(10) Same as (2) introducing 0.5% sodium bicarbonate.

The results of these experiments are shown in the following table:

Table.—Nature of Precipitate in Lotio Flava

Experiment Number	Precipitate	Precipitate after Two Months
1	S	Coarse; settles quickly
2	S	Coarse; settles quickly
3	S	Finer; settles more slowly
4	S	Coarse; settles quickly
5	S	Finer; settles somewhat slower
6	RB	Fine; settles slowly
7	RB	Fine; settles slowly
8	S	Fine; settles slowly
9	S	Coarse; settles quickly
10	RB	Fine; settles slowly

Legend: S = satisfactory; RB = reddish brown.

CONCLUSIONS

An examination of the results shown in the above table and the various procedures would indicate that the preparation is sensitive to the *carbonate ion* and that the reddish brown precipitate appears when the lime water has been exposed to the air or when this ion (CO_3^{--}) has been introduced into the lime water by other means. This would indicate that a portion of the precipitate formed might be a basic carbonate or in other words, a mixture of the oxide and this compound. Our observations seem to refute the statement that the reddish brown precipitate is formed because of too much mercuric chloride or the use of lime water deficient in calcium hydroxide. It would seem fitting, however, to recommend that the National Formulary direct the use of freshly prepared lime water in the preparation of Lotio Flava.

REFERENCES

(1) Snow, C. M., "Essentials of Pharmacy," C. V. Mosby Company, St. Louis, 3rd Edition (1927), page 218.

(2) *Ibid.*, page 367.

NOTICE

Papers to be presented at the next Annual Convention in Richmond, Va., May 5th–12th, should be sent to the respective Section Secretaries promptly.

M.-E. Chevreul. The Fiftieth Anniversary of His Death

By Mary Elvira Weeks and Lyle O. Amberg*

On April 9, 1889, the life of the great French chemist Michel-Eugène Chevreul came to a peaceful close shortly before his one hundred and third birthday. For nearly eighty years he had contributed article after article to the scientific journals. Both his parents had lived past the age of ninety years (1), (2), and one of his works was dedicated "to the memory of Michel Chevreul and of Etinnette-Madeleine Bachelier, respectful homage from their son in recognition of the moral sense and good health they transmitted to him" (1).

Chevreul was born at Angers on August 31, 1786, and at the age of seven years he looked through the window, with childlike curiosity, to watch the guillotining of two young girls. In later life, however, his bright outlook was not marred by the dark scenes of his childhood (2). He received his early training at the Central School in Angers. At the age of seventeen years he went to Paris to study under the great pharmacist and chemist Nicolas-Louis Vauquelin, assistant to A.-F. de Fourcroy at the Collège de France, and three years later he took charge of the laboratory. His first scientific memoir (3), a chemical examination of some fossil bones, was published in 1806, and in the same year he assisted Vauquelin in analyzing some human hair (4).

Since Vauquelin was greatly interested in the purple vapor evolved when indigo is heated, he asked Chevreul to investigate it (5). Chevreul found that indigo purified by successive treatments with water, alcohol and hydrochloric acid gave off "a vapor of a superb purple, much more intense than that produced by an equal quantity of the same indigo when not purified; from which it follows that this phenomenon is produced by the indigo and not by foreign bodies to which it is united." He showed that this vapor is the indigo itself, most of which volatilizes without decomposition; that indigo can be purified by sublimation or by recrystallization; that pure indigo is purple and not blue; and that the intensity of the color increases as the molecules are brought closer together. He also demonstrated the presence of indigo in its white, reduced form in pastel, or woad. Four years later he published a paper on the preparation of natural indigo (5). He also examined Brazilwood and logwood (6) and discovered brazilin and hæmatoxylin.

In 1823 he published the results of eleven years of research on the hardness of soaps (7). He found that the sodium soap of a given fat is harder (less soluble in cold water) than the corresponding potassium soap but that the fat as well as the alkali

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is a determining factor. He determined the solubility in cold water of the sodium and potassium soaps of stearic, "margaric" and oleic acids, and showed that the hard soaps lose water on exposure to air. He also proved that the hardest soaps are obtained from the fats in which the stearates are high in proportion to the "margarates" and oleates and that the soaps from natural oils can be imitated by mixing the fats to be saponified.

Chevreul found that when soaps are used as detergents, they are hydrolyzed to form free alkali and an acid salt, such as potassium bistearate of the approximate composition $C_{18}H_{35}O_2K.C_{18}H_{36}O_2$. His work was confirmed by Krafft and Stern in 1894, who concluded that it would be difficult to add anything essentially new to "the simple and clear views of Chevreul, Berzelius and Persoz" (8).

In 1809 a specimen of soft soap used in fulling cloth was sent to Chevreul for analysis (9), (10). When he dissolved some of it in a large volume of water, he observed some shining crystals. "When one places some soap formed from pork fat and potash in a large volume of water," said he, "part of it dissolves, while another part precipitates in the form of little shining spangles, which I shall call nacreous matter. After having decanted off the liquor, one washes the deposit repeatedly with cold water and then throws it on a filter." He then washed the pearly scales with alcohol and, upon treating them with hydrochloric acid, liberated a new fatty acid which he named "margaric acid" because of its mother-of-pearl luster. He also prepared the same substance from other soaps and used it in separating the solid acids ("margaric," palmitic and stearic) from the liquid oleic acid, the potassium salt of which remained in solution. Although Chevreul's "margaric acid" was merely an intimate mixture of palmitic and stearic acids, a compound $C_{17}H_{34}O_2$, intermediate between palmitic and stearic acids, is now known by the same name.

Chevreul gave the name phocenic acid to the principal odorant (trivaleric acid) of the soaps of dolphin oil, "hircic acid" to that of mutton fat and butyric acid to the odorant of butter fat, and stated that the latter "contains two other acids which I name capric and caproic" (7), (11). His "hircic acid" is now known to be a mixture of homologous fatty acids present in mutton suet. Chevreul made ultimate analyses of butyric, phocenic and "hircic" acids and emphasized the practical value of a knowledge of the odorous organic acids in the manufacture of cheese.

M. Chevreul in His Hundredth Year at Work in His Laboratory. (From a Photograph by M. David.)

When C. M. d'Ohsson, a friend of Berzelius, and the physiologist François Magendie visited Chevreul, he showed them some of his new products, including butyric acid, "which smelled horribly bad . . . I tried in vain," said d'Ohsson in a letter to Berzelius "to discover some new instruments in his and Gay-Lussac's laboratories. I found, on the contrary, that everything there was of the greatest simplicity, and your laboratory certainly does not suffer by comparison" (12).

Even in his early thirties, Chevreul was already at the height of his powers. In 1819 Berzelius wrote to W. von Hisinger, "The greatest chemists now in France are Gay-Lussac, Dulong, Chevreul and

Thenard" (12). During his visit to Paris in the summer of 1819 Berzelius wrote, "With Thenard, Gay-Lussac, Dulong and Chevreul I lived on the same footing as among my old schoolmates at Upsala" (13). Berzelius often watched the experiments on saponification, and once said of Chevreul, "He is the most excellent observer of details; none of them are too small for his notice; and the services he has rendered to the science, which are by no means small, result merely from his study of details. However, he is not so fortunate in the presentation of general theoretical concepts . . . " (12), (14). Chevreul believed that "elementary and professional education should be confined to that which is true and easily demonstrated to be true" (15).

In 1813 he began to lecture on fats and their saponification products before the French Academy of Sciences, and ten years later these discourses were published under the title "Chemical researches on fatty substances of animal origin" (16), (17). Fats had formerly been regarded as acid substances which could unite directly with a base to form a soap, which was thus believed to be a binary salt of fat and alkali. In 1741 Claude-Joseph Geoffroy (Geoffroy the Younger), a member of a famous family of French apothecaries, showed that, when a soap solution is neutralized with a mineral acid, the resulting fatty substance differs from the original one by dissolving readily in alcohol.

"When olive oil," said he, "is separated, by means of an acid, from the soap which has been dissolved in spirits, it becomes similar to an essential oil; it is more flammable, gives less soot, and combines immediately with spirit of wine. On distillation, however, it does not, like the true essential oils, pass over with the water" (19).

In 1783 C. W. Scheele, in his quiet pharmacy, heated a mixture of olive oil and litharge and obtained a "sweet principle," which is now known as glycerol (18). He also obtained the same substance from other vegetable and animal fats and clearly distinguished it from sugar and honey.

In 1816 Chevreul quantitatively saponified the fats of man, the sheep, the cow, the jaguar and the goose, and found that, in each case, about ninety-five per cent of the fat had been saponified. He computed by difference that there must be about five per cent of soluble matter in each of these fats, and observed that "the sirupy liquid which contained the sweet principle produced by saponification (glycerol), although evaporated until it began to volatilize, always weighed much more than the fat had lost of soluble matter" (20). He believed at first that he had merely been unable to remove all the water and "saline matter." When in 1818 he discovered phocenin (glyceryl valerate) and butyrin, he realized that they were compounds of the volatile acids and anhydrous glycerol (20) and that the excess weight represented the quantity of water fixed by the fat to form the glycerol in saponification. He knew too that the fatty acids and the glycerol were not merely mixed in the fats, for, if that were true, it would be possible to leach out the glycerine with water. Moreover, alcohol, which dissolves both fatty acids and glycerin, does not dissolve the fat. He compared the fats in this respect with ethyl acetate and postulated that they must be formed of fatty acids and a substance which adds on water to form glycerol.

In the first book on his treatise on fats Chevreul showed that the classification, according to melting point, into waxes, fats, butters and oils was unscientific, and described methods for the ultimate analysis of fatty substances. Book two describes many fats and the saponification products obtained from them with different alkalis; an investigation of the fatty acids and their physical and chemical properties; a study of the metallic salts of oleic acid; and descriptions of cholesterin, ethal (cetyl alcohol), cetin, olein, phocenin, butyrin and "hircin" (17).

In the third book he discussed the saponification of cetin, a crystalline fat obtained from spermaceti. He obtained no glycerol from the cetin, but ethal (cetyl alcohol) instead. In book four he gave comparative results of the saponification of various fats, including those from dolphins and porpoises, from edible fish and from cadavers. Although Fourcroy had not distinguished clearly between the adipocere he discovered in dead bodies, the spermaceti from the sperm whale and the crystalline substance, cholesterin, obtained from biliary calculi, Chevreul proved that these are three distinct substances (21), (22), (23), (24). He was led to this discovery by his careful investigation of some crystals which had formed, after several months, on the surface of a fatty material which had been brought from Rouen for analysis.

In book five Chevreul discussed contemporary views on saponification and proved that acetic acid and carbon dioxide are not produced and that gaseous oxygen is not necessary for the saponification reaction. He also determined the weight of fat which can be saponified by a given weight of potash, *i. e.*, the saponification number of the fat (17), (20). Book six contains a résumé of the researches and their applications, and discusses the properties of the stearates, "margarates" and oleates of sodium and potassium and their solubility in alcohol, acids and alkalis.

In 1825 Chevreul and Gay-Lussac obtained a patent for the production of fatty acids for the manufacture of candles by treating tallow and oils with potash, soda or other alkali and then decomposing the resulting soap with hydrochloric acid. Since the glycerol could be recovered from the aqueous solution, it, too, could be produced on a large scale.

Although the first candles made by the Chevreul-Gay-Lussac method were greasy and unsatisfactory, the engineer, Jules de Cambacérès, improved them by his invention of the plaited wick, and in 1831 M. Adolphe de Milly, one of Chevreul's former students, and M. Motard introduced the use of lime instead of caustic soda and began to manufacture excellent stearin candles near the Barrière de l'Étoile, which became known as "star, or adamantine" candles. They had been made possible by Chevreul's discovery that the removal of glycerol from fats enormously increases their hardness and illuminating power (21), (25), (26).

To appreciate the importance of this improvement, one must view it through the eyes of Chevreul's contemporaries. "The stearic candle industry," said A. W. von Hofmann, " . . . opens a new era in the history of illumination. In the present generation only the oldest still recall the tallow candle, soft and dripping, disagreeable in color, giving off a sickening odor, requiring constant care as it burned and giving only a dim, smoky flame. Suddenly the tallow candle was replaced by the stearic candle of brilliant whiteness, odorless, hard and sonorous, burning without the slightest aid and with a bright flame. It is your hands which have opened to the grateful world a source of light in no way inferior to that of wax candles, capable of competing with gas light, the use of which was already widespread, and which does not seem menaced by the illumination of the future, by the electric light" (16), (27).

In observing the centenary of Chevreul's discovery on which the stearic candle industry is based, the late Henry E. Armstrong said, "Chevreul was the first to study the 'gas' from which Faraday, a year later, was to isolate benzene . . . To-day Chevreul and Faraday march arm in arm, illuminating the world—the one bearing the candle, the other the electric torch . . . Working as chemists, Chevreul and Faraday between them, practically at the same time, laid the foundations of organic chemistry: Chevreul of its open or paraffinoid, Faraday of its closed or phenoid systems . . . Like Faraday, Chevreul was no mere laboratory worker; he was not only a philosopher but also a systematist and logician of the first order. His scientific writings are all models of clear and simple statement . . . The *bougie stéarique* is no mere illuminant to-day but something at which we can greatly marvel. The chemist can see massed in it wondrously built, tall staircases of atoms, up which the imagination may climb to infinite heights . . . " (15).

In 1824 Chevreul published his great work entitled "General considerations on organic analysis and its applications" (28), the first part of which is devoted to proximate organic analysis and the second to its applications. Like the naturalists, Chevreul used to classify everything into families, genera and species. Among the immediate, or proximate, principles he included the sugar, gum, starch and lignin of a plant; the fibrin and albumin of the cellular tissue of an animal. In the term *species* he included these immediate principles and compounds of two or more of them according to definite proportions. He applied the term *variety* to specimens of a given organic species which differ in secondary crystalline form or other minor properties from the substance considered as typical of the species. By *genus* he meant a collection of organic species which possess one or more important properties in common. He conceived of each specimen of a given species as an aggregation of identical individuals and realized that the true individuals are the compound atoms (molecules).

Berzelius had stated that blood fibrin, albumin and gelatin are partly converted by the action of alcohol and ether into a fatty substance similar to adipocere. Chevreul, realizing that, if alcohol and ether were to be used in proximate organic analysis, this point must be settled, proved quantitatively that the fatty substances contained in alcohol and ether placed in contact with tendons, fibrin, etc., had merely been extracted from those substances. On treating elephant tendons with alcohol, he obtained stearin and olein. When he treated the same tendons with dilute potash, he produced a quantity of stearic, "margaric" and oleic acids equivalent to the stearin and olein previously obtained by means of alcohol. Berzelius later extracted fat from the fibrin of ox blood and acknowledged that Chevreul's statements were correct (29).

Chevreul's book on organic analysis discusses, among other things, the effect of heat and of oxygen on organic compounds; solvents used in organic analysis; saponification as a method of analysis; and the applications of proximate organic analysis to the arts and industries and to medicine, pharmacy, toxicology and the biological sciences.

In the section on pharmacy he wrote: "If in medicine, in a given case, one is in doubt as to the dose of medicaments such as the sulfates of soda and of magnesia, the subphosphate (sousphosphate) of soda, the bitartrate of potassium or of emetic, the composition of which is rigorously defined, there is all the more reason for being so when it is a matter of prescribing such medicaments as extract of opium, cinchona barks, ipecacuanha roots, etc., which contain unknown proportions of the active principles. Proximate organic analysis, which gives the methods of isolating these principles from the foreign substances with which they are united or mixed in the extracts, barks, roots, etc., and which, by defining them as *species* possessed of constant properties, brings them to the condition of the first medicaments of which I spoke, renders eminent services to pharmacology by destroying a cause of uncertainty which the use of many of the most important remedies of the healing art used to present. Physicians, then, should lend full support to researches such as those of MM. Sertürner, Robiquet, Boullay, Gomes, Magendie, Pelletier, etc., to whom we owe the discovery of morphine, of the vesicant principle of cantharides, of picrotoxin, of cinchonine, of quinine, of emetine, of strychnine, of brucine. Researches of this nature are well suited to change the opinions of those who believe with Descartes in the danger of *the remedies of chemistry*" (28).

Chevreul was evidently referring here to F. W. Sertürner's discovery of morphine in 1805–1817; P.-J. Robiquet's analysis of cantharides in 1810;

P.-F.-G. Boullay's discovery of picrotoxin in 1811; B. A. Gomes' memoir on the gray ipecacuanha of Brazil (Lisbon, 1801); the researches of Joseph Pelletier and F. Magendie on ipecacuanha in 1817; and the discovery of strychnine in 1818, of brucine in 1819 and of quinine and of cinchonine in 1821 by Joseph Pelletier and J.-B. Caventou. In his eulogy at the funeral of Robiquet, Chevreul said: "His examination of cantharides informs us of the presence of uric acid in insects which feed on leaves and also of the existence of a principle to which they owe the property of acting as a vesicatory, a discovery which is remarkable in that, by demonstrating as early as 1810 the possibility of extracting the active principle of a complex medicinal substance, it can be considered as the point of departure for numerous researches on this subject . . . "

Chevreul also pointed out in his treatise that, when the medicinal property of a root, bark or extract is due to a combination of several principles and not to any one of them alone, such "active combinations" may be separated from the foreign materials which weaken their essential properties and make correct dosage difficult.

Conservative pharmacists had raised two objections to the use of the pure active principles: (1) it is more difficult to weigh out a few milligrams of the active principle than to weigh several decigrams of the natural product; and (2) the advantages of isolating the active principle are more than counterbalanced by the labor and chemical knowledge required. To the first, Chevreul replied that the active principle could be intimately mixed in known proportion with an absolutely inert constituent; to the second, he asserted that "in the interest of the public, the preparation of remedies should not be very easy, for, the more scientific knowledge it requires, the more pharmacists charged with the sale of medicaments will keep the traffic in them exclusive" (28).

To Chevreul, pharmacy was not merely a heritage from the past but an advancing science of the future. "The most heroic remedies of medicine," said he, "were found only by tests and experiments. If, then, we do not wish to leave entirely to the less enlightened ages the honor of having discovered them, if we think it possible to discover new ones, the torch of the sciences must enlighten us."

At the close of the book he discusses the origin of life. Although he did not believe that the phenomena of life and those of inorganic matter have identical causes, he added that "it must not be concluded that I share the opinion of those scientists who claim to explain the mysteries of organization by one or more forces which they call vital." Even before Wöhler's synthesis of urea had been announced, Chevreul stated that "it would be contrary to the spirit of chemistry to base a classification on the impossibility which has hitherto existed of completely forming an organic compound absolutely dentical with one which formed part of an organized bieing; and according to what we know to-day, there are more reasons for hoping that this formation will be accomplished than there are for believing the contrary" (28).

On September 9, 1824, Chevreul became director of the dye plant at the Gobelin Tapestry Works (30). "On entering the Gobelins," said he, "I found neither barometer nor thermometer nor accurate balances nor platinum ware nor mercury trough nor reagents; the laboratory was a sort of stable or kitchen, paved and damp." He devoted the years from 1828 to 1864 to a study of colors and the technique of dyeing. His first published work on color appeared in 1830 under the title "Memoir on the influence that two colors can have on each other when seen separately" (31). In 1829 and 1830 Chevreul published his lectures on chemistry applied to dyeing (32), and in 1832 he discovered creatine as a normal constituent of muscular tissue (21), (33).

Between the years 1836 and 1862 he read before the Academy of Sciences fourteen memoirs based on his researches on dyes. In these he compared the affinities of various textiles for sulfuric acid solutions by analyzing a known weight of the solution before and after contact with the textile; determined the proportions of water which thoroughly dried textiles absorb at different temperatures; studied the separate and combined effects of water, light, atmospheric agents and hydrogen on textiles dyed with weld, yellow wood, archil, Brazilwood, Campeche wood, madder, turmeric, cochineal, annatto, safflower, sulfoindigotic acid and Prussian blue; investigated the methods of removing grease and sulfur from wool, and the chemical composition of wool fat; showed the effect of the mordant on the tone of the color and on its stability in sunlight and discussed the theory of bleaching and the preservation of colors. He investigated the effect of temperature on the value of the mordants used; studied the effect of natural and artificial contaminants of the fabrics on the beauty and durability of the color and compared distilled water, Seine River water, Parisian well water and artificially prepared waters as to their suitability for use in the dye baths (34).

In 1828, soon after his work on fats and organic analysis had opened up two great fields of research, Chevreul broke ground in a third new field, the psychology of color, and in 1839 he published his great work on "The principles of harmony and contrast of colors and their application to the arts" (35). He showed that the chemical composition of the colors had nothing to do with the effects of their simultaneous contrasts; distinguished between simultaneous, successive and mixed contrast of colors; showed how to imitate colored objects with the coloring materials in a state of very small division and how to produce given effects with colored threads and applied his results to the production of Gobelin tapestries, Beauvais furniture tapestries and Savonnerie carpets, to color printing on cloth and paper, to horticulture and to the making of maps, mosaics, glass windows, engravings and clothing. He himself stated that his work on contrast of colors was just "as experimental and as exact" as his previous treatises on fatty bodies and organic analysis (35).

Before he began these researches, the intermediate shades were produced by a process called *rabattage*. To decrease the intensity of a bright color, the dyers plunged the dyed fabric into a dilute solution of a ferrous salt mixed with an astringent. The iron salt then imparted a gray tone to the color, but, when the dyed textiles were exposed to the air, the iron was oxidized, and the gray shades were changed to brown or black. Thus the entire fabric, including even the portions which were intended to be brightly colored, acquired a dingy appearance.

"In searching for the causes of the complaints raised against the quality of certain colors prepared in the Gobelin dye-works," said Chevreul, "I soon convinced myself that if the complaints regarding the instability of the light blues and violets, of the grays and of the browns were well founded, there were others, especially those concerning the lack of vigor of the blacks used to make the shadows in blue and violet draperies, which were unwarranted; for after having procured woolens dyed black in the most famous plants in France and abroad, and after having recognized that they were not at all superior to those dyed at the Gobelins, I saw that the lack of strength complained of in the blacks was caused by the color placed next to them and was due to the phenomenon of contrast of colors; it then became clear to me that, in order to fulfil the duties of director of dyeing, I had two entirely different subjects to treat: the first was the contrast of colors, broadly considered, both in its scientific and its practical aspects; the second concerned the chemical part of dyeing. These, indeed, have been the two centers to which all my researches for ten years have converged" (30), (35). These researches made it possible for the Gobelin plant to produce effects hitherto unknown and to do it with a limited number of carefully chosen colors of well-established permanence.

Feeling the need for a definite standard with which colors could be compared, Chevreul constructed a chromatic circle, using as his fundamental points of comparison certain rays of red, yellow and blue, each of which was marked by a well-defined Fraunhofer line. He placed these three colors at equidistant points on the circle and interpolated twenty-three definite color mixtures in each of the three intervening sectors. In addition to this "normal" circle, he prepared eight others, in which the colors were toned down with definite known proportions of black. He thought that official standards of color ought to be preserved like standards of weights and measures, but realized the difficulty of obtaining enough dyes which would be sufficiently permanent. In his lectures at the Gobelins, he used to construct a mammoth circle of skeins of worsted on the floor of the great exhibition hall (36).

In 1854 he published an exposé of the divining-rod and other psychic and spiritualistic phenomena which were then creating a furor on both sides of the Atlantic (37). Professor Joseph Jastrow has recently published an interesting account of these psychological researches (38).

Chevreul also made notable contributions to the history of chemistry, including an "Histoire desconnaissances chimiques," and a more extensive work "Résumé d'une histoire de la matière depuis les philosophes grecs jusqu'à Lavoisier inclusivement," only a portion of which was published (39), (40). Mme. Metzger has emphasized the fact that these works are well worthy of study by historians of chemistry (41).

When he was about ninety years old Chevreul made a detailed psychological study of the changes which accompany old age (42). In 1883, at the suggestion of J.-B.-A. Dumas, Chevreul, then ninety-seven years old, was appointed "director of advanced studies for the observation and analysis of the colors of dyes" (30). Chevreul had been publishing scientific memoirs for twenty-nine years before the *Comptes rendus* was founded, yet among its great volumes from the years 1836 to 1888, inclusive, there are scarcely any which do not contain one or more of his articles or critical discussions or notices of his appointment to important committees.

Since B.-B. de Fontenelle had died a month before his one-hundredth birthday, and since Chevreul's birthday comes in the summer, when most scientists are away from Paris, the observance of the Chevreul centenary began three months ahead of time. On May 17, 1886, the Academy of Sciences had a ceremony in his honor, and on August 30th and 31st the Society of Agriculture paid homage to him. According to tradition, Chevreul had been elected president of this society every alternate year, and he had fulfilled these duties "with a punctuality one would never expect from a centenarian" (2). When he arrived at two o'clock, he was greeted by the eleven presidents of the sections of the society, each carrying a large bouquet of roses.

The third celebration was that of the city of Paris and the Museum of Natural History, aided by the press. An exhibition of industrial products which had been improved through Chevreul's researches, which had been suggested, had to be abandoned for lack of space to display all the materials which were submitted (36). When the statue of Chevreul was unveiled, the entire Museum was decorated with red velvet, flowers and the finest tapestries, ancient and modern, which had ever been made at the Gobelin plant, and more than two thousand delegates from learned societies, schools, museums and workshops came marching in with banners.

The informal dinner at six-thirty was illuminated by thousands of candles presented by the stearin manufacturers of Paris. When the clock at the Hôtel de Ville struck eight, M. Janssen arose and announced that that very moment marked the centenary of Chevreul's birth. At the request of M. Goblet, Minister of Public Instruction, Chevreul, who had never before indulged in wine, joined the guests in the toast "Vive la France!" An hour later, wearied by the long ceremonies, he asked permission to retire, and the festivities were concluded with a torchlight procession from the Hôtel de Ville to the Place de la République and gala performances at three theaters.

After the centenary, Chevreul lived very quietly and drove daily to watch the construction of the Eiffel Tower. M. Gaston Tissandier, the editor of *La Nature*, has left us the following picture of Chevreul the centenarian: "M. Chevreul is tall of stature and is, even to-day, slender and erect. Elegant of manner, of incomparable affability, he rarely greets you without a smile on his lips. His head is wonderfully expressive, the forehead large and powerful, covered with white hair. A few years ago he still used to attend the winter ball at the Elysée, and we recall seeing him there at midnight, fresh and smiling, surrounded by ladies, whom he was gallantly entertaining, with exquisite and charming grace" (2). To a new assistant he once said, "You must have courage to accept a position as my préparateur; I have already killed off four of them" (2).

The monograph on the national manufactures of France, which was published in 1889, shortly before Chevreul's death, states that "Thanks to the resolute vigor of his intellect, accumulating discovery after discovery, M. Chevreul has pursued these great researches at the Gobelins up to the present. The famous scientist whose centenary all Paris celebrated two years ago still discharges in an honorary capacity the duties with which he was entrusted in 1824 . . . " (30). Only a few days before his death, Chevreul suffered the loss of his only son, Henri, a bibliophile like himself. The introduction to the "Law of simultaneous contrast of colors" was written by M. Henri Chevreul, and he had also intended to prepare a preface for the reprint of the "Chemical researches on fatty bodies" which was issued in 1889 (17).

The ode by Emile Guiard, which the actor Albert Lambert read at the Odéon at the time of the centenary, eloquently acknowledges society's indebtedness to Michel-Eugène Chevreul:

"Prends la vie de ces gens à la vie inféconde,
Qui ne savent marquer leur passage en ce monde
  Que par leur instinct destructeur;
Prends leurs jours consacrés à la haine, à l'envie,
Prends leurs jours et fais-en une éternelle vie
  Pour les Chevreul et les Pasteur."

REFERENCES

(1) Anon., "Le centenaire de M. Chevreul," *Moniteur Scientifique* (Quesneville), 1193–1200 (October 1886). Signed: Dr. Q.

(2) Tissandier, G., "M.-E. Chevreul," *La Nature*, 14 (2) (August 28, 1886), 197–202.

(3) Chevreul, M.-E., "Examen chimique des os fossiles trouvés dans le département de Maine-et-Loire," *Ann. chim. phys.*, (1), 57 (1806), 45–50.

(4) "Abstract of a memoir on human hair read at the National Institute on the 3rd of March by M. Vauquelin," *Nicholson's J.*, (2), 15 (October 1806), 141; *Ann. chim. phys.*, 58 (1806), 41.

(5) Chevreul, M.-E., "Expériences chimiques sur l'indigo. Expériences chimiques sur le pastel," *Ann. chim. phys.*, (1), 66 (April 30, 1808), 5–53; *Nicholson's J.*, (2), 32 (July 1812), 211–216; "Sur la préparation de l'indigo," *J. de physique*, 74 (1812), 471–473.

(6) Chevreul, M.-E., "Expériences chimiques sur les bois de Brésil et de Campèche," *Ann. chim. phys.*, (1), 66 (June 30, 1808), 225–265.

(7) Chevreul, M.-E., "Sur les causes des différences que l'on observe dans les savons, sous le rapport de leur degré de dureté ou de mollesse, et sous celui de leur odeur; et sur un nouveau groupe d' acides organiques," *Ann. chim. phys.*, (2), 23 (1823), 16–32.

(8) Krafft, F., and Stern, A., "Ueber das Verhalten der fettsauren Alkalien und der Seifen in Gegenwart von Wasser," *Ber. d. deutschen chem. Ges.*, 27 (June 25, 1894), 1747–1761.

(9) Simon, L.-J., "Chevreul. Les corps gras d'origine animale. L'Analyse immédiate et l'espèce chimique. L'Atome composé," *La Nature*, 53 (2) (1925), 235–238.

(10) Chevreul, M.-E., "Researches on various fatty bodies . . . ," *Annals of Philos.*, 12 (September 1818), 186–199; 12 (October 1818), 257–290; *Ann. chim. phys.* (1), 88 (December 31, 1813), 225–261; *Ibid.*, (1), 94 (April 30, 1815), 80–107.

(11) Chevreul, M.-E., "On newly discovered animal acids," *Annals of Philos.*, 22 (September 1823), 209–210; *Ann. chim. phys.* (2), 23 (1823), 16–32.

(12) Söderbaum, H. G., "Jac. Berzelius levnadsteckning," Almqvist & Wiksells Boktryckeri A.-B., Upsala, 2 (1929–1931), 76. Letter of d'Ohsson to Berzelius, July 4, 1817; *Ibid.*, Vol. 2, page 159. Berzelius to Hisinger, June 6, 1819; *Ibid.*, Vol. 3, pages 542–543. Berzelius to Philippe Plantamour, June 11, 1847.

(13) Söderbaum, H. G., "Jac. Berzelius reseanteckningar," P. A. Norstedt & Söner, Stockholm (1903), page 196.

(14) Söderbaum, H. G., "Jac. Berzelius Självbiografiska anteckningar," P. A. Norstedt & Söner, Stockholm (1901), page 75; English translation by Olof Larsell, Williams and Wilkins Co., Baltimore (1934), page 101.

(15) Armstrong, H. E., "M.-E. Chevreul, 1786–1889," *Nature*, 116 (November 21, 1925), 750–754.

(16) Malloizel, G., "Oeuvres scientifiques de Michel-Eugène Chevreul," Comité du Centenaire, Paris (1886), 298 pages.

(17) Chevreul, M.-E., "Recherches chimiques sur les corps gras d'origine animale," Levrault, Paris (1823), 484 pages; *Imprimerie Nationale, Paris* (1889), 425 pages, folio.

(18) Dobbin, L., "The collected papers of C. W. Scheele," G. Bell and Sons, Ltd., London (1931), pages 255–258; Scheele, C. W., *K. Vet. Acad. Nya Handl.*, 4 (1783), 324–329.

(19) Geoffroy, C.-J., "Mittel, den Weingeist gefrieren zu machen, und den fetten Oelen einige Eigenschaften der wesentlichen Oele zu geben," *Crell's Neues chem. Archiv,* 4 (1785), 229–232; *Hist. de l'acad. roy. des Sciences* (Paris) (1741).

(20) Chevreul, M.-E., "Recherches chimiques sur les corps gras," *Ann. chim. phys.* (1), 94 (May 31, 1815), 113–144; *Ibid.* (1), 94 (June 30, 1815), 225–280; *Ibid.* (1) 95 (July 31, 1815), 5–50; *Ibid.* (2), 2 (August 1816), 339–372; *Ibid.* (2), 7 (1818), 155–181, 264–275, 367–382.

(21) Matagrin, A., "Chevreul et la bougie stéarique," *L'Industrie Chimique,* 12 (1925), 400–402.

(22) Thomson, Thomas, "Account of the improvements in physical science during the year 1815," *Annals of Philos.,* 7 (January 1816), 58–59.

(23) Cuvier, M. le Chevalier, "Royal Institute of France. Chemistry," *Ibid.* 7 (March 1816), 232.

(24) Fourcroy, A.-F., "Système des connaissances chimiques," Baudouin, Paris (Brumaire, An IX), 9 (1800), pages 33, 61, 250, 255, 296; Vol. 10, pp. 43, 56, 83, 302.

(25) Carpenter, W. L., "A treatise on the manufacture of soap and candles," E. and F. N. Spon, London (1885), pages 253–4.

(26) Riemer, H., "Hundert Jahre Fettsäure-Industrie," *Z. deutschen Öl- und Fett-Industrie,* 45 (1925), 576–578, 590–592.

(27) Hofmann, A. W. von, "M.-E. Chevreul," *Ber. d. deutschen chem. Ges.,* 22 (May 13, 1889), 1163–1169.

(28) Chevreul, M.-E., "Considérations générales sur l'analyse organique et sur ses applications," F. G. Levrault, Paris, 256 pages (1824).

(29) Berzelius, J. J., "Lehrbuch der Chemie," Arnoldische Buchhandlung, Dresden and Leipzig, 4th Edition, 9 (1840), 87–88.

(30) Havard and Vachon, "Les manufactures nationales. Les Gobelins, la Savonnerie, Sèvres, Beauvais," Georges Decaux, Paris (1889), pages 291–304.

(31) Chevreul, M.-E., "Mémoire sur l'influence que deux couleurs peuvent avoir l'une sur l'autre quand on les voit séparément," *Quarterly J. Sci.,* 1 (1830), 409–410; *Mém. Acad. Sci.* (Paris), 11 (1832), 447–520.

(32) Chevreul, M.-E., "Leçons de chimie appliquée à la teinture," *Pichon et Didier, Paris,* 3 Vols. (1829–1830).

(33) "Creatin, eine neue im Muskelfleisch enthaltene Substanz," *Liebig's Annalen,* 4 (1832), 293–294.

(34) Chevreul, M.-E., "Recherches sur la teinture," *Compt. rend.,* 2 (1836), 20–22, 292–296; 4 (1837), 2–12; 5 (1837), 167–177, 881–892; 10 (1840), 121–124, 631–640; 14 (1842), 783–785; 23 (1846), 954–956; 36 (1853), 981–987; 52 (1861), 327–332, 762–771, 825–833, 885–890, 937–942; 53 (1861), 981–985; 54 (1862), 877–880; 57 (1863), 133–141, 173–181.

(35) Chevreul, M.-E., "De la loi du contraste simultané des couleurs, et de l'assortiment des objets colorés . . . ," Pitois-Levrault, Paris (1839), 735 pages; "The principles of harmony and contrast of colours and their applications to the arts," George Bell and Sons, London, 3rd Edition (1889), 450 pages.

(36) Anon., "Foreign honorary members. M.-E. Chevreul," Proc. Am. Acad. Arts and Sciences, 24 (1889), 452–457.

(37) Chevreul, M.-E., "Traité de la baguette divinatoire, du pendule dit explorateur et des tables tournantes," Mallet-Bachelier, Paris (1854), 258 pages; "Sur une classe particulière de mouvements musculaires," *Compt. rend.,* 23 (December 14, 1846), 1093–1096.

(38) Jastrow, J., "Chevreul as a psychologist," *Sci. Mo.,* 46 (June 1937), 487–496.

(39) Chevreul, M.-E., "Histoire des connaissances chimiques," Gide et Guérin, Paris (1866), 479 pages.

(40) Chevreul, M.-E., "Résumé d'une histoire de la matière depuis les philosophes grecs jusqu'à Lavoisier inclusivement," Didot, Paris (1878); *Mém. Acad. Sci.* (Paris), 39 (1877), 322–757.

(41) Metzger, Hélène, "Eugène Chevreul. Historien de la chimie," *Archeion,* 14 (January–March 1932), 6–11.

(42) Chevreul, M.-E., "Sur l'explication de nombreux phénomènes qui sont une conséquence de la vieillesse," *Compt. rend.,* 80 (June 14, 1875), 1414–1419; *Ibid.,* 80, 1542–6 (June 28, 1875); 81, 5 (July 5, 1875); 81 (July 12, 1875), 61–64.

Book Reviews

Industrial Solvents, by IBERT MELLAN, M.SC. Reinhold Publishing Company, 330 West 42nd St., New York, N. Y., 1939. 480 pages, 291 figures. Price, $11.00.

Beginning with a brief discussion of theories and facts in connection with solvent action, vapor pressure and evaporation, viscosity, plasticity, inflammability and toxicity, the author presents extensive data concerning the common as well as the lesser known solvents. Classification of solvents is made according to their chemical constitution, *i. e.,* hydrocarbons and hydrogenated derivatives, halogenated hydrocarbons, alcohols, aldehydes, acids, ketones, ethers, esters; the properties, uses and other technical data are given for individual solvents under the foregoing classification. Inclusion of 126 tables and 291 charts, graphs and figures showing the properties of solvents and mixtures of solvents provides for a ready comparison of these substances under varying conditions. A chapter on plasticizers, giving their properties and uses, is also presented. The last of the 17 chapters of the book deals with methods of graphical expression and interpretation, particularly as these apply to the subject of solvents. Abundant literature references are given at the close of each chapter. Chemists and others who are concerned with solvents will find a wealth of information which may well make the book indispensable to them.—ARTHUR OSOL.