

ART. XXXVII—*Jean-Baptiste-André Dumas*; by J. P. COOKE.*

JEAN-BAPTISTE-ANDRÉ DUMAS was born at Alais, in the south of France, July 14, 1800. His father belonged to an ancient family, was a man of culture, and held the position of clerk to the municipality of Alais. The son was educated at the college of his native place, and appears to have been destined by his parents for the naval service. But the anarchy and bloodshed which attended the downfall of the First Empire produced such an aversion to a military life that his parents abandoned their plan, and apprenticed him to an apothecary of the town. He remained in this situation, however, but a short time; for, owing to the same sad causes, he had formed an earnest desire to leave his home, and, his parents yielding to his wish, he traveled on foot to Geneva in 1816, where he had relatives who gave him a friendly welcome, and where he found employment in the pharmacy of Le Royer.

At that time Geneva was the center of much scientific activity, and young Dumas, while discharging his duties in the pharmacy, had the opportunity of attending lectures on botany by M. de Candolle, on physics by M. Pictet, and on chemistry by M. Gaspard de la Rive; and from these lectures he acquired an earnest zeal for scientific investigation. The laboratory of the pharmacy gave him the necessary opportunities for experimenting, and an observation which he made of the definite proportions of water contained in various commercial salts, although yielding no new results, gained for him the attention and friendship of De la Rive. Soon after we find the young philosopher attempting to deduce the volumes of the atoms in solid and liquid bodies by carefully determining their specific gravities, and thus anticipating a method which thirty years later was more fully developed by Hermann Kopp.

About this time, young Dumas had the good fortune to render an important service to one of the most distinguished physicians of Geneva, whose name is associated with the beneficial uses of iodine in cases of goitre. It had occurred to Dr. Coindet that burnt sponge, then generally used as a remedy for that disease, might owe its efficacy to the presence of a small amount of iodine; and on referring the question to Dumas, the young chemist not only proved the presence of iodine in the sponge, but also indicated the best method of administering what proved to be almost a specific remedy. It was in connection with this investigation that Dumas's name

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first appears in public. The discovery produced a great sensation, and for many years the manufacture of iodine preparations brought both wealth and reputation to the pharmacy of Le Royer.

Soon after, Dumas formed an intimacy with Dr. J. L. Prévost, then recently returned from pursuing his studies in Edinburg and Dublin, and was induced to undertake a series of physiological investigations, which for a time withdrew him from his strictly chemical studies. Several valuable papers on physiological subjects were published by Prévost and Dumas, which attracted the notice of Alexander von Humboldt, who on visiting Geneva, in 1822, sought out Dumas and awakened in him a desire to seek a wider field of activity than his present position opened to him. In consequence he removed to Paris in 1823, where the reputation he had so deservedly earned at Geneva won for him a cordial reception at what was then the chief center of scientific study in Europe. La Place, Berthollet, Vauquelin, Gay-Lussac, Thenard, Alexandre Brongniart, Cuvier, Geoffroy St. Hilaire, Arago, Ampère, and Poisson, all manifested their interest in the young investigator. Dumas was soon appointed Répétiteur de Chimie at the École Polytechnique, and also Lecturer at the Athenæum, an institution founded and maintained by public subscription for the purpose of exciting popular interest in literature and science; and from this beginning his advancement to the highest position which a man of science can occupy in France was extremely rapid.

In 1826 he married Mdlle. Herminie Brongniart, the eldest daughter of Alexandre Brongniart, the illustrious geologist, an alliance which not only brought him great happiness, and at the time greatly advanced his social position, but also in after years made his house one of the chief resorts of the scientific society of Paris. The many who have shared its generous hospitality will appreciate how greatly, for more than half a century, Madame Dumas has aided the work and extended the influence of her noble husband.

1828-29 Dumas united with Théodore Olivier and Eugène Pécelet in founding the École Centrale des Arts et Manufactures, an institution which met with great success; in which, as Professor of Chemistry, Dumas rendered most efficient service for many years, and in 1878 had the very good fortune to aid in celebrating the fiftieth anniversary of his own foundation, and to see it acknowledged as among the most important and efficient scientific institutions of the world. In 1832 Dumas succeeded Gay-Lussac as Professor at the Sorbonne; in 1835 he succeeded Thenard at the École Polytechnique; and in 1839 he succeeded Deyeux at the École de Médecine. Thus

before the age of forty he had filled successively, and for some time simultaneously, all the important professorships of chemistry in Paris except one. This exception was that of the College of France, with which he was never permanently connected, although it was there that he delivered his famous course on the History of Chemical Philosophy, when temporarily supplying the place of Thenard.

Dumas early recognized the importance of laboratory instruction in chemistry, for which there were no facilities at Paris when he first came to what was then the center of the world's science; and in 1832 founded a laboratory for research at his own expense. This laboratory, first established at the Polytechnic School, was removed to the Rue Cuvier in 1839, where it remained until broken up by the revolution of 1848. The laboratory was small, and Dumas would receive only a few advanced students, and these on terms wholly gratuitous. Among these students were Piria, Stas, Melsens, Leblanc, Lalande, and Lewy, with whose aid he carried on many of his important investigations. By the Revolution of 1848 Dumas's activities were for a time diverted into political channels; but under the Second Empire his laboratory was re-established at the Sorbonne, and in 1868 was removed to the *École Centrale*.

The political episode of Dumas's life was the natural result of an active mind with wide sympathies, which recognizes in the pressing demands of society its highest duties. The political and social upheaval of 1848 seemed at the time to endanger the stability in France of everything which a cultivated and learned man holds most dear; and Dumas was not one to consider his own preferences when he felt he could aid in averting the calamities which threatened his country. Immediately after the Revolution of February, he accepted a seat in the Legislative Assembly offered him by the electors of the *Arrondissement of Valenciennes*. Shortly afterwards the President of the Republic called him to fill the office of Minister of Agriculture and Commerce. During the Second Empire he was elevated to the rank of Senator, and shortly after his entrance into the Senate he became Vice-President of the High Council of Education. In order to reform the abuses into which many of the higher educational institutions of Paris had fallen, he accepted a place in the Municipal Council of Paris, over which he subsequently presided from 1859 to 1870.

In 1868 Dumas was appointed Master of the Mint of France, but he retained the office only during a short time, for with the fall of the Second Empire, in 1870, his political career came to an abrupt termination. The Senate had ceased to exist, and in the stormy days which followed, the Municipal Council had naturally changed its complexion; and even at the Mint, the

man who had held such a conspicuous position under the Imperial government was obliged to vacate his place. Some years previously he had resigned his professorships because his official positions were incompatible with his relations as teacher, and now, at the age of seventy, he found himself for the first time relieved from the daily routine of official duties, and free to devote his leisure to the noble work of encouraging research, and thus promoting the advancement of science. He had reached an age when active investigation was almost an impossibility, but his commanding position gave him the opportunity of exerting a most powerful influence, and this he used with great effect. In early life he had been elected, in 1832, a member of the Academy of Sciences in succession to Serullas; in 1868 he had succeeded Flourens as its Permanent Secretary; and in 1875 he was elected a member of the French Academy as successor to Guizot, a distinction rarely attained by a man of science.

It was, however, as Permanent Secretary of the Academy of Sciences that Dumas exerted during the last years of his life his greatest influence. He was the central figure and the ruling spirit of this distinguished body. No important commission was complete without him, and on all public occasions he was the orator of the body, always felicitous, always eloquent. In announcing Dumas's death to the Academy, M. Rolland, the presiding officer, said:—

“Vous savez la part considérable que Dumas prenait à vos travaux et vous avez bien souvent admiré, comme moi, la haute intelligence et la tact infini avec lesquels il savait imprimer à nos discussions les formes modérées et courtoises inhérentes à sa nature et à son caractère. Sous ce rapport aussi la perte de Dumas est irréparable, et crée dans l'Académie un vide bien difficile à combler. Aussi, longtemps encore nous chercherons, à la place qu'il occupait au Bureau avec tant d'autorité, la figure sympathique et vénéérée de notre bienaimé Secrétaire perpétuel.”

And while Dumas was still occupying his conspicuous position in the Academy, one of the most distinguished of his German contemporaries * wrote of him: “An ever-ready interpreter of the researches of others, he always heightens the value of what he communicates by adding from the rich stores of his own experience, thus often conveying lights not noticed even by the authors of those researches.”

When the writer last saw Dumas, in the winter of 1881–82, the great chemist had still all the vivacity of youth, and it was

* A. W. Hofmann, in *Nature*, February 6, 1880, to whose admirable and extended biography the writer is indebted for much of the material with which this notice has been prepared.

difficult to realize his age. He took a lively interest in all questions of chemical philosophy, which he discussed with great earnestness and warmth. There was the same fire and the same exuberance of fancy which had enchanted me in his lectures thirty years before. At an age when most men hold speculation in small esteem, I was much struck with his criticism of a contemporary, who, he said, had no imagination, although he spoke with the highest praise of his experimental skill. At that time Dumas showed no signs of impaired strength. But during the following year his health began to fail, and he died on the 11th of April, at Cannes, where he had sought a retreat from the severity of the winter climate of Paris.

Dumas was one of the few men whose greatness cannot be estimated from a single point of view. He was not only eminent as an investigator of nature, but even more eminent as a teacher and an administrator. Beginning the study of chemistry at the culmination of the epoch of the Lavoisierian system, and regarding, as he always did, the author of that system with the greatest admiration, he nevertheless was the first to discover the weak point in its armor and inflict the wound which led to its overthrow. Without attempting to detail Dumas's numerous contributions to chemical knowledge, we will here only refer to three important investigations, which produced a marked influence in the progress of chemical science.

While still in Geneva, Dumas, as has been said, made numerous determinations of the densities of allied substances, with a view to discovering the relations of what he called their molecular or atomic volumes; and it is no wonder to us that the problem proved too complex to be solved at that time. After his removal to Paris he took up the much simpler problem which the relations of the molecular volumes of aeriform substances present, and his paper "On Some Points of the Atomic Theory," which was published in the *Annales de Chimie et de Physique* for 1826, had an important influence in developing our modern chemical philosophy. Gay-Lussac had previously observed, that not only the relative weights of the several factors and products concerned in a chemical process bear to each other definite proportions, but also, when the materials are aeriform, the relative volumes preserve an equally definite and still simpler ratio. Moreover, on the physical side, Avogadro, and afterwards Ampère, had conceived the theory, that in the state of gas all molecules must have the same volume. It was Dumas who first saw that these principles furnished an important means of verifying the molecular and atomic weights.

"I am engaged," he writes, "in a series of experiments intended to fix the atomic weights of a considerable number of

bodies, by determining their density in the state of gas or vapor. There remains in this case but one hypothesis to be made, which is accepted by all physicists. It consists in supposing that, in all elastic fluids observed under the same conditions, the molecules are placed at equal distances, i. e. that they are present in them in equal numbers. An immediate consequence of this mode of looking at the question has already been the subject of a learned discussion on the part of Ampère,"—and Avogadro as the author subsequently adds,—“to which, however, chemists, with the exception perhaps of M. Gay-Lussac, appear to have given as yet but little attention. It consists in the necessity of considering the molecules of the simplest gases as capable of a further division,—a division occurring in the moment of combination, and varying with the nature of the compound.”

Here, it is obvious, are the very conceptions which form the basis of our modern chemical philosophy; and at first we are surprised that they did not lead Dumas at once to the full realization of the consequences which the doctrine of equal molecular volumes involves in the interpretation of the constitution of chemical compounds, and to the clear distinction between “the physical smallest particles” and “the chemically smallest particles,” or the molecules and the atoms, as we now call the physical and the chemical units. This distinction is implied throughout Dumas’s paper already quoted, and is illustrated by a striking example in the introduction to his treatise on “Chemistry applied to the Arts,” published two years later; but the ground was not yet prepared to receive the seed, and more than a quarter of a century must pass before the full harvest of this fruitful hypothesis could be reaped.

There were, however, two important incidental results of this investigation from which chemical science immediately profited. One was a simple method of determining with accuracy the vapor densities of volatile substances which has since been known by Dumas’s name. The other was a radical change in the formula of the silicates. On the authority of Berzelius, who based his opinion chiefly on the analogy between the silicates and the sulphates, the formula SiO_2 had been accepted as representing the constitution of silica. But from the density of both the chloride and the fluoride of silicon Dumas concluded that the formula was SiO_3 , a conclusion which is now seen to be in complete harmony with the scheme of allied compounds. To Berzelius, however, the new views appeared wholly out of harmony with the system of chemistry which he had so greatly assisted in developing, and he opposed them with the whole weight of his powerful influence, and so far succeeded as to prevent their general adoption for many years.

Still, "the new mode of looking at the constitution of silicic acid slowly but surely gained ground, and it is now so firmly rooted in our convictions, that the younger generation of chemists will scarcely understand the pertinacity with which this innovation was resisted."*

But if this investigation of gas and vapor densities brought a great strain upon the dualistic system, the second of the three great investigations of Dumas, to which we have referred, led to its complete overthrow. The experimental results of this investigation would not be regarded at the present day as remarkable, and cannot be compared either in breadth or intricacy with the results of numerous investigations of a similar character which have since been made. The most important of these results were the substitution products obtained by the action of chlorine gas on acetic acid. They were published in a series of papers entitled "Sur les Types Chimiques," and the capital point made was that chlorine could be substituted in acetic acid for a large part of the hydrogen without destroying the acid relations of the products; and the inference was, that the qualities of a compound substance depend not simply on the nature of the elements of which it consists, but also on the manner or type according to which the elements are combined.

To the chemists of the present day these results and inferences seem so natural that it is difficult to understand the spirit with which they were received forty years ago. But it must be remembered that at that time the conceptions of chemists were wholly moulded in the dualistic system. It was thought that chemical action depended upon the antagonism between metals and metalloids, bases and acids, acid salts and basic salts, and that the qualities of the products resulted from the blending of such opposite virtues. That chlorine should unite with hydrogen was natural, for no two substances could be more unlike; but that chlorine should supply the place of hydrogen in a chemical compound was a conception which the dualists scouted as absurd. Even Liebig, the "father of Organic Chemistry," warmly controverted the interpretation which Dumas had given to the facts he had discovered. Liebig himself had successfully investigated the chemical relations of a similar class of organic products. He had, however, worked on the lines of the dualistic system, showing that organic substances might be classed with similar inorganic substances, if we assume that certain groups of atoms, which he called "compound radicals," might take the place of elementary substances. In the edition of the organic part of Turner's Chemistry bearing his name, Organic Chemistry is defined as the "Chemistry of Compound Radicals," and the formulæ of

* Hofmann, *loc. cit.*

organic compounds are represented on the dualistic system. Liebig's conceptions were therefore naturally opposed to those advanced by Dumas, but it is pleasant to know that the controversy which arose never disturbed the friendly relations between these two noble men of science, who could approach the same truth from different sides, and yet have faith that each was working for the same great end. In his commemorative address on Pelouze, Dumas expresses toward Liebig sentiments of affectionate regard, and Liebig dedicates to Dumas, with equal warmth, the German edition of his "Letters on Chemistry."

By the second investigation, as by the first, although Dumas gave a most fruitful conception to chemistry, he only took the first step in developing it. His conception of chemical types was very indefinite, and Laurent wrote of it, a few years later: "Dumas's theory is too general; by its poetic coloring, it lends itself to false interpretations; it is a programme of which we await the realization." Laurent himself helped towards this realization, and in his early death left the work to his associate and friend Gerhardt, who pushed it forward with great zeal, classifying chemical compounds according to the four types of hydrochloric acid, water, ammonia and marsh gas. Hofmann, Williamson, Wurtz, and many others, greatly aided in this work by realizing many of the possibilities which these types suggested; and thus modern Structural Chemistry gradually grew up, in which the types of Dumas and Gerhardt have been in their turn superseded by the larger views which the doctrine of quantivalence has opened out to the scientific imagination. It is a singular fact, however, that, while the growth began in France, the harvest has been chiefly reaped by Germans; and that, although in its inception the movement was strongly opposed in Germany, its legitimate conclusions are now repudiated by the most influential school of French chemists.

The third great investigation of Dumas was his revision of the atomic weights of many of the chemical elements, and in none of his work did he show greater experimental skill. His determination of the atomic weight of oxygen by the synthesis of water, and of that of carbon by the synthesis of carbonic dioxide, are models of quantitative experimental work. To this investigation, as to all his other work, Dumas was directed by his vivid scientific imagination. In his teaching, from the first, he had aimed to exhibit the relations of the elementary substances by classing them in groups of allied bodies; and at the meeting of the British Association in 1851 he had delighted the chemical section by the eloquence and force with which he exhibited such relations, especially triads of elementary substances; such as chlorine, bromine and iodine; oxygen, sulphur

and selenium; phosphorus, arsenic and antimony; calcium, barium and strontium; in which not only the atomic weight, but also the qualities of the middle member of the triad, were the mean of those of the other two members. Later, he came to regard these triads as parts of more extended series, in each of which the atomic weights increased from the first to the last element of the series, by determinate, but not always by equal differences, the values being, if not exact multiples of the hydrogen atom according to the hypothesis of Prout, at least multiples of one half or one quarter of that weight. There can be no doubt that these speculations were more fanciful than sound, and that Dumas did not do full justice to earlier theories of the same kind; but with him these speculations were merely the ornaments, not the substance of his work, and they led him to fix more accurately the constants of chemistry, and thus to lay a trustworthy foundation upon which the superstructure of science could safely be built.

That exuberance of fancy to which we have referred made Dumas one of the most successful of teachers, and one of the most fascinating of lecturers. It was the privilege of the writer to attend the larger part of two of his courses of lectures given in Paris in the winters of 1848 and 1851, and he remembers distinctly the impression produced. Besides the well-arranged material and the carefully prepared experiments, there was an elegance and pomp of circumstance which added greatly to the effect. The large theatre of the Sorbonne was filled to overflowing long before the hour. The lecturer always entered at the exact moment, in full evening dress, and held to the end of a two hours' lecture the unflagging attention of his audience. The manipulations were entirely left to the care of a number of assistants, who brought each experiment to a conclusion at the exact moment when the illustration was required. An elegance of diction, an appropriateness of illustration, and a beauty of exposition, which could not be excelled, were displayed throughout, and the enthusiasm of a French audience added to the animation of the scene.

To the writer the lectures of Dumas were brought in contrast to those of Faraday. Both were perfect of their kind, but very different. Faraday's method was far more simple and natural, and he excelled Dumas in bringing home to young minds abstruse truths by the logic of well arranged consecutive experiment. With Dumas there was no attempt to popularize science: he excelled in clearness and elegance of exposition. He exhausted the subject which he treated, and was able to throw a glow of interest around details which by most teachers would have been made dry and profitless.

Two volumes of Dumas's Lectures have been published;

one comprises his course on the Philosophy of Chemistry, delivered at the College of France in 1836; the other contains only a single lecture, accompanied by notes, entitled "The Balance of Organic Life," which was delivered at the Medical School of Paris, August 20, 1841. In both these volumes will be found the beauty of exposition and the elegance of diction of which we have spoken, and they are models of literary style. But of course the sympathetic enthusiasm of the great man's presence cannot be reproduced by written words.

The lecture on "The Balance of Organic Life" was probably the most remarkable of Dumas's literary efforts. It dealt simply with the relations that the vegetable sustains to the animal kingdom through the atmosphere, which, though now so familiar, were then not generally understood; and the late Dr. Jeffries Wyman, who heard the lecture, always spoke of it with the greatest enthusiasm.

As might be expected, Dumas's oratory found an ample field in the Chamber of Deputies and in the Senate; and whether setting forth a project of recasting the copper coinage or a law of drainage, or ridiculing the absurd theories of homeopathy, he riveted the attention of his colleagues as completely as he had entranced the students at the Sorbonne.

In the early part of his life, Dumas was a voluminous writer, and in 1828 published the "Traité de Chimie appliquée aux Arts," in eight large octavo volumes, with an atlas of plates in quarto. But besides this extended treatise, the two volumes of Lectures just referred to are his only important literary works. He published numerous papers in scientific journals, which, as we have seen, produced a most marked effect on the growth of chemical science. But the number of his monographs is not large compared with those of many of his contemporaries, and his work is to be judged by its importance and influence rather than by the extent of the field which it covers.

In his capacity of President of the Municipal Council at Paris, of Minister of Agriculture and Commerce, of Vice-President of the High Council of Education, and of Perpetual Secretary of the Academy of Sciences, Dumas had abundant opportunity for the exercise of his administrative ability, and no one has questioned his great powers in this direction; but in regard to his political career we could not expect the same unanimity of opinion. That he was a liberal under Louis Philippe, and a reactionist under Louis Napoleon, may possibly be reconciled with a fixed political faith and an unswerving aim for the public good; but his scheme for "civilian billeting" (by which wealthy people having rooms to spare in their houses would have been compelled to billet artisans employed in public works) leads one to infer that his statesmanship was not equal

to his science. Nevertheless, there can be no question about his large-hearted charity. He instituted the "Crédit Foncier," which flourishes in great prosperity to this day; he also founded the "Caisse de Rétraite pour la Vieillesse," and several other agricultural charities, which, though less successful, afford great assistance to aged workmen. Louis Napoleon used to say in jest that the whole of the War Minister's budget would not have been enough to realize M. Dumas's benevolent schemes; and once, half dazzled, half amused, by one of the chemist's vast sanitary projects, he called him the "the poet of hygiene."

It was to be expected that a man working with such eminent success in so many spheres of activity, and at one of the chief centers of the world's culture, should be loaded with medals, and marks of distinction of every kind. It would be idle to enumerate the orders of knighthood, or the learned societies, to which he belonged, for, so far from their honoring him, he honored them in accepting their membership. It is a pleasure, however, to remember that he lived to realize his highest ambitions and to enjoy the fruits of his well-earned renown. France has added his name in the Pantheon

"AUX GRANDS HOMMES LA PATRIE RECONNAISSANTE."