

British Association can scarcely realise the extreme isolation of Australasian scientific workers separated from one another by distances as great as from London to Constantinople. As in the case of the British Association, so, and even more so in the case of the Australasian Association, the crowning triumph of the work has been the bringing together for personal interchange of thought of so many remotely separated scientists.

In regard to Liversidge's work at the University, as a teacher he was always remarkably successful and impressive with his practical demonstrations and lecture experiments. Starting with very small buildings and next to no equipment, he was able, when he retired from the chair in 1908, to hand over to his successor, Prof. Fawsitt, a large and flourishing school provided with laboratories, lecture-rooms, and equipment reasonably up to date in view of the great distance of Australian universities from centres of science in the old world.

In spite of the time spent in teaching and organising, Liversidge's output of research work was considerable. His researches were directed chiefly to descriptive and experimental mineralogy. His chief published work was "The Minerals of New South Wales." He did much to stimulate interest in meteorites, collecting, analysing, and describing many Australian meteorites. Meteorites led him to study Australian meteoritic dust, especially the very finely divided red dust deposits which, in the hot dry climate of Australia, owe their origin to the transporting power of circular storms in the interior of the continent. He also published several papers on the origin and precipitation of gold, gold in solution in sea water, and the possible growth of gold nuggets in Australian alluvial deposits.

Altogether Liversidge contributed more than one hundred papers relating chiefly to chemistry and mineralogy, to the Chemical Society, the Royal Society of New South Wales, and the Royal Society of London. He made a hobby of acquiring minerals and meteorites, and his collections have frequently been displayed at exhibitions in Australia and in the northern hemisphere. Since retiring from the chair of chemistry at the University of Sydney, he continued until lately his researches at London laboratories. He was vice-president of the Chemical Society (1910 to 1913); vice-president of the Society of Chemical Industry (1909 to 1912); president of the Royal Society of New South Wales (1886, 1890, and 1901); president of the Australasian Association for the Advancement of Science (1888 to 1890); and vice-president of the British Association (1896). He was also a member of the Philosophical Society of Cambridge, of the Physical Society, of the Mineralogical Society of Great Britain and France, and he was elected a fellow of the Royal Society of London in 1882. Honorary degrees or memberships were conferred upon him by universities and scientific bodies, totalling thirteen in number.

Liversidge to the last was no less loyal to Australia than to the mother country, and after his return to England he continued to correspond

overseas and to study carefully Australian journals, and if he found any matter needing his help either in Australia or New Zealand that help was freely given. Previously to the migration of Liversidge to Australia, the case of scientific men there might be described as that of *quot homines tot septentiae*, but after his years of residence there and the founding and fostering of the Australasian Association, men of science in Australia and New Zealand spoke with one voice, a voice which met with such a fine response in the visit to Australia of the British Association in 1914 and the Pan-Pacific Science Congress in 1923.

Liversidge's beautiful home and grounds, Fieldhead, Coombe Warren, Surrey, with the historic spring from which Cardinal Wolsey carried the water in large lead pipes all the way thence, with a dive under the Thames, to Hampton Court, was for many years past the Mecca of pilgrims of science from Australia. There, too, he frequently entertained—for he loved hospitality—not a few of his old colleagues whom he used to meet regularly at the Athenæum.

One thing surely stands out among the many for which Liversidge will be gratefully remembered, and that is his splendid striving for the *fraternity* of science.

"*Frater ave atque vale.*"

T. W. E. D.

PROF. GÖSTA MITTAG-LEFFLER, FOR. MEM. R.S.

The mathematical world is appreciably poorer by the death of Mittag-Leffler, of Stockholm, who died there on July 7 last. He was born at Stockholm on Mar. 16, 1846.

For the best part of his long life of eighty-one years, Mittag-Leffler had been a proud standard-bearer in the extraordinary march of the theory of functions during the nineteenth century. How wonderful the progress has been we may realise by comparing the scope of some of the earliest with that of some of the latest publications. A sort of warning is given by the title of Lagrange's volume, dated Prairial, an V. (Second Edition, 1806): "Théorie des fonctions analytiques, contenant les principes du Calcul différentiel dégagés de toute considération d'infiniment petits ou d'évanouissans, de limites ou de fluxions, et réduits à l'analyse algébrique des quantités finies." But compare its contents with that of Weierstrass's posthumous paper, published in 1903, "Allgemeine Untersuchungen über $2n$ -fach periodische Functionen von n -Veränderlichen"; this is described by Mittag-Leffler as only a fragment of Weierstrass's "Lösung des Rätsels dass sein ganzes Leben in Anspruch genommen hat," which remains, he says, in 1916, "noch eine ungelöste Aufgabe, eine der grössten, die den Mathematikern unserer Tage obliegt." Think of the contributions of Abel, of Cauchy, of Gauss, of Jacobi, of Riemann, of Weierstrass, of Poincaré, and of others, who, from the first recognition that the complex variable is the natural foundation of a general theory, have steadily erected a structure of constantly increasing grandeur and beauty.

Of all this progress in the branches of mathematics to which he was devoted, Mittag-Leffler was an enthusiastic observer, and, of its later phases, a conscientious historian; and he took upon himself the mission of fostering, in every way he could, amicable relations between mathematicians of different nationalities, and encouraging a disinterested pursuit of high intellectual aims, unaffected by any political or material bias. With evident joy he tells how, three years after "la funeste année 1870" "je vins à Paris suivre le cours d'Hermite; je n'oublierai jamais la stupéfaction que j'éprouvai aux premiers mots qu'il m'adressa: 'Vous avez fait erreur, Monsieur,' me dit-il; 'vous auriez dû suivre les cours de Weierstrass à Berlin. C'est notre maître à tous.' Hermite était Français et patriote; j'appris du même coup à quel degré aussi il était mathématicien." But Mittag-Leffler was more than a standard-bearer of a mighty army; he was keenly anxious for the success of his subject. He quotes Weierstrass's plea for the unity of all scientific endeavour, "Die einzelnen wissenschaftlichen Disziplinen erhalten ihre Bedeutung dadurch, dass sie alle zu diesem Zwecke mitwirken—in dem Mit- und Nacheinandersein der Dinge Ordnung und gesetzmässigen Zusammenhang zu entdecken—aber nicht zusammenhanglos, sondern gleichsam eine Kette bildend." But he is aware of the conflict of his own subject with others whose aims have a more popular appeal; and when, in 1916, on his seventieth birthday, he devotes his house and library to the perpetual service of research in pure mathematics, he writes (*Acta Math.*, 40), "Peu de gens, en dehors des spécialistes, comprennent l'importance et la mission des mathématiques pures," "un peuple que n'accorde pas aux mathématiques un rang élevé dans son estime, ne sera jamais en état de remplir les plus hautes tâches civilisatrices et de jouir, par suite, de la considération internationale."

Mittag-Leffler was the son of J. O. Leffler, headmaster of a secondary school, and of G. V. Mittag. He was university lecturer in 1872 at Upsala, where he took his doctor's degree. After three years of travel (1873–1876) in Germany and France, he was professor of mathematics at Helsingfors until 1881, when he became professor at Stockholm (and Rector in 1885–6 and 1891–2). He resigned this post in 1911. In 1882, with an editorial staff of mathematicians from the four Scandinavian nations, and under the patronage of King Oscar II. of Sweden, he founded the journal *Acta Mathematica*, having noted, as he explains, that, after 1870, the German *Crelle's Journal*, and the French *Liouville's Journal*, had both ceased to have an international character. Of his own journal he remained editor in chief for forty years, until Vol. 40 (1925), maintaining, through this long period, it may safely be said, both the devotion to modern developments and the high standard set by Poincaré, in expounding his theory of Fuchsian functions in the early volumes. Special volumes were devoted to papers sent from all parts in commemoration of the

centenary of the birth of Abel (1902); a volume (38, 1921) was given to contributions by various writers in memory of Poincaré, and a volume (39, 1923, 258 quarto pages), written largely by Mittag-Leffler himself, is in effect a first hand critical history, of extreme value and interest, of the ideas associated with the names of Weierstrass and Poincaré. Beside the 57 pages dealing with the personal history and work of Weierstrass, this volume contains a paper of 65 pages largely composed of letters from Weierstrass to Sonja Kowalewsky. Mittag-Leffler was in a good position to write, as he had collected the necessary documents over many years.

The latter paper directs attention to another side of Mittag-Leffler's activity, and helps also to a better understanding of a book written by his sister, Anne Charlotte Leffler (Mme. Eddgren, and, later, Duchess of Cajanello); this is a biography of Sonja Kowalewsky, written in continuation of the autobiography of the early years of the latter; it is a book which every one who is interested in contemporary intellectual movements will have, or should have, read.¹ It appears that after Mme. Kowalewsky had spent her four student years with Weierstrass (in continuation of her studies at Heidelberg), and was settled in Russia, it was suggested by Weierstrass to Mittag-Leffler, then in St. Petersburg, that he should call on Mme. Kowalewsky. The final outcome was that, very soon after Mittag-Leffler had been appointed professor in Stockholm, he took great trouble to open the way for Mme. Kowalewsky to settle there as lecturer in mathematics. Of his admiration for her personality, and of his feeling that he was doing a great thing for higher education, and for Stockholm, there is ample evidence—there is also evidence in Weierstrass's letters to Sonja of the regard which he had conceived for the personality of Mittag-Leffler. The end of the experiment at Stockholm is given in graphic phrase in the book referred to. The gist seems to lie in A. Ch. Leffler's description of Sonja's "ardent besoin d'intimité intellectuelle, et de la souffrance intense que lui causait le sentiment de la solitude. . . . Le travail par lui-même, la recherche abstraite d'une vérité scientifique, ne la satisfaisant pas, il fallait qu'elle fût comprise, devinée, admirée, encouragée à chaque pas, à chaque nouvelle idée qui naissait en elle. . . . Mittag-Leffler disait souvent à ce sujet, que ce besoin d'être comprise était chez Sophie une faiblesse de femme; un homme de génie ne dépend jamais ainsi de la sympathie des autres."

It will be gathered from what has been said how important was the service of Mittag-Leffler, as a link, as a sort of gracious master of the ceremonies, for one aspect of modern mathematics; it were to be wished that in England we gave more of the reverent care which animated him, to the historical and personal side of the development of the subject. His own personal contributions to the theory of functions need no long comment here. One of his

¹ "Souvenirs d'enfance de Sophie Kowalewsky, suivis de sa biographie" (Hachette, 1895). Also in Swedish, German, and English (Walter Scott).

papers, dealing with the formation of a function of which the behaviour at its singular points is specified *a priori*, was the occasion for a paper presented to the Berlin Academy, in association with the name of Mittag-Leffler, by Weierstrass. It is perhaps opportune to remark that the intimately related construction, by Weierstrass, of an integral function with given zeros, which one might naturally have thought to be suggested by Gauss's factorisation of the gamma function, was given only in 1874, when Weierstrass was fifty-nine years old (letter to Sonja Kowalewsky, *Acta Math.*, 39, 151); and that the form of Gauss's factorisation which exactly suggests the general

theorem was given in 1848, by F. W. Newman, in the *Camb. and Dublin Math. Journal*, 3. This was remarked by the late G. B. Mathews in the pages of NATURE, long ago; it is not referred to by Mittag-Leffler in dealing with Weierstrass's early investigations (1843, 1856) on the analytical *Facultäten*. Another matter of a different kind occupied Mittag-Leffler in a series of papers: the expression of a function, with singularities for finite values of the independent variable, in a form which is valid over the whole plane as dissected by lines passing to infinity from the singular points of the function. Other papers, many written in Swedish journals, are not as yet so well known.

News and Views.

AGRICULTURE is the oldest of the chemical industries. The business of feeding man and his friends has, fortunately, been able to jog along for a very long time without entering into any close relationship with synthetic chemical industries other than that carried on so universally and so successfully by certain of the lower organisms of the soil. There has, moreover, been a disinclination to apply some of the new knowledge that has been placed at the service of the farmer, it being dismissed as being of little consequence when compared with the accumulated practical experience of generations on the land. Doubtless, too, the lack of consideration has not all been evidenced on one side. However this may be, it is a fact that we cannot continue indefinitely to live on the reserve fertility of the virgin plains of the earth. Sir Alfred Mond, in an address read before the delegates to the Imperial Agricultural Research Conference at Billingham on Oct. 18, based his remarks on this truism, and on the part which synthetic chemical industry must play in the future development of agriculture. So far as the British Empire is concerned, the economic aspect of the situation is no less considerable than the scientific. As was pointed out in the address, for many years Europe has paid to South America millions upon millions of pounds for nitrogen in the form of guano or of sodium nitrate. Imperial Chemical Industries, Ltd., has set itself the ambitious task not only of supplying the whole Empire with fertilisers, but also of acquiring and disseminating information concerning their application to soils of varying qualities and varying needs.

NUTRAM, LTD., the selling organisation which has been set up to deal with the new synthetic fertilisers, has, said Sir Alfred Mond, already instituted a free and disinterested advisory service to farmers. It has also established a research station, with upwards of 400 acres of farm lands, where problems relating to the use of fertilisers and to the feeding of stock are to be investigated. The activities at Billingham, however, will not be confined to the manufacture of simple synthetic nitrogenous fertilisers, but will extend to the production of compound fertilisers, containing nitrogen, phosphorus, and potassium—the three chief plant foods—according to the demands of experi-

ment and experience. Naturally, the fertiliser requirements of the British Isles will be the first to receive attention.

A CAREFUL consideration of Sir Alfred Mond's address leads one to the conclusion that, although he had no startling or even new thesis to present, he was able to show that Imperial Chemical Industries, Ltd., fully realises the nature of the problem—that of most effectively using chemical and mechanical knowledge in the multiplication of the fruits and riches of the earth—in its future as well as in its present aspects, and that the organisation is solving it in a patriotic as well as in a commercially successful manner. It is not merely a question of there being so many more mouths to feed and bodies to clothe each year. Neither is it entirely a question of meeting a demand for a more varied food supply; for satisfying the requirements of a generation better instructed than its fathers in the relation of diet to health. There is also an increasing demand from the chemical industries themselves for new material. The artificial silk industry is a case in point; the alcohol motor-fuel industry is another; and man has only just begun to learn the rules for training bacteria, in 'commercial numbers,' to do his will.

THE Slaughter of Animals (Scotland) Bill, which comes before the House of Commons for its third reading on Nov. 15, provides for the licensing of slaughterhouses in order to check unskilful slaughtering, and for the stunning of animals with a mechanically operated instrument before slaughter. At the committee stage considerable concessions had to be made to the opponents of humane slaughtering: the effect of the bill was restricted to slaughter-houses and knackers' yards, swine were exempted from the operation, and the usual exemption for Jewish slaughtering was introduced. While the first two, at least, of these concessions will be generally regretted by humanitarians, there can be no doubt that they were wisely made, for in exchange the opponents of the bill have undertaken to allow it to pass into law. Indeed, the Government would not need any great courage to adopt the bill as its own during the final stages. The subject is to be discussed at a debate arranged by