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The Eminent French Chemist Claude-Louis Berthollet (1748-1822) in the Literature between the 19th and 21st Centuries

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Abstract. Claude-Louis Berthollet (1748-1822) was one of the greatest French chemists of the eighteenth and the first 20 years of the nineteenth century. His life and scientific achievements were described in the literature published between the 19th and 21st centuries in different countries. The purpose of this article is to familiarize readers with the important events in the life of Berthollet and his research activities, in particular some of his experimental research results, as well as his selected publications. In addition, the names of authors of biographies or biographical notes about Berthollet, published in 1823-2018 are presented.

Keywords: C.-L. Berthollet, composition of ammonia, Natron Lakes of Egypt, The Society of Arcueil, France (XVIII-XIX century).

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La chimie fut toujours l'occupation principale de sa vie;
et il aima et protégea tous ceux qui la cultivèrent
(Chemistry was always the principal occupation of his life;
and he loved and protected all who cultivated it)
Jacques-Alphonse Mahul (1795-1871) [1]

1. THE IMPORTANT EVENTS IN BERTHOLLET'S LIFE

Claude-Louis Berthollet (1748-1822) (Fig. 1) was born in Talloire (Upper Savoy) on December, 9, 1748, and he was the son of Louis Berthollet, a notary and castellan, and Philiberte Donier. He first studied at a nearby college in Annecy and then at a college in Chambery.

To continue with his education, he began medicine studies at the University of Turin. He graduated from the Turin University in 1770. After two years he continued his education in Paris, where he became a naturalized French citizen. He attended the courses of lectures on chemistry given by Augustin Roux (1726-1776), Jean-Baptiste-Michel Bucquet (1746-1780), and

Figure 1. Claude-Louis Berthollet (1748-1822) (Public domain, from reference 3).

Pierre-Joseph Macquer (1718-1784). Then he worked as physician-in-ordinary at the household of Louis Philipe I (1725-1785), Duke of Orléans. He was assigned to the service of Charlotte-Jeanne Béraud de La Haye de Riou (1738-1806) known as Madame de Montesson, the second wife of the Duke of Orléans.

Berthollet continued his medical practice for several years. In 1778 he began the process of obtaining a medical degree from the Paris Faculty of Medicine. In 1779, he successfully defended his doctorate thesis *De lacté animalium médicamentose.* In the same year he married Marguerite-Marie Baur. Their only son, Amédée-Barthélemy, was born in 1780.[2]

Since 1784, he, as a well-known chemist, was administrator at the Gobelins Manufactory in Paris. He worked in it as a dyeing director.[4]

In 1792, he was appointed as one of the Mint's Commissioners, into the processes of which he introduced significant improvement. Two years later, he was named member of the Commision of Agriculture and the Arts.[5]

On November 9, 1794, Berthollet was chosen as Professor of Chemistry at the Normal School in Paris. His Chemistry Course included 12 oral lectures delivered from January 26 to May 11, 1795, and an additional lecture delivered on June 10, 1801, in which he described the progress of chemistry since 1795. The lectures were included in the seven volumes (I-VI and IX), published in Paris in a new edition in the years 1800-1801, under the title *Séances, Des Écoles Normales, Recueillies Par Des Sténographes, Et Revues Par Les Professeurs*. They were published in 2006.[6] The French historian of science Bernadette Bensaude Vincent, who was one of the authors of the edition of Berthollet's lectures wrote about them as follows: "The structure of Berthollet's course (…) reveals both an interest in the theoretically arcane and a concern for practical aspects of the social practice of chemistry. In his first programmatic lecture Berthollet advocated the view of technological applications and improvements deduced from theoretical understanding. He intended to provide the broad deductive framework on which basis future teachers would have to develop more particular aspects according to their audience."[7]

Berthollet, Napoleon and the Egyptian campaign

Berthollet was a friend and confident of Napoleon Bonaparte (1769-1821), and he was one of the scientists who went with Napoleon to the Egyptian campaign, which began with the landing at night at Marabout on July 1, 1798, after a 40-day journey. Another person who accompanied Napoleon's army in this campaign was the mathematician Gaspard Monge (1746-1818), a good friend of Berthollet. "A staff of over a hundred savants, mechanics, engineers, architects, authors, and interpreters, among others, Monge, the mathematician, and Berthollet the chemist, accompanied the general to make a scientific conquest of the East, to prepare the way for the projected colonization, and to open up the indispensable waterways".[8]

In one of the letters received by the German naturalist Alexander von Humboldt (1769-1859) on April 30, 1798, the astronomer and mathematician Johann Karl Burckhardt (1773-1825) informed him about the preparations for the Egyptian campaign and Berthollet's participation in it. "Berthollet, Bonaparte's physician, is director in chief of the scientific department of the expedition, in which are included the following antiquarians:" Dominique-Vivant Denon (1747-1825), Edme-François Jomard (1777-1862), François Pouqueville (1770-1838)], and François-Michel de Rozière (1775-1842). "On the 30th Floréal (May 19, 1798) the fleet weighed anchor from Toulon, and Bonaparte's campaign in Egypt was openly declared".[9]

In Egypt Napoleon, the commander in chief, formed *L'Institut d'Égypte* (The Institute of Egypt) on the 3d Fructidor, 6th year (20th August, 1798) in Cairo. The Institute was divided into four scientific sections which

were named "Mathematics", "Natural Philosophy", "Literature and the Fine Arts", and "Political Economy". Berthollet belonged to the section "Natural Philosophy" which was composed of ten members. There were among them, Nicolas-Jacques Conté (1755-1805), inventor of the graphite pencil and the Conté crayon, the chemist Hippolyte-Victor Collet-Descotils (Descostils) (1773-1815), the mineralogist Déodat de Gratet de Dolomieu (1750-1801), whose name is given to the Dolomites in the Italian Alps and the mineral dolomite, and the naturalist Étienne Geoffroy Saint-Hilaire (1772-1844).[10]

One of Berthollet's assignments in Egypt was "finding fuels for bread ovens, substitutes for hops in the brewing of beer, and raw materials for the manufacture of gunpowder."[11] On January 23, 1799, he and the mathematician Joseph Fourier (1769-1830) were the main civilian members who took part in the five-day expedition under the command of General Antoine François Andréossy (1761-1828) to explore the Valley of the Natron Lakes.[12] They were six lakes below sea level, situated on the borders of the North-Western Desert, some 45 miles [72 km] to the north-west of Cairo. The Natron lakes were bordered by a thick crust of natron[3] (a mineral form of sodium carbonate decahydrate).[14] The aim of this visit was to prospect the possibility of exploiting the deposits of soda, a product of economic importance in the nitre refining for the gunpowder production. In addition, the observation of the efflorescence of soda was a significant point in Berthollet's construction of his system of chemical affinities. One of the most important essays provided to *L'Institut d'Égypte* by him in 1800, contained conclusions from the study of the nature of some phenomena presented by the Natron lakes.[15]

Bonaparte's Egyptian campaign ended when Napoleon abandonment of his command leaving behind his troops on August 21, 1799. He decided to return to France suddenly and secretly. Bonaparte chose only Monge and Berthollet among the scientists to accompany him on a dangerous journey back. His army remained two more years in Egypt before returning to France.

The Austrian historian August Fournier (1850-1920), Professor of History at the University of Vienna, in the biography of Napoleon, wrote: "On the night of August 21st, Napoleon set sail, accompanied only by a few devoted followers, Berthier, Lannes, Marmont, Murat, Andréossy, Bessières, Duroc, Monge, Berthollet, Bourienne, and a few hundred soldiers of the Guard."[16] The supreme command of Napoleon's army in Egypt was entrusted in writing to General Jean-Baptiste Kléber (1753-1800).

Berthollet's career in the years 1799-1814 was staggering. After the Egyptian campaign on December 1799, he became a senator in the French Senate under the Napoleon Bonaparte as a first Consul. On 14th June 1804, Napoleon made him Grand Officer of the Legion of Honour and Count. On May 14, 1806 he became *titulaire de la sénatorerie de Montpellier* (holder of the Senatorie of Montpellier). Berthollet received a Great-Croix of the Order of the Reunion on April 3, 1813, and after the restoration, Louis XVIII created him a peer of France on June 4, 1814. On April 23, 1820, the *Académie des Sciences, Belles-Lettres et Arts de Savoie* (Academy of Sciences, Belles-Lettres and Arts of Savoy) elected Berthollet its member in recognition of his merits.

Disease and Premature Death of Berthollet's Son

Amédée Berthollet lived only 31 years. Hugh Colquhoun in his article *On the Life and Writings of Claude-Louis Berthollet* briefly described his suicide in 1811. This event to the last degree embittered the life of his father. "The promising son of Berthollet, in whom his happiness was wrapped up, was unhappily subject to the fearful malady of despondency, which at length grew upon him to such a degree that neither the rank and fame of his father, nor the affection of his aged mother, nor the respect of friends, nor the honours which science seemed to hold out to his young years, could prevent it from gaining a gloomy mastery over his soul. He grew weary of his existence, and at length his life became wholly unsupportable. Retiring to a small room, he locked the door, closed up every chink and crevice which might admit the air, carried writing materials to a table, on which he placed a second watch, and then seated himself before it. He now marked precisely the hour, and lighted a brazier of charcoal beside him. He continued to note down the series of sensations he then experienced in succession, detailing the approach and the rapid progress of delirium, until, as time went on, the writing became confused and illegible, and the young victim dropped dead upon the floor!"[17]

Berthollet and the Society of Arcueil

Berthollet and the mathematician Pierre-Simon Laplace (1749-1827) were a founding members of the Society of Arcueil.[18] The name of this Society comes from the village in which they lived as neighbors. A very complete laboratory was created there in Berthollet's house, suitable for carried out experiments in physics and chemistry. On June 7, 1809, the members of the Society of Arcueil were the physicists Jean-Baptiste Biot (1774-1862) and Étienne-Louis Malus (1775-

1812), the naturalist Alexander von Humboldt, the chemists Joseph-Louis Gay-Lussac (1778-1856), Louis-Jacques Thénard (1777-1857) and H.-V. Collet-Descotils, the Swiss botanist Augustin Pyramus de Candolle (1778–1841), Berthollet and his son, Amédée.[19] In 1813, Malus, Collet-Descotils and Amédée Berthollet were not on the list of members of the Society. However, the names of new members appeared. There were among them the physicist Dominique-François Arago (1786-1853), the mathematician Siméon Denis Poisson (1781-840), the chemists Pierre-Louis Dulong (1785-1838), invited by Berthollet in 1811[20], Jacques-Étienne Bérard (1789-1869) and Jean-Antoine Chaptal (1756-1832).[21] This Society has published three volumes of very valuable memoirs. The first volume appeared in 1807.[22] The second volume was published in 1809[23] and the third in 1813.[24] The activities of the Society have been partially discontinued for political reasons in 1816.[25]

Death of Berthollet

The article, written by Hugh Colquhoun, appeared three years after Berthollet's death. He wrote about Berthollet's disease and the last several months of his life as follow: "His end was worthy of the manner in which he had lived. A fever, apparently slight, left behind it a number of boils, which were soon followed by a gangrenous ulcer of uncommon size. Under these he suffered for several months with the greatest constancy and fortitude. His complaint was of that desperate nature which medicine cannot cure. He himself, as a physician, knew the extent of his danger, felt the inevitable progress of the malady, and steadfastly but calmly regarded the slow advance of death. During all this time, his mental suffering, and the loss of his son, engrossed him more than his bodily pain. At length, after a tedious period of suffering, in which his equanimity had never once been shaken, Berthollet died on the 6th of November, 1822, at the advanced age of 74 years. He has left the faithful partner of his joys and griefs, to mourn his loss in desolate, childless widowhood."[26]

Etienne Pariset in *Éloge De M. Le Comte Berhollet* described Berthollet's meeting with his friend Jean-Antoine Chaptal the day before Berthollet's death. Berthollet felt his death approaching. "Mr. Chaptal, alone with him, sought to reassure him on his situation. "I give you thanks," Berthollet answers tenderly hollet taking his hand; but your goodness is deceiving. Herself trying to abuse me. I feel death approach, and I feel it with joy. Why should I fear it? I have never done any harm, and at the last hour I carry off the consoling idea that the friendship which has attached us to each other for more than forty years, and of which you have given so much proof to me and mine, has never been troubled for a moment. That it is given to few men to render of themselves a such a testimony! This one is enough for me: I do not want others."[27]

At the funeral of Berthollet, Joseph-Louis Gay-Lussac and Louis-Jacques Thénard spoke at his grave alternately. Jean-Antoine Chaptal honored his memory on the tribune of the Chamber of Peerst, the upper house of the French Parliament.[28]

2. BERTHOLLET'S WORKS

Berthollet's published works are extremely numerous and have a very diverse character. The list includes 88 papers.[29] The earlier ones were mainly published in various volumes of *Mémoires De L'Académie Royale Des Sciences*. He published many papers in the *Annales De Chimie*, and the *Journal De Physique, De Chimie, D'Histoire Naturelle Et Des Arts*. His papers can also be found in various volumes of the *Mémoires De Physique Et De Chimie, De La Société D'Arcueil.*

In 1787, Berthollet jointly wrote *Méthode De Nomenclature Chimique* with Louis-Bernard Guyton de Morveau (1737-1816), Antoine-Laurent Lavoisier (1743-1794) and Antoine-François de Fourcroy (1755-1809).[30]

Berthollet's research interests also focused around chemistry and technology of dyes. In the years 1798-1799, he published two articles in *La Décade Egyptienne, Journal Littéraire Et D'Économie Politique* about the use of safflower[31] and henna[32] in Egypt.

He was the author of a two-volume book entitled *Essai De Statique Chimique* (1803) published in Paris.[33,34] This book has also been published in Italian[35,36] and English a year later.[37,38] The German edition was published in 1811.[39,40] In this work he was the first to define the new notions of chemical equilibrium and mass action. The rules he proposed was one of the first and important contributions to the study of predicting chemical reactions.

Amédée Berthollet (1780-1811), the most persistent and succesful young man, collaborated with his father in preparing a second edition of the *Éléments De L'Art De La Teinture*. These books have been revised, corrected, increased and was published in the year XIII (1804) under names C. L. and A. B. Berthollet.[41,42] "The names of the father and son stand together on the title-page as joint authors, and the natural affection which must ever subsist between two persons connected by so intimate a degree of relationship was in their case strengthened and exalted by a community of feeling, and by kindred pursuits."[43]

3. BERTHOLLET'S GREATEST DISCOVERIES

The year 1785 marks an important event in the career of Berthollet. It was then he formally renounced the phlogiston theory and supported Lavoisier's theory of combustion. In the same year, he discovered that after heating ammonium nitrate to about 150°C, it decomposes into water and *diminished nitrous air* (laughing gas, nitrous oxide). The following reaction took place: $NH_4NO_{3(aq)} = N_2O_{(g)} + 2H_2O_{(l)}$.[44]

One of Berthollet's greatest discovery was the determination of the composition of the alkaline gas (volatile alkali), which the Swedish chemist Torbern Bergman (1735-1784) gave the name ammonia in 1782. Berthollet's paper in this topic appeared in the *Journal De Physique, De Chimie, D'Histoire Naturelle, Et Des Arts* on May 1785. In addition, he read his paper *Analyse De L'Alkali Volatil* before the Academy on June 11, 1785.[45] In 1786 he sent a letter to an English natural philosopher Henry Cavendish (1731-1810) regarding the analysis of alkaline gas (ammonia). He wrote, among others: "I have used a method that is more direct and more exact: 1.7 cubic inches of alkaline gas when decomposed yielded 3.3. cubic inches of a gas… I exploded four measures of this gas with an excess of vital air [oxygen] in the eudiometer of Mr. Volta, and this experiment showed that this gas contains 2.9 of inflammable gas of water [hydrogen] and 1.1 of mephitic air [nitrogen]."[46]

Amédée Berthollet repeated the ammonia analysis previously carried out by his father. His results were reported to the *Institut de France* on March, 24, 1808. He found that "*1 litre de gaz ammoniac fournit, par sa décomposition, 2litres, 046 d'un mélange de gaz dans lequel il entre 1 litre, 545 d'hydrogène et o litre, 501 d'azote* [the decomposition of 1 liter of ammonia gas yielded 2.046 liters of a mixture that contained 1.545 liter of hydrogen and 0.501 liter of nitrogen]". From these he calculated that "*d'ammoniaque contiennent 18,87 d'hydrogène et 81,13 d'azote* [ammonia contains 18.87 per cent hydrogen and 81.13 per cent nitrogen]."[47] The corresponding modern values are 17.76 and 82.24 per cent.

Berthollet also determined the composition of *prussic acid* (hydrogen cyanide) in 1787[48], and *sulphuretted hydrogen* (hydrogen sulfide) in 1789.[49] A year earlier, he the first prepared in a pure state potassium chlorate (*Berthollet salt* – potassium chlorate) by passing chlorine into hot *aqueous potash* (potassium hydroxide). The reaction is expressed by the following equation: $6KOH_{(aq)} + 3Cl_{2(g)} = 5\ KCl_{(aq)} + KClO_{3(aq)} + 3H_2O_{(l)}$[50] This discovery was of great importance to obtain a more powerful kind of gunpowder replacing nitre. In 1788, he also determined the usefulness of chlorine and potassium hypochlorite as bleaching agents.[51]

Berthollet's greatest theoretical discovery was his innovative theory of the chemical affinities.[52] This was a theory that intended to replace the theory of the elective affinities and that gave support to the law of the variable proportions of combination in opposition to Joseph-Louis Proust's (1754-1826) law of the fixed proportions of combination. In the second volume of the English edition of his *Essai De Statique Chimique*[53], he "definitely challenged Proust's opinion that invariable proportions and constant attributes characterise all the true compounds of art or of nature, and that the chemist is no more able to control these proportions and attributes than he is able to control the affinities which the elements possess for one another. (…) Berthollet maintained that the elements can combine in variable proportions, constancy of composition being secured only when some constituent crystallises out, or distils out from the mixture of interacting substances."[54]

Berthollet held a lengthy controversy with Proust about the law of fixed (definite) proportions.[55] At the end of the first decade of the nineteenth century, the discussion between them ended in favor of Proust. The law of definite proportions was recognized by most chemists. At the begining of the 20th century, it turned out that the Proust's law is not universally true, because solid compounds with slight variations in chemical composition were discovered. In memory of Berthollet they were called "Berthollide compounds" or "non-stoichiometric compounds".[56]

4. BIOGRAPHIES OR BIOGRAPHICAL NOTES ABOUT CLAUDE-LOUIS BERTHOLLET PUBLISHED IN 1823-2018

In the nineteenth century, some authors wrote biographical notes or biographies of Berthollet. There was among them Jacques-Alphonse Mahul, who wrote his biographical note in 1823[57], and Hugh Colquhoun, who published his article about him in *Annals Of Philosophy.*[58]

In 1823, the *Biographical Memoir of Count Claude-Louis Berthollet* was also published in the *The Edinburgh Philosophical Journal* by an anonymous author.[59] The physician and historian of medicine Giovanni Giacomo Bonino (1791-1858), wrote Berthollet's biographical note in his book entitled *Biografia Medica Piemontese* in 1825.[60] The naturalist George Cuvier (1769-1832) wrote about him in his *Éloge Historique De M. Le Comte Berthollet*.[61] Berthollet's life and activities was also described by historian of chemistry Thomas Thomson

(1773-1852) in his book entitled *History of Chemistry*.[62] Jomard wrote his biography in the book entitled *Notice Sur La Vie Et Les Ouvrages de Cl. L. Berthollet*.[63] The Perpetual Secretary of the Royal Academy of Medicine Etienne Pariset (1770-1847) wrote about him in his *Éloge De M. Le Comte Berthollet*.[64] A Berthollet's biographical note written by Cecilia Lucy Brightwell (1811-1875) was published in 1859.[65] Ferdinand Hoefer (1811-1878) described his life in *Histoire de la Chimie*.[66]

At the beginning of the second decade of the 20th century, Berthollet's life and work was described by Ethel Roberts.[67] The chemist James Cambell Brown (1843-1910), professor at the University of Liverpool, published a biographical note about him in 1920.[68] Doctor of Medicine and Pharmacy Pierre Lemay (1893-1962) and historian of chemistry Ralph Edward Oesper (1886-1977) briefly described the life and discoveries made by Berthollet in their article published in *Journal of Chemical Education*.[69] The chemist and historian of chemistry James Riddick Partington (1886-1965) wrote Berthollet's biographical note in his book published in 1962.[70] Berthollet's full-length biography was written by Michelle Sadoun-Goupil (1934-1993) in 1977. In this book, the first eleven chapters are devoted to the life of the scientist. The second part of this monograph is devoted to the work of Berthollet. The structure of the book also includes notes, very extensive systematic bibliography and complete index of names and persons. In addition, this work is enriched by list and summary of the content of Berthollet's correspondence with many scientists.[71] Another author Nicole Fleury-Heusghem wrote about Berthollet in her article published in *Bulletin de la Sabix*.[72] His biographical note was published at the *Vestnik Rossiyskoy Akademii Nauk* in 2003[73] , as well as by Jaime Wisniak in 2008.[74] In 2018, Valentin Matyukhin also wrote about him on the 270th anniversary of his birth.[75]

5. CONCLUSION

Claude-Louis Berthollet was one of the greatest French chemists of his time. He was elected a member of *L'Académie Royale Des Sciences* (The Royal Academy of Sciences) in Paris on April 21, 1780.[76] *La Société Hollandaise Des Sciences à Haarlem* (The Dutch Society of Science in Haarlem) elected him a foreign member in 1786.[77] On December 17, 1787, he was elected a national member of *L'Académie Royale Des Sciences De Turin* (The Royal Academy of Sciences of Turin).[78] On April 30, 1789, he became a Fellow of *The Royal Society of London*.[79] On April 30, 1790, he was elected an honorary member of *The Literary and Philosophical Society of Manchester*.[80]

Berthollet's death did not go unnoticed. In the nineteenth century, books and articles with his biographical notes or biographies were published in France, Great Britain, and Italy. In the twentieth and twenty-first centuries, his life and discoveries were described by authors of books and articles from Great Britain, United States, France, Russia, Israel and Lithuania.

For Cecilia Lucy Brightwell, Berthollet was an outstanding chemist. In her book, she wrote: "Among the illustrious men renowned for their devotedness to the cause of science, and its application to the practical purposes of civil and social advantage, M. Berthollet holds a high and honourable place. His name has long been known in every part of Europe, and will ever rank among those of the distinguished chemists of the nineteenth century".[81]

Berthollet, while he was still alive, was considered by his colleagues a great chemist. The mathematician Joseph Fourier, spoke about him in a letter sent in January/February 1795, to his teacher Claude-Louis Bonard (1757-1819)[82], a professor of mathematics at the *École Centrale* in Auxerre, with "*Notes on the École Normale and the persons attached to that Estabilishment*". He also listed some of the personality traits characteristic for him: "Berthollet is the greatest chemist we have, either in France or aboard: he is not old and has a rather ordinary appearance. He only speaks with the most extreme difficulty, hesitates and repeats himself ten times in one sentence, and seems to find difficulties in the least important details of an experiment. His course is only understood by those who study much or understand already, and it is for this reason that he displeased the great majority. His course is a collection of useful dissertations, very wise and very learned; he has much difficulty in making himself understood".[83]

Hugh Colquhoun wrote about his friend as follows: "There are some men whose characters combine those estimable qualities which render them the delight of their friends, with those splendid talents which destine them to form an era in that branch of study to which they devote themselves, – men, whose memories should live from age to age endeared to the cultivators of science, a generous incitement to their ardour as students, and a bright example to their conduct as philosophers. Such a friend, and such a man of genius, (…) nor needs there much of prophecy to pronounce that such also shall long be the hallowed memory of Claude-Louis Berthollet".[84]

In the months of February and March 1819, the Swedish chemist Jöns Jacob Berzelius (1779-1848) stayed in Berthollet's country-house in Arcueil. He carried out many experiments there in Berthollet's laboratory.[85] In the years 1810-1822, correspondence was exchanged

between them. It consisted of 42 letters, including 21 from Berzelius and the same from Berthollet. Berzelius sent the last letter to him on November 18, 1822, twelve days after his death.[86]

After Berthollet, not only his papers and letters survived. In addition, several of his lithographic portraits were produced by French lithographers in various years of the nineteenth century. His portraits were made by Julien-Léopold Boilly (1796-1874)[87], Ambrosie Tardieu (1788-1841)[88], Ephraïm Conquy (1808-1843)[89], Alphonse Boilly (1801-1867)[90] and François-Séraphin Delpech (1778-1825).[91] Pierre Lemay in his article presented a portrait of Berthollet when he received the honorary title of Peer of France.[92] Noteworthy is the fact that the oil painting painted by Théobald Chartran (1849-1907) in 1886-1889, depicting Berthollet in the Lavoisier laboratory, is a decoration of the peristyle at the Sorbonne University in Paris.[93]

In addition to lithographic portraits and oil painting, the bust of Berthollet was commissioned by the state to the French sculptor Raymond Gayrard (1807-1855). The plaster bust was modeled, after Berthollet's death. Then it was carved in marble. Its height is 59.0 cm, width 40.0 cm and depth is 25.0 cm. There is an inscription on the plinth: C. L. BERTHOLLET / SC. 1748-1822. The sculptor's name as well as date appear on the right: GAYRARD ST / MDCCCXXIII.[94]

On August 25, 1844, a monument was erected by subscription in honor of Berthollet in Annecy, not far from Talloires, the village where he was born. Four years earlier, King Charles Albert of Savoy (1798-1849) agreed to build the monument and was one of the subscribers. The clay model of the statue was made free by French sculptor baron Carlo Marochetti (1805-1867). Its founder was Louis Claude Ferdinand Soyer (1785-1854). In 1863, the Berthollet statue made of bronze was transported to the open space in a public garden and placed on a new pedestal ornamented with basreliefs erected by architecte Henri Poreaux (1818-1893). On four basreliefs we can see Berthollet introduce itself to the physician Théodore Tronchin (1709-1781) in Paris; Berthollet receives the Duke of Orléans in his laboratory; Berthollet and Bonaparte in front of the pyramids in Egypt; Berthollet sits at the bedside of sick Monge in Saint-Jean-d'Acre. In 1944, by order of the occupation authorities, the statue was intended to be melted, but it survived and took its place again on October 12 of that year.[95] Upon the front of the statue was the following inscription, in French, "CLAUDE-LOUIS BERTHOLLET, / HIS FELLOW CITIZENS AND ADMIRERS. / MDCCCXLIII [1843]. / BORN IN TALLOIRES, THE IX [9] DECEMBER MDCCXLVIII [1748]. / DIED AT ARCUEIL, NEAR PARIS, THE VI [6] NOVEMBER MDCCCXXII [1822])." Inscriptions, in French, on the opposite side of the pedestal inform the reader about the education of Berthollet, his work, and honors, for example "PROFESSOR OF CHEMISTRY IN THE L'ÉCOLE NORMALE / AND IN THE L'ÉCOLE POLYTECHNIQUE, / MEMBER OF THE ACADEMY OF SCIENCES OF THE INSTITUTE. / HE CREATED WITH LAVOISIER THE CHEMICAL NOMENCLATURE."[96]

Berthollet was a very talented chemist and went down in history as the author of numerous chemical discoveries. One of the asteroids (12750 Berthollet) discovered by the Belgian astronomer Eric Walter Elst (b. 1936) on February 18, 1993, was named in his honour.[97] It is also worth emphasizing that the genus of South American plants *Bertholletia*, to which is assigned the species the Brazil nut (*Bertholletia excelsa* Humb. & Bonpl.) in the family Lecythidaceae[98], was estabilished in 1808[99], and named after Berthollet. "The genus *Bertholletia* was so named by Humboldt and Bonpland in honour of Berthollet, of which the grandest species – *Bertholletia excelsa* – is the Juvia or Brazil-nut tree, one of the largest trees of the primeval forests in the central parts of Brazil, bordering the Amazon, In its colossal fruit are contained those hard three-cornered nuts, similar in flavour to the cocoa-nut, which abound in all the fruit markets of Europe, and pass among the ignorant as palm-nuts."[100]

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