attempting to solve this problem quite a number of substances have been tried by the writer, such as plaster, gutta percha, wax, modeling clay, etc., and when the relief is not great and other conditions are favorable, some acceptable impressions have been made. In many cases, however, the shape of the mold is such that the opening, through which the cast must be drawn, is too small to allow it to pass, if the above substances are used, or the sculpturing, on the plates of a crinoid, for instance, is so delicate that in drawing a rigid cast out of a rigid mold, the finer markings are destroyed.

The properties which a substance must possess to give a reproduction of the form of a shell over which a natural mold was formed are: (*a*) ability to become liquid or plastic to such a degree that it can be forced into every crevice of the mold; (*b*) little or no shrinkage in cooling or drying; (*c*) elasticity, to insure its resuming its original form after the distortion necessary in drawing the cast out of the mold and (*d*) durability. Glue possesses most of these properties and gives satisfactory casts for some purposes, but they shrink after a day or two. A substance found very satisfactory when the molds are large and the ornamentation not too delicate is the so-called 'roller composition,' such as is used in making the ink rollers on printing presses. This composition, which can be purchased at any printers' supply house, is used as follows: Melt the composition in a double glue pot, to avoid burning, as a comparatively high temperature is needed. Heat the natural molds as hot as they can be handled and thoroughly oil with lard oil just before the composition is put in. Keep the mold hot for five or ten minutes after the composition is put in and stir the composition to allow any air bubbles to rise to the top, otherwise the mold may not entirely fill. After the composition is quite cold it can be removed from the mold and will last for a long time without shrinking. The writer has some casts that were made in 1901 from this substance and they are still in good condition.

When the molds are small and irregular with delicate sculpturing, the writer was unable to get rid of the bubbles or to obtain sharp impressions with the composition. Unvulcanized rubber, such as is used for making rubber stamps, was tried and by vulcanizing it in the molds, under pressure, very satisfactory casts have been made on which the surface markings are perfectly preserved. The process is as follows: Dust the inside of the mold and anything that is to come in contact with the rubber with talcum powder to prevent sticking. Cut the rubber in small pieces and, after cleaning in benzine, pack it tightly into the mold, until the mold is a little more than full; then put the mold in a screw clamp to press the rubber while it is vulcanizing and insure complete contact throughout the mold. The vulcanizing is accomplished by placing the mold in a drying oven heated to 135° or 140° Centigrade. The time required varies from half an hour to an hour or more according to the size of the mold.

Arthur W. Slocom
Field Museum of Natural History

PIERRE EUGÈNE MARCELLIN BERTHELOT[1]

France, for the third time in the space of a few months, mourns the loss of an illustrious savant. Again the nations of the world extend their sympathy. The heroes acclaimed were not martial victors over mankind, whose honors were bought in the price of blood, but men of lofty ideals who conquered nature, brought truth to light, instituted new industries and improved old ones, thus bettering man's physical, and through enlightened thought elevating his moral condition. Truly 'science guides humanity.'

Curie, Moissan, Berthelot! How varied the achievements of each, though each chose chemistry as a field of labor. How differently each worked out his task and how successfully.

Berthelot was born in Paris, October 25, 1827. His father was a physician, and the young man inherited not only a taste for a scientific career, but was schooled most effectually for it. His education at the Lycée Henri IV. developed the taste for historical research

[1] Read at the meeting of the New York Section of the American Chemical Society, April 5, 1907.

which won him his first prize and which later directed his attention to the early history of alchemy, the foundations of our science. His great erudition, his mastery of the Greek language and his love of exactitude in securing fundamental facts have given us nine volumes covering the several topics of these researches. They appeared from 1885–1893 and represent his maturer years when the activities and acquisitions of middle life were subjected to the criticism of a calm judgment. This phase of Berthelot's character is also seen in his frequent minor articles dealing with questions of education, morals and philosophy. He possessed a marvelous memory. He lived in a period when the sciences were rapidly developed. He obtained an extraordinary grasp of their relationship. He lived in an environment which was stimulating. He quickly understood what was fundamental in each, and so at eighty he was one of that type of men, now growing rare because of the intense specialization of our day, known as 'the encyclopedists.'

His first scientific memoir was presented to the Académie des Sciences the twenty-seventh of May, 1850. It described the liquefaction of gases by the pressure secured by the dilatation of mercury. He found that pressure alone would not reduce gases to the liquid state. From that date there was no cessation in his labors; he attended, as its perpetual secretary, a meeting of the Académie within an hour of his death, March 18, 1907.

He became assistant to Balard at the Collége de France and obtained his doctorate in 1854 with a sensational thesis on the synthesis of natural fats from glycerin and the fatty acids. A continuation of these researches, especially on the polyatomic alcohols led, in 1863, to the founding of the chair of organic chemistry at the Collége de France, that he might have the conditions for carrying out his personal ideas. He thus entered on a field of work which made him famous. *Analysis* had until this period been the chemist's aim. *Synthesis* now claimed his attention, and before the end of the nineteenth century wonders were indeed wrought, revolutionizing both philosophy and the arts.

By causing an electric arc to play between carbon electrodes in an atmosphere of hydrogen Berthelot secured the direct union of carbon and hydrogen with the production of acetylene. He then converted this by the action of heat into benzene, and from these passed to other syntheses. He also experimented with the silent discharge turning oxygen to ozone. With the induction current he combined acetylene and nitrogen to hydrocyanic acid. He obtained formic acid starting from carbon monoxide. By the use of sealed tubes in which chemicals were subjected to high temperature and pressure through considerable time he influenced them to combine, and also gave us a new general method in chemical manipulation. Six important works, in all nine volumes, attest his genius as applied to this department of his labors. His soul was in his work. When one contemplates how his experiments steadily progressed, effecting the grouping of the elements to form hydrocarbons, alcohols, acids, ethers, sugars, fats, thus simulating natural processes and building up compounds which up to his day were conceived as being solely the result of vital force, we little wonder that he became permeated with the idea that ultimately man would manufacture his own sustenance. In his address to the second International Congress of Applied Chemistry he says: "No one can deny that the day is perhaps near when the progress of chemistry will realize the manufacture of foods; in that day the cultivation of wheat and the raising of cattle will be exposed to the same destiny which has overtaken the culture of madder in our day." What perplexing situations will then arise with reference to the pure food law!

Berthelot took an active part in the great movement of the middle of the nineteenth century when the correlation of the sciences was discussed and the conservation of energy was established as the basis principle in physics. It was, therefore, natural that he should attempt to measure the energy developed by chemical reactions in definite terms. He labored indefatigably for thirty-five years in founding thermochemistry. The facts and principles are collected in two volumes published in 1897. They had been preceded by a work entitled 'Essai de Méchanique Chimique,' also in two volumes, 1879, followed by a volume, 'Traité pratique de Calorimétrie chimique,' 1893. His two volumes 'Sur la force des matières explosives,' 1883, was intimately connected with these other laborious researches in thermochemistry, and led to the discovery by others of smokeless powder. His work on the detonation of endothermic substances, such as cyanogen and acetylene, was followed by a research on explosive waves by which he elucidated many seeming contradictory facts. During the stirring times of 1870 Berthelot was made president of the scientific committee on defense; he afterwards became consulting member of the committee on powder and saltpetre, and president of the commission on explosives. In connection with these duties he devised many original methods of research.

His thesis that chemical phenomena are identical in animate and inanimate nature is thus expounded in 1855:

> we may, I say, claim to form anew all the substances which have been developed since the origin of things, to form them under like conditions in virtue of the same laws, by the same forces which nature brings into play in their formation.

And as a necessary sequel of his life's work we find him attacking the serious problems of the theory of agriculture and of biological chemistry. His 'Chimie Agricole,' in four volumes, and his 'Chimie Animale,' in two volumes, were both published in 1899.

The beautiful experiment farm at Meudon was the scene of his labors. One climbs the 'tour Berthelot' of over eighty feet in height and about one is the charming scenery of this suburb overlooking Paris. Here the master undertook his experiments on the influence of electricity on the growth of plants—generating this force or deriving it from the atmosphere. Here it was that the fixation of nitrogen was studied, a problem that has engaged the sturdiest minds, and here it was that he found that microbic life was the means of transferring atmospheric nitrogen to the living plant cell. The import of this phenomenon he tersely stated in saying: 'The soil is something alive!' To us the products of whose broad acres furnish enough for ourselves and to spare this discovery is of incalculable value. And yet this man, who instructs us in economic farming, does not hesitate to indicate how we may manufacture our own food and thus make ourselves independent of climatic influences.

The experimental investigation on plant life led to that of the animal organism. The principles of the production of heat in living beings was a topic quite germane to the investigations on thermochemistry.

While Berthelot found his greatest pleasure in experimentation in science he was fully alert to the intimate relations his investigations bore to the advancement of the liberal arts. He made his position in this regard quite clear to the audience he addressed at the second International Congress of Applied Chemistry:

> In chemistry, as in all studies useful to man, theory and practise are related to each other by indissoluble bonds.
>
> Senseless the theorist who, shutting himself up in the solitude of his egotistical personal views, affects to disdain the incessant applications of science to civilization, for the wealth and happiness of mankind!
>
> Senseless, no less senseless, the practical man who, satisfied with the knowledge acquired by his ancestors, out of admiration for their conservatism and tradition, opposes all progress, refuses to enlarge or change the processes used in his industry, that it may remain each day in complete accord witn the newest and most advanced theory!
>
> No science probably, more than chemistry, shows the necessity of this constantly renewed harmonious relation between practise and theory.

To-day the traffic of this great city, the incessant tide of travel, the lighting of its streets and homes, is effected by the aid of electricity generated by the burning of coal, and the specifications, under which the coal is bought, require that its calorific value shall be determined by the bomb calorimeter, invention of Berthelot, devised for theoretical purposes.

While a great theorist, he invariably had recourse to the experimental method for establishing his premises on a sure foundation. His temperament was that of an idealist, of a literateur, yet he foreswore in part his allegiance to science to serve his country.

France had honored him by the bestowal of many favors in recognition of his labors. Member of the Institut, 1900, grand officer of the Legion of Honor, 1886, perpetual secretary of the Academy of Sciences, 1889, succeeding Pasteur; but she also made him senator for life, 1881, gave him the portfolio of the Minister of Public Instruction and the Fine Arts, 1886, and made him Minister of Foreign Affairs, 1895, and he served his country with ardor.

The fiftieth anniversary of his first scientific publication was celebrated at the Sorbonne on November 24, 1901. Official delegates of foreign scientific societies voiced their congratulations. The French Academy, in a stirring discourse delivered by Moissan, 'tendered him its homage and thanked him for having given it a little more of truth.' All departments of the government were represented at this unique festival. A beautiful medal, by Chaplain, bore on its face the likeness of Berthelot and the inscription, 'La Synthese Chimique. La Science Guide l'Humanité.' On the reverse side the savant appears seated before his laboratory table, on which is placed now classical apparatus, while above are two figures typifying the inscription 'Pour la Patrie et la Verité,' and the president of the republic, M. Loubet, as he handed him this gift, kissed the dear old man in token of the love and gratitude of the nation and in behalf of his admirers of all other nations.

Berthelot was particularly happy in his surroundings. He was constantly in his laboratories in Paris, Meudon and elsewhere; it was here that his *positive* science claimed him. In late years he resided in the Institut, a palace formerly occupied by Cardinal Mazarin. It was here, surrounded by his family and friends, that he enjoyed his *ideal* science.

He married early in life a beautiful and charming woman by whom he had five children, the four sons surviving. The forty-five years of married life came to a dramatic end. Both husband and wife suffered from heart trouble. Berthelot, anxious about his partner's failing health, was ever watchful. He left her to be present at the semi-monthly meeting of the academy, but returned shortly —only in time, however, to be with the beloved one in her last moments. Shattered by the blow he was led to a couch in his work room. Alas! The strain had been too great and his own heart, weakened by age and the present anguish, ceased beating.

On March 25 this noble man and woman were given public obsequies. The great Pantheon was filled with the representatives of all branches of the government from President Fallières down. The edifice was crowded with distinguished men and women. As the two bodies rested on catafalques M. Briand gave an eloquent discourse. Afterwards the body of Berthelot was placed on another catafalque before the church and the army passed in review, saluting the great dead. In the afternoon the public did him homage, and towards evening he and his dear wife were placed in the crypt, not far from the remains of Victor Hugo.

In his peroration to the second congress Berthelot summed up his views of life; he fulfilled them in his own:

> Our duty is clearly outlined. Let us be doing, that is let us work! Work without cessation; let us try to be useful. Diligence and the love of mankind! This is the true aim of both home and public life.

CHARLES G. DOREMUS

THE GEOLOGICAL SURVEY AT JAMESTOWN

Under the general direction of Mr. David T. Day, a comprehensive exhibit of the geologic, topographic, and hydrographic work of the United States Geological Survey will be made at the Jamestown Tercentenary Exposition. The geologic data will be prepared by Mr. J. S. Diller, the topographic by Mr. H. M. Wilson, and the hydrographic by Mr. M. O. Leighton.

A pillar of mounted geologic maps will be one of the most important exhibits. It will include maps from 70 of the Survey's folios, representing areas throughout the United States.

Special maps have been prepared showing the general distribution of important economic mineral products east of the Rocky Mountains. These will include maps showing the