THE PASSING OF TWO GREAT SWISS CHEMISTS.

P. A. GUYE and T. SANDMEYER.

With the passing of Guye and Sandmeyer, Swiss chemistry has sustained two losses which are also the losses of science; for science is universal. Both were men of exceptional worth in scientific attainment and personality, and it is very difficult to realise that they are no more. The writer of these lines enjoyed the great privilege of intimate association with them—with Guye as an esteemed friend and colleague, with Sandmeyer as a technical collaborator for nearly eight years.

PHILLIPE A. GUYE.

Phillipe Guye was born in Saint-Christophe, Canton de Vaud, Switzerland, on June 12, 1862. He studied in Geneva and in Paris, graduating at both universities. After a long residence in the French capital, during which he worked under Friedel, Guye was called to the University of Geneva, where his output of scientific work was prodigious. His papers are so numerous that it is impossible to give an adequate account of them, even in outline; nearly 200 papers emanated from his laboratory, and the publications which bear his name number over 600 and cover more than 10,000 pages.

Following a number of researches in organic chemistry, Guye concentrated his energies on physical chemistry, a field in which he discovered new and fundamental relationships between the physical constants of fluids and their chemical constitution, especially with regard to the size of molecules; and concurrently with these extensive researches he developed his original and brilliant theory of the dissymmetry of molecules, which he supported with an almost incredible array of facts and other evidence.

From 1903 he turned to the field which he made particularly his own, viz., the determination of atomic weights. He was the author of over 100 papers relating to the atomic weights of nitrogen, chlorine, and bromine, and it is impossible to overrate the accuracy of his work, which is second to none in this fundamental branch of chemistry. The accuracy which Guye attained in this work, 1:10,000, has never been surpassed; and he obtained these marvellous results without the aid of costly apparatus, for the University of Geneva is not rich; his manual dexterity and his scientific *fleur* overcame every difficulty. His researches on atomic weights represented a distinct advance on those of Marignac and Stas.

During all this time Guye never lost contact with the technical world. His investigations on the combination of nitrogen and oxygen under the influence of the electric arc gave rise to a number of fundamental patents, and his motive in doing this work was to enable Switzerland to produce all its requirements in nitrogenous fertilisers by developing its great water-power resources, amounting to 4 million h.-p.

Having always regretted that Switzerland had no periodical chemical literature of its own, Guye founded his *Journal de Chimie Physique*, and he took a very active part in founding the *Helvetica Chimica Acta*.

Honours poured upon him. He presided in turn over practically every chemical society in Switzerland, and was a member of the International Committee on Atomic Weights. France made him a Chevalier de la Légion d'Honneur, and gave him the Prix Vaillant. The Royal Society, in addition

to awarding him the Davy Medal, made him an honorary member; and a similar honour was bestowed upon him by the chemical societies of Madrid, London, Petrograd, and Bucharest.

To the writer all the honours and success which fell to Guye's lot were of little significance in comparison with his personality. He was a most sincere friend, a most conscientious teacher and investigator, and a brilliant lecturer. His tact was recognised in every quarter, and although for him science had no frontiers, his sympathies were decidedly with France; Guye, with his magnificent sympathy, was the true link between the belligerent nations. His early death is sincerely regretted, not on account of unfinished work—work is never finished—but because men of his stamp, personality and world-wide reputation are rare and irreplaceable.

T. SANDMEYER.

In many respects Traugott Sandmeyer and Phillipe Guye represented two very distinct types. Sandmeyer was scarcely known outside the small circle of his collaborators and colleagues, he disliked publicity in every form, and although his life was devoid of startling adventures and great worldly successes, nevertheless, it was not without romance. His method of investigation and his manner of working differed so much from those of other chemists that everyone who came in contact with Sandmeyer felt that his personality was not an ordinary one and that he was capable of doing things which only genius can achieve. For this reason and because his ideas were inimitable and brilliant, he had no enemies, and even envy passed him by. The clue to all his successes was his extraordinary faculty of observation; he could detect the slightest deviation in a reaction and his discovery of a new method for synthesising indigotin was the result of this exceptional power, together with the gift of chemical divination. As a colleague he was always ready to help and advise, never expecting or desiring thanks. Most of the apparatus he used was of his own construction, for he was an expert mechanic. During the construction of the great dye-house in the Basle factory in 1918, he communicated to the architect his "feeling" that the reinforcement of the concrete was not one-third of the strength required, and on investigation it was found that a mistake had been made which would certainly have caused the five-story building to collapse. Owing to his conscientious method of work, to be his assistant was no easy task, not because he was an exacting master, but because he would perform every experiment himself; in fact, he had only one assistant, namely, himself, and a reaction which he had not seen did not exist for him. The discovery that 1,2,4-aminonaphthol-sulphonic acid can be diazotised, contrary to the statement of Otto N. Witt, was made because Sandmeyer tried not only naphthol as a coupling agent but also resorcinol, which couples much more readily with the minute quantity of diazo-compound that is formed, in spite of Witt's assertion. His discovery of the "Sandmeyer reaction" is another example of his power of observation, and there are many others. Entering the Geigy factory in 1888, he brought with him the constitution of Primuline, discovered by Green, and he told the writer that it took him but a few hours to find out (by distillation with zinc) that Primuline is related to thio-toluidine. But before 1888 Sandmeyer was already well known to organic chemists for his discovery of

the "Sandmeyer reaction" and the dangerous esters of hypochloric acid, and he was also the discoverer of thiophene.*

† The first result of Sandmeyer's studies in Basle was the discovery of diamidophenyltolyl, which enabled the Geigys to imitate all the Benzidine colours with the homologue. In 1889 he prepared Chrome Violet by condensing salicylic acid with formaldehyde and oxidising with nitrous acid, a reaction which was of great technical importance as it gave rise in later years to the beautiful series of the Azurols and the Aurins of the Malachite-Green series. In the same year he discovered his remarkable process for making Auramine (from tetramethyldiamidodiphenylmethane, sulphur, ammonium chloride and ammonia), carrying out the reaction in a kettle of his own construction. The year 1890 saw the discovery of the important method for producing dyes of the triphenylmethane

Setopaline, Setocyanine, Erioglaucine Supra, and a number of intermediates which were more of scientific interest. Sandmeyer was the first to discover that a sulphonic group in the *ortho*-position to the carbinol-group in the triphenylmethane-dyes gives rise to the Patent Blues, and that the methyl-group has a similar action.

The years 1887-1899 yielded new and highly interesting results of a scientific character. He made the *p*-aminobenzaldehydes by the action of hydroxylamine-derivatives on formaldehyde-derivatives and amines; and *p*-dimethylaminobenzaldehydes, which play an important part in the diagnosis of syphilis were prepared in almost unlimited number. He also made a number of aldehydes (e.g., vanillin, naphthaldehyde) by a modification of the Tiemann-Reimer method, and these compounds proved to be important in the manufacture of colours of the Naphthalene-Green type.

From a photograph by
PROF. H. E. FIERZ.

T. Sandmeyer.

class (starting from the hydrol) which is now in very general use in dye-manufacture (Acid Violet 5B, 6B). The following year he made the disulphonic acid of amidophenol (2.6.4) by the action of bisulphite on *p*-nitrosodiethylaniline, and found that formanilide when reduced with zinc-dust yields pure monomethylaniline, which at that time was needed in the manufacture of antipyrine. His achievements in the field of triphenylmethane-dyes were particularly numerous in the succeeding years; he made Helvetia Blue, Erioglaucine,

The year 1899 saw Sandmeyer's most remarkable achievement, viz., the preparation of indigotin from thiocarbanilide by a method which, although used only for a short time, appears to be one of the most brilliant in technical organic chemistry. In 1904 Sandmeyer showed how to diazotise the 1.2.4-amidonaphtholsulphonic acids from which were obtained Erio Chrome Blueblack B and R, Chrome Black T and A, and Erio Chrome Red B. Later, he prepared Erio Chrome Azurol and similar dyes by the reaction he had used in discovering Chrome Violet. During the war he took a very active part in the manufacture of the naphthalene-derivatives which the Basle manufacturers had previously bought from Germany. His last achievement was the finding of a new and very important method for manufacturing isatins, starting from amines, chloral and hydroxylamines, a method which gives quantitative yields and whose discovery showed that Sandmeyer was still the master of the subject.

On his retirement in 1919, Sandmeyer gave a large portion of his wealth to the pension fund of the firm for which he had worked during 31 years,

* Sandmeyer, whose voracity is beyond any doubt, told the writer the story of this discovery, which differs slightly from the version generally accepted. Victor Meyer wanted to show to his students the well-known isatin reaction of benzene with concentrated sulphuric acid. The benzene had just been prepared, during the lecture, from benzoate, but the red colour did not appear. Meyer got impatient, so Sandmeyer gave him a drop of benzene from a bottle on the shelf, the substitution passing unnoticed by Meyer. After the lecture Sandmeyer told Victor Meyer that there must be "something" in technical benzene, but Meyer had forgotten the incident entirely. It was only then that the case was investigated.
† The succeeding three paragraphs are based on notes supplied by Dr. H. Hagenbach.

and he retired to Zollikon, near Zürich. After a short illness, which was followed by an operation, he passed away early in April, in his 68th year.

The following additional facts were written by Sandmeyer a few weeks before he died.

Sandmeyer was born in Wettingen (Aargau) in 1851, on the day before the death of his father, who was a teacher of natural science and agriculture. Owing to this calamity, his mother had to resume her former occupation of school teacher, at Aarau, where Traugott attended the communal school. Stimulated by reading scientific books from his father's library, he developed a great interest in physical apparatus and manual work, so that instead of proceeding to the cantonal school he entered an engineering workshop.

Three years later he obtained employment in the mechanical and optical shop of J. F. Meier, of Zürich, but his health failed, and his mother having come to live in Zürich, he started a workshop in his own home and supplied apparatus to the chemical departments of the Federal Polytechnic. In this way he was brought into contact with the professorial staff, and in 1882 he became lecture-assistant to Victor Meyer, and soon started investigations which were published subsequently in the *Berichte*. In 1885 he accompanied Victor Meyer to Göttingen for one semester, and then returned to Zürich, where he served for three years under Hantzsch. In 1888, after three offers from dye-manufacturers, he joined the firm of J. R. Geigy, thus realising his secret wish to enter a technical branch of chemistry. In 1892 he married his step-niece Mina Billeter, of Männedorf.

In recognition of his work, the University of Heidelberg conferred upon him, in 1891, the degree of Phil. Doc., *honoris causa*. Ten years later he was appointed a director of J. R. Geigy and Co., which was then converted into a limited liability company; and when the firm celebrated its 150th anniversary in 1915, he was made an honorary doctor of the Technical "Hochschule," Zurich.

The lives of Guye and Sandmeyer appear to have little in common; but those who knew them intimately cannot accept this view. Guye and Sandmeyer represent the type of scientific men, like Bayer, Bunsen and Emil Fischer, which pursues science for its own sake. These great men never played any part in so-called society; and as we look around us we can but regret the disappearance of this school. Bon and Isler, too, have gone; colour chemistry seems to be at the end of its wisdom.

Sandmeyer and Guye were very different from many industrial chemists of the present time, and the idea that money comes before science could never have entered their heads. What would they have thought of so-called chemists who live by imitating their competitors and who even boast of appropriating the ideas of others? The young generation which has not seen a really great chemist at work overlooks only too readily the fundamental difference between knowledge which has been gained through original research and knowledge which has been learned from books and other second-hand sources. Every one of the truths which have been brought to light by these great and modest men entailed long years of hard, self-denyng work. They represented the new ideas; they were the incarnation of science. Have the younger men the genius and the sense of modesty which alone bring lasting success? Have they the necessary power of persistent effort? This question seems the most important outcome of the lives of these two men. Their work was truly remarkable, but the example they have set overshadows even the greatness of their achievements.

H. E. FIERZ.

ACETYLENE IN TECHNICAL CHEMICAL SYNTHESSES.

The reactivity of acetylene renders it very useful in many chemical syntheses, and production at a low price is the only consideration determining the practical use of this gas in many well-known reactions. Such products as acetic acid, ethyl alcohol, acetal, aldol, and chlorine-containing solvents can be manufactured by reactions easily adaptable to large-scale operations, and the newer synthetical methods will come to the fore, in competition with older processes, so soon as the initial raw material, calcium carbide, is available at low cost.

The manufacture of calcium carbide involves the expenditure of over 4000 kw.-hr. of electrical power per ton of carbide, and if this power is available at, say, 0.1d. per unit, carbide will be manufactured at a cost of £5 per ton (*cf.* Report of the Nitrogen Products Committee, 1919). With power at about 0.33d. per unit, carbide could be produced at less than £10 per ton. Thus, countries possessing large water-power resources should be in an excellent position to manufacture cheap carbide, and, indeed, before the war, Norway generated power at 0.07d. per unit.

Many reactions which to-day are merely laboratory methods of preparation have been thoroughly investigated in large-scale apparatus and only await cheap acetylene for competitive manufacture to be commenced.

No attempt at collective recording of the possibilities of acetylene in industry has been made, so far as the writer is aware, except a flow-sheet published by Deschiens (*Chim. et Ind.*, 1921, 239). It is, therefore, proposed in this article to discuss the methods available for producing acetaldehyde, acetic acid, hydrogen cyanide, and condensation products such as pyridine, pyrrole, thiophene, but detailed estimates of costs of production cannot be considered owing to limitations of space. It should, however, become apparent that many of the methods to be considered are quite capable of technical realisation, and the costs of actual operation being relatively small, all that is required for economic success is cheap calcium carbide. To quote but a single example in advance, there seems every possibility that ethyl alcohol could be produced synthetically at about 1s. 6d. per gallon, provided calcium carbide is obtainable at £6 per ton, a likely figure in localities where cheap hydro-electric power, coal and limestone are available.

Acetaldehyde and Acetic Acid.

The manufacture of acetaldehyde from acetylene by catalytic hydration in the presence of mercuric salts as catalysts, and the oxidation of the aldehyde to acetic acid, have been described previously by the writer (*cf.* *J.*, 1921, 315 n). That the processes involved are capable of practical application is shown by the results of the operations of the Canadian Electro Products Co., of Meister, Lucius and Brünig, of the British Cellulose Co., and others. The commercial success of the process for manufacturing synthetic acid depends essentially upon the cost of calcium-carbide production, and when this cost becomes sufficiently low, it will be possible to manufacture economically many derivatives of acetic acid and acetylene. Thus, acetone can be produced by passing acetic acid over dehydrating catalysts at about 400° C., and the following long range of products may all be regarded as derivatives of acetylene: the acetates, acetyl chloride and anhydride, ethylidene diacetate, acetyl derivatives of organic acids, *e.g.*, acetylsalicylic acid, and