RESEÑA BIOGRAFICA

Nicolas Lémery

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RESUMEN. A Nicolas Lémery (1645-1715), uno de los químicos Franceses líderes de la segunda mitad del siglo diecisiete, se le considera haber escrito poco, pero haber enseñado mucho y muy bien a estudiantes muy calificados y haber popularizado la enseñanza de la química en Francia y Europa. Lémery sacó la enseñanza Francesa de la Química fuera de la tradición Parcelsiana hacia la filosofía Cartesiana atomística natural. Aun cuando Lémery no desarrolló ninguna teoría rigurosa de la materia, explicó las reacciones químicas en términos de forma y movimiento de partículas, tal como lo hizo Jean-Baptiste Sénac.

ABSTRACT. Nicolas L,mery (1645-1715), a leading French chemist of the second half of the seventeenth century, is considered to have written little but taught much and very well to highly qualified students, and of having popularised Chemistry in France and Europe. Lémery brought French chemical teaching out of the Paracelsian tradition into the Cartesian and atomistic natural philosophy. Although Lémery did not develop any rigorous theories of matter he explained chemical reactions in terms of particle shape and movement, the same as Jean-Baptiste Sénac did.

LIFE AND CAREER

Nicolas Lémery (Fig. 1) was born at Rouen, France, on November 17, 1645, the fifth of seven children born to Julien Lémery, Procurator to the Parliament of Normandy, and his second wife, Susan Duchemin. When Nicolas was eleven years old, his father died, leaving a widow and four surviving children.

Little is known about the initial education of Lémery but it is very possible that for his being the son of a Protestant that he began his studies at the Protestant school of Queville, in the *banlieu* of Rouen, his natal town.[1] Shortly before his fifteenth birthday he was indentured as an apprentice apothecary to his uncle Pierre Duchemin in Rouen. In 1666, after serving six years with his uncle, Lémery moved to Paris, where he became a boarding apprentice with Christopher Glaser (1628-1670). According to Bernard le Bouvier de Fontenelle (1657-1757):[2] "*Il s'adressa à Glaser, alors démonstrateur de chymie au Jardin du Roi, et se mit en pension chez lui pour être à une bonne source d''expériences et d'analyses. Mais il se trouve malheuresement que Glaser étoit un vrai chymiste, plein d' idées oscures, avare de ces idées-la-mêmes, et très-peu sociable. Lémery le quitta donc au bout de deux moins…*" (Lémery became a boarding apprentice with Glaser, then demonstrator in chemistry at the *Jardin du Roi*, to be near a good source of experiment and analysis. Unfortunately he found him to be a real chemist, full of obscure ideas,

***Fig. 1**. Nicolas Lémery (1645-1715). By permission of Edgar Fahs Smith Collection, University of Pennsylvania Library.*

covetous of these ideas, and unsociable... and left him after about two months). In addition to being demonstrator Glaser was the apothecary in ordinary to both King Louis XIV and his brother, the Duke of Orleans, and had also published a very successful chemical textbook, *Traité de la Chymie*.[3] Most importantly Glaser, like Lémery, was a Protestant, and could offer Lémery legal protection from the Catholic-dominated apothecaries guild of Paris.[4,5]

After quitting Glaser resolved to travel through France, to see those skilled in the art, one by one, and to compose science for himself from the diverse information that he would draw from his trip. Few details survive of this period in his life. Lémery traveled for six years; he is known to have visited Lyon and Geneva and to spend a considerable part of the time between 1668 and 1671 in Montpellier, where he resided with the young Protestant master apothecary Henry Verchant, where he had the convenience of working and, what was more important, the advantage of giving lessons to a number of his host's students. He did not fail to profit much from his own lessons and soon drew all the professors of the faculty of medicine and the curious of Montpellier, for he already had novelties to offer the most adept. In the summer of 1670 he was registered as a student of Pharmacy in Montpellier was permitted to attend the courses on "simples" and anatomy given at the Faculty of Medicine for such students.[2]

In 1672 he returned to Paris and worked in the laboratory of Bernardin Martin, the apothecary to Louis, the Prince of Condé and a Catholic convert who still had Protestant sympathies. Through his connection with Martin he was able to attend scientific salons at the homes of various private persons, such as the Abbé Bourdelot, physician to the prince, and the jurist Henri Justel (1620-1693), secretary of King Louis XIV (1638-1715). In this manner he associated with members of the household of the prince and was introduced to the main intellectual circles of Paris. The association with Martin allowed him not only to profit from the laboratory that his friend had at the mansion of Condé, but also to give courses in chemistry.[2]

By 1674 Lémery had saved enough money to secure his professional status by purchasing the office of the apothecary to the King and *grand prévôt* of France, and thus circumventing the legal obstacles in the path of a Protestant seeking admission to the guild of apothecaries of Paris. During the next seven years he established a highly successful pharmaceutical business in the *rue* Galande, where he lodged, specializing in patent medicines. Fontanelle (1715) described Lémery's laboratory in the following terms: "...less a room than a cellar, an almost a magic cavern, illuminated only by the light of the furnaces; yet the influx of people was so great that there was scarcely enough room for his operations. Even women, carried along by fashion, had the audacity to show themselves at such learned assemblies". In addition, he gained a considerable reputation as a teacher of chemistry by his private courses, which not only catered to the professional needs of pharmacy apprentices, but also attracted a large audience from fashionable Parisian society interested in semi-popular scientific expositions.[5] The most famous named heard his course in chemistry: François Bernier (1620-1688), Adrien Auzout (1622-1691, astronomer), Régis (physicist), Jacques Rouhalt (experimental physicist), and Joseph Pitton de Tournefort (1656-1708, botanist).[2] Lémery's initiative of giving private lectures was not a novelty. From the beginning of the seventeenth century on it had become very common for scientists to give private courses open to a fee-paying audience composed of interested students and general public. What made Lémery's course so remarkable was his way of teaching and the extraordinary successful notes he prepared for them,[6] which remained a bestseller during most of the eighteenth century, even after his death. According to Fontanelle (1715), the book sold like a work of romance or satire. Lémery brought French chemical teaching out of the Paracelsian tradition into the Cartesian and atomistic natural philosophy; he did not develop any rigorous theories of matter but explained chemical reactions in terms of particle shape and movement, the same as Jean-Baptiste Sénac (1693-1779) did (see Salts, below).

His reputation as an apothecary had also a considerable utility, as the preparations coming from his hands were in vogue. He made a prodigious sale of them in Paris and in the provinces; the sale of *magistere du bismuth* (magistery of bismuth, Spanish white, bismuth oxynitrate), of which only he had a successful recipe, alone, sufficed for all the expenses of his household. Magistery of bismuth, not a remedy but a cosmetic, was prepared by dissolving bismuth in nitric acid and precipitating out bismuth nitrate with salt water. It was also considered by some to be a remedy for chronic diarrhoea and cholera.[2]

For most of the second half of the sixteenth century France had been raged by bloody religious conflicts between Huguenots (Protestants) and Catholics. After Henry IV (1553-1610) ascended to the throne he decided to put an end to this fight and in 1598 he issued the so-called Edict of Nantes, in which Catholicism was declared the established religion of France but gave the Huguenots freedom to practice their religion, the right to work in any field or for the State, and to bring their grievances directly to the King. The Edict did not solve the religious problem but brought some tranquility to the country.

By 1680 mounting religious intolerance placed Lémery's legal rights as a practicing apothecary in jeopardy. Louis XIV, under the influence of a radical Catholic contingent at court gradually began to limit the professional liberties of Protestants and purge Protestant members of his household. In 1681 Lémery lost his position as apothecary to the King, being replaced by Denis Machereau. Unworried he continued to manage his apothecary commerce and to give chemical instruction until April 1683, when the Court ordered Nicolas Gabriel de Le Reynie (1605-1729), the Parisian lieutenant general de police, to close down Lémery's shop. Friedrich Wilhelm, the Elector of Brandenburg seized this occasion to propose, through Ezechiel Spanheim (1629-1710), his envoy to France, that Lémery come to Berlin where the Elector would create for him a commission as chemist. Lémery rejected this offer.

In 1683, in an attempt for a new kind of patronage, Lémery sent a copy of the 1681 edition of his *Cours de Chymie* to Robert Boyle (1627-1691), and then traveled to England alone, perhaps expecting to secure a position with King Charles II (1630-1685). He left his family in France and after much disappoint-

ment returned home after one-year abroad.[2] He now moved to Caen where in 1684 he took a medical degree (1684) at the local university in order to establish his professional status following the loss of his position as privileged apothecary. Lémery continued his teaching in increasing difficult circumstances until 1685 when Louis XIV revoked the Edict of Nantes and issued the Edict of Fointanebleau declaring Protestantism illegal. The new Edict meant that Protestants lost their professional and legal rights, for example, being forbidden to practice medicine. In spite of this set back, Lémery did not give up an continued to give courses in chemistry under powerful protection, one course for the two young brothers of Jean Baptiste Colbert, Marquis of Seignelay (1619-1683), Secretary of State, and another for Lord Salisbury, who did not believe it possible to obtain the same instruction in England. Only after he and his family converted to Catholicism was he allowed to reopen his laboratory and shop in Paris (1686) and to resume the practice of medicine. Le Reynie, the faculty of medicine, and the master and warden apothecaries opposed his request to practice apothecary again.[2] Lémery was forbidden to take apprentices, following opposition from the Paris guild of apothecaries on the ground that he had forfeited his right as an apothecary by qualifying as a physician.

After 1686 he began to rebuild his career, and his chemical writings eventually made a profound impact on the French scientific community. During the six years before his shop was closed in Paris, Lémery made significant additions to the second (1677), third (1679) and fourth (1681) editions to the *Cours de Chymie*, which became the most popular chemical textbook in France, passing through thirty editions by 1757, and being translated from French into Latin, German, Dutch, Spanish, Italian, and English. The English translation was done by Walter Harris (1647-1732), ordinary physician for Charles II.[5] Lémery devoted the next twelve years largely to pharmacy, publishing at the end of this period his *Pharmacopée Universelle*[7] and the *Traité des Drogues Simples.*[8]

In 1699 he was admitted to the reorganized *Académie des Sciences* as associate chemist, and in November of the same year he succeeded Claude Bourdelin (1621-1699) as *chimiste pensionnaire*. His subsequent scientific work was associated almost exclusively with the Academy. By the time Lémery joined the *Académie des Sciences* he was possibly the most famous and influential chemist in Paris, and according to Fontenelle,[2] the Secretary of the Academy, Lémery's reputation alone urged and obtained for him the place of associate chemist.

At the Academy, from which he received a salary, Lémery undertook two projects: one culminated in a memoir published in 1700 in which he hypothesized that sulfurous substances were the chemical causes of earthquakes, thunders, and volcanoes;[9] the other was an immense survey of the chemistry of the mineral known as antimony (stibnite), in search for useful medicaments. He presented it to the Academy in installments from 1700 to 1707 and culminated in the book *Traité de l'Antimoine* containing a description of all the changes to which the mineral was subject by dissolutions, sublimations or modifying its virtues. Lémery wrote in the introduction to the book "When I resolved to study antimony thoroughly in all its aspects. I believed it proper to begin with some reflections on the nature of this compound and the places where it occurs; on the names which were applied to it, and their diversity; on how to select it; and on its medicinal virtues".[10]

In 1676 Lémery married Madelaine Bellanger; they had six children, of whom two of the sons followed their father's interest in chemistry, and both became members of the Academy. The elder, Louis Lémery (1677-1743), succeeded his father as *chimiste penssionaire* in 1715. A younger son, Jacques Lémery (1678-1815) was an associate of the Academy from 1715, publishing several *memoirs* on phosphorus before his early death.[4]

Lémery was extremely influential in changing the French approach to chemistry and its distancing from alchemy. He spent his life first teaching the newer chemistry by simple experiments in his own room, and later to larger classes under the auspices of the Academy. Lémery was greatly influenced by Decartes's idea of matter as made up of particles in motion, and fire as resulting from terrestrial particles agitated by the "materia coelestis", i.e., fire is violent motion of minute particles (*corpuscles ignées*) about their common center. Decartes held that flame was directed upward because it contains a large amount of material coelestis, lighter than air. In Metzger's account Lémery became the primary figure in this profound revolution through his replacement of Paracelsian analogies, similitudes, and sympathies with the mechanical and, thus, conceptually superior Cartesian philosophy. [5]

Lémery did not discover new facts or added new theories; he just presented the contemporary ideas in a wonderful manner and made them attractive to a large public. His primary service to science was that of a teacher and textbook writer. Lémery not only taught practical chemistry, he also taught a more palatable theory when compared to alchemical or iatrochemical theories, but which was not much more solidly grounded and which seems now an isolated incident in the history of chemistry.[2]

Lémery had several attacks of apoplexy followed by paralysis of one side; this did not prevent his going out. He always attended the Academy for which he had conceived a strong attraction. He finally had to renounce assemblies and remain at home. He gave up his place as *pensionner*, which was given to the elder of his two sons. He was stricken by a last attack of apoplexy, which lasted six or seven days and died on June 19, 1715.[2]

Johann Gottlob Spitzley (1690-1750), a German pharmacist who had moved to Paris, took over the laboratory of Lémery.

SCIENTIFIC AND PROFESSIONAL ACTIVITIES

As mentioned above, Lémery did not contribute significantly to the experimental and theoretical advance of chemistry, his fundamental apportation was to the teaching and diffusion of this science, particular through his books and courses. The content of his books is important because it reflects the chemical ideas that were current at his time, and also his own interpretation of different phenomena.

Books

Lémery's teaching and textbook in chemistry, *Cours de Chymie*, owed their success to clear and entertaining presentation of chemistry in corpuscular mechanist terms.

The strong influence of his friends Pierre-Sylvain Régis (1632-1707) and François Bernier's (1620-1688, staunch partisans of Cartesian and Pierre Gassendi's (1592-1655), natural philosophy, led Lémery to drop the prevalent chemical French viewpoints of Paracelsus (1493-1541) and Johannes Baptiste van Helmont (1579-1644) and replace it by the Cartesian one. Nevertheless, his presentation of chemistry remaining closely tied up to the pharmaceutical goals of the teaching tradition established at the *Jardin du Roi*, and in practical content and organization his text follows very closely the world of his predecessors Nicolas Le Fèvre (1620-1674) and Glaser.

Cours de Chymie, while treating theory in a minor manner, did offer an explanation of chemical activity. It defined chemistry as "that art which teaches the separation of different substance encountered in a mixture," a definition that seems less satisfactory than those of some of Lémery's predecessors. Its "sensible principles," which he does not regard as elementary, he found by analysis to be mercury or spirit, salt, phlegm, and earth. These modest and, for the time, sensible observations are not, however, the basis of his explanations of chemical activity. That role is played by his doctrine of figured particles, which derived both from contemporary atomism and from René Descartes (1596-1650).

The book contains the following parts: Introduction treating the principles of chemistry, the vessels employed, the different bitumen, fires and their degrees, and terms used. The first part deals with minerals, metals and non metals and their combinations, the second part of vegetables, the third of animals, in this part the author gives a long description of the distillation of snakes, and of the head and brain of humans, urine, phosphorus, honey, wax, etcetera. At the end of the book it is found a list of the virtues of medicines, a list of the new procedures added to Lémery's course, and a list of the principal operations described. Distillation equipment corresponds to most of the plates, which contain also an explanation of the chemical characters of the epoch. The chemical course, as conceived by Lémery, does not present in practice new facts or notions, but it exposes very simply and with many details all the operations of chemistry, to make them easy to understand and to execute.[1]

In the preface to his book Lémery wrote that his intention was to describe each operation first as a simple recipe and only afterwards present a mechanical explanation for it. Early editions of Lémery's text described chemical operations and pharmaceutical recipes identical to the ones found in Glaser's text. Lémery also employed the same iatrochemical terms to explain chemical operations, but he insisted that all the entities he utilized in his explanations were material. Whereas Paracelsian iatrochemists described chemistry as *spagyria*, the purification and manipulation essences, Lémery defined chemistry as the "art of separating different substances that are encountered in the mixt." The term *mixt* described the compound state of naturally occurring bodies. He held that mixts were composed of five chemical principles: spirit, oil, water, salt (see below) and earth. "We mean by the principles of chemistry only those substances separated and divided as far as we are capable by our own efforts; and since chemistry is a demonstrative science, it only received as its foundation that which is palpable and demonstrative. It is as a matter of fact a great advantage to have principles so sensible and of which one may be reasonable assured".[5]

The first editions of his book followed very closely that of Glaser's but in a more verbose manner. Lémery began his discussion of chemical principles with the traditional "first principle" of mixt bodies, the "Universal Spirit". According to Powers[5] he did not deny the existence of the Universal Spirit but discarded the idea that it should be the basis for the understanding of chemical action. Instead, he defended the need to establish empirical and material principles. Similarly, when he considered the chemical principle, spirit, he maintained that chemical spirits were essentially material liquors. By defining certain non-material entities as unintelligible and transforming others into material substances, Lémery erected a boundary that distanced his chemistry from iatrochemical concepts that were antithetical to the mechanical philosophy.

According to de Milt,[11] the name of Glaser is perpetrated in old books on chemistry and pharmacy in the term Glaser's salt (impure potassium sulfate), which he first prepared by the heating of a fused mixture of niter and sulfur, and in the name of the mineral glaserite, natural occurring crystalline potassium sulfate. In practice it was he the one that first wrote a simple textbook of laboratory preparations in chemistry, the first book in chemistry in which substances are discussed from the perspective of their source and chemical relationship as mineral, vegetable, and animal substances, a practice that would be followed by many other famous chemistry teachers as Rouelle. In practice, by a twist of history this credit has been universally accorded to Lémery. As claimed by de Milt, a quick comparison of Glaser's recipes with those reported by Lémery in the early versions of his book, will show their strong similarity, with Lémery even using the same phrases in describing the operations and commenting on the product.

The ancient physicians, beginning with Hippocrates (460-377 BCE), were physicians, apothecaries, and surgeons. But subsequently medicine had been divided into three parts. Lémery, however, united all three for he was also a surgeon, and in his youth he had conducted surgical operations, in which he had succeeded very well, especially in bleeding. Because of his great knowledge of pharmacy and the actual practice of that art, he was the double of an ordinary physician. He proved it by his two great works *Pharmacopée Universelle* and *Traité des Drogues Simples*, for which he asked a copyright for 15 years, the judges believing it too short, granted him twenty.[2] These two books are alphabetically arranged list of composites and simples respectively, giving the source, doses, and therapeutic action of the various medicaments and represent a comprehensive dictionary of pharmaceuticals. Their chief rival was Pierre Pomet's (1658-1699) *Histoire Générale des Drogues*.[12]

Although in his book he divulged some chemistry secrets, he reserved some of them for himself. For example, an emetic, very gentle and more certain than the ordinary, and a mesenteric opiate with which he was said to have made surprising cures, and which none of those who worked under him had been able to discover.[2]

The *Pharmacopée Universelle* is a comprehensive collection of the compound remedies described in the books of pharmacy of all European nations. It is so arranged that a particular country, which, either by the differences of climate and temperament, or by ancient usages, used different remedies, could find, as in a grand pharmacopeia, the particular remedy, which best suited it. Of all the medicines that Lémery retained, of which the number is prodigious, he advises as to their virtues and gives the method of preparation, thus facilitating preparation or curtailing useless ingredients. For example, from the famous theriac of Andromachus (a universal protection against poisons), composed of sixty-four drugs, he omitted twelve, and that perhaps too few.[2]

The *Traité des Drogues Simples* is the basis of the *Pharmacopée Universelle*. The book about drugs carries an explanation of the names of the authors listed in the book, a bibliographic list of the authors that have specialized in particular drugs, an alphabetical list of the drugs, giving for each the Latin and other names, a description and their origin, two long tables of Latin and French names, and a collection of 25 plates, each one with 16 drawings.[1] The treatise is an alphabetical collection of all the materials, mineral, animal, and vegetable that enter into the accepted medicines. Since there were very few that were not involved, a good part of the treatise is natural history. One finds there the description of drugs, their virtues, how to choose them, and their history. As regards to foreign drugs, Lémery furnishes all available information. There were many drugs in common use at that time about which little was known. For example, he points out that the common opinion that true opium is a tear is false; also that coffee is not a bean.

Lémery knew all the remedies described well but trusted only but a few. He used chemicals only with a great caution, although he might have been inclined in their favor. He gave most of the analyses merely to satisfy the curiosity of physicians, and believed that as far as medicine was concerned, chemistry because if had to reduce mixtures to their principles, often reduces them to nothing.[2]

Lémery reported the use of the weight balance more explicitly and frequently than his predecessors, a fact reflected in the description of his recipes. They look like a cookbook, but frequently he gives an explanation of the gains and losses in weights. These explanations involve, when such are needed, the loss in volatile parts, the retention of fire particles, and the like.[2]

Chemistry

When Lémery began his chemical career during the 1660s, chemistry was a controversial subject among the French scientific establishment. Leading French natural philosophers saw the philosophy of the chemist as a rival to their own Cartesian mechanical philosophy and, thus, portrayed chemical methods as careless and questionable. For example, Jean-Baptiste Du Hamel (1623-1706), the secretary of the *Académie des Sciences*, attacked chemical theory in his *Philosophica Vetus et Nova de Usum Scholae Accomodata.*[10] In his discussion of the principles of physics, Du Hamel rejected the chemical elements on the ground that they did not occur in nature: they were products of the chemist's fire and undisciplined imagination. All chemical phenomena could be better explained in terms of the congregation, texture, and motion of corpuscles. Du Hamel claimed, "The spirit of chemistry is more confused, more hidden, whereas the spirit of physics, that is, the mechanical philosophy, is more distinct, more simple, more clear."

Lémery's last major work was the*Traité de l'Antimoine,*[11] which contained the results of his investigation into the properties and preparations of mineral antimony, was his chosen research topic on admission to the Academy of Sciences in 1699. It is a thorough and systematic collection of preparations of antimony arranged according to technique of preparation, very similar as those discussed in his *Cours de Chymie*. The book consists of a methodical review of all the chemical operations involving antimony, described in the context of more than180 recipes and experiments. The choice of antimony for such a work was in itself significant, because in alchemical lore antimony was believed to be a magnet for extracting philosophical mercury from other metals, and was thus a key component in a number of alchemical recipes for making the Philosopher's Stone. In the Preface of his work, Lémery acknowledged this connection, but he demarcated his approach to the subject from that of the alchemists. He stated that he included some "extraordinary preparations…when they have been clearly described," but that he "does not wish nor is able to undertake a great number of preparations recorded in enigmatic terms in the books of the alchemists".[5]

Lémery also published in the *Mémoires de l'Académie* papers on the physical and chemical explanations of subterranean fires, earthquakes, hurricanes, thunder, and lightning,[9] which he attributed to the spontaneous reaction of iron and sulfur, and on the analysis of camphor,[14] honey,[15] cow's urine,[16,17] and experiments on corrosive mercuric sublimate (mercuric chloride).[18]

The first edition of *Cours de Chymie* contained nothing on the phenomenon of luminescence. Lémery regarded light as "fire, which coming tempestuously from the sun in great rays, divide themselves into an infinite number of small rays, which cover the Universe, and turn weaker in proportion as they go from their Center…" In the year 1669 phosphorus was accidentally discovered in human urine as "a dark, unctuous, daubing mass" by Hennig Brandt, a merchant and alchemist of Hamburg, while searching for a liquid capable of transmuting silver into gold. This new material appeared in the second edition of *Cours du Chymie* where Lémery defines phosphorus as "A luminous matter distilled from Urine that has been fermented," and gives information about its discovery and detailed instructions for its preparation, together with the following remark: "It is observed, that those who commonly drink Wine their Urine doth scarce afford any phosphorus, probably because the Wine being spirituous, its luminous matter doth very easily evaporate; for a viscous substance is necessary to retain it, like that of Ale or Beer. Hence it is that they succeed in this operation in England, Flanders, and Germany, much better than in France." Lémery describes various properties of phosphorus, such as its solubility in turpentine or better in oil of cloves, which "corrects its offensive smell," its ability to set fire to paper or to bedclothes, and its luminosity: "After some experiments

made one day at my house upon the Phosphorus, a little piece being left negligently upon the Table in my Chamber, the maid making the bed took it up in the bedclothes she had put upon the Table, not seeing the little piece; the person who laid afterwards in the bed, waking at night..., perceived that the coverlid was on fire". The phosphorus itself can be used for writing when "the letters do seem to be a perfect fire" or "you may also mix carefully a little Phosphorus with a good quantity of Pomatum, and anoint such parts of the body with it, as you would have to appear luminous, without any danger, for the burning particles of the Phosphorus are tempered by the Pomatum".[14]

The second edition of Harris's translation devoted fifteen pages to the element, phosphorus, and four pages to the Hermetick phosphorus of Christian Adolph Baldouin (1632-1682). However, the third English edition (and succeeding ones), edited by James Keill (1673-1719) in 1698, gave a really extensive account (pages 684-732) of phosphorus, was well as Homberg's, the Bolognian and the Balduinian phosphors. This edition was entitled *A Course of Chymistry Containing and Easie Method of preparing this Chymical Medicins which are used in Physick*." Detailed descriptions (page 701) are given for making the "New Phosphorus of Monsieur Homberg" from fusion of "exactly one part Sal Ammoniack powdered and two parts of Quicklime quenched by the Air...If you strike this matter with the Hammer of Pestle, you shall presently see it on fire." A detailed description of the discovery of the Bolognian Stone and preparation of the Bolognian phosphor is given, together with various observations and conjectures regarding it. The chapter ends with a short account of "The Hermetick Phosphorus of Balduinis" which results from the fusion of a "mixture of Chalk, and the Acid Spirits of Aqua fortis, which makes it lucid...This phosphorus is in its effects very like to the Bolonian Stone, but that takes the Air much sooner than this Stone, because it contains abundantly more salt; its light does not endure so long as that of the Phosphorus which I have described before" (page 732).

Lémery's contribution to the knowledge of phosphorus is not based in experimental work but in his attempts to explain the origin of the light of various luminescent bodies. Some of his explanations follow: "from considering all the kinds of Phosphorus both Natural and Artificial, and from the Experiments that have been made upon them, I cannot but conclude that the general case of the light they give does proceed from a very great agitation of insensible parts; and whereas it is very probable that fire is only a very violent motion of little bodies round their center, the parts of our Phosphorus may be said to have received the same determination by the fermentation it that undergone; for Wood never shines in the dark until it becomes rotten, that is to say, until it has gone a sufficient fermentation to make its more subtle parts move nimbly around their center. The Bolonian Stone is not luminous until it has been calcined a certain time, in order to excite a motion of its parts, A Cat is not luminous throughout the whole body but if you rub its back against the hair, in the night, it will shine, because this irritates the Animal, and determines the Spirits to more strongly than otherwise they would do. We may also say, that the Eyes of a Cat are a kind of Phosphorus...The Viper being irritated darts forth its Tongue with so much quickness, that it appears all on Fire. Many little creatures, such as some kinds of Caterpillars and Woodlice do shine in the night, because they have a matter so exceedingly subtle towards their Tail, that it produces a sort of fire; and it is for the same reason of the motions of parts that Urine becomes luminous...That which gave occasion to the working upon Urine for the making of Phosphorus was, that in some little holes of the earth wherein there had been some standing puddles of Urine, a light has been observed to be seen at nights."

Lémery's explanation of luminous meat is very interesting. He wrote (page 698): "Sometimes there has been found in the Shambles pieces of Veal, Mutton and Beef, which do shine in the dark, though they have been but newly killed, and yet other pieces of the same kind dilled at the same time hall not shine at all. Nay, this very year was seen at Orleans, in a very temperate season, a great quantity of meat of this sort, some of it would shine all over and others it would shine only in certain places, in form of Stars...I conceive that this Phenomenon may be imputed to two causes, first, to the pasturage of the Beasts; for it is certain that in some Countries the herbs are more spirituous than in other...they have a disposition to the making of phosphorus Secondly, to these Beasts having been heated more than others in their driving upon the road, or else to their having been killed before they had sufficiently rested after their journey; for the spirits being put into a great motion, there by, do not every where lose it after the beast is killed, and so long as the spirits do continue their rapid motion, so long the Phosphorus is to be seen....But you will not fail to make me this Objection; If the Phosphorus does consist in a violent motion of the insensible parts, then stinking meat should be more luminous than that which was newly killed, because the smell proceeds from the separation of the principles of a mixt body by fermentation...there foe there must needs be a great motion in parts in stinking meat than in that which is fresh. I answer, that which makes the Phosphorus in meat newly killed is a matter much more active and more subtle than that which gives the ill smell to stinking meat; it is a remainder of the spirits which do run with prodigious swiftness through the body of a living creature in all its parts... In considering the light which appears upon the surface; of standing Urines, I have been led to think that there are often ferocities that settle in the bodies of sick persons, which might be in a condition to make kinds of Phosphorus, if they had but air enough to illuminate them..."[18]

It is important to note that Lémery held that the crushing of Bolognian stone must be made in a brazen mortar in order to have some success in preparing the phosphor. An iron mortar was particularly bad, as grinding in iron led to products that did not shine at all. He wrote: "So it seems there is something in Iron prejudicial to this quality and that on the contrary Brass is agreeable to the Nature of the Stone, As to the Marble, Porphyry and Crystal, without doubt they want the agreeable quality of the Brass but they do not make such a prejudicial impression as iron. This bad quality of the Iron, it may be, proceeds from the Vitriolick acid of this metal, which unites with the exalted Sulphur of the Stone, thereby fixing it so that it hinders the light from kindling it to make it shine."

Salts

During a long time in the development of chemistry the concept of salt remained obscure and ill defined. For the ancients, salts had the two characteristics dominant in marine salt: taste and solubility in water. These ideas about salts remained extant during the Middle Ages and on their basis completely different compounds such as marine salt, rock salt, ammonia salt (ammonium chloride), nitre salt (potassium nitrate), and vegetable salt (potassium tartrate) were grouped together. Vitriols (sulfates) were placed in a different class although they possessed the two essential characters of a salt (taste and solubility); some chemists did not consider them even as salts.[20]

The qualification of solubility in water led to the inclusion in the category of salts compounds having the most opposed properties, such as acids, and animal and vegetable matter. According to Joachim Becher (1635-1682), salt represented that which was fixed and incombustible, and in a certain manner, that which was mineral in bodies. George Ernst Stahl (1660-1734) defined salt in various confusing and contradictory terms and considered salts, acids, earths, and alkalis, to be analogues, and the same as Becher; he included under this term all chemical combinations. He accepted the analogy between acids, salts, and alkali, and thought that one could be converted into the other. In addition, he considered that salts were in some way, a stage in the transformation of alkalis into acids. According to Stahl and the ancient chemists, sulfuric acid was the only substance saline by itself, a unique saline principle that by the more or less intimate union that it achieved with other non saline substances, it was able to form a large number of saline substances, less simpler in structure. Although sulfuric acid was the only substance saline, it was a secondary principle, formed by the intimate contact between the two primitive elements of water and earth. Hence, salts should present properties intermediate between these two components. Thus, sulfuric acid had a density larger than water and smaller than earth and its crystallization at a temperature above that of melting ice (because of hydrate formation) was due to the tendency of the earth to solidify. Another proof of its resemblance to water was the fact that sulfuric acid was limpid and colorless.[20]

A curious detail is the way salts were visualized by Lémery and some of his contemporaries. The violent reactions generated by combining mineral acids with alkaline substance, such as potash, had traditionally been explained anthropomorphically in terms of the antipathy between acidic and alkaline substances. An acid salt was an assemblage of rigid particles, oblong and pointed at both ends. Why was this so? Acid salts were capable of dissolving most solid bodies, hence its particles had to be very rigid and sharp. An acid would burn the tongue without roughening it like an acrid salt; hence its particles were rigid and piquant. An acid always penetrated bodies easily: hence it was necessary that its two extremes be pointed and sharp. Contrary, alkalis were composed of earthy solid particles whose interstitial pores were so shaped as to admit entry of the spike particles of acid. Alkalis were those substances that reacted with acids producing ebullition or effervescence. The latter phenomenon was a result of the shape of the respective particles; when the sharp acid particles penetrated into the pores of the alkaline particles, they met with resistance with the resulting effervescence.[20,21] Lémery regarded salt as one of the five basic chemical principles, but the structure of any particular salt was determined by its acid and alkaline components. For Lémery, the acid-alkali reaction also served as the model for his general understanding of chemical activity, but in the *Cours de Chymie* he replaced the antipathy model with an explanation based on the shape of motion of acid and alkali corpuscles. Lémery postulated that, for reaction to occur between a particular acid and alkali, there had to be an appropriate relationship between the size of the acid spikes and alkaline pores. During a chemical reaction, the acid points broke off or were blunted inside the alkali pores, forming a salt. Lémery found that he could explain a wide range if chemical phenomena employing this model. For example, he explained the fact that some acids would not react with certain alkaline substances by positing that the points these acids had were of improper size or shape to penetrate the pores of the alkali. Similarly, the bubbling that occurred when a fixed alkali was added to an acid solution was caused by the dislodging of particles of fire (atomes ignées) that remained in the pores of the alkali after its synthesis through the combustion of plant matter. Lémery supported his rationalizations regarding particle shape with simple empirical arguments. The fact that acid particles possessed sharp points, he reasoned, was observed in the crystallization of acid salts, "all acid salts crystallize with edges", and "these crystals consist of points differing both in length and shape from one another, and this diversity must be attributed to the sharper of blunter edges of the different types of acids." Lémery noted that the points of acids may be verified simply by tasting any acidic substance, "I hope nobody will offer to dispute whether an acid has points or no, seeing every one experience does demonstrate it, they need but taste an acid to be satisfied for it, for its pricks the tongue like anything keen and finely cut.[6] These ideas were readily accepted because of the wide use of both organic acids and basic carbonates in chemical tests. This geometric atomism made Lémery markedly different from chemists both before and after him.[2]

Lémery suggested that all salts had a common origin: the fossil or gem salt (common salt), which was formed from the acid liquor flowing in the veins of the earth. The acid liquor penetrated into the pores of stones and after brewing for several years it formed this primordial salt. Fossil salt was the source of all salts, with the exception of saltpeter, which was generated from acidity directly from acid particles present in the atmosphere. He cautiously suggested, however, that the acid liquor responsible for the formation of fossil salt could also derive its acidity from the acid particles in the atmosphere. Terrestrial was absorbed by vegetables from the ground and could be transformed into three different kinds of vegetable salts: the acid or essential salt crystallized directly from the juice of plants; the volatile alkaline salt produced by distilling macerated and fermented seeds and fruits; and the alkaline fixed salt derived from the ashes of combusted plant materials. In other words, one type of salt was present in the living plant and the two other salts were the result of the action of fire on the plant. Lémery's discussion of vegetable salts led to con-

clude that fire destroyed and confounded most things it dissected, and there was no reason to believe that it yielded substances in their natural state. The virtue of fire as a tool in vegetable analysis became a subject of much discussion and debate in the Academy of Sciences in Lémery's lifetime and subsequently.

In spite of this and other curious interpretations, Lémery has been portrayed as the chemist who formulated the first successful system of chemistry based on the mechanical philosophy.

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