We are dealing, in the Lower Carboniferous Primofilices, with early races, already specialised on their own lines, and probably only indirectly connected with the main current of Fern-evolution.

The "Seed-Ferns" or Pteridosperms appear to have attained a great development in Lower Carboniferous times. A considerable variety of seeds is met with, and in some cases there is strong evidence for attributing them to plants with a fern-like foliage. In one such example, described by Nathorst, the seed (Thysanotesta) is remarkable for having a distinct pappus; it was thus adapted to wind-dispersal, like the achenes of Composites.

No less than six families, referred to Pteridosperms, are known by their anatomy. In only one is there any evidence as to the seed, but all these groups show, in their structure, a nearer relation to known "Seed-Ferns" than to any other phylum. The case referred to is that of Heterangium, a genus with a solid wood and no pith. A beautifully organised seed (Sphærostoma, Benson), obviously related to that of the Upper Carboniferous Lyginopteris, is found in close association with *Heterangium Grievii* and probably belonged to it. The two genera, Heterangium and Lyginopteris, are closely related, as shown by Dr. Kubart's discovery of intermediate anatomical features, in species of Millstone Grit age.

The Lyginopterideæ extend to the Upper Carboniferous, but the other five anatomical groups are peculiar to the Lower.[1] They show a great variety in structure, but none of them bear any anatomical resemblance to contemporary Ferns. Our knowledge of so many, more or less isolated, types indicates that we have only found a few relics of what was really a most extensive class of plants.

The family most richly represented is that of which Calamopitys is the type. A number of species of Calamopitys are known; they are plants with a pith (sometimes "mixed"), large leaf-trace bundles, and much secondary wood. The petioles, often of large size and with many vascular strands, have long been known as Kalymma. Some of the species, with dense secondary wood of a Coniferous type, have been separated by Dr. Zalessky under the name Eristophyton. An interesting new genus, Bilignea, in which the pith is replaced by a central column of short tracheids, has been discovered by Dr. Kidston.

Apart from the "Seed-Ferns," we have the remarkable Lower Carboniferous family of the Pityeæ, already represented, as we have seen, in the Upper Devonian. Pitys was a genus of trees, with a relatively large pith traversed by slender strands of wood, while the secondary wood was of an Araucarian type. The foliage was quite unknown until recently, when Dr. Gordon discovered the leaves attached to the twigs in a species from the shores of the Firth of Forth. The leaves are totally different both from those of any Pteridosperm and from the well-known foliage of the Upper Carboniferous Cordaiteæ; they rather resemble the needles of a Fir, though more complex in structure. Dr. Gordon suspects an affinity with Araucarian Conifers.

Perhaps the chief conclusion that follows from this hasty sketch of the earlier floras is the great distinctness of the main phyla.

The Lycopods may perhaps become merged, as we trace them back, in the early Devonian Psilophytales, but nowhere approach any other group.

The Articulatæ appear as an isolated phylum throughout.

The Ferns may have come from thalloid plants, through some of the forms of Early Devonian age, where the frond is only represented by a bladeless rachis. The "Seed Ferns" now appear as a totally distinct line, parallel in certain respects to the true Ferns, but nowhere joining them, unless it be in some common thalloid source, about the Psilophytales level.

The higher Gymnosperms, represented in the period considered by Pitys and its allies, may have passed through an earlier Pteridosperm stage, but this is not proven. The Spermophyta generally may, for all we know, be as ancient as any other vascular plants.

Thus phylogeny still eludes us, though it remains the ultimate goal of the palæontologist.

[1] Space does not admit of any account of their remarkable characters. The five type-genera are: Rhetinangium, Stenomyelon, Protopitys, Cladoxylon and Calamopitys.

Obituary.

DR. C. G. KNOTT, F.R.S.

THE sudden death of Dr. C. G. Knott, reader in applied mathematics in the University of Edinburgh, and general secretary of the Royal Society of Edinburgh, has deprived physical science of a devoted follower and an accomplished exponent. On Wednesday, October 25, he was lecturing as usual and attending, in the afternoon, to the business of the Royal Society. At night he was taken ill and died of heart failure in a few hours.

Born at Penicuik in 1856, Knott entered the University of Edinburgh in 1872 and soon joined a little band of enthusiastic workers in the laboratory of Prof. Tait. To study under that great teacher was a privilege and an inspiration. The laboratory, then a new feature in university physics, was a small attic, meagrely equipped. Only a few of the best pupils cared to seek admission; they plunged at once into research, either sharing in the investigations on which Tait happened to be engaged, or undertaking some independent inquiry of their own. Tait was then collecting data for his thermoelectric diagram, and Knott's training was to measure the electromotive forces between pairs of some twenty different metals, through a wide range of junction temperatures. He also began the series of magnetic researches he was afterwards to pursue with the help of his own Japanese pupils. In 1879 he was appointed Tait's assistant, but gave up that post in 1883 when he became professor of physics in the University of Tokyo. After eight years as professor in Japan he returned, in 1891, to his own University of Edinburgh, where he spent the rest of his life, at first as lecturer and later as reader in applied mathematics. He also acted as the official adviser of students reading for honours in mathematics

and physics, or for degrees in science—a task which his wide knowledge, his unfailing good nature, his geniality, his ready sympathy, and his infinite capacity for taking pains, fitted him to discharge to the great advantage of many generations of undergraduates. For the last ten years he also held the office of general secretary in the Royal Society of Edinburgh, where the same characteristics found further exercise, along with others which eminently qualified him for editorial work.

In Japan, with pupils such as Nagaoka, Knott's influence as a teacher soon became conspicuous, and has proved enduring. His love of research was infectious. The school of young Japanese seismologists and magneticians, then in its infancy, owed much to his example and encouragement. Along with Tanakadate, he carried out a magnetic survey of "all Japan." His industry was untiring and the habit of research, formed in his student days, never left him. All his scientific work is sound and thorough. His published papers, more than seventy in number, cover a wide range, but the subjects of ferro-magnetism, especially in its relation to strains, and of seismology, continued to engage his main attention. His book on the physics of earthquake phenomena, published in 1908, is an admirable digest of the whole subject, linking up the older with the newer seismology. His last long paper, published by the Royal Society of Edinburgh in 1919, completed a series in which the theory of earthquake-wave propagation is discussed with much originality.

Probably the best known of Knott's books is his Biography of Tait (Camb. Univ. Press, 1911). No other disciple was so fit to undertake the difficult task of writing the life of the master, for on Knott the mantle had most directly fallen, and he, more than any, continued to wear it. Tait himself, in a preface to his collected papers, speaks of Knott as an adept in quaternions as well as in physics, and adepts in quaternions have always been rare. Knott's grasp of mathematical methods, his intimacy with Tait's work and appreciation of Tait's genius, and above all his affectionate comprehension of an often whimsical personality, inspired him to write what is beyond question an exceptionally adequate and deeply interesting biography. More recently he organised the Napier tercentenary (1914), and edited the memorial volume. Almost his last act was to pass for the press the final sheets of collected papers by the late Dr. John Aitken, F.R.S.

An unselfish, modest, Christian gentleman, whose life was a constant round of unobtrusive service, Knott is mourned by many friends. J. A. E.

BY the death of Thomas Francis Moore the National Museum, Melbourne, has lost one of the most valued members of its staff. Mr. Moore had filled the position of osteologist at that institution for nearly twenty-two years. His work was of a very high order and universally known. As a link with the past, it may be mentioned that Mr. Moore's father, Mr. T. J. Moore, was for forty years curator of the Liverpool Museum, and from 1865 to 1884 organised and took part in the Liverpool Free Public lectures. Dr. Frederick Moore, of the East India Company's Museum, well known by his work on oriental Lepidoptera, was an uncle of Mr. T. F. Moore.

THE *Chemiker Zeitung* of October 17 reports the death, at the age of sixty-four years, of Prof. Lassar-Cohn, who had occupied the chair of chemistry at Königsberg since 1894. His work was mainly in the fields of organic and technical chemistry, and his text-books were well known in English translations.

Current Topics and Events.

THE following is a list of those recommended by the president and council of the Royal Society for election to the council at the anniversary meeting on November 30:—*President*: Sir Charles Sherrington; *Treasurer*: Sir David Prain; *Secretaries*: Mr. W. B. Hardy and Dr. J. H. Jeans; *Foreign Secretary*: Sir Arthur Schuster; *Other members of Council*: Prof. V. H. Blackman, Prof. H. C. H. Carpenter, Prof. T. R. Elliott, Prof. A. Harden, Sir Sidney Harmer, Prof. W. M. Hicks, Prof. H. F. Newall, Prof. G. H. F. Nuttall, Prof. D. Noel Paton, Lord Rayleigh, Prof. O. W. Richardson, Sir Ernest Rutherford, Dr. Alexander Scott, Mr. F. E. Smith, Sir Aubrey Strahan, and Prof. J. T. Wilson.

IT is announced in *Science* that Dr. S. W. Stratton, director of the Bureau of Standards at Washington for the past twenty-one years, has been elected president of the Massachusetts Institute of Technology. Dr. Stratton was professor of physics and electrical engineering at the University of Illinois and professor of physics at the University of Chicago before his appointment as director of the Bureau of Standards in 1901; he found the department a small office employing three or four people, and from it he built up the present department with a staff of about 900. Commenting on Dr. Stratton's resignation, Mr. Hoover is reported by the *New York Times* to have said: "The Massachusetts Institute of Technology, an educational institution, finds no difficulty in paying a man of Dr. Stratton's calibre three times the salary the government is able to pay him." It appears that it is impossible to live and to provide for old age while at Washington on a government salary, and for this reason it is difficult to induce men of science to undertake responsible national posts.

PROF. A. SMITHELLS' retirement at the end of the present session from the chair of chemistry of the University of Leeds, after thirty-eight years of active work, will be a serious loss to the whole educational world as well as to the narrower sphere of academic life of the University in the progress and development of which he has played so conspicuous and devoted a part. His intention in retiring is to employ part