneura*, and other genera, stretching from South America through India to Australia.

In Brazil, Professor Zeiller has recorded the occurrence of a flora including *Lepidophloios*, a well-known European member of the Lycopods, associated with such characteristic southern types as *Gangamopteris* and *Noeggerathiopsis*. Similarly, from the Transvaal a European species of *Sigillaria*, with a Lepidodendroid plant, and another northern genus, *Psygmophyllum*, have been found in beds containing *Glossopteris*, *Gangamopteris*, *Noeggerathiopsis*, *Neuropteridium*, and other members of the so-called Glossopteris flora. In India, the Glossopteris flora exhibits an entire absence of *Lepidodendron*, *Calamites*, *Sigillaria*, and other common northern genera, while *Sphenophyllum* is represented by a single species. The Australian Permo-Carboniferous flora is also characterised by the absence of the great majority of the northern types. Until a few years ago the genus *Glossopteris* had not been discovered in Europe, but in 1897 Professor Amalitzky recorded the occurrence of this genus in association with *Gangamopteris* in Permian strata in northern Russia.

We see, then, that in Brazil and South Africa the Glossopteris flora and the northern flora overlapped, but the former was the dominant partner. On the other hand, in rocks belonging to a somewhat higher horizon in Russia, we meet with a northern extension of the Glossopteris flora.

There seems good reason for assuming that the Glossopteris flora originated in the South, and before the close of the Permian period, as well as in the succeeding Triassic era, pushed northward over a portion of the area previously occupied by the northern flora. This northward extension is shown by the existence of *Glossopteris* in Upper Permian rocks of Russia, by the occurrence of several southern types in plant-bearing beds of the Altai Mountains, and by the existence in Western Europe during the early stages of the Triassic era of such southern genera as *Neuropteridium* and *Schizoneura*.

Triassic, Jurassic, and Wealden Floras.—It is unfortunate that the records of plant-life towards the close of the Palæozoic and during the succeeding Triassic period are very fragmentary; the documents are few in number, and instead of the fairly continuous chapters in which the records of the Coal age have been preserved, we have to be content with a few blurred pages. During the Triassic period the vegetation of the world gradually changed its character; the balance of power was shifted from the Vascular Cryptogams, the dominant group of the Palæozoic era, to the Gymnosperms.

One of the few floras of early Triassic age of which satisfactory relics have been preserved is that described in 1844 by Schimper and Mougeot from the Bunter Sandstones of the Vosges. The genus *Neuropteridium*, a plant which may be a true fern, or possibly a surviving member of the Cycadofilices, is represented by a species which can hardly be distinguished from that which flourished in South America, South Africa, and India in the Permo-Carboniferous period. This genus and another southern type, *Schizoneura*, both of which are met with in the Triassic rocks of the Vosges, would seem to point to a northern migration of certain members of the *Glossopteris* flora, which took place at the close of the Palæozoic era. In the Lower Triassic flora Conifers are relatively more abundant than in the earlier periods; such genera as *Albertia* (resembling in its vegetative features some recent species of *Araucaria*), *Voltzia* (with cones that cannot be closely matched with those of any existing members of the Coniferæ), and other representatives of this class are common fossils. *Lepidodendra* have apparently ceased to exist; *Sigillaria* may be said to survive in one somewhat doubtful form, *Sigillaria oculina*. The genus *Pleuromeia*, which makes its appearance in Triassic rocks, is perhaps more akin to *Isoetes* than to any other existing plant. The Calamites are now replaced by large

Equisetaceous plants, which are best described as Horsetails with much thicker stems than those of their modern descendants.

Passing to the Peninsula of India, we find the genus *Glossopteris* abundantly represented in strata which there is good reason for regarding as homotaxial with the European Trias, and the occurrence in the same beds of some other genera of Permo-Carboniferous age shows that the change in the character of the southern vegetation at the close of the Palæozoic era was much more gradual than in the north.

The comparative abundance of plant remains in the northern hemisphere in rocks belonging to the Rhætic formation is in welcome contrast to the paucity of the records from the underlying Triassic strata. From Virginia and adjacent districts in the United States a rich flora has been described, which by some authors is assigned to the Keuper or Upper Triassic series, while others class it as Rhætic. A similar assemblage of plants is known also from the Lettenkohle beds of Austria, which, as Stur has shown, clearly belong to the same period of vegetation as the American flora.

(*To be continued.*)

II.—On some Dinosaurian Bones from South Brazil. By A. Smith Woodward, LL.D., F.R.S.

THE author had received from Professor H. von Jhering a few cervical vertebræ and phalangeal bones of a reptile discovered by Dr. Fischer in red rocks in the province of Rio Grande do Sul, Brazil. He described these remains, and suggested that they belonged to a short-necked Dinosaur. The ungual phalanges were especially remarkable, apparently unique, in being deeply concave on their inferior face and having a very sharp rim. Comparison seemed to show that, among known Dinosaurs, the cervical vertebræ most closely resembled those of *Euskelesaurus* from the Karoo formation of South Africa. The newly-discovered bones were therefore probably the first traces of the Gondwana-land terrestrial fauna, the discovery of which had long been expected in South America.

III.—On a Carboniferous Acanthodian Fish, *Gyracanthides*. By A. Smith Woodward, LL.D., F.R.S.[1]

THE author exhibited and described a restored drawing of *Gyracanthides* from the Carboniferous of Victoria, Australia. The fossil had pectoral fin-spines much like those named *Gyracanthus* from the Carboniferous of the northern hemisphere, but these spines lacked posterior denticles. The fish was either toothless or with minute teeth which had escaped observation. It was covered with dense shagreen, but there were no enlarged plates round the eyes. The body was depressed and broad in front, with a small and not

[1] Abstract of paper read before the British Association, Southport, Section C (Geology), September, 1903.

very stout tail. The pectoral fins were relatively large, with almost sickle-shaped spines, while the pelvic fins were rather small, with straighter spines, and situated very far forwards. There were two pairs of peculiar free spines near the base of the pectoral fins. The two dorsal fins and the anal fin were provided with much smaller spines. *Gyracanthides* was evidently one of the most highly specialised Acanthodians, and showed that among these primitive fishes, as among modern Teleosteans, there was a tendency for the pelvic pair of fins to become displaced forwards in the higher types. The author had already described the same phenomenon in the typical family Acanthodidæ.

IV.—Land-Shells in the Infra-Glacial Chalk-rubble at Sewerby, near Bridlington.[1] By G. W. Lamplugh, F.G.S.[2]

THE Chalk-rubble which underlies the glacial drifts of Flamborough Head has not hitherto been known to contain organic remains. In a recent exposure of this material on the foreshore between Bridlington Quay and Sewerby the writer found numerous small fragile land-shells contained principally in intercalated streaks of brown earth. These shells belong mainly, if not entirely, to the species *Pupa muscorum*, Linn. The level at which they were found was about 8 feet below the top of the Sewerby Infra-Glacial sea-beach, and the Chalk-rubble is known to descend to at least 25 feet below this level.

The rubble usually rests directly upon the Chalk, but at Sewerby it overlies the Infra-Glacial blown-sand which is banked against the buried cliff of chalk. The presence of the land-shells proves that the rubble is a subaërial rainwash, and that it was formed when the sea stood at a lower level than when the Infra-Glacial beach was deposited. The conditions thus indicated are strikingly similar to those which obtain in the deposits associated with the Infra-Glacial buried shores of South Wales and co. Cork, where the old marine beaches and the accompanying blown-sand are covered by local rainwash or 'head,' and then by Boulder-clay.

The Chalk-rubble at Sewerby contains many small pieces of flint, though no flint is present in the Chalk within two miles of this locality; a few small fragments of yellow grit or quartzite foreign to the neighbourhood, along with one subangular boulder of similar rock 18 inches in diameter, were also found in it. Part of the material was probably deposited almost immediately before the glaciation of the district.

V.—On Dedolomitisation. By J. J. H. Teall, M.A., F.R.S., Director of the Geological Survey.[2]

THE Durness dolomites, as they approach the plutonic complex of Cnoc-na-Sroine, become transformed into a white marble which generally contains one or more of the following minerals: forsterite,

[1] The full text of this paper will be published in *Proc. Yorks. Geol. and Polytech. Society*.

[2] Abstract of paper read before the British Association, Southport, Section C (Geology), September, 1903.

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or serpentine after forsterite, tremolite, diopside, and brucite. The dominant carbonate of the marble is calcite, but dolomite occurs in variable quantity. The amount of dolomite decreases as the total amount of the magnesian silicates and brucite increases. The original dolomite contains a variable amount of silica in the form of chert.

When the altered rocks are examined under the microscope it is seen that forsterite, serpentine, and tremolite are invariably associated with calcite, but that diopside is sometimes associated with dolomite. These facts of paragenesis can be easily accounted for if we assume that the silica of the original dolomitic rock has combined with the bases of the carbonate, and preferably with the magnesia, for diopside is rare. Thus forsterite, a magnesian silicate, cannot have been formed in the dolomite without the liberation of lime, and consequently we find either detached crystals of forsterite surrounded by aureoles of calcite in a matrix of dolomite, or, when forsterite is abundant, a simple aggregate of forsterite and calcite. The formation of tremolite in which the ratio of CaO : MgO is 1 : 3 also implies the separation of lime from magnesia; and it is invariably found, like the forsterite, in direct contact with calcite. But in diopside the ratio of CaO : MgO is the same as in dolomite; so that in accordance with the principles above explained we should expect to find these two minerals in contact, and this has been observed.

The above facts clearly point to the conclusion that the cherty dolomites have been dedolomitised by the formation of magnesian silicates. Carbonic acid has been driven off, but the ratio of the bases has not been disturbed. The ratio of CaO : MgO in the altered as in the unaltered rocks is approximately 1 : 1.

But dedolomitisation has also been produced in another way. Certain varieties of the marble are composed of calcite and brucite. The brucite is probably a pseudomorph after periclase, just as the serpentine is a pseudomorph after forsterite. We are therefore compelled to conclude that, under the conditions which prevailed during the intrusion of the plutonic rocks, the carbonic acid freed itself more readily from the magnesia than from the lime; thus, in the absence of silica, giving rise to the formation of periclase and converting the original dolomite into an aggregate calcite and periclase, the latter mineral subsequently being changed to brucite. The resulting rock is identical with the well-known predazzite of the Tyrol, which was probably formed in a similar way.

VI.—On the Fossil Flora of the Ardwick Series of Manchester.

By E. A. Newell Arber, M.A., F.L.S., F.G.S.[1]

THE Ardwick Series of Manchester forms the highest portion of the Coal-measures of the great South Lancashire Coalfield. The plant-remains in the shales associated with the *Spirorbis* Limestones of this series have been already mentioned or described by Williamson, Salter, and especially by the late E. W. Binney.

[1] Abstract of paper read before the British Association, Southport, Section C (Geology), September, 1903.

A revision of these records has been recently undertaken with a view to determining the true position of the Ardwick Series in the Coal-measures as indicated by the character of the flora. For this purpose Binney's collection, now in the Sedgwick Museum, Cambridge, has been re-examined, and several further identifications have been made. The flora is found to belong to a palæobotanical horizon known as the Upper Transition Series, which is antecedent to the true Upper Coal-measures, and which is represented in several English and Welsh Coalfields. The Lower Pennant Grits in the South Wales and the New Rock and Vobster Series in the Somersetshire Coalfields belong to this horizon.

VII.—Fossil Floras of South Africa. By A. C. Seward, F.R.S.[1]

1. *Uitenhage Flora.*—The plants from the Uitenhage series of Cape Colony include types characteristic of Wealden and others more closely allied to Jurassic species. On the whole there is a balance of evidence in favour of a Wealden horizon.

Onychiopsis Mantelli (Brongn.).
Cladophlebis Browniana (Dunk.).
Cladophlebis denticulata (Brongn.), forma *Atherstonei.*
Sphenopteris Fittoni (Sew.).
Sphenopteris, sp.
Tæniopteris, sp.
Zamites recta (Tate).
Zamites Morrisii (Tate).
Zamites africana (Tate).
Zamites Rubidgei (Tate).
Nilssonia Tatei, sp. nov.
Cycadolepis Jenkinsiana (Tate).
Benstedtia, sp. (cf. *Coniferocaulon Columbeæforme*, Fliche).
Carpolithes, sp.
Araucarites Rogersi, sp. nov.
Taxites, sp.
Brachyphyllum, sp.
Conites, sp. α. }
Conites, sp. β. }
Coniferous wood.
Planta incertæ sedis.

2. *Stormberg Flora.*—The plants from the Stormberg series point to a flora of Rhætic age. The Rhætic vegetation, of which remnants have been recorded from Scania, Franconia, and other parts of Germany, North America, New Mexico, Honduras, Tonkin, China, Turkestan, India, Australia, South America, and elsewhere, was characterised by its uniform character throughout the world.

Schizoneura Krasseri, sp. nov.
Strobolites, sp.
Thinnfeldia odontopteroides (Morr.).
Thinnfeldia rhomboidalis (Ett.).
Cladophlebis, sp. (Feistmantel).
Callipteridium stormbergense, sp. nov.
Tæniopteris Carruthersi (Ten.-Woods).
Chiropteris cuneata (Carr.).
Chiropteris Zeilleri, sp. nov.
Baiera stormbergensis.
Baiera Schencki (Feist.).
Phœnicopsis elongatus (Morr.).
Stenopteris elongata (Carr.).

3. *Permo-Carboniferous Flora of Vereeniging.*—The conclusion to be drawn from the Vereeniging plants is that they belong to a flora which flourished in South Africa, India, South America, and Australia during some portion of the Permo-Carboniferous epoch. On the whole, it would seem probable that the age of the plant-beds corresponds most nearly with the Upper Carboniferous period as represented in Europe. It is of necessity difficult to attempt to

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express the geological age or homotaxy of South African beds in terms of the geological chronology of the Northern Hemisphere, but the close correspondence of some of the Vereeniging types with Indian and South American species points to their correlation with the Karharbari beds of the Lower Gondwana system. The occurrence of such types as *Sigillaria, Bothrodendron,* and *Psygmophyllum* shows a closer correspondence between the South African flora and that of the Northern Hemisphere than occurs in the Indian vegetation. We have evidence of an overlapping or commingling of the northern and southern botanical provinces in South Africa and in South America that is not afforded by the Lower Gondwana floras of India and Australia.

Glossopteris Browniana (Brongn.). Under this head may be included, at least for present purposes, *G. indica* and *G. angustifolia.*
Gangamopteris cyclopteroides (Feist.).
Sphenopteris, sp.
Neuropteridium validum (Feist.).
Psygmophyllum Kidstoni, sp. nov.
Sigillari Brardi (Brongn.).
Bothrodendron Leslei, sp. nov.
Noeggerathiopsis Hislopi (Bunb.).
Conites, sp.
Cardiocarpus, sp.
Phyllotheca, sp.
Schizoneura, sp.

A detailed account of the above species will be published in a forthcoming volume of the Annals of the South African Museum. The writer is indebted to the officers of the Geological Survey of Cape Colony for the opportunity of examining the collections from which these lists have been compiled.

VIII.—On the Disturbance of Junction Beds from Differential Shrinkage and similar Local Causes during Consolidation. By G. W. Lamplugh, F.G.S.[1]

UPON returning to the investigation of comparatively undisturbed Mesozoic strata, after having studied distortion structures produced by earth-movement in the older Palæozoic rocks, the author's attention has been frequently arrested by local disturbances of the original bedding which cannot be assigned to the agency of deep-seated earth-movement, but are clearly due to minor stresses arising from some local cause in tracts limited in extent, both horizontally and vertically.

These disturbances are most noticeable where thin bands of one kind of material are imbedded in thick deposits of another kind, and along the junctions where thick masses of different lithological character occur in stratigraphical sequence.

Examples of the first-mentioned condition are abundant in the Hastings beds of the Wealden formation, where thin layers of clay or shale interbedded with thick sands and sandstones are often disrupted into irregular patches and partly mixed with the inclosing sands. The second condition is frequently illustrated in junctions of the Lower Greensand with underlying clays, where strips have been torn from the irregular surface of the clay and dragged up

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for a few inches into the sands, as was seen in the recently widened railway cutting at Redhill and in the pit-sections at the Dover Colliery. Similar effects have often been supposed to denote the breaking up of the surface below the junction by erosive agencies, but this explanation is rarely adequate.

While some of these local disturbances may have been caused by unequal loading within limited basins of sedimentation, in the matter discussed by E. Reyer,[1] the author is of opinion that in most cases they may be assigned to local stresses resulting in part from the differential contraction of sediments of diverse composition while losing their water of sedimentation, and in part from their unequal yielding under equal superincumbent load. Masses of peat, sand, clay, and calcareous sediments accumulated under normal conditions must pass from the wet state to the consolidated or partly consolidated state with different time-rates and with different physical results; and we may expect to find signs of local tension and readjustment along the boundaries of such masses.

In thick wedges of strata which thin out rapidly, as, for example, in the Triassic rocks of many localities and the Wealden and Lower Greensand of the south of England, differential shrinkage may be responsible for many of the smaller vertical displacements by which the beds are readjusted. Faults are sometimes found to dwindle and die out downward, and in certain cases these may be explicable as the result of unequal contraction in masses of irregular thickness.

IX.—Photographs of Geological Interest in the United Kingdom.[2] Fourteenth Report of the Committee:

Consisting of Professor James Geikie (Chairman), Professor W. W. Watts (Secretary), Professor T. G. Bonney, Professor E. J. Garwood, Professor S. H. Reynolds, Dr. Tempest Anderson, Mr. Godfrey Bingley, Mr. H. Coates, Mr. A. K. Coomáraswámy, Mr. C. V. Crook, Mr. J. G. Goodchild, Mr. William Gray, Mr. Robert Kidston, Mr. J. St. J. Phillips, Mr. A. S. Reid, Mr. J. J. H. Teall, Mr. R. Welch, and Mr. H. B. Woodward.

THE Committee have to report that during the year 463 new photographs have been received, bringing the total number in the collection to 3,771. This exceeds by 50 the largest number of new photographs previously recorded in a single year, and the yearly average now reaches 268. About 60 additional photographs have been sent in since this report was written.

The usual geographical scheme is appended. Brecknock, Cardigan, Nairn, and Ross appear for the first time, and very substantial additions are made to Cheshire, Dorset, Norfolk, Yorkshire, Glamorgan, the Channel Islands and Scilly, Inverness, Sutherland, Antrim, and Louth. The following twenty-five counties are still entirely unrepresented :—Cambridge, Huntingdon, Rutland, Carmarthen, Clackmannan, Dumbarton, Dumfries, Kincardine, Kinross, Roxburgh, Selkirk, Carlow, Kildare, Kilkenny, King's County,

[1] K.K. Geol. Reichsanstalt Wien, Jahrbuch, xxxi (1881), pp. 431-444.

[2] Abstract of paper read before the British Association, Southport, Section C (Geology), September, 1903.

Leitrim, Longford, Monaghan, Queen's County, Roscommon, Tyrone, Waterford, Westmeath, Wexford, and Wicklow.

The high standard mentioned in the last report is maintained, the photographs being usually taken in sets and with a definite geological aim. Mr. W. Jerome Harrison sends two large series taken to illustrate glacial phenomena on the Norfolk and Holderness cliffs. Mr. Morton and Mr. Howard contribute illustrations from Brecknock; Mr. R. H. Preston from the Scilly Islands; Mr. Guiton from Jersey; and Mr. Maidwell from the Nuneaton district. Mrs. Coomáraswámy has taken several series from the north of Scotland and of Ireland; Mr. Wright a useful set from Dublin; and Mr. Lamond Howie some interesting Scottish mountain photographs. The Croydon Natural History and Scientific Society continues to illustrate the geology of Surrey; Dr. Abbott that of Durham; Mr. Hopkinson that of Bedfordshire; and Mr. Hodson that of Leicestershire.

The members of the Committee have not been idle, as is testified by Professor Reynolds' series from Dorset, Gloucestershire, Somersetshire, Glamorgan, Antrim, Down, and Kerry; Mr. Bingley's sets from Cheshire and Yorkshire; Mr. A. K. Coomáraswámy's series from Ross, Sutherland, and Berwick; Professor Garwood's contribution from Westmorland; Mr. Teall's photographs from Hertfordshire; and Mr. A. S. Reid's continuation of his series from Eigg and Perthshire.

To all those contributors named and to the following the Committee desire to tender their warmest thanks for photographs received or help rendered: Mr. J. B. Scrivenor, Mr. C. M. Gillespie, Mr. Howard Fox, Mr. G. T. Atchison, Mr. A. Wheen, Mr. E. M. Wrench, Mr. H. A. Hinton, Mr. R. H. Rastall, Mr. C. H. B. Epps, Mr. F. Greenwood, Mr. A. A. Armstrong, Mr. W. G. Fearnsides, Mr. J. H. Baldock, Mr. N. F. Robarts, Mr. C. G. Cullis, Mr. Caradoc Mills, Mr. G. E. Blundell, Mr. H. W. Monckton, Mr. E. K. Hall, and Mr. H. B. Woodward.

A few photographs have been received for the duplicate series, but will be held over for the present. This collection has been sent during the year to natural history societies at Winchester and Croydon, and accounts of the work have been given by Mr. Whitaker.

	Previous Collection.	Additions (1903).	Total.
England	2,051	257	2,308
Wales	224	26	250
Channel Islands	15	23	38
Isle of Man	60	—	60
Scotland	326	96	422
Ireland	536	61	597
Rock Structures, etc.	96	—	96
Foreign	—	—	—
Total	3,308	463	3,771

The collection is stored at the Museum of Practical Geology, Jermyn Street, and the Committee wish to express their thanks to the Director and to Mr. Crook for the care taken of it and the space devoted to it.

The second of the three contemplated issues of the published series of photographs has been sent to subscribers. The issue consists of eighteen half-plates, four quarter-plates, and four whole plates, and it has been published in the form of mounted and unmounted prints and lantern-slides. The negatives were contributed by thirteen photographers, and the descriptions by twenty geologists. To all who have thus contributed to the success of the issue the Committee give their best thanks.

The process of selection for the third issue is well advanced, and it is hoped that publication will take place within this year.

The Committee are prepared to publish a second series if there is a demand for it. The number of names at present sent in is only about sixty, and at least twice that number would be required to put the issue on a possible financial basis. The first two issues of the first series show a small profit. The Committee intend to apply one-half to the purposes of the collection, and thus avoid calling upon the Association for any grant for a few years, while they are returning the other half to the subscribers in the form of additional photographs. The subscribers have already received an 'interim dividend' (rather a larger one than the present profits warrant) in the form of four whole-plate photographs and additional slides.

Applications by local societies for the loan of the duplicate collection should be made to the Secretary. Either prints or slides, or both, can be lent, with a descriptive account of the slides. The carriage and the making good of any damage to slides or prints are expenses borne by the borrowing society.

REVIEWS.

I.—Geological Survey of Canada. Robert Bell, M.D., Sc.D. (Cantab), LL.D., F.R.S., Acting Director. Annual Report (New Series), Vol. XII: Reports A, B, C, G, I, J, M, O, R, S. 1899. Plates and Maps. (Ottawa: S. E. Dawson, 1902.)

THE volume before us contains ten reports, as lettered above. Report A (224 pp.) was written while the previous volume to the one under review was still in progress, and is the work of the late Director of the Survey, Dr. George M. Dawson; it is dated January, 1900, and has already been issued as a separate pamphlet. This summary report brings again into prominence the geological and topographical investigations carried on by Mr. R. G. McConnell in the richly auriferous region of the Klondike. A somewhat full preliminary report upon the district is given. The geology of the gold region is said to be complicated; the rocks are separated into the following divisions, none of which can as yet be exactly correlated with formations previously described in British Columbia, the Yukon District, or Alaska. The order is apparently ascending—

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