

the "Cape Bulbs," and Mr. C. H. Wright, assistant in the Herbarium, Royal Botanic Gardens, Kew, who sub-edited the whole of the contributors' manuscript.

It is interesting to note that Sir William Hooker estimated both the number of volumes and the financial support that would be needed to carry out the work with remarkable accuracy. He fixed the number of volumes at ten, which is the number now published, and he also estimated that ten thousand would be the number of species to be dealt with. The actual number, however, is 11,705, and of these 2016 are described for the first time.

The "Flora of Tropical Africa," like the "Flora Capensis," though it owes so much to the energy and sagacity of Sir William Thiselton-Dyer, was commenced before he was able to assume any control over its preparation. Originally it was intended to be the joint work of Sir William Hooker and Prof. Daniel Oliver, Keeper of the Kew Herbarium; but the work was handed over to Prof. Oliver, and the first three volumes appeared in 1886, 1871, and 1877 respectively. Then, as with the "Flora Capensis," came a long break, and it was not until Sir William Thiselton-Dyer was able to take the matter in hand that the preparation of this flora could be resumed. As an outcome of his activities a new volume of the Flora appeared in 1898 devoted to the petaloid monocotyledons, Volume 7 of the entire work, this being the first volume to be produced under Sir William's editorship. This was followed in due course by Volume 4, published in two sections, Volume 5, Volume 8 and Volume 6, Section 1, the latter, which was published in 1913, being the last to appear under his editorship. The Flora has been continued under the editorship of Sir David Prain, and only some two parts, dealing with the grasses, now remain to be published.

The work entailed in arranging for the collection and naming of the material for these two great works would, it might well be thought, be sufficient to have occupied the full attention of the director of Kew, upon whose time there are so many calls with regard to botanical problems both at home and abroad; nevertheless, Sir William found time to initiate yet another work, *The Kew Bulletin of Miscellaneous Information*, for the purpose, more especially, of disseminating knowledge about the economic botanical

products of the Empire. The *Bulletin* was started in 1887 and is still in a flourishing condition, despite one or two times of difficulty—one of which was during the War, when an attempt was made to suppress it on the mistaken idea of economy.

Sir William's preface, which we quote, fully explains the scope and purpose of the work:

"It is proposed to issue from time to time, as an occasional publication, notes too detailed for the Annual Report on economic products and plants, to which the attention of the Staff of the Royal Gardens has been drawn in the course of ordinary correspondence, or which have been made the subject of particular study at Kew. It is hoped that while these notes will serve the purpose of an expeditious mode of communication to the numerous correspondents of Kew in distant parts of the Empire, they may also be of service to members of the general public interested in planting or agricultural business in India and the Colonies.

"W. T. THISELTON-DYER,
"Director.

"1st January 1887."

The present condition of the Kew Museums is also largely due to Sir William Thiselton-Dyer. Originally started by Sir William Hooker, the collections grew apace and fortunately they came under Dyer's purging hand, with the result that much encumbering dross was removed and the economic products were displayed to the best possible advantage. At the same time the Museum guides were produced and put on sale, in order that the public might be provided with accurate information on the wealth of the vegetable kingdom and the economic products derived therefrom.

These, with the two African floras and the *Kew Bulletin*, are a record of service which is of the highest importance, not only in the development of our knowledge of the botanical resources of the Empire but also because of the impetus this gives to scientific research in botany.

Such services as these, and many other activities displayed by Sir William Thiselton-Dyer in various botanical enterprises, have rarely been surpassed in value and importance by the labours of any other public servants to whom the British Empire owes so much.

Obituary.

PROF. FELIX KLEIN, FOR. MEM. R.S.

FELIX KLEIN, who was born at Düsseldorf on April 25, 1849, died on June 22, 1925. He had been professor at Göttingen since Easter 1886, having previously been at Erlangen (1872-1875), Munich (1875-1880), and Leipzig (1880-1886). With a trenchant expository style, revealing a forceful genial character, he wrote on almost every branch of mathematics; he was editor of the *Mathem. Annal.* from the time of the death of Clebsch (1872), originator of the "Enzyklopädie" for mathematics and mathematical physics (from 1895), and, in his own country, worked incessantly for a living co-operation of physics, engineering, and mathematics, and (since 1908) to bring the teaching in the schools into touch with current scientific problems. He was also a constant traveller and lecturer; was

twice in America and many times in England, since 1873. His exceptional personality appeared at once after his student days at Bonn; he took his doctor's degree at the age of nineteen; issued the second part of Plücker's book on line-geometry at the age of twenty; by the end of 1871, when he was twenty-two, had published eighteen original papers (some of these with Lie); by the end of 1875 he had published forty. Many of these are still mines of suggestiveness; his Erlanger Programm (1872) has been translated into English, French, Italian, Polish, Russian, and Hungarian.

Klein's mathematical papers were published, under his own supervision, in three volumes, in 1921-1923, containing more than two thousand beautifully printed pages; in these is inserted a running personal commentary; in effect, a detailed account of his scientific

thoughts and aims from the age of eighteen, with many references to colleagues and pupils. These volumes, intensely interesting from so many points of view, are the sufficient and authentic basis for a review of his life.

It appears, what will be new to many, that Klein's life was lived under a resolve, never relinquished, made when serving Plücker as assistant for his lecture on experimental physics, to devote himself to physics. He desired only, first, as a preparation for this, to make himself acquainted with all branches of mathematics, in order to trace the connexions of their leading ideas, and to be in a position to raise physics to a higher plane. The notes enable us to trace how this resolve was modified by circumstances, and only realised in the work of others whom he inspired: two leading causes are brought out—his pre-eminently sympathetic temperament, and a serious breakdown of health at the age of thirty-three. It seems clear that he worked mainly by discussion with friends and pupils, and by lecturing. His vivid account of the time spent with Lie in Paris in the early part of 1870; his evident interest in meeting Sylvester, Cayley, Clifford, and Ball at the British Association at Bradford, in 1873; and the reference to the happiest time of his productive activity (1876–1880), when he, from Munich, and Jordan, from Erlangen, each travelled a long way to enjoy on Sundays a *Mathesis quercupolitana* at the half-way Eichstädt, are examples of what appears throughout.

Now such discussions were conditioned by the interests of his colleagues, as his early work had been influenced by his teachers (Plücker, Clebsch, Weierstrass, Kummer); and thus Klein was led into giving his publications a form quite other than physical. We see, however, how he fought to maintain his early resolve, particularly in the manner of approach to Riemann's theory of functions, and, later, in his volume (with Sommerfeld) on the motion of the top. This begins in a mathematical way; but, in the course of the thirteen years occupied in its publication, reaches a very technical plane. But besides this concession to his surroundings, it appears that, first at Munich, and then more seriously at Leipzig (in 1882), he was warned that he could not continue to work with the same intensity, and must needs live on a different level. Thus he began to limit himself to the supervision of the long series of books and lectures, on almost every subject of mathematics and mathematical physics, of which the detailed work was carried out by others.

Meanwhile Klein's unceasing anxiety for the organic working union of physics and mathematics expressed itself in administrative ways. He secured, one can imagine with what trouble, a co-operation of German Academies, to bear the responsibility for the "Enzyklopädie"; he travelled hither and thither to secure competent contributors, especially to England (there being, as he explains, no sufficient sympathy in Germany between mathematicians and physicists); himself undertook the part dealing with mechanics, in connexion with which he obtained the translation into German of Routh's "Dynamics," Lamb's "Hydrodynamics," and Love's "Elasticity." In his own Göttingen, later on, were founded a Physical Institute, with the help of German manufacturers, and a society for the encouragement of mathematical physics; to him it appeared

"Mechanik, überhaupt angewandte Mathematik, kann nur durch *intensive Beschäftigung mit den Dingen selbst gelernt werden*; die Literatur gibt nur eine Beihilfe." He took every opportunity, by visits to conferences and lectures, to keep in touch with engineers and physicists; he organised vacation courses for teachers to give their teaching the proper modern orientation; and finally, from 1908, he gave his attention to the schools, and lamented the ruin the War had wrought in the extensive preparations made for an international campaign.

Little need be said in this place of the brilliance of the mathematical papers, especially of Klein's earlier years. If the reader agrees with Poincaré, in a letter quoted here, "Je ne crois pas qu'une démonstration puisse être résumée; on ne peut en retrancher sans lui enlever sa rigueur et une démonstration sans rigueur n'est pas une démonstration," he will find here, also, Klein's reasoned reply. Nor need we think that his international aims were not genuine because of his evident patriotism, and his desire to see Göttingen "über Alles." These are desires which he would have commended in others. For we are bound to feel that his life was devoted to a very real and practical problem of our time, and that he worked at it loyally and unremittingly—namely, how to bring under as few points of view as can be grasped by one man the astonishing output of physical and mathematical thought in the last hundred years. The difficulty is not that the ideas involved are so wide apart; on the contrary, they are very cognate—Bohr uses the ideas of the theory of Abelian functions, and would use the approximation theory elaborated by Lagrange, combined with Planck's physical results, to construct an explanation of spectrum lines; Einstein uses an absolute differential calculus, tracing its origin to Lie's work for continuous groups as well as to Riemann's thoughts on geometry, with a realistic outlook such as was discussed by Mach, to found a new calculus for the motion of material bodies. It is probably the case that the grooves in which the mind of the physicist can move, to elaborate his theories, have generally been worn by the imagination and systematising efforts of the mathematician, who, in rare cases, may be the same person; and it is certain that only by the development of all aspects of thought can progress be continued. But how shall one man secure an adequate understanding of all that may concern him in the work of so many others? Must we say that the answer is that only if the civilised world can continue in patience and amity to co-operate to this end, can the end be reached?

At least we owe honour to the commanding personality and penetrating intellect of Felix Klein, for his life's devotion to the solution of the problem.

COUNT GOBLET D'ALVIELLA.

THE death of Count Goblet d'Alviella on September 8 as the result of a motor-car accident is announced from Brussels. Count Goblet d'Alviella was born in 1846, and for some time was professor of the history of religion at the University of Brussels. He had a distinguished career in public life successively as a member of the Chamber of Deputies, member of the Senate, of which he became vice-president in 1912, and Minister of State and member of the cabinet during the War.