EULOGY ON GAY-LUSSAC.

By M. Arago.

INTRODUCTION.

The biography which I am about to read is of unusual length, notwithstanding the numerous excisions I have made in it this very morning. I might, as an excuse, say that Gay-Lussac is no ordinary academician; that he will occupy a very eminent position in the scientific history of the first half of the nineteenth century; that the titles alone of the important memoirs he has published would fill a large number of pages, &c., &c.; but, I prefer frankly acknowledging it, I was too late in discovering that I had exceeded the established limits, and when there no longer remained the necessary time for giving a new form to my work. I therefore resign myself unreservedly to any criticisms that the subject may call forth. I will merely observe to all those who, coming here to seek relaxation, should unfortunately only find weariness, that an old man, drawn into dwelling even to garrulity upon the divers merits of a friend, has perhaps some claim to indulgence.

CHILDHOOD OF GAY-LUSSAC—HIS ADMISSION TO THE POLYTECHNIC SCHOOL.

Joseph Louis Gay-Lussac, one of the most illustrious scientists of which France can boast, was born, September 6, 1778, at Saint Leonard, a small town of the ancient province of Limousin, situated near the frontier of Auvergne. His grandfather was a physician, and his father king's procurateur (prosecutor) and judge at Pont de Noblac.

Those who have had an opportunity of observing the frigid reserve which characterized Gay-Lussac in mature age will be undoubtedly surprised to hear me say that in his childhood he was boisterous, turbulent, and very venturesome. To justify my appreciation, I will cite one fact from a thousand which I have gathered from the lips of Gay-Lussac himself, and which was also related to me by his relatives: A venerable curé, uncle of our future associate, occupied a house only separated from that of Gay-Lussac's family by a small yard; he had established his fruitery in a room on which looked the chamber where Gay-Lussac and a brother, a year younger, were in the habit of studying. A desire to taste the forbidden fruit took possession of Gay-Lussac. He hurriedly

stretches, with all imaginable difficulty, a pole from the window of this room to that of the good curé; and armed with a stick, to the end of which the blade of a knife was securely attached, he places himself astride upon the fragile bridge; the end of his excursion reached, he breaks a window-pane, pierces the finest of the fruit with his instrument, and returns triumphant, safe and sound, to his own apartment. This exploit, which might have cost him his life, was repeated several times at short intervals. Finally, Gay-Lussac's parents suspected the truth, and the two brothers were taken to the priest to ask pardon. The first thought of the child was to deny, but the evidence of his guilt became clear. Gay-Lussac experienced such humiliation at being surprised in the very act of telling a falsehood that he resolved never again to depart from the truth, a resolution religiously kept during the rest of his life. Those who like to seize, in the boyhood of great men, indications of the character exhibited later in life, will pardon me if I interrupt for a moment the order of dates to relate another anecdote remembered by our associate with very natural pleasure; this likewise involves a question of apples.

Gay-Lussac having gone to Paris, the superintendent of the school in which he was placed one day discovered that several apple-trees in his garden had been completely stripped. As the offense could not, he thought, be attributed to the pupils, since in order to pass from the yard to the garden, it was necessary to climb two high walls, he resolved to dismiss the servants. Gay-Lussac learns this, solicits and obtains an interview, and then exclaims, "The servants are innocent; it is the pupils who have taken your fruit. I will not tell you who took part in the raid, but I am sure of the fact since I was one." Let us add that the exceptional frankness of the youthful Gay-Lussac was not on this occasion followed by any serious consequences. It won for him, on the contrary, the most marked affection of the superintendent and his wife, who, from this time, lavished upon him truly parental care.

Gay-Lussac began the study of the Latin language under the direction of a priest who resided in Saint Leonard, for whom he always testified the sincerest attachment. That his taste for the noisy pastimes of youth might not interfere with his desire to perform his duties, he devoted a portion of the night to study, after playing all day with his comrades.

The revolution of 1789, so legitimate in its objects, and which began with so much grandeur and majesty, had ended by rushing into the most deplorable digressions. The law against suspicious persons reached Gay-Lussac's father. The removal of this excellent man to Paris would probably have been followed by his death. Our friend, filled with alarm, repaired diligently to the club, which met in his native town, to ascertain the slightest indication which could threaten his father. The sight of a strong and valiant youth inspired the leaders of the epoch with a desire to enroll him in the army, then fighting the

Vendeans. Gay-Lussac might gladly have donned the military capote and shouldered his musket, but his filial affection prevailed; he proved that, according to the letter of the law (he was but fifteen years of age) he was exempt from joining the defenders of the republic, and he was left undisturbed. After the ninth thermidor, Gay-Lussac's father, who had fortunately remained in the prisons of Saint Leonard, regained his liberty. The first use he made of it was to devote himself to the future of the highly-gifted son, who, during his imprisonment, had given him the most intelligent proofs of love. He placed him at M. Savouret's school in Paris.* This was in 1795. The scarcity and impossibility of procuring food for his pupils induced M. Savouret to close his establishment. Gay-Lussac was soon after received into the boarding-school of M. Sensier, which, established first at Nanterre and afterward at Passy, outside of the walls of Paris, enjoyed some advantages of which the schools of the capital were deprived at that time.

I have recently met in our assemblies old college-mates of Gay-Lussac, and all have preserved the most pleasant recollections of him. One of them, M. Darblay, a representative of the people, said to me, with feeling: "He was the model of his school-fellows; we never saw him, notwithstanding his uncommon spirit, give way toward any one to an impulse of anger or impatience; as to his diligence, that was never relaxed." A pupil, taken to the theater by his friend, when asked at what hour he returned, would reply: "I do not know, but it must have been very late, as there was no light in Gay-Lussac's chamber."

The difficulties under which M. Savouret had succumbed very soon reached M. Sensier himself. Of all his pupils, he alone retained Gay-Lussac, whose parents secretly were in the habit of sending him small quantities of flour. Reduced to the most cruel extremities, Madame Sensier every night carried to Paris, for sale, the milk of two cows, fed in her garden, but the road being unsafe, Gay-Lussac begged and obtained the favor of daily escorting his benefactress, armed with a large sword suspended to his belt. It was during the return, which was made by daylight, that our friend, stretched on the straw of the cart of the impromptu milk-woman, studied geometry and algebra, thus preparing himself for the examinations for the Polytechnic School, which he was soon to undergo.

The sixth Nivôse, year VI, after brilliant examinations, Gay-Lussac received the much-coveted title of pupil of the Polytechnic School. We see him in this establishment always conversant with the required duties, and giving during the hours of recreation private lessons to young men who were intended for public services. It was in this way he added small sums to the thirty francs that each pupil of the original Polytechnic School received as his monthly allowance, and that he suc-

* I regard as a duty the preservation in this biography of the names of all persons who had any relations with our friend in his youth.

ceeded in maintaining himself in Paris without imposing fresh sacrifices on his family.

Gay-Lussac was one of the most distinguished of the scholars of the Polytechnic School, as, at a later period, he was one of the most illustrious and popular of the professors.

DÉBUT OF GAY-LUSSAC IN CHEMISTRY—HE BECOMES COLLABORATOR OF BERTHOLLET AND ASSISTANT PROFESSOR OF THE FOURCROY COURSE—AERONAUTIC VOYAGE WITH M. BIRT.

Berthollet, who had returned from Egypt with General Bonaparte, requested, in 1800, a pupil from the Polytechnic School, whom he wished to make his aid in the work of the laboratory. Gay-Lussac was this privileged pupil. Berthollet suggested to him an investigation whose results were diametrically opposite to those expected by the illustrious chemist. I could not venture to affirm that Berthollet was not somewhat disturbed at finding himself mistaken in his predictions, but it is certain that, unlike many other scientists whom I could name, after the first impulse of vexation, the frankness of the young experimentalist only served to increase the esteem that the author of *Static Chemistry* had already conceived for him. "Young man," said he to him, "your destiny is to make discoveries; henceforth you shall be my collaborator. I desire, and it is a title of which one day I am sure I shall be able to boast, I desire to be your father in matters of science."

Some time afterward, without giving up his position with M. Berthollet, Gay-Lussac was chosen assistant professor of the Fourcroy course and often supplied Berthollet's place, which soon gained him the reputation, that was constantly growing, of one of the most distinguished among the very able professors at that time collected at the capital.

Man, by reason of his weight and limited muscular force, seemed condemned to move forever on the surface of the earth, and only to be able to study the physical properties of the elevated regions of our atmosphere by painfully climbing to the summit of mountains; but what are the difficulties over which genius allied to perseverance cannot triumph?

A scientist, who was a member of this academy, Montgolfier, calculated that by rarefying, by means of heat, the air contained in a paper balloon of limited size, he would obtain an ascensional force sufficient to raise men, animals, and instruments of all kinds. This idea was partially realized, June 1783, in the town of Annonai. The astonished Parisian population saw, November 21, of that same year, the intrepid voyagers, Pilatre de Roziers and d'Arlandes, sail through the air, suspended from a montgolfière. Another physicist, whom the academy has also numbered among its members, Charles, showed the possibility of making balloons of a varnished material almost impermeable to hydrogen, the lightest of known gases, which could take the place of heated

air with advantage. From his voyage made December 1, 1783, in company with Robert the artist, in a balloon thus inflated, date ascensions infinitely less adventurous, and which in our day have become a pastime for idlers.

It is to the original Academy of Sciences we must likewise go back, if we wish to find one of the first scientifically useful ascensions made with hydrogen-gas balloons.

It seemed to result from the experiments made during an ascension by Robertson and Lhoest at Hamburg, July 18, 1803, and renewed at St. Petersburg, under the auspices of the Imperial Academy of that city, by the same Robertson and the Russian physicist, Saccharoff, June 30, 1804, that the magnetic force which directs the needle at the surface of the earth grew considerably weaker in proportion as they rose in the atmosphere. This fact, which confirmed the diminution of this same force that M. de Saussure supposed he had discovered in his celebrated journey to the Col du Géant, seemed to the principal members of the Institute, with good reason, to justify an especial experiment. This was confided to the physicists, Messrs. Biot and Gay-Lussac, both young, enterprising, and courageous. This last term may perhaps seem somewhat exaggerated to those who, in our day, have seen women, aping in their costumes winged butterflies, placed entirely outside of the car of the aerostat, rise from our public gardens, before the eyes of a wonder-struck crowd. But such would forget that now balloons are constructed with infinitely more care, and the means of safety have very much increased.

Our two physicists ascended from the garden of the Conservatoire des Arts et Metiers August 24, 1804, furnished with all the instruments necessary for investigation, but the small dimensions of their balloon did not allow them to exceed a height of 4,000 meters. At this elevation they endeavored, with the aid of the oscillations of a horizontal magnetic needle, to solve the problem which had been the chief object of their ascension, but the rotary motion of the balloon presented unforeseen and serious obstacles. They succeeded, however, in partly surmounting them, and they determined, in these aerial regions, the duration of five oscillations of the magnetic needle. It is known that this duration must increase when the magnetic force which brings back the needle to its natural position has decreased, and that this duration must be shorter, as the same directing force has increased. It is therefore a case entirely analogous to that of the oscillating pendulum, although the motion of the needle is performed in a horizontal direction. The consequences deduced from their experiments seem to me subject to difficulties, which I shall point out after giving an account of the ascension made a few days later by Gay-Lussac alone.

ASCENSION OF GAY-LUSSAC ALONE—CONSEQUENCES OF THE OBSERVATIONS MADE ON MAGNETISM AND TEMPERATURE—IMPORTANCE OF AERONAUTIC VOYAGES.

This ascension took place September 16, 1804, at forty minutes after nine in the morning. This time Gay-Lussac ascended to a height of 23,000 feet, 7,016 meters above the sea, the greatest well-authenticated height that man had then succeeded in attaining, and which, since that epoch, has been but once slightly exceeded by Messrs. Barrel and Bixio.

This second ascension has enriched physics with several important results, which I will endeavor to explain in a few words.

We find, for instance, that at the moment when Gay-Lussac's thermometer, at a height of 7,016 meters, indicated 9°.5 below the freezing point, that of the Observatory of Paris, in the shade, and with a northern exposure, stood at + 27°.75. Therefore 37° was the extent of the thermometrical scale to which Gay-Lussac found himself exposed during the interval from 10 o'clock in the morning till 3 in the afternoon. It was therefore no longer possible to attribute the perpetual snows existing on the summits of high mountains to any special action exerted by those rocky summits on the surrounding strata of air, as no considerable terrestrial elevation existed in the regions above which Gay-Lussac's balloon had successively passed.

Are these enormous variations of temperature connected in any way by a simple mathematical law with the changes of height?

By taking as exact the thermometrical observations, about which Gay-Lussac himself raises some doubts, on account of the rapidity of the ascensional motion of the balloon, and the time required by a thermometer to indicate exactly the temperature of the mediums into which it is immersed, we would arrive at this curious result, that the temperature would vary less for a given change of height near the earth than in the regions of the atmosphere of a mean elevation.

But I must remark that the ordinary manner of discussing aerostatic observations leads us into a vicious circle. The analytical formula, by means of which the successive heights of the balloon are calculated, absolutely supposes, in fact, an equal abatement of temperature in every region of the atmosphere for the same change of height. The observations of 1804, and those subsequently made, will only give results free from all objection when discussed according to the profound method for which we are indebted to our ingenious and illustrious associate M. Biot.

The difficulties might have been avoided if observers, furnished with theodolites, and distributed at proper distances, had determined trigonometrically by their combined observations the successive heights of the balloon. Scientists and academies desiring to enter anew upon

the scientific study of the physical constitution of our atmosphere will certainly not fail to take my suggestions into serious consideration.

The hygrometer of de Saussure gave indications, during the ascension of Gay-Lussac, of an irregular movement, but taking into account, at the same time, the degrees indicated by this instrument and the temperature of the strata in which it was observed, our associate found that the amount of humidity contained in the air continued to diminish with extreme rapidity.

It was already known at the time of this memorable ascension that air in all latitudes, and at a height very slightly above the level of the sea, contained about the same proportions of oxygen and azote. This resulted with proof from the experiments of Cavendish, Macarty, Berthollet and Davy. It had also been ascertained by the analyses of Theodore de Saussure, of air brought from the Col du Géant, that at the height of that mountain the air contains the same proportions of oxygen as that of the plain below.

The eudiometrical analyses of Gay-Lussac, made with the greatest care, of air collected at a height of 6,636 meters, established the fact that the air of those high regions was not only composed of oxygen and nitrogen, like that at the surface of the earth, but, moreover, that it did not contain an atom of hydrogen.

It is not necessary to insist here upon the importance of these results; they showed the vagueness of the explanations given then by meteorologists of shooting-stars and other atmospheric phenomena.

The following extract from Gay-Lussac's own narrative gives some clew to a true explanation of the discomfort experienced by the most robust travelers in climbing elevated peaks, such as Mont Blanc:

"On reaching the highest point of my ascension, 7,016 meters above the mean level of the sea," said the courageous physicist, "my respiration was sensibly affected, but I was far from feeling yet a discomfort sufficient to induce me to descend. My pulse and respiration were very much accelerated; breathing very rapidly in air of extreme dryness, I ought not to have been surprised that my throat was so dry that it was impossible to swallow bread."

Let us now pass on to the experiment which was the chief object of the two aerostatic voyages, undertaken under the auspices of the first class of the Institute. The question was, as I have previously said, to assure themselves whether, as announced, the magnetic attraction exerted by the earth on a magnetic needle decreases very rapidly with the height. Gay-Lussac succeeded, in this second ascension, in counting, in a given time, twice as many oscillations as in the first. The results must, therefore, furnish much greater exactness. He found that a needle which at the surface of the earth required 42°.2 to make ten oscillations, at a height of 4.808 meters above Paris made the same number of oscillations in only 42°.8. The result was 42°.5 at 5,631 meters, and 41°.7 at 6,884 meters. These numbers do not give much

regularity; it would have been necessary, as Gay-Lussac himself remarks, in order to deduce rigorous consequences, to combine them with the corresponding measurements of the inclination, which could not be effected.* Our friend, as M. Biot did, from the discussion of the numbers collected in the first ascension, drew from his observations the conclusion that magnetic attraction is constant at all accessible heights. This consequence was logical, at a period when it was not generally known that, in a given place and under given circumstances, the duration of the oscillations of a magnetic needle is influenced by its temperature, and that a decrement of the thermometer of 37° must produce the most remarkable changes. We see that owing to the imperfect state of the instruments, and of science in 1804, it was impossible to arrive at an exact solution of the problem in question. Moreover, it would be astonishing at the present time to hear that the problem had been solved.

No considerations of any nature would authorize throwing a veil over the gaps of science. This reflection especially concerns the works of men whose authority is incontestable and uncontested.

Gay-Lussac, after having finished all his investigations with the calmness and composure of a physicist seated in his laboratory, landed at forty-five minutes after three o'clock, between Rouen and Dieppe, forty leagues from Paris, near the hamlet of St. Gourgon, whose inhabitants executed with great readiness all the maneuvers directed by the aerial voyager in order that the car should avoid the shocks that would have placed the instruments in danger.

The dignity of this assembly and of the narrative should not, I think, prevent my relating a singular anecdote, for which I am indebted to my friend. Having reached a height of 7,000 meters Gay-Lussac was desirous to rise still higher, and for this purpose rid himself of every article not absolutely needed. Among these was a white wooden chair, which fell by chance into a bush near a young girl guarding some sheep. What was the astonishment of the shepherdess, as Florian might have said. The sky was pure, the balloon invisible. How explain the chair, if it came not from paradise? The only argument against this conjecture was the coarseness of the work; the workmen, said the skeptics, must be very unskillful above. The dispute was at this point when the journals, publishing the particulars of Gay-Lussac's voyage, put an end to it, and classed among natural effects what until then had seemed to them a miracle.

The ascensions of M. Biot and Gay-Lussac will live in the memory of men as the first which have been made with marked success for the solution of scientific questions.

The very remarkable meteorological phenomena of a fall of the ther-

*Gay-Lussac succeeded in observing the dip of the needle, only at a height of 4,000 metres. He found there, in round numbers, 30°. This result, supposing it to be exactly reported, differs immensely from the dip which takes place upon the earth.

mometer to 40° below freezing at a height of 7,049 meters, verified by M. Bixio and M. Barrel during an ascension, undertaken at their own expense, July 27, 1850, clearly prove that glorious discoveries are awaiting those who will follow in their footsteps, provided they have the necessary information and are furnished, as were these two physicists, with a collection of exact instruments. It is sincerely to be regretted that the ascensions, made almost every week, under circumstances more and more dangerous, and which, it may be painfully predicted, will end in some terrible catastrophe, have turned aside the friends of science from their projected voyages. I can imagine their scruples, but without sharing them. The spots on the sun, the mountains in the moon, the ring of Saturn and the belts of Jupiter have never ceased to be objects of investigation to astronomers, although now shown for ten centimes on the *terre-plein* of Pont-Neuf, at the foot of the column of the Place Vendome, and at different points of our boulevards. The public, now so discriminating and enlightened, would not confound those who daily expose their lives for lucre, with physicists, running the same risks to rob nature of some of its secrets.

ASSOCIATION OF GAY-LUSSAC WITH M. DE HUMBOLDT—WORK ON THE EUDIOMETER—TRAVELS IN ITALY AND GERMANY.

However slightly conversant with the literary history of the first half of this century, all have heard of the warm and profound friendship of M. de Humboldt for Gay-Lussac, and of the influence it exerted over the scientific career of the able chemist; but it is not so well known how it originated and was developed, and this deserves to be related.

Before starting on the memorable journey which has made America known to us under so many different aspects, M. de Humboldt prepared himself for it by diligent study. The object of one of his researches was the eudiometrical means in use to determine the constituent principles of air; this work, done in haste by an imperfect process, was somewhat inaccurate. Gay-Lussac perceived this and criticised the error with an alacrity that I would venture to condemn, if it were not rendered excusable by the author's youth. It is unnecessary to mention that Berthollet received M. de Humboldt on his return with the frank cordiality and well-bred politeness which characterized the illustrious chemist, and which is engraved in indelible characters on the minds and hearts of all who had the happiness of knowing him.

One day, M. de Humboldt remarked, among the company assembled in the salon of the country-seat of Arcueil, a tall young man of modest but dignified bearing. "This is," said some one to him, "Gay-Lussac, the physicst, who recently fearlessly ascended into the atmosphere to the greatest height yet reached by man, to solve important scientific questions." "This is," added Humboldt aside, "the author of the sharp criticisms on my eudiometrical work." But soon mastering the sentiment of resentment, naturally inspired by such a reflection on a high-spirited

nature, he approached Gay-Lussac, and, after some complimentary remarks on his ascension, extended his hand and affectionately offered his friendship. It was, with due allowance, the *Soyons amis, Cinna!* (Let us be friends!) of the tragedy, but without the mortifying reflections which, as Voltaire relates, were made by the Maréchal de la Feuillade, after having heard them for the first time. "Ah! Auguste, how you do spoil the *Soyons amis, Cinna!*" Such was the origin of an attachment that was never interrupted, and that soon bore the happiest fruits. We see in fact, immediately afterward, the two new friends executing conjointly an important eudiometrical work.

This work, read at the Academy of Sciences, the 1st Pluviôse, year XIII, had for its principal object an estimate of the exactness that could be arrived at in an analysis of air with Volta's eudiometer; but the authors at the same time touched upon a multitude of questions relating to the chemistry and physics of the earth, throwing great light upon them and making very ingenious conjectures. It is in this memoir that the remark is found (which has since received, at the hands of Gay-Lussac, developments so important) that oxygen and hydrogen, considered in volumes, unite to form water, in the definite proportion of 100 of oxygen and 200 of hydrogen.

Our scientific annals present a large number of memoirs published under the name of combined authors. This kind of association, much less common abroad, is not without its drawbacks. If we except the very rare case, of which however I could cite instances, where the part of each collaborator was clearly defined in the joint editorship, the public is obstinate in refusing an equal share to both associates. It frequently dismisses, as caprice dictates, the formulas, *we thought, we imagined*, on the very plausible pretext that the same idea cannot present itself at the same time to the minds of both associates. It refuses to one of them all intellectual initiative and reduces his share to the mechanical execution of the experiments.

These inconveniences of publishing in common, almost inherent in human nature, disappear when, by way of exception, one of the associates resolves not to indulge the public in its prejudiced and often malicious surmises, by unhesitatingly disclaiming any part belonging to the other. It was the good fortune of Gay-Lussac to meet with such a collaborator. Here is, in fact, what I read in a note by M. de Humboldt: "Let us insist upon the remark contained in this memoir, that 100 parts in volume of oxygen require 200 parts in volume of hydrogen gas for saturation. Berzelius has already reminded us that this phenomenon is the germ of what was discovered later about definite proportions, but the fact of complete saturation is due to the sagacity of Gay-Lussac alone. I co-operated in this part of the experiments, but he alone foresaw the importance of the result to the theory." A declaration so frank and loyal from this illustrious and venerable academician will astonish no one.

We will refer farther on to this very remarkable portion of Gay-Lussac's works. Gay-Lussac, assistant professor of the Fourcroy course, obtained, through the friendly intervention of Berthollet, leave for a year to accompany M. de Humboldt in his travels through Italy and Germany. The two friends, before leaving Paris, provided themselves with meteorological instruments, and especially apparatus suitable for determining the inclination of the magnetic needle and the intensity of the variable force which directs the magnetic needle in different latitudes. They left Paris March 12, 1805, and experimented with their instruments at Lyons, Chambéry, St. Jean de Maurienne, St. Michel, Lanslebourg, and Mont Cenis, &c. I will return elsewhere to the magnetic results of this journey in a memoir of our colleague inserted in the collection of the Society of Arcueil. Gay-Lussac had imbibed in his youth the meteorological theories of Deluc, some of which had almost captivated him, but in his passage over the Alps his ideas were entirely modified. He felt the need, for example, of having recourse to the action of ascending atmospheric currents to explain a large number of curious phenomena.

Nothing enlightens and enlarges the ideas more, with regard to natural phenomena, than traveling in mountainous regions, especially when so fortunate as to enjoy the society of as cultivated, ingenious, and experienced an observer as M. de Humboldt.

Gay-Lussac and his illustrious fellow-traveler, after visiting Genoa, went to Rome, where they arrived July 5, 1805, and alighted at the palace Tommati alla Trinita di Monte, the residence of William de Humboldt, chargé d'affaires of Prussia.

In the society of him who has so eloquently described it, the grand scenery of the Alpine regions could not fail to excite genuine enthusiasm in Gay-Lussac's soul. The sight of the immortal monuments of architecture, of the painting and sculpture with which Rome abounds, joined to the learned conversations of the Rauches, Thorwaldsens, &c., habitués of the Tommati Palace, awakened in the youthful traveler a taste for the fine arts, which until then had been latent. Finally he enjoyed the advantage of admiring the fascination of talent; for Madame de Staël then held every salon of the Eternal City under the spell of her eloquent and spirituel conversational powers. Gay-Lussac's sojourn in Rome was not without fruit to the science of chemistry. Thanks to the courtesy of Morrichini in placing a chemical laboratory at the disposal of the young traveler, he was able to announce, July 7, that fluoric acid existed with phosphoric acid in the bones of fishes. July 9, he finished the analysis of the alum rock of the Tolfa.

July 15, 1805, Messrs. de Humboldt and Gay-Lussac left Rome and started for Naples, accompanied by M. Léopold de Buch, who, though still young, had already distinguished himself by very valuable geological researches. Vesuvius, in a state of rest at that period, suddenly exhibited the most magnificent and terrible evolutions, (as if to celebrate

the welcome of the three illustrious observers;) eruptions of dust, torrents of lava, electrical phenomena, nothing was wanting.

Finally Gay-Lussac had the *good fortune*, (the expression is not mine; I borrow it from one of the fellow-travelers of the learned chemist)—he had the good fortune of being witness of one of the most frightful earthquakes ever experienced at Naples.

Gay-Lussac eagerly seized this opportunity of coping with the problem which, since Empedocles, had defied the sagacity of observers. We will soon give an account of the results collected by our friend in the six ascensions of Vesuvius which followed each other in quick succession.

The time not devoted by Gay-Lussac to the study of the burning volcano was employed in examining the collections of natural history, and especially of former volcanic eruptions, which are found in great numbers in Naples; our travelers had much reason to be gratified at the kind attentions and exquisite politeness of the Duke de la Torre and Colonel Pole; but such was not their experience with Dr. Thompson. When they presented themselves, accompanied by a Neapolitan scientist, to study his museum, he addressed them in these outrageous words: "Separate yourselves, gentlemen; I can keep my eyes on two, but not upon four." One feels tempted to ask from what society of lazzaroni had Dr. Thompson borrowed sentiments so low and language so indecent; but all is explained when we learn that Thompson was the physician, friend, and confidential agent of General Acton, the instigator of the political assassinations which defiled Naples at the close of the last century.

In his expeditions around Naples, by land and water, M. Gay-Lussac corrected some erroneous ideas, then generally entertained. He found, for example, that the air confined in sea-water contained, instead of 21 parts of oxygen, as ordinary air does, above 30 parts of oxygen for 100. He visited Monte Nuovo and Epomeo with M. de Buch. On seeing Monte Nuovo, Gay-Lussac fully adopted the opinion that M. de Buch was then beginning to disseminate in the scientific world, according to which mountains may suddenly spring out of the earth by means of upheavals.

Epomeo seemed to them to have the characteristics of an abortive volcano, without fire, or smoke, or crater of any kind.

After having finished their labors in Naples, our travelers returned to Rome, where they remained but a short time. On the 17th of September, 1805, Messrs. de Humboldt, de Buch, and Gay-Lussac quitted Rome to repair to Florence. They took the mountain road, in order to visit the celebrated baths of Nocera, near which Popes Clement XII and Benoit XIII had erected some real palaces, with all the necessary appliances for invalids, who, from June until September, brought plenty into the surrounding country.

There an important problem was presented. Morrichini had found, by chemical analysis, that air obtained from these waters contained 40

per cent. of oxygen—that is to say, about double the proportion of the same gas in atmospheric air, which seemed incredible. Gay-Lussac discovered in reality that the air procured from the water of the baths contained 30 per cent. of oxygen, as spring-water usually does. The salutary effects of the waters must therefore be sought elsewhere, as they were found so remarkably pure, no re-agent disturbed them. Is it this purity that renders them so efficacious?

In mythological times, heroes, celebrated by the Greek poets, roamed desert countries to battle with the brigands and wild beasts they sheltered. Our travelers, as we see, seemed in their turn to have assumed the mission of destroying by the way errors and prejudices, which often make more victims than the monsters of antiquity exterminated by Hercules, Theseus, Pirithöus, &c.

These scientists reached Florence September 22, and Fabbroni, superintendent of the museum, received them with the greatest distinction. He did the honors of the rich collection, at the head of which the Tuscan government had placed him, in a manner to prove how worthy he was of the confidence he enjoyed. Gay-Lussac took great delight in his society; he especially admired the knowledge and ability displayed by Fabbroni in pointing out the merits of the productions of Michel Angelo and of the illustrious painters and sculptors, successors of this great man. He was not so much charmed with the learned director when, on asking him the value of the inclination of the magnetic needle, Fabbroni replied that the beautiful instruments which adorned the laboratory of the grand duke had not been used for fear of tarnishing the metal. He did not enjoy either the reunions where Madame Fabbroni, celebrated for the elegance and beauty of her poetry, the center of a circle composed of the most distinguished society of Florence, was in the habit of directing against every topic in succession flashes of wit to which the individual addressed was obliged to reply at once and in his best manner. These theatrical customs have happily disappeared from among our neighbors to give place to conversations where each freely takes the part which suits his position and even his timidity.

On the way from Florence to Bologna, where our three travelers arrived safely September 28, they stopped at Piétra-Mala to study the perpetual flames previously examined by Volta.

At Bologna Gay-Lussac visited Count Zambeccari, who had lost six fingers by sliding along a rope to escape a catastrophe which was threatening him, the montgolfiérè in which he had ascended into the air having taken fire; his sufferings did not prevent his discussing with Gay-Lussac a plan he had formed, and which, at a later period, was to cost him his life—that of ascending again—but this time with a balloon filled with hydrogen gas which he could heat more or less at will, by means of a circle of lamps with a double draught of air. It will be seen that the unfortunate aerial traveler was contriving in his new scheme a method by which he would substitute the risks of explosion

for those of the conflagration of his first attempt. Our travelers remained but a short time in Bologna, whose university had then singularly declined from its ancient reputation. The professor of chemistry of this university, M. Pellegrini Savigny, had left no very favorable impression upon Gay-Lussac's mind; our colleague accused him of having degraded the science by inserting in his *Traité de Chimie* (Treatise upon Chemistry) methods of his own invention for preparing good sherbets and excellent soups for every day in the year.

Did not our friend indulge in some exaggeration in classing the subjects alluded to in the treatise of M. Pellegrini among those which a scientist, who has any self-respect, should abandon to professional charlatans? I will venture to say, in spite of my profound deference for Gay-Lussac's opinions, that he who should succeed in reducing to uniform and precise rules the preparation of our food, especially that of the poorer classes, would solve an important hygienic question. I am persuaded that some day posterity will manifest astonishment on learning that in the middle of the nineteenth century the alimentary regimen of the masses was abandoned to empirics, of both sexes, without education or intelligence.

Byron relates in his memoirs, that during Sir Humphry Davy's sojourn in Ravenna, a fashionable woman expressed the desire that the illustrious chemist should prepare for her a pomade to darken her eyebrows and make them grow. I would unreservedly share the contemptuous disdain with which our young friend would undoubtedly have received such a proposition as this. But there is, it seems to me, a wide difference between the pomade for the fashionable woman and formulas for improving the food of the people, and even that intended to satisfy the sensuality of the rich.

Messrs. de Humboldt, de Buch, and Gay-Lussac reached Milan October 1. Volta was then in that city, but they had great difficulty in finding him.

The civil and military administration of Milan, which would not have hesitated a moment if asked the address of a simple Hungarian or Croatian sublieutenant, of a contractor, or of any titled personage whatsoever, seemed utterly unmindful of Volta, that great man, the glory of Lombardy; whose name will be uttered with respect and admiration when the breath of time will have swept away even the slightest recollection of generations of his contemporaries.

Let us turn aside from these several anomalies, a thousand instances of which it would be easy to enumerate, and resume our narrative.

Our three young travelers learned in Milan that the scientific world was alive with the rumor of a pretended discovery by M. Configliachi. According to the Italian chemist, water was composed of muriatic acid and soda, elements that the battery decomposed without difficulty. Volta, consulted by our three travelers as to the merit of the observation, replied, "I have seen the experiment, but I do not believe in it."

It was in these terms the immortal physicist expressed the caution which should meet all extraordinary facts similar to the pretended phenomenon by which his pupil Configliachi hoped to attain a great reputation. The remark is peculiarly applicable to facts ascertained by instruments of a delicacy so extreme as to be influenced by the presence, breath, and emanations from the body of the observer. The Voltaic dictum, "I have seen it, but do not believe in it," might have been applied on some recent occasions; it would have saved science some retrograde steps, and certain authors unqualified ridicule.

On the 14th and 15th of October our travelers crossed Saint Gothard. Gay-Lussac was denied the enjoyment of a spectacle from which he had anticipated much pleasure and instruction, a thick fog concealing from view even the nearest objects for a whole day. He compensated himself for this disappointment by a minute study of General Pfiffer's fine relief of Switzerland.

At Gottingen, November 4, the great naturalist Blumenbach, at that time full of life and activity, cordially extended the honors of the university to our young countryman.

On the 16th of the same month Gay-Lussac arrived at Berlin, where he remained all winter under the roof of M. de Humboldt, kindly welcomed and appreciated by all the distinguished men of the city; he passed much of his time in the society of Klaproth, the chemist, and Erman, the physicist.

Gay-Lussac quitted Berlin in the spring of 1806. He very suddenly determined to leave on learning that the death of Brisson left a vacancy in the Institute, and that he might be chosen to fill the place of the aged physicist.

In examining now the works of Gay-Lussac's contemporaries who, in 1806, were in a position to contend with him for the vacancy in the Academy of Sciences, it seems astonishing that his presence should have been indispensable to his success; but it is that we forget that at the end of the eighteenth century and beginning of the nineteenth no one was a real physicist unless possessing a valuable collection of instruments well polished, well varnished, and arranged in glass cases. It was not without trouble that Gay-Lussac, who owned only a few instruments of research, succeeded in overcoming such prejudices. Let us preserve these memories for the consolation of those who have experienced, or may in the future experience, disappointments in academic elections.

GAY-LUSSAC'S RESEARCHES ON DILATATIONS.

A short time before Gay-Lussac, now a member of the institute, had begun to apply his experimental talent to the study of the changes of the elastic force of gases with the temperature, and the formation and diffusion of vapors, the same field of research had been explored in England by an equally clever man, Dalton, numbered by the academy among its eight foreign members. Dalton, although his genius was

not unknown to his countrymen, occupied in the small town of Kendal the very humble and somewhat unprofitable position of private tutor of mathematics, and had only at his command for his experiments imperfect instruments. There would then have been no impropriety in subjecting his results to careful verifications. Gay-Lussac was not acquainted with the works of the illustrious English physicist, as there was no mention of them in the full and instructive account of the experiments made by the physicists who had preceded him. Dalton had found that air expands 0.392 in the interval between 0° and 100° of the centigrade thermometer. Already, previously, as I had ascertained from a printed document, Volta had given for this expansion 0.38. Finally, in 1807, Gay-Lussac found it to be 0.375. This number was generally adopted up to a recent period, and employed by all the physicists of Europe.

According to the late determinations of Rudberg, and Messrs. Magnus and Regnault, there was an error of about $1\frac{1}{36}$ in the value of the dilatation of air given by Gay-Lussac; our colleague never objected to the number 0.3665 substituted by our fellow-laborer, M. Regnault, for the number 0.375 which he had given. But what could be the real cause of this difference? Gay-Lussac has never given any public explanation of this disagreement. Not anticipating the catastrophe which so suddenly removed him from us, I was guilty of the fault of not interrogating him directly upon this subject.

It would not be uninteresting, however, to investigate how so careful a physicist could allow himself to be drawn into such an error.

A German professor, celebrated for the importance of his discoveries, M. Chladni, visited Paris some years since. Smarting under the difficulties which he had encountered in all his investigations, he said in an impressive tone and petulant manner, never to be forgotten, for in their exaggeration they almost bordered upon the ridiculous: "When you desire to lift the smallest corner of the veil which envelopes nature, she invariably exclaims "No! No! No!" M. Chladni might have added that at the moment when it seems about to yield, it surrounds the observer with snares into which the most skillful fall without suspecting it.

What could be the causes of error in the experiments of Volta, Dalton, and Gay-Lussac that these illustrious physicists had not perceived? I have heard it said that the drop of mercury designed to intercept communication between the vessel in which the air was expanded and the external atmosphere, leaving a slight space and giving passage to a portion of the dilated air, was not displaced as much as it would have been without that; but this cause would evidently have given too small a co-efficient, and it was in the opposite direction, according to the recent observations, that the number upon which Gay-Lussac had decided was in fault. It was much more probable that the interior of the sides of the vessel in which the celebrated academician operated were not sufficiently dry; that the hygrometric vapor, adhering to the glass at low tem-

peratures, evaporated when the apparatus was submitted to high temperatures; that it increased, therefore, without any means of detecting it, the volume of the elastic fluid upon which they desired to operate. I point out this cause with the more confidence that it is now established that the glasses, according to their composition, and even according to their degree of annealing, are diversely hygrometrical; so that the degree of heat which would cause complete desiccation in one of these glasses would be insufficient when operating in another apparatus. Gay-Lussac had perfectly understood the effect that hygrometric vapor should produce, and he attributed to this cause the errors of his predecessors. Therefore, it was in following with a little more precaution in the paths traced by our friend that this error of $\frac{1}{36}$ imputed to him was discovered, an error which could do no real injury to the just and legitimate reputation for exactness which this learned physicist had acquired and which subsequent works so fully justified.

When Gay-Lussac was occupied with the numerical determination of the dilatation of elastic fluids by heat, our most skillful physicists thought that different gases have different co-efficients. Witness, for example, what Monge says, which I quote from his memoir on the composition of water: "Elastic fluids are not all equally dilatable by heat." Gay-Lussac found within the limits to which his experiments were confined that this was an error. Since then there has been a return to the first opinion. Indeed, it is almost a consequence of the fact verified by Davy, and especially by our colleague, M. Faraday, that gaseous bodies can be liquefied, and under pressures different for each one of them.

SOCIETY OF ARCUEIL—MEMOIRS ON MAGNETISM—LAWS OF GASEOUS COMBINATIONS—CATHETOMETER.

In 1807 Berthollet formed a private scientific society, composed of a small number of individuals and called the Society of Arcueil, after the commune, in the neighborhood of Paris, in which the country-seat of this illustrious chemist was situated. Gay-Lussac, as may be readily imagined, was one of the first members of the new society. Before proceeding further, let us say a few words about the criticisms to which this kind of dismemberment of the first class of the institute formerly gave rise. It was eminently flattering to young *débutants* in science to have as chief judges and counselors in their labors men of European celebrity, such as Laplace, Berthollet, Humboldt, &c.; but could it be asserted that preconceived ideas to which the cleverest minds more readily abandon themselves in an intimate reunion, so to speak, than before a promiscuous public, had not a tendency to arrest the spontaneity of genius and repress its researches below a conventional level? On the other side, might not the desire to give evidence of fertility of mind, in the presence of the most famous scientists, sometimes lead enthusiastic spirits to venture upon bold theories?

Whatever may be thought of these doubts, which I mention with

great hesitation, the independent and sober judgment of Gay-Lussac would have placed him beyond influences which would not have been called into play except under cover of eminent merit or fertility and of imagination. His publications in the three volumes of the memoirs of the Society of Arcueil deserve in every respect, from their variety, their novelty, and also their exactness, to occupy the most distinguished place in an impartial history of the sciences.

The first volume of the collection, published by the Society of Arcueil, begins by a memoir in which Gay-Lussac has combined the results of all the magnetic observations made in conjunction with M. de Humboldt, during the journey through France, Italy, and Germany, of which we have already spoken at length. This branch of the science has for some years been making very considerable progress, and yet we can confidently recommend to physicists those pages on which Gay-Lussac has examined all the causes of error which may affect the measurements of inclination and intensity, and the precautions to be taken to avoid them. We know now that the horizontal force which directs the magnetic needle is subject to a diurnal variation which depends in part, but only in part, upon a corresponding variation in the inclination. We have likewise learned that in a given place and at a given time the duration of the oscillations of a needle depends upon its temperature. It would therefore be now necessary, if a magnetic voyage were undertaken, to take into account all of these disturbing causes; but, and we can say it without flattery, at the period when it was published, the work of Messrs. de Humboldt and Gay-Lassac was a model.

If we cast our eyes over the second volume of the Memoirs of Arcueil, we will find there, among other clever works of interest—a *Memoire sur la Combinaison des Substances Gazeuses entre elles*, "Memoir on the combination of gaseous bodies with each other." This memoir contains results so remarkable, so important, that they are habitually called the laws of Gay-Lussac. It would now be very difficult for me to give a detailed and perfectly accurate account of the atomic theory. This sketch should, I think, go back as far as Higgins, an Irish chemist, whose work, published in 1789, is only known to me through very short quotations by Humphry Davy. Then come the researches of Dalton in 1802. It is a matter of certainty that the law of volumes was demonstrated experimentally by our associate in 1808, without any knowledge on his part of the first more or less systematic investigations of his predecessors.

The laws to which we have alluded may be announced in these terms:

Gases, in acting upon each other, combine in volume in the simplest ratios; such as 1 to 1, 1 to 2, or 2 to 3. Not only do they only unite in these proportions, but again, the apparent contraction of volume which sometimes occurs by the combination bears also a simple ratio to the volume of one of the combined gases. Gay-Lussac, later, had the boldness to deduce from his laws the density of the vapors of several solid

bodies, such as carbon, mercury, and iodine, integral parts of certain gaseous combinations. This boldness, as proved by subsequent experiments, was crowned with perfect success.

Recently it was thought possible to deduce from the unequal dilatation of different gases by heat the proof that the law of volumes is not mathematically exact. Let us suppose, the learned critics say implicitly, that two gases combine in equal volume and at a fixed temperature—for example, that of 20° centigrade—and that the combination is made molecule by molecule let us carry to 40° the temperature of the two gases. If at 20° equal volumes contain the same number of elementary particles, such would not be the case at 40°. There will then be unequal volumes which will enter into combination, supposing that the union must always be effected molecule by molecule. It will be seen that the criticism implies the absolute truth of the atomic theory of combination, which, by the way, may seem not so firmly established as the law of Gay-Lussac. Besides, would not that have been a very singular coincidence which should have led our colleague to operate precisely at the temperatures at which this law should be rigidly exact?

Let us remark, in point of fact, that in the study of nature it has rarely happened that experiment has led, through some light deviations, to simple laws, unless these laws have become the definite regulators of the phenomena. The system of the earth offers a striking example of this truth. The laws of the elliptical movement of the planets are only exact by disregarding the irregularities known under the name of perturbations, and which place each planet sometimes in advance, sometimes behind the position assigned to it by the immortal laws of Kepler.

If it is ever established by direct experiments that the principles laid down by Gay-Lussac are not confirmed when the temperatures come to vary, it will be the time to investigate whether there be not a natural cause to which these perturbations may be attributed.

In the limited compass assigned me I could only present simple doubts on the nice question I have ventured to broach; at all events, the assimilation which they have suggested to me seems of a nature to satisfy the most enthusiastic partisans of the scientific glory of Gay-Lussac. When Laplace, looking at capillary phenomena in a new light, desired to compare the results of his skillful calculations with those of observation, and when he wished the subject to have the final seal of experiment, he applied to Gay-Lussac. The latter fully responded to the confidence of the immortal geometer. I should add that the instrument which he invented is of small dimensions—the same, under the name of cathetometer, now so generally in use among physicists. I leave to those who consider they have the right, the responsibility of laying claim to priority in the use of the word cathetometer now generally adopted; but the instrument in principle and even in form will not the less remain one of the valuable inventions with which our colleague has endowed science.

WORKS ACCOMPLISHED BY MEANS OF THE BATTERY OF THE POLYTECHNIC SCHOOL.

We have now reached the period when, treading in the path so successfully opened by Nicholson and Carlisle and followed by Berzelius and Hisinger, Sir Humphry Davy succeeded, by means of the battery, in transforming potash and soda into metals which could be kneaded with the fingers, like wax; which float on the surface of water, because lighter than it, and which ignite spontaneously in this liquid, diffusing the brightest light.

The announcement of this brilliant discovery, at the close of 1807, created a profound sensation in the scientific world. The Emperor Napoleon took part in it, and placed at the disposal of the Polytechnic School the fund necessary for the erection of a colossal battery. While this powerful instrument was being constructed, Messrs. Gay-Lussac and Thénard, to whom it was to be confided, conceiving that ordinary affinity, well directed, would suffice for the production of potassium and sodium, attempted various very dangerous experiments, and succeeded beyond their expectations. Their discovery was published March 7, 1808. From this time the two new metals, which were only obtained in very small quantities by the battery, could be produced in great abundance, and thus became the usual instrument of chemical analysis.

As may be easily imagined our two celebrated countrymen did not allow the means of investigation they had just so skillfully prepared to remain idle in their hands. They placed the potassium and sodium in contact with nearly all known chemical substances, and noticed, during the experiment, the reactions most fertile in theoretical consequences. We will content ourselves by citing here the decomposition of the acid formerly known as boracic, and the discovery of its radical, called by its discoverers *boron*. We must likewise rank very high in their investigations the very difficult and varied experiments by which they determined the actions exerted by the two new metals on ammonia; the results of their work on fluoric acid, now called fluohydric, and the discovery of the new gas which they named fluoboric. Following the chain of their researches, the two illustrious chemists were led to attempt the analysis of the substance then denominated oxygenated muriatic acid; they made known the results of their numerous experiments February 27, 1809. Their communication finished with this paragraph, which I transcribe literally: "According to the facts reported in this memoir, it might be supposed that this gas (oxygenated muriatic acid gas) is a simple body. The phenomena which it presents are sufficiently well explained in this hypothesis; we do not seek, however, to vindicate it, because it seems to us that they are explained still better by regarding oxygenated muriatic acid gas as a compound body." They made by this declaration a large concession in favor of the prevailing opinions of the Society of Arcueil; to those supported with

great warmth by Laplace and Berthollet. Sir Humphry Davy, who was in no wise constrained by personal considerations, maintained that the first interpretation alone was admissible; he regarded oxygenated muriatic acid as a simple body, that Amperè proposed to call *chlorine;* common muriatic acid became then the combination of this radical with hydrogen, under the name of hydrochloric, or chlorohydric acid. This manner of interpreting facts is now generally adopted.

It is seen by this example that there are cases where the counsels of genius, when they assume the imperious character that counsels should never have, may sometimes lead the soundest minds astray from truth.

When the colossal battery constructed with the funds granted the Polytechnic School by Napoleon was finished, Messrs. Gay-Lussac and Thénard were eager to study its effects, but less energy was shown than was expected. So after various trials, without striking results the two illustrious chemists confined themselves to laying down general principles on the mode of action of these apparatus when they exceed the usual dimensions. We find in their work a chapter in which they examined the different causes which create a variation in the energy of the galvanic battery, in which they give the means of measuring its effects, and in which they study the influence exerted by the liquid contained in the troughs, according to its nature and the variations of intensity which may depend upon the number and surface of the plates employed.

ANALYSIS OF ORGANIC MATTER.

The analysis of animal and vegetable substances for some years has received immense developments and led to the most important results. This progress of the science is chiefly due to a method invented by Gay-Lussac to effect organic analyses, and which has been adopted by all chemists. Our colleague burned the substance to be analyzed with the binoxide of copper. This process was a great improvement upon the one he used with his associate and friend M. Thénard, in which combustion was effected by means of oxymuriate of potash, now known as chlorate of potash.

RESEARCHES ON IODINE.

M. Courtois, a manufacturer of saltpeter in Paris, discovered, about the middle of 1811, in the ashes of varec a solid substance which corroded his boilers, and which since, at the suggestion of Gay-Lussac, has been called *iodine*, from the extremely remarkable violet color of its vapor. M. Courtois sent samples of this substance soon after its discovery to Messrs. Desormes and Clément, who made it the subject of experiment. M. Clément did not make public M. Courtois's discovery, and the results he had obtained conjointly with M. Desormes, until the meeting of the first class of the institute, December 6, 1813. Sir Humphry Davy, who, on account of his scientific genius, had obtained from the Emperor especial permission to pass through France, was then in Paris.

He received from M. Clément, a short time after his arrival, numerous samples of the mysterious substance. M. Gay-Lussac learned this, and saw at a glance what mortifying criticisms affecting the honor of our experimentalists and academies might arise from resigning the priority, the result of chance and thoughtlessness, to the investigations of a foreign chemist. He went immediately to rue du Regardà, to the poor workman, obtained a small amount of the matter discovered by him, set himself to the task, and produced in a few days a work equally remarkable for the variety, the importance, and the novelty of the results. The iodine, under the searching eye of our colleague, became a simple body, furnishing a peculiar acid by combining with hydrogen, and a second acid by uniting with oxygen. The first of these acids proved, by a new example, that oxygen was not the only acidifying principle, as was believed for a long time. This work of Gay-Lussac upon iodine was subsequently completed; and there are found in a very long and beautiful memoir, read August 1, 1814, and published among those of the academy, the varied results of the investigations of our colleague.

Every chemist who has read this work admires in it the fertility of the author in varying experiments, and the soundness of judgment which always guides him when necessary to interpret them and draw from them general consequences. In several chapters of this very remarkable work the author dwells especially upon the analogy which he establishes between chlorine, iodine, and sulphur, which throws great light upon several branches of the science then involved in obscurity.

DISCOVERY OF CYANOGEN.

Prussian blue, a substance known to manufacturers and painters, had been the subject of the researches of a large number of scientists, among whom we will chiefly cite the academician Macquer, Guyton de Morveau, Bergman, Scheele, Berthollet, Proust, and M. Porrett.

Guy-Lussac, in his turn, entered the lists. His results are recorded in a memoir which was read before the first class of the Institute September 18, 1815. From this moment everything doubtful became a certainty; light succeeded obscurity. This memoir, one of the most beautiful of which science can boast, revealed a multitude of new facts of immense interest to chemical theories. Those who will read it with care will see at the cost of what fatigue, with what precautions, what sobriety in the deductions, what soundness of judgment, an observer succeeds in avoiding false steps, and bequeathing to his successors a definitive work; I mean a work which subsequent investigations will not essentially modify.

In that admirable memoir, the author first gives an exact analysis of the acid which enters into the composition of Prussian blue, and which was called by Guyton de Morveau prussic acid, but which was never obtained, until the work of our friend, in a state of purity, but mixed only with water. He then showed how he succeeded in separating the

radical from prussic acid, which has since been denominated cyanogen. He established the fact that cyanogen is a compound of azote and carbon; that prussic acid is definitively formed from hydrogen and this radical; and that it should take the name of hydrocyanic acid, for which chemists now often substitute that of cyanhydric acid. He points out with the greatest care its reactions on a great number of substances, simple or compound, solid or gaseous. He makes known the combination of cyanogen with chlorine, which should naturally bear the name of chloro-cyanic acid. In brief, in this work Gay-Lussac filled a gap in chemistry by showing that there exists a combination of azote and carbon. He proved that cyanogen, although a compound, plays the part of a simple body in its combinations with hydrogen and metals, which, at the period when our colleague wrote, was the sole example in the science. I have said that, to establish results so grand, Gay-Lussac displayed indefatigable perseverance. If proof of it is wanted, I will mention, for instance, that, wishing to know what modifications electricity could produce in a mixture of two gases, he passed into it at least fifty thousand sparks.

We read with great regret, in the memoir of our colleague, the following paragraph: "I had indulged the hope, in devoting myself to these researches, of being able to throw some light on all the combinations of hydrocyanic acid; but the duties I have to perform have forced me to interrupt them before they had reached the degree of perfection to which I expected to bring them." What were these duties which, in 1815, hindered Gay-Lussac from completing this work of genius? It was—and I mention it with regret—the necessity of providing for his family, by giving public lectures almost daily, which consumed the time our friend had wished to devote more usefully to the advancement of science.

Cyanogen, one of the constituent principles of Prussian blue, furnishes, by combining with hydrogen, a poison so subtile that a celebrated physiologist, the first to use it in experiments on living animals, exclaimed, on seeing its effects, "Henceforth one may believe all that antiquity has said of Locusta." The same learned academician has proved by his experiments that in the poisoned animals no lesion in the organs essential to life is seen.

This action of the liquid obtained for the first time by Gay-Lussac will appear the more mysterious from the fact that it is produced by a substance composed of azote, one of the constituent principles of atmospheric air, of hydrogen, one of the constituent principles of water, and carbon, whose innocuousness is proverbial. One more reflection, and I have done with this article. Chemists never fail, when they discover a new product, to describe its taste. Who does not think with horror that if he had not departed from the usual custom, if he had placed one single drop of this liquid on his tongue, our friend would have fallen

instantaneously, as if struck by a thunderbolt. The odor of bitter almonds which is exhaled, it is said, by the dead bodies of animals that have perished from the effects of hydrocyanic acid, would then have given no clue to the cause of this national catastrophe.

SIPHON BAROMETER—MANNER IN WHICH CLOUDS ARE SUSPENDED—STORM-CLOUDS—DIFFUSION OF GASES AND VAPORS—CENTRAL HEAT OF THE GLOBE.

Gay-Lussac published, in 1816, the description of a portable siphon barometer, now so widely spread, especially since the improvements made in it by the artist Bunten.

This is not the only service rendered to meteorology by our friend. In a note inserted, in 1822, in the twenty-first volume of the *Annales de Chimie et de Physique*, (Annals of Chemistry and Physics,) he has explained his views on the manner in which clouds are suspended. On looking at the ascensional motion that the ascending atmospheric current gives to soap-bubbles, evidently heavier than the air, he thought he might attribute the suspension of vesicular molecules to this same current, at much more considerable elevations.

Before this epoch, in 1818, in a letter addressed to M. de Humboldt, Gay-Lussac had investigated the causes of the formation of storm-clouds. According to him, the electricity constantly diffused in the air suffices to explain the phenomena presented by this kind of cloud. When the storm-clouds are of great density, they possess the properties of solid bodies; the electricity originally disseminated in their masses rises to the surface where it has considerable tension, by virtue of which it can overcome, at times, the pressure of the air and dart forth in long flashes, either from one cloud to another, or over the surface of the earth. It will be seen how greatly these views differ from those of Volta, the master of everything connected with electricity. Whatever be the opinion pronounced upon the rival theories, it must be acknowledged that in the discussion of what Gay-Lussac calls his conjectures, he has shown himself a very skillful logician and perfectly familiar with the most subtile properties of the electric principle.

Among the researches of our friend, designed to throw light upon the nicest points of meteorology, we must also mention those which concern vaporization and the dissemination of vapors, either on empty spaces or in spaces containing aeriform fluids.

I perceive that I shall scarcely be able to say even a few words about Gay-Lussac's views with regard to volcanic phenomena. These opinions were published in 1823, under the title of *Réflexions*, in a memoir inserted in the twenty-second volume of the *Annales de Chimie et de Physique*. The author does not believe that the central heat of the earth, if that heat exist, contributes at all to the production of volcanic phenomena. These phenomena, according to him, are owing to the action of water, probably

sea-water, on combustible substances. According to this hypothesis, the torrents of gaseous matter which issue from the craters of volcanoes should contain a great deal of hydrogen and hydrochloric acid. The manner in which the author explains the absence of hydrogen in these aeriform emanations, and the processes which he points out to such men as Montecelli, Cavelli, and other scientific observers, suitably placed to ascertain the existence of hydrochloric acid, must be sought in the original memoir. I do not think that this memoir, in spite of its ingenuity, has solved the so much controverted question of volcanic phenomena. But I will in this case simply imitate the reserve of Gay-Lussac, who modestly said in beginning his memoir, "I do not possess the extent of information (in geology) required to treat such a subject. I shall merely skim lightly over its surface."

SERVICES RENDERED TO THE INDUSTRIES BY GAY-LUSSAC—ALCOHOLMETER—ALKALIMETER—MANUFACTURE OF SULPHURIC ACID—ASSAY OF GOLD AND SILVER BULLION.

According to the logical and unavoidable consequences deduced from the language of certain biographers, whose merits, in other respects, it gives me pleasure to acknowledge, the young man who devotes himself to science, particularly when brilliant success has marked his first steps, surrenders by so doing his personal freedom. In fact, they not only sometimes examine what those whose history they are writing have done, but claim to be able to determine what they should have done, at a period, too, when for want of inspiration they have felt, for the sake of their dignity and fame, the need of rest. In this examination they disregard the fatigue induced by age, the infirmities resulting from it, and family obligations, all as sacred to the man whose life is given up to study as to any other citizen.

Gay-Lussac has not escaped the consequences of this somewhat censurable manner of criticising. It has pleased some to divide the career of our colleague into two distinct phases: the first devoted to the speculative study of natural phenomena, the second entirely confined to the applications from which he was to realize substantial benefits.

In this second phase, which they claim fades into insignificance, if it is not diminished in importance by comparison with the first, Gay-Lussac, enjoying the favor of the government, was selected in succession to aid by his scientific knowledge in the manufacture of gunpowder; to act as adviser in the administration of the excise; to manage the assay office become vacant by the death of Vauquelin, &c.

The invention of new processes, characterized by exactness, simplicity, and elegance, proves what a slave Gay-Lussac was to his duties, and that the government could not have bestowed its confidence more judiciously.

The academy, called upon to pronounce upon the merits of the

alcoholmeter in every-day use, with our colleague, adopted, June 3, 1822, a report, concluding as follows:

"It is obvious, in brief, that M. Gay-Lussac has treated the subject of areometry under every aspect, and with his accustomed skill. The tables he has deduced after a tedious toil of more than six months, will be a valuable acquisition to the industries and sciences; the authorities will find in them also, as he hoped, the means of improving and simplifying the collection of taxes, and the safest guide they can follow."

As fertile in the invention of industrial methods as in the discovery of scientific truths, one after the other, as if by enchantment, Gay-Lussac created chlorometry, invented methods for determining the richness of the alkalies of commerce, contrived ingenious means by which the manufacture of sulphuric acid has become less expensive, and has no longer need to be brought from unfrequented places; and he crowned this series of important works by the discovery of a process which has been substituted in all civilized countries for cupellation, an ancient and defective method for analyzing alloys of silver and copper. Truly, I ask myself, with what theoretical speculations could Gay-Lussac have better filled the second phase of his career, since phase there is, than by producing works which to their scientific merits add the advantage of being susceptible of positive and multiplied applications, which serve as safe guides to the natural industries and to enlighten the public authorities?

To pretend to confine men of genius to the path of pure abstraction, and to forbid discoveries which may be useful to the human race, would be to yield to the most erroneous ideas, in my opinion. And besides, do you wish to know to what you expose yourself when you decide, according to preconceived ideas, what a scientist could do, or should have done?

Gay-Lussac, in your opinion, was in the enjoyment of excellent health, and should have been able, as a septuagenarian, to manifest the ardor, activity, and fertility of intellect of his youth, and a cruel event has proved to you that he bore in his bosom the germ of the disease which carried him off so unexpectedly to scientific Europe.

You thought him entirely absorbed in conducting his business affairs, and at that very time he was constructing, at great expense, in his country-seat, a laboratory which might serve as a model for those chemists who, for themselves or for the public, may have to direct the construction of establishments of the same kind.

Our colleague was represented as exclusively preoccupied with the lucrative applications of science, at a period when, concentrating his faculties to meditate upon numerous and different theories, he was writing the first chapters of a work, which unfortunately he did not finish, entitled *Philosophie Chimique*, (Chemical Philosophy.)

I hope, after these few words, the biographers whose opinions have rendered this digression necessary, will feel, on such occasions, the ne-

cessity of confining their explanations simply to the scientific productions which have been submitted to the public, and of remaining silent about those with which, according to their judgment, the scientist should have enriched the world. It is almost preaching ingratitude to posterity.

I should add that the illustrious savants, whose opinions on a special point I have thought it my duty to combat, would likewise like to limit these biographies to purely technical analysis; they would discard everything which concerns the sentiments of the man and the citizen. They allege that details of private life (they call them anecdotes, with a desire to stigmatize them with absolute censure) ought not to be preserved in our academic archives. When, without pretending to show, as might reasonably be done, any comparison between the productions of the early secretaries and my own humble biographies, I reminded these aristarchs of the very interesting portraitures contained in the admirable eulogies of Fontenelle and Condorcet, they replied that everything is good in its time, that the progress of knowledge has rendered the modifications they demand indispensable. I do not share these opinions, notwithstanding the respect due the savants who commend them.

I regard as an essential part of the mission I have to fulfill an investigation into whether the associates whom we have had the misfortune to lose have caused the worship of science and that of integrity to keep pace with each other; whether they have, as the poet expresses it, allied fine talents to a fine character. Nevertheless, in such matters the public is the only competent judge; I will wait until it has made known its sovereign decision, and unreservedly yield obedience to it.

GAY-LUSSAC AS PROFESSOR—HIS LABORATORY—HIS WOUNDS—SIMPLICITY OF HIS MANNERS.

I am going, therefore, without further explanation, to take the liberty of introducing you into those amphitheaters where our colleague delighted with his eloquence a large and brilliant audience. We will then pass into his laboratory; I will even collect various anecdotes, (you see I do not hesitate to use the word,) from which an estimate may be formed, from a new point of view, of the full extent of the loss which the academy has sustained.

In a discussion among the learned to decide whether a treatise on the world was or was not by Aristotle, Daniel Heinsius decided in the negative, and the following is his principal argument: "The treatise in question presents none of that majestic obscurity which, in the works of Aristotle, repels the ignorant."

Gay-Lussac would assuredly never have obtained encomiums from the Dutch philologist, for he always approached his object by paths the most direct, the most distinct, and with the least parade.

Gay-Lussac, on all occasions, showed his profound dislike for those ostentatious phrases into which his first titular professor, notwithstand-

ing his well-merited celebrity, often allowed himself to be drawn, and in which the most pompous words were found side by side with such technical expressions as ammonia, azote, carbon. His language and style were grave, correct, nervous, always perfectly adapted to the subject and characterized by the mathematical spirit which he had imbibed in his youth at the Polytechnic School. He had the power, as others had, of exciting astonishment in his audience by presenting himself before it without any manuscript notes in his hand; but he would have run the risk of using erroneous figures, and exactness was a merit which touched him most nearly.

Gay-Lussac's knowledge of the foreign languages, Italian, English, and German, enabled him to enrich his lectures with erudition of the purest kind, and drawn from the original sources. He it is who has initiated our own chemists and physicists into several theories originating on the right bank of the Rhine. In brief, Gay-Lussac, who has not been surpassed by any contemporary chemist in the importance, novelty, and brilliancy of his discoveries, has also indisputably occupied the first rank among the professors of the capital upon whom devolved the task of teaching the sciences at the Polytechnic School.

On entering Gay-Lussac's laboratory every one was struck, at the first glance, with the intelligent order which reigned everywhere. The machines and different utensils, for the most part prepared by his own hands, were remarkable for the most careful conception and execution. You will pardon me these details, gentlemen. If, as Buffon has said, "Style makes the man," we might add with not less reason that the great chemist and good physicist are recognized by the condition of the apparatus which they use. Imperfections in the operation are always more or less reflected by the results.

When the chemist operates upon new substances and combinations with unknown reactions, he is exposed to real and almost inevitable dangers. Gay-Lussac realized this but too truly. During his long and glorious scientific campaigns, he was seriously wounded on several different occasions; the first time, June 3, 1808, by potassium, prepared in large quantities by a new method. Messrs. de Humboldt and Thénard led our friend with his eyes bandaged from the laboratory of the Polytechnic School, where the accident occurred, to his house rue des Poules, which, by the way, it would be well to call rue Gay-Lussac. In spite of the prompt attention of Dupuytren, he lost the lachrymal glands and thought himself perfectly blind for a month. This disheartening prospect for a man of thirty was borne by our friend with a calmness and serenity that the stoics of antiquity might have admired.

"For nearly a year," said Madame Gay-Lussac, (in a note she had the goodness to send me,) "the reflection from a small night-lamp before which I placed myself to read to him, was the only light he could endure. During the rest of his life his eyes remained red and weak."

The last explosion of which Gay-Lussac was the victim, took place at a period of his life when misinformed individuals declared him to be

idle. Our friend was busy with the study of the carbureted hydrogens proceeding from the distillation of oils. The glass balloon containing the gases, and which had been set aside for several days, was taken by M. Larivière, a young chemist, to be submitted to Gay-Lussac's inspection. While our colleague was absorbed in the minute examination necessary to give the projected experiments the desirable precision, a frightful explosion took place, the cause of which, even to this day, is not perfectly understood, which completely shattered the balloon. Such was the velocity of the fragments of glass, that they made on the window-panes of the laboratory clear holes without the trace of a fissure, as if by projectiles from fire-arms. Gay-Lussac's eyes, which were but a few centimeters (not more than an inch) from the balloon, this time escaped all injury; but one of his hands was seriously wounded, and required long and painful treatment. Some persons saw in this terrible wound the original cause of the painful disease to which our friend succumbed a few years afterward.

The members of the academy, who went daily to visit him on his bed of suffering, heard him with emotion congratulate himself that the wounds of his young friend and assistant, M. Larivière, were insignificant, and on this occasion his own life alone had been endangered.

Some have desired to regard these accidents as the consequences of negligence and thoughtlessness; say, rather, by a comparison whose appropriateness will be recognized by all who know our friend, that if he were often wounded it was because he was often under fire, and that he did not hesitate to examine things very closely, even when there was great danger in doing so. It has been thought the successes of Gay-Lussac in his scientific researches only afforded him that calm satisfaction which the discovery of some new truths must naturally produce. Appearances were deceitful. To protect himself from the dampness of the laboratory, which was on the ground floor, Gay-Lussac usually wore sabots over his shoes. Pelouze, one of his favorite pupils, told me that after the success of an important experiment he had frequently seen him through the half-open door of his study give signs of the liveliest pleasure, and even dance in spite of his clumsy wooden shoes.

This reminds me of an anecdote which I will borrow from my friend Sir David Brewster, simply, I confess, that it affords me the opportunity of connecting the name of Gay-Lussac with that of the immortal scientist of whom Voltaire, without being charged with exaggeration, has said:

> Confidants of the Supreme, creatures of immortal life,
> Ye who burn with fire divine, and your wings with glory rife,
> Spread around your Master's throne, can you, from your stations high,
> View great Newton here below undisturbed by jealousy?
>
> Confidents du Très-Haut, substances éternelles,
> Qui brûlez de ses feux, qui couvrez de vos ailes
> Le trône où votre maître est assis parmi vous,
> Parlez: du grand Newton n'êtiez-vous point jaloux?

In 1682 the great Newton, turning into account the dimensions of the earth, obtained by Picard, of this academy, renewed a calculation

which he had before attempted, but without success, according to the former determinations of Norwood. His object was to ascertain whether the force which retains the moon in its orbit and prevents its escaping in a tangent by virtue of the centrifugal force, was not the same as that which causes bodies to fall at the surface of the earth, diminished only in the ratio of the square of the distances measured from the center of our globe. This time the numerical calculation justified the anticipations. The great man experienced such delight, this coincidence produced so much nervous excitement, that he was incapable of verifying his numerical calculation, as simple as it was, and found himself obliged, for the purpose, to have recourse to a friend.

Let us not omit, when the opportunity occurs, to show that calm scientific labors afford not only more durable emotions than those derived from the frivolities of the world, but that they are often accompanied by the same vivacity.

There was in Gay-Lussac's laboratory, by the side of furnaces, retorts, and apparatus of every kind, a small white wooden table, on which our friend recorded the results of his experiments as they progressed. It was, if I may be allowed the comparison, the exact bulletin written during battle. It was on this little table that were also traced the articles concerning different points of doctrine or questions of priority.

It would be impossible, in relating the life of a man whose chief works date back to the beginning of this century, the period of an entire renovation in chemistry, that we should not have to mention discussions of this kind. These scientific polemics took place especially between Gay-Lussae, Dalton, Davy, Berzelius, &c. You see our friend dealt with doughty antagonists, with adversaries worthy of him. In these discussions our old friend marched straight forward, regardless of any one, with the vigor, let us say more, with the dryness, of a mathematical demonstration. Rarely do we find in them phrases like the balm applied to freshly-made wounds. But how is it that no one has remarked that Gay-Lussac treated himself with a want of ceremony quite equal to that which he used toward others?

The following lines are quoted literally from one of his writings: "The results that I have given," said he, in the Memoirs of Arcueil, "of the different combinations of azote and oxygen are not exact."

Should not he who criticises his own works so frankly be excusable for being so exclusively preoccupied with the interests of truth in examining the works of others?

MARRIAGE OF GAY-LUSSAC—HIS LOVE FOR HIS NATIVE LAND—UNCHANGEABLE DEVOTION TO HIS FRIENDS—HIS NOMINATION TO THE PEERAGE.

Those who only knew Gay-Lussac slightly, fancy there could have been no romance in his private life. Perhaps they will change their opinion after hearing this recital.

There was, in Auxerre, at the beginning of our first revolution, a musical artist who was attached to the four large societies and to the college of that city. The suppression of these establishments, in 1791, brought great pecuniary troubles upon this respectable family. The artist did not, however, lose courage, and devoted the small fortune of his wife to the education of his three daughters, whom he wished to fit for the honorable position of governess. But the eldest of these young girls, Josephine, becoming aware of the narrowness of the means of her parents, and of the sacrifices they would have to endure before attaining their object, earnestly begged to be placed in a mercantile establishment in Paris, to remain there until the ages of her sisters and their education should enable them to realize the hopes entertained for them by their parents.

It was at a linen-draper's, the usual refuge of women of all conditions and ages, whose lives had been disturbed by revolutions, where Josephine had placed herself, that Gay-Lussac made her acquaintance. He saw, with curiosity, a young girl of seventeen seated behind the counter holding in her hand a small book which seemed to fix her attention deeply. "What are you reading, miss?" he said. "A work, perhaps, beyond my comprehension; it interests me, however, much—a treatise on chemistry." This singularity excited the interest of our young friend; from that moment the unusual necessity for linen ware brought him constantly to the draper's, where he entered repeatedly into conversation with the young reader of the chemical treatise; he loved her and was loved in return, and obtained from her a promise of marriage. Our illustrious colleague, as a future marriage dower, placed Josephine in a boarding-school to complete her education, and especially to learn English and Italian. Some time after she became his wife. I would not venture to advise this rash fashion of choosing a wife, although our celebrated chemist perfectly succeeded in it.

Beautiful, sparkling with wit, brilliant, and admired in society, for which nevertheless she cared but little, for the grace and distinction of her manners, Madame Gay-Lussac constituted for more than forty years the happiness of her husband.

From the beginning, they adopted the amicable custom, the consequence of some slight mutual concession, of merging their thoughts, desires, or sentiments into one thought, one desire, one sentiment common to both. This identification in everything was such that they ended by so entirely having the same handwriting that an amateur of autographs might readily believe that a memoir copied by Madame Gay-Lussac had been written by the celebrated academician.

Three days before his death, touched by the infinite solicitude lavished upon him, Gay-Lussac said to his wife, "We will love each other to the last; the sincerity of attachments is the only happiness." This tender, affectionate language will not spoil the portrait I have desired to draw of our colleague.

Gay-Lussac's demeanor was always very grave; he entered frankly into the bursts of merriment that a well-chosen anecdote created in societies where he was surrounded by his friends, but he never provoked them himself.

Gay-Lussac carried his love for his native land so far as never to be willing to be witness of a performance of "Pourceaugnac," brought out by Molière at Limoges; his joy, therefore, knew no bounds when there appeared, under the name of "Nouveau Pourceaugnac," a vaudeville by M. Scribe, in which the principal character, M. de Roufignac, also a native of Limousin, instead of being mystified, renders all the other actors the sport of his witty mystifications.

It is related that La Fontaine, at one time, accosted all his friends with, "Have you read Le Prophete Baruch?" So it was with Gay-Lussac; he never failed, no matter how little the circumstances authorized it, to ask with candor equal to that of the fabulist, "Do you know the 'Nouveau Pourceaugnac?' It is a charming piece; I advise you to go to see it." And I must say for him that, though so saving of his time, he preached by example.

A single fact will suffice to show that Gay-Lussac gave himself up enthusiastically to the honest inspirations of his soul, when necessary, even at his own risk and peril, to baffle an intrigue or defend a friend. At the second restoration it had been decided in high places, it was said, to remove a professor, whose liberal sentiments had rendered him an object of suspicion, from the Polytechnic School. But how effect this dismissal without exciting great opposition? The professor was zealous, respected, and even, I must say, beloved by all his pupils. The case was embarrassing, when it was discovered that this victim of public animosity had during the hundred days signed the additional act. The professor of literature (it was not, let it be well understood, M. Andrieux, but his successor) undertook to make every use of this discovery. In a meeting of the corps of instruction he declared that, in his opinion, those who gave their support to the usurper, that Corsican ogre, whatever might be their motives, were not worthy to lecture before the youth to whom the future of the country was to be confided; they should themselves decline to officiate. The member of the corps of professors against whom this attack was directed asked permission to explain himself, when Gay-Lussac arose impetuously, interrupted his friend, and announced in a sonorous voice that he also had signed the additional act; that he would not hesitate in the future to sustain the government, whatever it might be, even the government of Robespierre, when the enemy threatened the frontiers; that, if the patriotic sentiments which guided him were a subject of reprobation, he formally demanded that the proposed reformation should begin in his person.

The professor of literature saw, therefore, that his proposition would be followed by consequences which would far exceed the limit within which he wished to confine it, and no more was said.

Berthollet died in 1822; it was then known he had bequeathed his sword, an integral part of his costume as peer of France, to Gay-Lussac This bequest excited much surprise. But it will be found quite natural if we follow out the chain of ideas which influenced the venerable academician.

As the most illustrious of our chemists, Berthollet had been senator under the empire and peer of France during the restoration. Should we be surprised that he was persuaded that a science which was the source of glory and wealth to our country, should not cease to be represented in the highest tribunals of the state? When near his end, Berthollet examined, with the independence, tact, and judgment usually displayed by the dying, to which of the living chemists this honor should revert; his opinion was decidedly in favor of his friend and colleague Gay-Lussac; which he testified as fully as his habitual reserve allowed him, by giving him a part of his future costume as peer. This was what this gift signified, which it would be very difficult to understand without this explanation. Berthollet had often heard, while in Egypt, of the symbolical language of flowers, frequently used by Mussulmans, and a language which is the pride of many oriental poets. The circumstance just related is but an extension of those poetical usages. The venerable academician expressed, by the gift of an object so little in harmony with the ordinary occupations of Gay-Lussac, the esteem he felt for our friend and his inviolable attachment. This act of enlightened justice however, was not realized as promptly as was hoped. "Why," said the friends of Gay-Lussac to the dispensers of royal favors, "why make him wait so long for a reward which he must receive sooner or later? Do you think him not sufficiently distinguished?" "You wrong us," they reply. "Have you any fault to find with his connections?" "We are not ignorant that they are all honorable and of gentle birth." "Is it by any accident a question of fortune?" "We know that Gay-Lussac enjoys an ample competence, the fruit of his own labor." "What, then, is the obstacle?" And then they acknowledged, softly, very gently, shrouding themselves in mystery, as if ashamed of such an avowal, that the great chemist worked every morning with his own hands at the assay-office, which seemed incompatible with the dignity of a peer of France.

Such was the wretched motive which, for several years, interfered with the fulfillment of Berthollet's ingenious horoscope. Indeed, it is difficult to imagine that a man can degrade himself by working with his hands in attempting to prove the reality of his theoretical conceptions.

To take an instance at random, and from foreign sources, do the discoveries of Huygens and Newton forfeit any of their importance and brilliancy because the first made spectacles and the second telescopes with their own hands? Are the immortal views of Herschel on the constitution of the heavens at all lessened for having been obtained by instruments fashioned by the illustrious observer himself?

Has a single voice in the House of Lords, so proud of its ancient privileges, been raised to claim that Lord Ross had recently degraded himself by becoming in turn founder, forger, and polisher of metal, when, by this triple qualification, he has endowed the science of astronomy with the colossal telescope, now one of the marvels of Ireland?

Could there be a puerility more worthy of contempt than that of which he would be guilty who could ask, at the time when Watt was trying, by the most careful experiments, to give the steam-engine that perfection which makes it the glory of the inventor and the power of his country, whether the hands of the illustrious mechanician were covered with iron-rust or coal-dust? At all events, reason finally triumphed over prejudice, and Gay-Lussac was admitted into the House of Peers.

DEATH OF GAY-LUSSAC—HIS LAST WORDS—HE CAUSES THE TREATISE ENTITLED PHILOSOPHIE CHIMIQUE TO BE BURNED.

Gay-Lussac saw his end approach with the resignation which a pure conscience must inspire. He not only faced death with calmness, but even the *act of dying*, as Montaigne might have said.

When the sad news fell like a thunderbolt upon Paris that the health of our colleague was a cause of great solicitude, one of his friends immediately wrote to the afflicted family who surrounded him to learn the truth. Gay-Lussac desired to reply himself. The following were the words of the dying man:

"My Dear Arago: My son has just told me of your letter to him. It is but too true; I have one foot in the grave, which must very soon close over me; but I gather all my strength to thank you for the interest you take in me, and to tell you that the mutual affection of our two families has been a source of great happiness to me all my life.

"Adieu, my dear Arago."

Do not imagine, gentlemen, for a moment, that I could, on this solemn occasion, wish to make a parade of sentiments so unaffected, so spontaneous, and so free from that straining after effect which formerly led Madame de Sévigné to describe the friendships of the dying hour. A self-deception emanating at all events from the heart would be forgiven.

The forebodings of Gay-Lussac, his family, and the public yielded every moment to more encouraging anticipations. Our colleague Magendie, who had hastened to his old friend with his scientific skill, was, for a short time, himself deluded by this general hope.

Gay-Lussac was removed to Paris, where his condition for some days seemed to improve. He spoke to us then of his future work, and of the regret he felt, at a time when there seemed no possibility of prolonging his life, at having given an order to his son to burn his treatise, *Philosophie Chimique*, the first chapters of which were nearly finished. But he was soon forced to abandon all hope.

The dropsy, with which he had been suddenly attacked, made rapid

progress, and our friend expired quietly and bravely on the 9th of May, 1850, at the age of seventy, and he might have said with one of ancient times, "If it were given me to live my life over again, I would on all ocasions do as I have done."

The obsequies of the learned academician were solemnized May 11, in the midst of a large concourse, including nearly the entire body of his early associates of the Academy of Sciences, and some of the most distinguished members of other acadamies; the entire institute testified in this manner that it could not at that time have suffered a greater loss. The early pupils of the Polytechnic School, the entire body of the two present classes of the school, the friends of science, and many grateful auditors of the two excellent courses of the Sorbonne and the Jardin des Plantés, also joined in the funeral procession.

The various political opinions which unhappily divided our country were blended together in this mournful train, and who could, indeed, say to which of these parties Gay-Lussac belonged? What party could flatter itself to have numbered the illustrious scientist in its ranks? The compatriots of our colleague once intrusted him with the honor of representing them in the Chamber of Deputies. Later, as we have seen, Louis Philippe made him peer of France; but he approached the tribunes of these two assemblies very rarely, and only to discuss special questions relating to his favorite studies. Should this reserve be attributed to timidity, or can it be simply explained by Gay-Lussac's desire not to introduce any disturbing elements into the even current of his life? If this last supposition be correct, he was perfectly successful. Never did the foulest of all calumnies, political calumny, attack the scientific career of our associate. His works have escaped the daily criticisms of those hireling writers who, before taking up the pen, ask themselves, not what are the real merits of the memoirs whose analysis they are about to publish, but what are the supposed opinions of their authors upon the exciting and yet perplexing questions of social organization. The discoveries of our colleague have always been appreciated in France at their just value. We can, therefore, say of him, in the words of Voltaire, written under a portrait of Leibnitz, "Even in his own country he lived respected."

The recollections of the profound friendship which bound me to Gay-Lussac for more than forty years have perhaps tempted me into too minute details in writing his biography. However that may be, I will sum up the history of this beautiful life in these few words: Gay-Lussac was a good father, an excellent citizen, an honest man in every event of his life, an ingenious physicist, and a peerless chemist. He honored France by his moral qualities, and the academy by his discoveries. His name will be uttered with admiration and respect in every land where science is cultivated. Finally, the illustrious academician will live forever in the hearts and memories of all who had the happiness to rejoice in his friendship.