## Cargill Gilston Knott, LL.D., F.R.S., General Secretary. By Professor E. T. Whittaker, F.R.S.*

(Read November 6, 1922.)

THE Fellows of the Royal Society of Edinburgh mourn the loss of one who for many years had been, as General Secretary, the centre of their corporate activity, and who was to most of them an honoured and beloved personal friend.

Cargill Gilston Knott was born at Penicuik in 1856, of a family which, though originally English, had been settled in Scotland for some generations. Maternally he was descended from the brother of Donald Cargill the martyr. His father, Pelham Knott, known as the author of a volume of poetry, died young, and the boy was brought up by an uncle and aunt who lived at Arbroath.

From the High School of Arbroath young Knott came up to Edinburgh University in 1872, and almost at once fell under the influence of Tait, then in the zenith of his powers. It is probably fair to say that no one of Tait's pupils entered so fully into the master's mind and outlook, or was inspired to follow him so directly in teaching and research. Long years afterwards Knott gratefully acknowledged the debt in his *Life of Tait*, one of the best scientific biographies ever written.

In Knott's early days the Scottish universities were poorly equipped for advanced work in mathematics or physics; but in 1868 Tait had added to the department of Natural Philosophy a laboratory, which was situated in an attic in the Old Quadrangle of the University. To this a certain number of the abler and more interested students were admitted, and were set to what was really research work in the first year of their attendance.

Knott entered the laboratory in 1873, at the age of 17, and worked with a group of young men—J. A. Ewing, J. G. MacGregor, A. Macfarlane, C. E. Greig, A. L. M'Leish, R. A. Lundie, P. R. Scott Lang, and C. Michie Smith—of whom several became ultimately distinguished men of science.

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The Professor's Assistant at this time was D. H. Marshall, in conjunction with whom in the same year Knott published his first paper.

For ten more years he remained in the laboratory, first taking his degree and then, in 1879, being promoted to the Assistantship. His researches were on different aspects of the relation of heat to electricity and magnetism (thermo-electricity, variation of electric resistance with temperature, etc.). In this choice of a subject he was of course following Tait, who in 1870 had discovered that the "specific heat of electricity" in pure metals is proportional to the absolute temperature, and, moreover, that variations in ohmic conductivity are parallel to variations in thermal conductivity. There can be little doubt that inspiration came also from the close association of Tait and the Royal Society of Edinburgh with W. Thomson (Lord Kelvin), to whom the general theory of thermo-electric phenomena is due.

In 1883 Knott took a leading part in a new movement which, in the years that have since elapsed, has led to important developments. The influence of Tait and Chrystal—especially Chrystal—had at this time reached the secondary schools and had created a lively interest in mathematical studies among the teachers whose pupils passed on to the University. Two of these teachers—Mr A. Y. Fraser of George Heriot's and Mr Barclay of George Watson's—after consultation with Knott, joined with him in issuing a circular suggesting the foundation of an *Edinburgh Mathematical Society*. A meeting was called, the Society was established, and Knott as Secretary and Treasurer canvassed for members, arranged programmes, and contributed a paper of the kind that was adapted to the membership.* The Society now has a recognised position among the great national mathematical organisations, and has published in the forty volumes of its *Proceedings* many researches which have become classical; while to its influence in bringing together the universities and the secondary schools must largely be ascribed the harmonious and continuous progress of Scottish mathematical teaching and organisation.

In the first year of the new Society's existence, Knott received an unexpected call to a new field of work. Some time previously—in 1878—his friend J. A. Ewing had gone out to Japan as Professor of Mechanical Engineering. While in Japan Ewing began his celebrated researches on magnetism, and added to his duties a certain amount of teaching of higher physics. When in 1883 he returned to this country, it was arranged that he should be succeeded by a Japanese in the Chair of Engineering, and

* Later he was more than once President, and acted for many years as Editor of the *Proceedings*.

that a new European should be invited to come out and continue the physical work. For this appointment Ewing recommended Knott, who accordingly resigned his Edinburgh assistantship and was elected Professor of Physics in the Imperial University of Japan.

During his eight years' tenure of this post, he had as pupils many Japanese who have since risen to great distinction, notably Nagaoka, the original suggester of the nucleus theory of the atom. Here, in a position of independence and responsibility, away from the dominating personality of Tait, his scientific activity expanded in new directions, and finally centred on the two departments of research with which his name will be chiefly associated.

The first of these was Magnetism. His interest in this subject dated indeed from the Edinburgh period, when he had discussed with Chrystal the latter's well-known article on "Magnetism" in the *Encyclopædia Britannica*. But in Tokyo he found that Ewing had brought together a school of young Japanese who were working at magnetic problems, and, taking the leadership among them, he initiated a series of researches on the relations of magnetism to strain, which occupied a great part of his later life. Dr Knott in 1887 organised a magnetic survey of Japan, and trained a band of students to assist him in this work. In order to cover the whole country within three months, he appointed his assistant Tanakadate to survey south of Tokyo, while he, in company with Nagaoka, went north. The survey was accomplished within the specified time, and the results were published in 1889. There is to this day a strong school of magneticians in that country, all of whom are pupils of Knott or of Knott's pupils. So greatly was he held in honour, that when the news of his death was received in Japan, a memorial gathering was arranged by the staff and students of the Science College in Tokyo, and was held on Christmas Eve 1922, at which Professor Tanakadate referred to the great debt the progress of physical science in Japan owed to their late "endeared professor."

The other new line of investigation was seismology. The frequency of earthquakes in Japan had attracted the attention of the British men of science who had preceded him in residence there, especially of John Milne, J. A. Ewing, and Thomas Gray, and under their auspices a Seismological Society of Japan had already been formed and instruments devised for recording the tremors. Knott, who at Edinburgh had studied geology under Geikie as well as physics under Tait, was drawn into the movement as soon as he arrived, and inaugurated a new era in it; for while his predecessors had been concerned chiefly with the instrumental difficulties and the obtaining of observational results, he attacked the problem from

the standpoint of theoretical physics and led the way in interpreting the accumulated material of the observations.

> "The main lines of his work," writes Professor H. H. Turner, "can readily be gathered from the excellent book he wrote in 1908, *The Physics of Earthquake Phenomena*, the outcome of a course of lectures delivered in the United Free Church College in Aberdeen during the Session 1905–6. He contributed, for instance, a sound piece of work on the possible periodicities of earthquakes, and their detection by harmonic analysis, and another on the speed of propagation of waves in elastic media, and their reflection and refraction at the surface separating two media. Following up this work, he studied the angles of emergence of seismic waves as actually observed, for inferences as to the earth's elastic constants. But he finally concentrated his attention on the forms of the curved paths of seismic waves inside the earth, as deduced from their observed times of arrival at a sequence of points on the surface. This was a laborious piece of numerical calculation (in which he acknowledges valuable assistance from Professor Whittaker), which he carried through and printed in *Proc. Roy. Soc. Edin.*, xxxix, Part II, No. 14, under title 'The Propagation of Earthquake Waves through the Earth, and Connected Problems.' But the great labour was well expended, and the results obtained must play a fundamental part in the study of earthquake problems. As one instance of their application, they have already been used (with the full approval of the author) to investigate the effect of depth of focus on the manifestations at the surface. The curves themselves were calculated on the supposition that the centre of disturbance (or focus) is in the earth's surface (or rather at a negligible distance below it); but the method of presentment is so complete that we can immediately adapt the results to the case of a disturbance at a considerable distance below the surface—at least to a first approximation: and this problem (of a possible considerable depth) was emphasised by the late G. W. Walker as the one most immediately pressing for solution. Knott certainly helped materially to this end."

His work in seismology will probably be regarded by posterity as his best work. His interest in it never flagged, and his last paper, written at the age of 62, was perhaps the best of the series.

The transference from Edinburgh to Tokyo was the great turning-point in Knott's life. In the latter city he met a Scottish lady, Miss Mary Dixon,

sister of the Professor of English Literature and daughter of the Rev. J. M. Dixon of Paisley, to whom he was married in 1885. The kindness and hospitality which were shown to many generations of students, both Japanese and Scottish, by Professor and Mrs Knott are gratefully remembered to-day in every quarter of the globe.

Leaving Japan at the end of his engagement in 1891, when the value of his services was recognised by the Japanese Government decoration of the Order of the Rising Sun, he had the good fortune to return to Edinburgh at a time when the ordinances then recently approved regarding University teaching were leading to the creation of a body of recognised lecturers. He was appointed to the Lectureship in Physics, the work allocated being that of applied mathematics for engineering students and of junior physics for medical students. Later, other subjects for Honours students in Science and Arts were added, and towards the end of his life he was raised to the status of Reader, under the Ordinance which created that rank. He acted, moreover, as the official adviser of candidates reading for honours in mathematics and physics, or for degrees in science, and as such earned the gratitude of the students for his warm-hearted willingness to help them, his geniality, and the incredible trouble which he took on their behalf.

As a pure mathematician, he will be remembered chiefly for his work in Quaternions. This was undoubtedly inspired in the first instance by Tait, who had succeeded to the generalship of the quaternionites on the death of Hamilton, and bequeathed it in turn to Knott. During the years 1892–3 a violent controversy broke out between the orthodox Hamiltonians and the upholders of the various types of vector analysis which have been proposed as substitutes for quaternions; the feeling resembled that of a religious heresy-hunt, and prompted Lord Rayleigh to quote Tertullian in a new version, "Behold how these vectorists love one another." Knott was the central figure in the fight, and served his cause manfully.

Literary work, beyond the preparation of research papers, had occupied much of his leisure throughout life. At 18 he was on the staff of the *Globe Encyclopædia*, and later he wrote many of the physical articles for the *Encyclopædia Britannica*, a well-known treatise on Physics, and countless reviews and biographies in *Nature* and elsewhere. He suggested and organised the highly successful Tercentenary Celebration of John Napier at Edinburgh in 1914, and edited the Memorial Volume in connection with it.

The value of his researches was acknowledged by many academies and universities; the Royal Society of Edinburgh awarded him the Keith Prize;

the Royal Society of London elected him to Fellowship; the University of St Andrews conferred on him the honorary degree of LL.D.; and the Scottish Meteorological Society elected him to the Presidential Chair.

By the Fellows of the Royal Society of Edinburgh his loss will be felt deeply. An enthusiast in the cause of the Society, he served on its Council with scarcely any interruption from 1894 onwards. After the death of Professor Chrystal in 1911 he was appointed General Secretary, an office which he held until his death.

Of the United Free Church he was a zealous and honoured member, serving the Mayfield congregation for many years as elder and assistant session clerk, and for twenty years as Sunday-school superintendent. He was also Treasurer of the Christian Unity Association of Scotland.

On Wednesday, 25th October 1922, he performed his usual duties at the University and the Royal Society, apparently in good health; on Thursday morning, in a sudden attack of heart failure, he passed away. His place in the scientific life of Scotland will be a difficult one to fill; his place in the hearts of those who knew him will never be filled.

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