contain a sufficiently abundant array of detailed facts to justify the conclusions at which I have arrived.

But even were this not the case, there are other important considerations that cannot be overlooked. As I have already hinted, we have become acquainted with a large number of curious organisms, many of which are unmistakably reproductive, but respecting the botanical affinities of which we are as yet entirely ignorant. New forms present themselves in a more rapid ratio than discoveries are made of the true character of older ones. Yet many of these objects are so remarkable that they must have constituted very important links in the chain of Palæozoic life; and until we learn more about them than we at present know, we cannot possibly assign to them their true place in that chain; whilst their omission must leave serious gaps in the succession.

But our difficulties do not end here. All the objects to which I have just referred have been discovered but recently. Ten years ago we knew nothing of their existence, and new forms are still being added to our cabinets. The old fossiliferous shales and sandstones revealed no traces of them. We only found them when the microscope came to be applied to the calciferous nodules of Oldham and Halifax. Our first supply of special types was derived from the former locality. The examination of the Halifax nodules revealed the existence of several new forms, though obtained from the same geological horizon and from localities but a few miles apart. Arran and Burntisland have, in like manner, contributed types wholly unknown in Yorkshire and Lancashire, and the French localities of Autun and St. Étienne (where also are found Carboniferous plants of which all the structure is preserved) have each their own characteristic forms.[1] We thus learn that so far as these six special localities are concerned, whilst certain common features characterise their floras, each locality has, as in living floras, genera or species peculiar to itself. Now we chiefly know the full extent of the localisation of these six Carboniferous floras from their accidental preservation in calcified or siliceous deposits, and not from the revelations of the ordinary fossiliferous shales and sandstones. But we cannot suppose that the six localities enumerated are the only ones that possessed floras peculiar to themselves. Does not common reasoning justify the suggestion that all Carboniferous plant-bearing localities would exhibit similar features, had their fossils been preserved as they are at Halifax or at St. Étienne? If so, seeing how widely Carboniferous deposits are diffused throughout the world, what myriads of minute, but phytogenetically important forms of plant-life must have existed of which we are absolutely ignorant—an ignorance that can only be diminished by the discovery of other localities as productive as the six that I have enumerated.

But even were we perfectly acquainted with the Carboniferous flora, we should not be much nearer the end. Beyond the fact, established by Dr. Dawson, that in the Devonian age a flora existed almost, if not wholly, as rich as the Carboniferous one, a flora in which Gymnosperms existed with as high an organisation as characterised the similar Carboniferous types, what do we know respecting the minuter forms of this flora, which correspond to those which I have described from the Coal-measures? But can it be doubted that such objects must have existed in abundance? Still less can it be supposed that so rich and highly organised a flora as that of the Devonian age first sprang into existence during that age. That flora must have been preceded by one rich in types of a lower terrestrial vegetation than is represented by the ferns—the Lycopods and the Dadoxylons of the Devonian beds of North America. But what do we know of this earlier flora? Almost nothing. The remains of pre-Devonian plants now known are so obscure that little reliance can be placed upon them. Eophyton is rejected from the vegetable kingdom by Nathorst, and most of the other so-called Fucoids of the Palæozoic strata are of almost equally dubious nature. Where more definite forms of what may probably be Marine Algæ do occur they come too late in time to avail in the construction of the Palæozoic pedigree. Even the Liassic *Chondraites bellensis* of the Lias cannot be depended upon with absolute certainty. It is only when we reach the Tertiary age that we find the Delesseriæ and Halymenites in shapes that leave little room for doubting their true nature. Yet our French friends trust to these dubious objects as being real Fucoids, and as such, the ancestral predecessors of the higher Cryptogams of the Devonian and Carboniferous ages. So long as this ignorance and uncertainty remain, it seems to me that we cannot construct, with any degree of probability, the genealogical tree of Palæozoic plant life.

As to the many detailed conclusions arrived at by MM. Saporta and Marion, I will only refer to two or three statements in addition to the more important ones to which I have already called attention. Thus Mr. Gardner's abstract states that "eight still existing Diatoms have been discovered in British Coal." I thought that I had thoroughly exploded that fallacy in my Memoir, Part X. MM. Saporta and Marion conclude that Asterophyllites was a floating or procumbent plant allied to the Equisetaceæ, thus following M. Renault in separating it from Sphenophyllum, which the authors believe to be a Rhizocarp allied to Salvinia. I see no ground whatever for these conclusions. They further consider that some of his Calamariæ (Equisetaceæ) were heterosporous. They arrive at this conclusion from my discovery that *Calamostachys Binneana*, which I believe to be a fruit of an Asterophyllitean plant, was a heterosporous Strobilus; but I wholly demur to the idea that either the plant or the fruit was Equisetaceous.

For the reasons above given, I doubt whether even my valued friend the Marquess Saporta, highly accomplished as I know him to be, will be able to "make clear the precise lines through which the evolution of the one from the other [*i.e.* the Phanerogams from the Cryptogams] has been accomplished." WM. C. WILLIAMSON

Owens College, Manchester, October 14

[1] I believe that this fact partly explains the unwillingness of the French palæontologists to accept our English views as to the close affinities existing between the Lepidodendra and the Sigillariæ. The peculiar Diploxyloid forms of Lepidodendron, *i.e.* those which possess the outer exogenous zone which the French botanists regard as characteristic of a Sigillarian stem, appear to be absent from the beds of Autun and St. Étienne, as they are rare in Canada and the United States. In Great Britain, on the other hand, they constitute, with several variations of specific details, our prevailing type.

THE INTERNATIONAL EXHIBITION AND CONGRESS OF ELECTRICITY AT PARIS[1]

V.

THE labours of the jury are now finished, and the distribution of medals took place on October 21 at the Conservatoire des Arts et Métiers. It is understood that they have been somewhat liberal in their distribution of honours, and have endeavoured to make things pleasant all round. Indeed the time allotted to them for investigation being postponed for a week at the beginning, and afterwards cut short by a week at the end, was quite insufficient to settle the burning question which is the best of all the electric lights.

The diploma of honour (*diplôme d'honneur*), which is the highest award of all, has been voted to Dr. Werner Siemens, Sir William Thomson, Mr. Edison, M. Gramme, Prof. Graham Bell, Prof. Hughes, Prof. Pacinotti, Prof. Bjerknes, M. Gaston Planté, M. Baudot, and M. Marcel Deprez, the last-named being the inventor of a system of distribution of electricity which has found much favour in Paris. M. Baudot is the inventor of a multiple printing-telegraph. The Exhibition has been announced to close on November 15, but there is some talk of a later date.

[1] Continued from p. 589

During the last week a body calling itself the Réunion International des Électriciens has been holding meetings in a room granted for the purpose in the Exhibition building. It is understood to be mainly composed of persons who felt slighted at not being appointed members of the Congress, and are determined to have a little congress of their own; but their movements have not attracted much public attention.

As this will be our last article, we will endeavour to supplement our previous accounts by some information on what must be regarded as the most important of all the objects in the Exhibition, namely, the machines which generate the electricity. Those which have permanent steel magnets are few in number, and the only large ones are the machines of De Meritens. These usually give alternating currents, but can be made to give direct currents by a change in the connections. The principal type contains five Gramme rings mounted on the same axis, each of them surrounded by eight horseshoe steel magnets with their feet inward. The introduction of the Gramme ring is the chief difference between this machine and the old lighthouse machine of Holmes. The great bulk of the machines in the Exhibition are dynamos, in which the whole current produced passes through the coils of the field magnets, and a large proportion of them are of the Gramme type, generally with one pair of straight massive field magnets arranged in one line above the ring, with a pair of like poles near together close to the ring, and with another similar pair below of opposite polarity to the first pair. The ring thus revolves between two very strong poles outside it, and massive iron pole pieces are usually employed, so shaped as to embrace a considerable arc of the ring. These are the machines for direct current. In the alternating current Grammes, the ring is generally broadened out into a hollow cylinder whose length is as great as its diameter. Sometimes this revolves between four external pole pieces attached to electro-magnets, and sometimes it is fixed, while four broad electro-magnets radiating from the common axis revolve within it. In some examples a separate exciter giving a direct current is mounted on the same stand and on the same axis.

The three firms of Siemens at Berlin, Paris, and London have a very large and diversified collection, partly historical, partly representing the commercial demands of the present day, and partly embodying their latest ideas for future improvement. The prevailing pattern is the well-known Siemens direct acting machine, in which an armature in the form of a cylinder, about three times as long as it is broad, rotates between two sets of pole-pieces, one above and the other below, of opposite polarity produced by the action of four straight flat and massive electro-magnets. The coil of the armature is wound, as nearly as the presence of the axle permits, in planes containing the axis, so that the wires cross one another at all angles at the two ends.

The most remarkable novelty that struck us in going over their collection was a machine in which two armatures consisting of cylindrical iron cores, each inclosed between four longitudinal segments of copper, revolve within two hollow cylinders of iron, which are the poles of a composite magnet, so that each armature is surrounded by a pole of one name, while opposite polarity is induced in the outer part of the iron core. The lines of force thus radiate from the common axis with complete symmetry, and the longitudinal coppers cut these lines at right angles in every position, so that the electromotive force in each copper remains constant as the armature revolves.

A peculiar adaptation of the ordinary Siemens armature has been made by Mr. Edison. The conducting portion of his armature consists of bars and disks. The bars form the outside of the cylinder, and the disks, with mica between for insulation, are built up into two solid masses which form the ends. The intervening portion is occupied by the core, which consists of a thousand or more very thin disks of iron separated by silk paper. The course of the current is nearly the same as in a Siemens armature, being first along a bar, then across a disk, then back along an opposite bar, then across another disk, and so on. The ends of the bars are disposed along two helical curves at the two ends of the cylinder, each helix having two convolutions. The object of having such excessively thin iron plates is to promote rapid demagnetisation and to avoid the formation of induced currents in the iron. This monster machine has only recently arrived, and is not yet ready for action. Its armature (to which, as well as to that of a smaller machine, the above description applies) is about four feet long by two in diameter. It has two straight and very long field magnets, which are actuated by a branch of the main current of the machine.

A very common pattern of machine for alternating currents, which one sees under various names, has a number of flattish cylindrical coils disposed in circular fashion like the holes of a siren, and revolving in siren fashion between pairs of fixed cylindrical field magnets of more massive appearance, the number of pairs of these fixed magnets being equal to the number of revolving armatures.

There are also some direct current machines of this construction. They can be distinguished by having a commutator of many segments on which the brushes rub to collect the currents, while the alternating machines give off their currents from two insulated rings which are not divided in any way.

Last Saturday evening there was a special gala at the Opera House in honour of the Electrical Congress, admission being by presentation ticket. In addition to the ordinary operatic performances there was a somewhat stilted poem in celebration of the achievements of electricity, which was read between two of the pieces by an eminent comedian; and the whole performance wound up with a grand chorus calling on the earth to light itself up. Preparations had been made for illuminating the house by electricity, but they were far from complete, and gas was decidedly in the ascendant. The place where the telephonic transmitters are bestowed was easily recognised, there being a wooden screen about ten inches high and six feet long on each side of the prompter's box.

We stated in a previous letter that a committee of jurors had undertaken some quantitative experiments on the machines and lamps. These are still going on, and will probably be continued till the Exhibition closes.

The chief practical result of the Congress has been the agreement to adopt the British Association system of units, and we understand that Prof. Everett's book, which is the recognised exposition of this system, will be immediately translated into French, German, and Italian.

THE IRON AND STEEL INSTITUTE

ONE of the most interesting features connected with the recent meeting of the Iron and Steel Institute was the fact that the Arsenal authorities abandoned at last the official reserve which has so long been complained of, and descended into the arena of professional discussion by reading papers on the manufacture of ordnance, projectiles, small arms, and gun-carriages, and submitting them to public criticism. We must specially congratulate Col. Maitland, the present distinguished head of Woolwich Arsenal, on having had the courage to take this step. His paper on the Metallurgy and Manufacture of Modern British Ordnance was extremely interesting. Its production also was well timed, coming at a period when the confidence of the public was consider-