MICHEL EUGÈNE CHEVREUL.

1786–1889.

Michel Eugéne Chevreul was born at Angers, France, August 31st, 1786, and died in Paris April 9th, 1889, at the age of 102 years, 7 months and 9 days.

His career was practically coextensive with the history of Chemistry, with which he is inseparably connected.

He was the "Doyen" of the students, as he liked to call himself.

It is a century of honor, probity and scientific labor which has descended into the grave. He died after having taken his part in the great intellectual impulse of this century and after having materially contributed to the advancement of French science, of which he was the Nestor. At his birth Chemistry, in its present sense, was practically an unknown science, the system of Lavoisier was just beginning to make headway against the Phlogiston theories of Beecher and Stahl, and the lingering remnants of Alchemy. Of all the splendid and surprising scientific achievements of the century since then, he has been an intelligent and interested witness, in many of them an important and vital factor. After having completed his course of studies at the "Ecole Centrale" of Angers, in 1803, at the age of seventeen Chevreul came to Paris and was admitted by Vauquelin as manipulator in his chemical manufactory, but soon after was made chief of the laboratory.

At that time chemical science was yet in a rudimentary state. Black's observations on lime in 1752, which led him to find what we now call carbonic acid, and to recognize that there were different kinds of air, had remained almost unnoticed, as well as Rey's and Mayow's much earlier works. In 1774 Priestley discovered a separate air which he called "Dephlogisticated air," which air or gas we now call Oxygen, according to the system of Lavoisier. These and other discoveries had given an impulse to chemical researches, and the active mind of Lavoisier, in conjunction with

the vigorous intellect of Guiton de Morveau, the mathematical power of Monge and de Laplace, and the manipulative skill of Berthollet and Fourcroy had correlated the facts, and from them elaborated the system and nomenclature which have been followed so long. Chevreul was but eight years old when Lavoisier died. The school of Lavoisier survived the death of its leader, and the time of Chevreul's arrival in Paris was that of the active spread of the spirit of experimental inquiry.

At the age of twenty, in 1806, he first published a scientific paper which bore a geological character, being a chemical examination of the fossils found in the Department of Eure and Loire.

In 1810 Vauquelin appointed him preparator to his course of applied chemistry at the Museum of Natural History, and in 1813, at the instance of his illustrious master, he was made an officer of the University and was given the chair of Chemistry at the "Lycée Charlemagne." In 1818 he was a candidate for membership at the "Académie des Sciences," but withdrew his name as candidate to allow Proust to be elected.

In 1824 he received the professorship of special chemistry at the Gobelins and succeeded Roart as director of the dye works of this establishment.

In 1826 he succeeded Proust at the "Académie des Sciences," and the same year was made a Fellow of the Royal Society of London.

In 1834 he obtained his first promotion in the "Légion d' Honneur."

In 1851 he was awarded a premium at the London industrial exhibition for the benefit his labors had conferred on industry. He was a member of the international jury at the universal exhibition of 1851, in London, and of 1855 in Paris.

He was the president of the Society of Agriculture. He had been made "Commandeur de la Légion d'Honneur" in 1844, "Grand Officer" in 1865, and "Grand-croix" January 5th, 1875.

February 10th, 1879, he resigned as director of the Museum, but still retained his professorship.

In 1886 France celebrated the jubilee of his first century, the Members of the Government entertained him at a banquet in the

"Hotel de Ville" and his statue was unveiled in the gardens of the Museum of Natural History with which he had been so long connected.

Among his numerous honorary titles, the first he received was the degree of M. D. from the University of Berlin, and the last the degree of LL.D. from the University of Glasgow, which was bestowed on him the day he reached his one hundredth year.

His funeral was conducted by the State with military honors, and among the deputations present was that of the French "Stéariniers."

In 1823 Chevreul published his "Recherches sur les corps gras," and showed that fats and ethers belonged to the same family; he also gave the theory of saponification obtained either by acids or by bases, and demonstrated that these agents decomposed the fatty substances by transforming them into acids and into glycerine, with the absorbtion of a certain number of molecules of water. The water absorbed in this transformation promotes the formation of the fatty acids and the glycerine is left free. He found that when a fatty substance is submitted to the action of a strong acid, the decomposition is instantaneous, because the acid (fatty) separates in the free state while the glycerine combines with the acid used for the decomposition. When a strong base is used it combines with the fatty acid and the glycerine is isolated.

Glycerine had been discovered in 1779 by Scheele, but it was considered as existing only accidentally in certain oils. Chevreul demonstrated that it was always separated during saponification and that fatty bodies might be considered as true salts formed by a fixed base, glycerine, and a variable acid.

The manufacture of "Bougies stéariques" or stearic candles has been a direct application derived from these researches. This industry made the fortune of numerous manufacturers, but not the fortune of the inventor nor that of Gay-Lussac who had joined Chevreul for the exploitation of the discovery. Chevreul abandoned his rights and the new industry was taken up by Demilly, of St. Denis, and to this day the products of this establishment are universally known under name of "Bougies de l'Etoile."

For this discovery Chevreul received, in 1852, the prize of

12,000 francs founded by the Marquis d'Argenteuil for the encouragement of national industry.

He was also rewarded by the Royal Society of London with the Copley medal.

In these researches on fatty bodies, oleic acid was isolated and applied in the preparation of wool for cloth.

When Chevreul was appointed director of the dye works of the Gobelins, he gave his attention to the practice of dying, which at that time depended very often upon the most complicated and unscientific recipes transmitted from father to son for generations. He introduced a process for dyeing in black; previously the black threads used in the Royal manufacture were obtained from a hat dyer who jealously guarded his process.

His works on dyeing are extensive and he divided them into three series.

1. *Physical Researches.*

The Contrast of Colors, published first in 1828 in Vol. XI. of the "Mémoires de l'Académie," completed and published in book form in 1839.

Theory of the Optical Effects of Silken Fabrics.

The Chromatic Circles.

Previous to Chevreul, Buffon (1744), the Jesuit Scherffer (1754), Æpinus and Darwin (1785) and Rumford (1802) had described several phenomena relating to colors, and these facts correlated and added to his own observations enabled Chevreul to give the law of their contrast.

According to Chevreul, a substance possessing any one of the colors of the spectrum can only be modified in four different ways.

1. By white, which reduces it in intensity.

2. By black, which diminishes its specific intensity.

3. By a certain color, which changes the specific property without rendering it less bright.

4. By a certain color which changes the specific property and renders it less bright, so that if the effect is carried to the highest degree, it results in black or normal gray, represented by black mixed with white in a certain proportion.

To express all these modifications, he used the following terms, which once defined can no longer be equivocal.

The *tones* of a color are the different degrees of intensity of which this color is susceptible, according as the matter which presents it is pure or simply mixed with white or black; the *scale*, the whole of the tones of the same color; the *shades* of a color are the modifications which it undergoes by the addition of another color which changes it without rendering it less bright; the *subdued scale*, the scale whose light tones as well as the dark ones are dulled by admixture with black (couleurs rabattues).

To construct the chromatic circles, he proceeded as follows:

Having divided a circle into seventy-two equal sections, he placed at equal distances three patterns of tinted wool, one red, another yellow, the third blue, of the same intensity of color. Between these three sections, and at an equal distance from each, he placed orange between the red and yellow, green between this latter and the blue, and violet between the blue and red. By continuing in the same manner successive intercalations and intermediate colors and shades, he at last obtained what he called a chromatic circle of "couleurs franches" reproducing the spectrum of solar light.

When these seventy-two shades were obtained, he took each of them to make a complete scale formed by the addition of increasing quantities of white and black, in order to have ten subdued tones and ten tones of the same color rendered clearer by white. Each scale therefore comprised, between the extremes of pure white and pure black, twenty different tones, of which the pure color is the tenth starting from white.

From this first combination there are already 1440 different tones, all deduced from the chromatic scale of pure colors, but in successvely subduing the seventy-two tones of this circle by the addition of 1, 2, 3, etc., tenths, of black, nine circles of subdued colors are formed, and each of the seventy-two tones which they comprise becoming in its turn the type of a scale of twenty new ones proceeding from white to black, there follows, for the complete series, a scale of 14,400 tones, to which must be again added the twenty ones of normal gray, which makes 14,420 different tones.

2. *Physico-Chemical Researches.*

The blending of colors and their application as dye stuffs.

3. *Chemical Researches.*

In these researches published in the "Mémoires de l'Académie" from 1831 to 1836, he isolated a great number of the coloring principles of the matters used in dyeing. He studied the action of light, heat, humidity, etc., upon dyed materials. He was led to admit that the coloring matters united with tissues by a special force which he called capillary attraction. He explained how fabrics dyed with Prussian blue and exposed to the rays of light in a dry or moist vacuum, lost their blue color in giving off cyanogen or hydrocyanic acid and how they regained it when exposed in an atmosphere containing oxygen.

From these observations he deduced some general principles and considerations relative to the matter of living organized beings, and conceived the following hypothesis: "Supposing that an or-
" ganized being contains Prussian blue in a liquid acting as sap or
" blood, and that this liquid enters an organ exposed to the action
" of light which could reduce the coloring principle into cyanogen
" and protocyanide of iron; supposing that an exhalation of
" cyanogen occurs, and then an absorbtion of oxygen; supposing
" this oxygen to be carried with the protocyanide of iron in
" organs where light has no action and where Prussian blue and
" peroxide of iron are formed, the exhalation of cyanogen and the
" discolorization of the liquid containing the Prussian blue in the
" organ which has been exposed to light, and the recoloration of
" this liquid produced by an absorbtion of the oxygen, are phe-
" nomena which would be explained as produced by a *vital force*, if
" the properties that we have described were not known; but if
" these properties were known, and if it were also known that a
" coloring matter having the characters above described was found
" in the liquids of a living being, it would be an easy matter to
" explain the discoloration and the recoloration without having
" recourse to a *vital force.*"

Another exhaustive work of Chevreul was his analysis of wool-fat. He pointed out that this peculiar compound "Suint" formed no less than one-third of the raw merino wool from which it may be readily freed by simple immersion in cold water.

From this wool-fat he isolated several bodies which he did not

name, but represented provisionally by Greek letters. One of these was named in the following manner : One day in 1868 Chevreul was in a room containing specimens belonging to the Museum, and his attention was attracted by an odor which was similar to the smell emitted by one of his unnamed products. This odoriferous emanation came from the stuffed body of an old albatross which had been forgotten in a closet. The bird was brought to the laboratory at the Gobelins, its feathers tied in bunches with a string and placed under an inverted jar with baryta water. After a month a current of carbonic acid was passed through the baryta water, the precipitate separated by filtration and the clear liquid submitted to distillation in a glass retort. Before the boiling point of water had been reached a liquid condensed in the receiver. Upon examination it proved to possess the same properties as one of the products of wool-fat. It was a volatile acid, and having been obtained from a bird it was named Avic acid. In extracting the fatty matters from wool Chevreul remarked that ether turns acid very quickly and therefore is not well suited for this kind of investigation.

It would be a difficult task to describe fully all the works of Chevreul. The scientific publications of his time are full of the results of his observations. We will therefore give only a brief record of some of his productions.

In his researches on indigo (1812) he found that woad and other indigo bearing plants held in their sap indigo white, which contains one molecule more of hydrogen than indigo blue. This indigo white is transformed by oxidation or exposure to air into indigo blue. He gave the composition of butter, showing that it is a compound of glycerides, among which he noted stearin and olein, and the combinations of butyric, caproic and capric acid with glycerine. He found that some salts formed by the union of a weak acid with alkalies are decomposed by water, and acid salt is precipitated and a portion of the alkali left in solution (Sodium stearate.)

He found that when spermaceti or cetin is saponified no glycerine is produced, but instead a matter which he named Ethal.

He discovered delphinic or phocenic acid (1817) in the oil of

Delphinus Phocæna, which acid proved to be the same as valerianic acid, obtained later from valerian.

He extracted hircic acid from the fat of the goat (Hircus).

He obtained sebacic acid from the distillation of oleic acid, and Butyral from the dry distillation of calcium butyrate.

He discovered that linseed oil could be rendered siccative by manganese oxide at a comparatively low temperature, thus giving a product much lighter in color than when litharge is used. He also suggested the use of oxide of zinc, instead of oxide of lead, for white paint.

Fourcroy thought that cholesterin and spermaceti were the same substance. Chevreul showed that it is a distinct product, made its analysis, described its properties and named it.

He gave the analysis and composition of adipocire.

He obtained creatin (1832) by treating with alcohol the residue from evaporation (in vacuo) of bouillon.

From cork he obtained suberin.

From nutgalls he obtained ellagic acid.

He found that when calcium sulphate is in contact in the dark with moist organic matter, it was transformed first into calcium sulphide, and later into hydrogen sulphide, and also demonstrated that the emanations produced when the ground is open in the vicinity of gas mains were not entirely due to a leakage of gas.

He showed that grape sugar has the same composition as diabetic sugar.

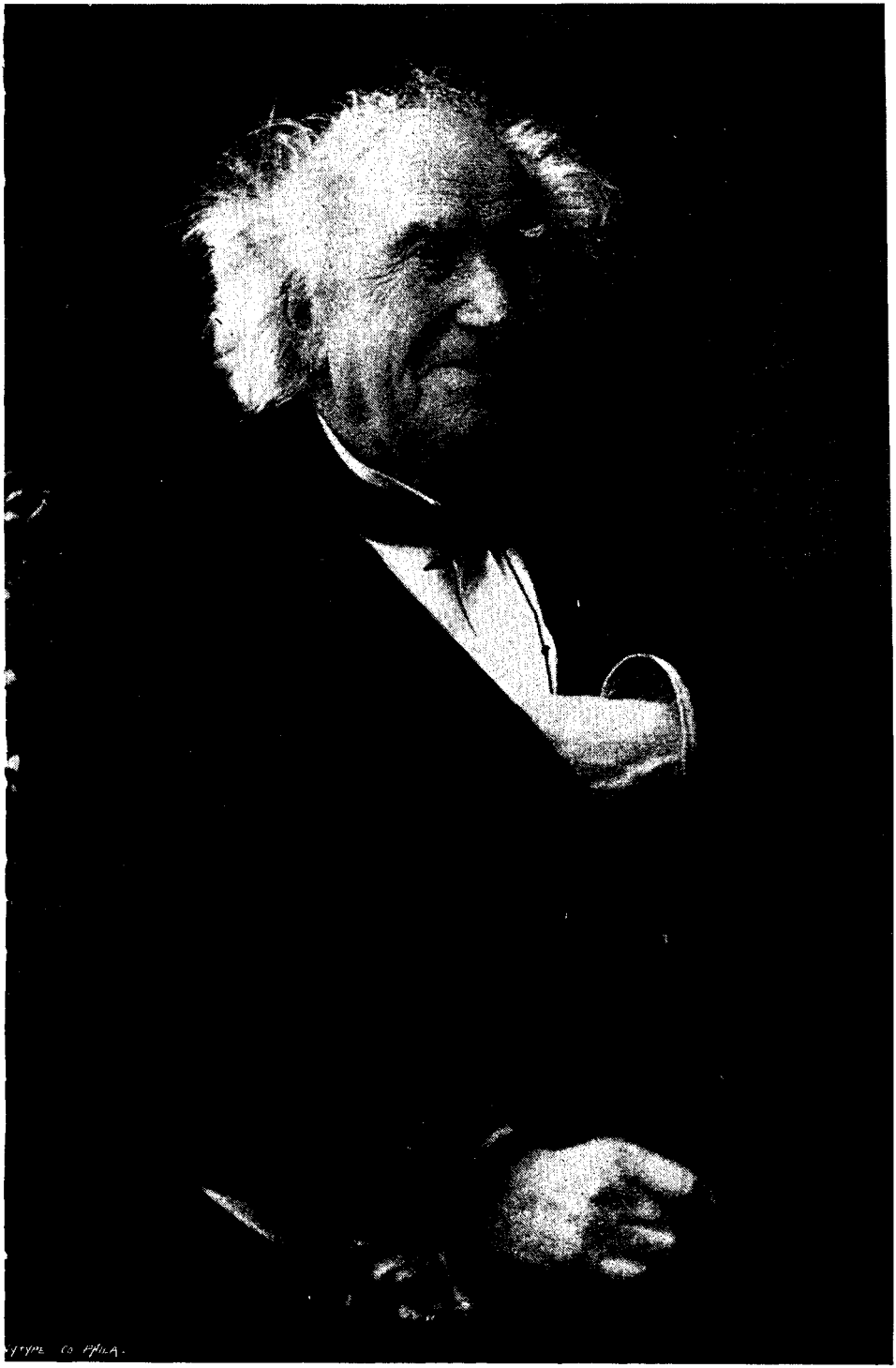
He gave a method for separating zirconium from iron founded on the difference of solubility of their chlorides in hydrochloric acid.

Another work of his, on sanitary influences, introduced the practice of charring the interior of water casks. In colaboration with Magendie, he gave the composition of intestinal gases.

It is to him that the methods of fractional distillation and fractional precipitation are due.

In 1885 he completed his studies on colors, and his observations on colors in motion were published in the "Mémoirs de l'Académie."

His definition of chemistry, "*La chimie est la science qui réduit la matière à des espèces qui sont caractérisées par leurs propriétés.*"



M. CHEVREUL AT 100 YEARS.

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He has published numerous works, among which are :

Leçons de Chimie appliquée à la Teinture, 1828–31.

De la loi du Contrast Simultané des Couleurs, 1839.

Essai de mécanique Chimique, 1854.

De la baguette divinatoire, 1854.

Considérations sur l'histoire de la partie de la Medecine qui concerne la prescription des remèdes, 1865.

Histoire des connaissances Chimique, 1866.

It would seem as if the amount of laboratory work performed by Chevreul would have required all his time, but indefatigable worker as he was, his moments of leisure, as he called them, were turned towards philosophy. A true friend of Truth, he only published his results after he had probed them with the severest criticism. He had borrowed his motto from Mallebranche, "*On doit tendre avec effort à l'infaillibilité sans y prétendre,*" and he never departed from it.

Studying and learning constantly he had acquired such a proficiency in the different branches of human knowledge that he has been surnamed "*Encyclopédie vivante.*" He did not like to be called a savant, and among all the distinctions and titles that he had received he said that the one he cherished the most was that of "*Doyen des Etudiants.*"

A monument was erected to Chevreul during his lifetime, but a more lasting tribute to his memory, one which would be coveted by any man of science, would be the publication of his complete works.

A. BOURGOUGNON,
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"Manufacture Nationale des Gobelins."