Georges-louis Leclerc Buffon Comte De | Encyclopedia.com

(*b*. Montbard, France, 7 September 1707; *d*. Paris, France, 16 April 1788)

natural history.

Buffon was the son of Benjamin-François Leclerc and Anne-Cristine Marlin, both of whom came from the bourgeoisie. Anne Marlin was related to a rich financier whose money enabled Benjamin to become, in 1717, lord of Buffon and of Montbard, and *Conseiller* to the Burgundian parliament. Georges-Louis, the naturalist, was the eldest of five children, of whom three others entered the church, where two of them rose to high position. In 1717 the Leclerc family moved to a fine house in Dijon, where they occupied an important place in society. The intellectual life of that provincial capital was active but not oriented toward science at that particular time.

Georges-Louis was a pupil at the Collége des Jésuites in Dijon from 1717 to 1723. He was only an average student, although he distinguished himself by his bent for mathematics. His father undoubtedly wanted him to have a legal career, and he did study law in Dijon between 1723 and 1726. As early as 1727, however, he became friendly with the young Swiss mathematician Gabriel Cramer, a professor at the University of Geneva. In 1728 he went to Angers, where he may have studied medicine and botany, as well as mathematics, with Père de Landreville, professor at the Collège de I'Oratoire. A duel forced him to leave Angers in October 1730, and he embarked on a long journey through Southern France and Italy with a young English nobleman, the duke of Kingston, and his tutor, Nathaniel Hickman, an obscure member of the Royal Society.

Buffon returned to France in 1732 and, despite his father's opposition, obtained his mother's fortune (she had died during his absence). At the same time, he began to make himself known in Parisian political and scientific circles. His first works on the tensile strength of timber were written at the request of the minister of the navy, Maurepas, who was seeking to improve the construction of war vessels. Buffon's *Mémoire sur le jeu du franc-carreau*, a study of probability theory, contributed to his admission to the Académie Royale des Sciences as adjoint-méchanicien on 9 January 1734. For six years he divided his time among finance (his fortune soon became considerable); research in botany and forestry (he wrote several dissertations and translated Stephen Hales's *Vegetable Statiks* into French in 1734); and mathematics (he wrote dissertations and in 1740 translated Newton's *The Method of Fluxions and Infinite Series* into French from the English translation of the original Latin manuscript, published in 1736 by John Colson). At the end of this time he also became interested in chemistry and biology and conducted some microscopic research on animal reproduction. In June 1739 he became an académicien-associé and transferred from the mechanical to the botanical section. That July, through the influence of Maurepas, he succeeded Dufay as intendant of the Jardin du Roi.

Each spring, from 1740 on, Buffon left Paris for Montbard, to administer his estates, continue his research, and edit his writings. His robust constitution allowed him to adhere to a well-organized schedule: he arose at dawn and spent the morning at his work, and the afternoon at his business affairs. For fifty years, Buffon spent the summer on his estate, returning to Paris in the fall. At the end of this time, he had doubled the area of the Jardin du Roi, enriched its collections, and enlarged its buildings considerably; moreover, he himself had become rich, having been showered with pensions and having increased his landholdings. He had published the thirty-six volumes of *Histoire naturelle* and was famous throughout Europe and even in America; he was a member of the Académie Royale des Sciences, the Académie Francaise, the Royal Society of London, and the academies of Berlin and St. Petersburg, among others. Catherine II bestowed gifts upon him, and Louis XV made him Comte de Buffon and commissioned the sculptor Augustin Pajou to do a bust of him.

In 1752 Buffon, scarcely inclined to be governed by his feelings, nevertheless married for love. His wife, Françoise de Saint-Belin-Malain, a pretty girl of twenty, was of gentle birth although poor. Mme. de Buffon led a retiring life and died young, in 1769, leaving a five-year-old son. Toward the end of his life, Buffon developed a Platonic affection for the wife of the famous Swiss financier Jacques Necker. His most serious personal worries were caused by his son, an unstable spendthrift, who was to die on the guillotine during the Terror.

In addition to his scientific works, Buffon published several speeches delivered before the Académie Française, of which only one—*Discours sur le style*, delivered on 25 August 1753, the day of his acceptance—is significant. This speech is of interest not only for the literary ideas that it contains, but also for its embodiment of Buffon's conception of the value of the original work of the scholar, which, according to him, lies less in the discovery of facts than in their organization and presentation.

Buffon's works may be grouped into two main categories, the *Mémoires*, presented to the Académie des Sciences and the *Histoire naturelle*. The *Mémoires*, which appeared between 1737 and 1752, deal with mathematics (theory of probability), astronomy (the law of attraction), physics (optics), plant physics (tensile strength of wood), forestry, physiology, and pyrotechnics (aerial rockets). Buffon considered most of these subjects again in the Supplément à *l'Histoire Naturelle* (I, II, IV, 1774–1777; for a complete description, see Hanks, pp. 275–281).

Buffon's works appeared in many editions throughout the eighteenth and nineteenth centuries; the list, with an analysis of each original edition, may be found in the bibliography by E. Genet-Varcin and J. Roger (1954). One must emphasize the importance of the chronology of the various texts, since Buffon's ideas evolved considerably as he assembled his great work.

It was probably his interest in mathematics that first drew Buffon toward science. He was reputed to have already discovered Newton's binomial theorem by himself when he was twenty years old; at this time he became associated with Gabriel Cramer. Their correspondence deals with all types of problems— mechanics, geometry, probability, theory of numbers, differential and integral calculus.

Buffon's first original work was the memoir *Sur le jeu de franc-carreau*, which introduced differential and integral calculus into the theory of probability by extending the latter to the field of surfaces. The study of the Petersburg paradox led Buffon to certain moral considerations that he clarified in the *Essai d'arithmétique morale* (published in the Supplément, IV, 1777). In that work, as well as in his memoirs on the tensile strength of wood and his research in the cooling of planets, Buffon obviously considered mathematics more as a means of clarifying the idea of reality than as an autonomous and abstract discipline, His reasoning is that of an engineer, a moralist, or a philosopher, rather than that of a pure mathematician. This is why he refused to accept the notion of infinity, which he considered to be no more than *une idée de privation*, and why, in his discussion with Clairaut on the law of attraction (1745), he insisted that a simple force ought to be represented by a simple algebraic formula. It was this "realism" that prevented him from becoming a pure mathematician. In fairness, however, it must be pointed out that, with Clairut and Maupertuis, he was one of the first French disciples of Newton.

A philosopher as well as a naturalist, Buffon throughout his works made observations on the nature and value of science. His most important writing on this subject is the *Discours sur la manière d'étudier et de traiter l'histoire naturelle* (1749), but the *Théorie de la terre* and the *Histoire des animaux* of the same date are also significant.

Breaking with the spirit of his time, Buffon attempted to separate science from metaphysical and religious ideas. As a disciple of Locke he denied idealistic metaphysics, stating that mental abstractions can never become principles of either existence or real knowledge; these can come only as the results of sensation. He thereby also brushed aside Plato, Leibniz, and Malebranche. He also rejected teleological reasoing and the idea of God's direct intervention in nature (herewith abandoning Newton): "In physics one must, to the best of one's ability, refrain from turning to causes outside of Nature" (*Théorie de la terre, preuves*, art. V).

Buffon was particularly sensitive to the disorder that appeared to rule nature: "It would appear that everything that can be, is" (*Sur la manière*…). He found fault with classifiers, especially Linnaeus, for trying on imprison nature within an artificial system, since man cannot even hope to understand nature completely. Only in mathematics is there evident truth because that particular science is man-made. Physics deals only with the probable. Buffon did not fall into the pit of skepticism, however. He thought that man should construct a science not based on certitudes but derived from nature.

As time went on, Baffon's ideas changed. In the two *vues de la nature* (Histoire naturelle, XII, XIII, 1764 and 1765), he seems to admit that man is actually capable of ascertaining fundamental laws of nature, and in the *Époques de la nature* (1779) he shows how the history of the earth obeys these laws.

Buffon viewed the study of the earth as a necessary prerequisite to zoology and botany and in 1749 wrote the *Histoire et théorie de la terre*, followed by nineteen chapters of *preuves*. He returned to this subject in the *Supplément* (II, V) and devoted his last work to mineralogy.

In the *Théorie de la terre*, Buffon, like most of his contemporaries, states neptunian views. He has no hesitations about animal or plant fossils or the stratigraphic principles set forth by Sténon. The presence of sea fossils and sedimentation of rock beds indicate former submersion of present continents, of which the topography, shaped under the water by ocean currents, is diminished by erosion and the action of the waters that carry earth to the sea. No explanation of the reemergence of formerly submerged continents is offered. Buffon resolutely refused to accept the notion of catastrophes, including the biblical flood, which many of his contemporaries upheld. He offered several hypotheses (such as subsidence of the ground or earthquakes) to account for the displacement of the sea, but he insisted that such changes "came about naturally". Buffon was an advocate of "real causes": "In order to judge what has happened, or even what will happen, one need only examine what is happening… Events which occur every day, movements which succeed each other and repeat themselves without interruption, constant and constantly reiterated operations, those are our causes and our reasons" (*Oeuvres philosophiques*, p. 56A).

On the other hand, in his cosmogony Buffon also rejected slow causes. According to Newton, planets and their movement had been created directly by God: this was the only possible explanation of the circumstance that the six planets then known revolved in the same direction, in concentric orbits, and almost on the same plane. Buffon's cosmogony was designed to replace the intervention of God by means of a natural phenomenon, a “cause whose effect is in accord with the laws of mechanics”. He then hypothesized that a comet, hitting the sun tangentially, had projected into a space a mass of liquids and gases equal to 1/650 of the sun’s mass. These materials were then diffused according to their densities and reassembled as spheres which necessarily revolved in the same direction and on almost the same plane. These spheres turn on their own axis by virtue of the obliquity of the impact of the comet on the sun; as they coalesced, they assumed the form of spheroids flattened on both poles. Centrifugal force, due to their rapid rotation, tore from these spheres the material that then became the satellites of the new planets.

This cosmogony, one of the first based on Newtonian celestial mechanics, is remarkable for its coherence. It is founded on the then generally accepted idea that comets are very dense stars, at least at their nucleus. But it also raises some serious difficulties, which were brought to light by Euler: according to the laws of mechanics, the material torn from the sun should have fallen back into it after the first revolution; the densest planets should be farthest away from the sun; and the planetary orbits should always coincide at the point of initial impact. Finally, as early as 1770, it became apparent that comets had a very low density, which destroyed the impact hypothesis.

Not only did Buffon retain this hypothesis, but he also made it the basis for a new theory of the earth, published in 1779 as *Époques de la nature*. In 1749, in the *Theéorie de la terre*, Buffon juxtaposed a plutonian cosmogony and a neptunian theory of the earth. In 1767, however, Buffon became convinced (probably by Jean-Jacques d’Ortous de Mairan’s *Dissertation sur la glace* of 1749 and Nouvelles recherches sur la cause générale du chaud en été et du froid en hiver of 1767) of the existence of a heat peculiar to the terrestrial globe. He saw it as the residue of primitive solar heat and immediately undertook large-scale experiments on the cooling period of globes of varying materials and diameters. He extrapolated the results of his experiments, published in Volumes I and II of the Supplement, in order to calculate the time required for the cooling of the earth and other planets.

The *Époques de la nature* presents a plutonian history of the earth—a piece was torn from the sun, the mass took form, the moon was torn from it by centrifugal force, and then the globe solidified during the first epoch. In the course of this solidification, primitive mountains, composed of “vitreous” matter, and mineral deposits were formed (marking the second epoch). The earth cooled, and water vapors and volatile materials condensed and covered the surface of the globe to a great depth. The waters were soon populated with marine life and displaced the “primitive vitreous material”, which was pulverized and subjected to intense chemical activity. Sedimentary soil was thus formed, derived from rocks composed of primitive vitreous matter, from calcareous shells, or from organic debris, especially vegetable debris such as coal. In the meantime, the water burst through the vaults of vast subterranean caverns formed during the cooling period; as it rushed in, its level gradually dropped (third epoch). The burning of the accumulated combustible materials then produced volcanos and earthquakes, the land that emerged was shaped in relief by the eroding force of the waters (fourth epoch). The appearance of animal life (fifth epoch) preceded the final separation of the continents from one another and gave its present configuration to the surface of the earth (sixth epoch) over which man now rules (seventh epoch).

This work is of considerable interest because it offers a history of nature, combining geology with biology, and particularly because of Buffon’s attempt to establish a universal chronology. From his experiments on cooling, he estimated the age of the earth to be 75,000 years. This figure is considerable in comparison to contemporary views which set the creation of the world at 4000–6000 b.c. In studying sedimentation phenomena, however, Buffon discovered the need for much more time and estimated a period of as long as 3,000,000 years. That he abandoned that figure (which appears only in the manuscript) to return to the originally published figure of 75,000 years, was due to his fear of being misunderstood by his readers. He himself thought that “the more we extend time, the closer we shall be to the truth” (*Époques de la nature*, p. 40).

The *Époques de la nature* contains a great deal of mineralogical material that was restated and elaborated in the *Histoire naturelle des minéraux*. Buffon’s work on mineralogy was handicapped by its date of appearance, immediately before the work of Lavoisier, Haüy, and J.B.L. Romé de I’Isle. Although it was soon out of date, Buffon’s book does contain some interesting notions, particularly that of the “genesis of minerals”, that is, the concept that present rocks are the result of profound transformations brought about by physical and chemical agents. Buffon did not have a clear concept of metamorphic rocks, however. It is also noteworthy that Buffon was one of the first to consider coal, “the pyritous and bituminous matter”, and all of the mineral oils as products of the decomposition of organic matter.

In the second volume of the *Histoire naturelle* (1749), Buffon offers a short treatise on general biology entitled *Histoire des animaux*. He takes up this subject again in the *Discours sur la nature des animaux (Histoire naturelle*, IV [1753]) and in a great many later texts. Although he deals with nutrition and development in these, he is most interested in reproduction. This, of course, was a question much discussed at that time, but for Buffon reproduction represented the essential property of living matter.

Buffon rejected the then widely accepted theory of the preexistence and preformation of embryos. He spurned its dependence on the direct intervention of God and held it to be incapable of explaining heredity. He further refuted the connected theories of ovism and animalculism because no one had actually seen the egg of a viviparous animal and because spermatozoa were not “animalcules”, but rather aggregates of living matter that were also to be found in female sexual organs. On the latter point Buffon was the victim of erroneous observations made during the course of a series of experiments conducted, with Needham’s help, in the spring of 1748.

The essentials of Buffon's theory of reproduction may be found long before this date, however. He set forth the principle of epigenesis because it exists in nature and allows heredity to be understood. Buffon revived the ideas of certain physicians of the late seventeenth century who were faithful to an old tradition, and assumed that nutritive matter was first used to nourish the living being and then was utilized in the reproduction process when growth was completed. After being ingested, the nutritive matter received a particular imprint from each organ, which acted as a matrix in the reconstitution of that organ in the embryo. But Buffon departs from his predecessors on two points: (I) he sees the action of these molds as capable of modifying the nutritive substance internally, due to "penetrating forces" (conceived of on the basis of Newtonian attraction), and (2) he considers nutritive material to be already living. Buffon also conceived of living universal matter composed of "organic molecules", which are a sort of living atom. His thinking was therefore formed by a mechanistic tradition, complicated by Newton's influence, and balanced by a tendency toward vitalist concepts.

This tendency diminished as time passed. In 1779, in the *Époques de la nature*, Buffon dealt with the appearance of life on the earth—that is, the appearance of living matter, or organic molecules. He explained that organic molecules were born through the action of heat on "aqueous, oily, and ductile" substances suitable to the formation of living matter. The physicochemical conditions that made such formation possible were peculiar to that period of the earth's history; consequently spontaneous generation of living matter and organized living creatures can no longer occur. Buffon thus resolved the contradiction in his text of 1749, in which he maintained that while living matter was totally different from the original matter, nevertheless "life and animation, instead of being a metaphysical point in being, is a physical property of matter" (*Oeuvres philosophiques*, 238A–B).

In 1749 Buffon saw nothing short of disorder in nature. The only notion that corresponded to reality was the idea of species, to which he gave a purely biological definition: "One should consider as being of the same species that which by means of copulation perpetuates itself and preserves the similarity of that species" (*ibid., Histoire des animaux*, p. 236A). If the product of such mating is sterile, as is the mule, the parents are of different species. Any other criterion, particularly resemblance, is insufficient "because the mule resembles the horse more than the water spaniel resembles the greyhound" (*ibid., Histoire naturelle de I'âne*, p. 356A).

If the species exists in nature, the family does not: "… one must not forget that these *families* are our creation, we have devised them only to comfort our own minds" (*ibid*., p. 355B). All classification is therefore arbitrary and has no merit other than convenience. Buffon violently attacked Linneaus and praised Tournefort. He himself followed an order that he believed to be "easier, pleasanter, and more useful" than any other, without being any more arbitrary— "taking the objects that are the most interesting to us because of their relation to us, and gradually moving toward those that are more distant" (*ibid., Sur la manière*… p. 17B). In the order Buffon followed, the dog follows the horse because, in reality, the dog "is accustomed, in fact, to [so] follow" (*ibid*., p. 18A). Buffon's order is formed by a philosophical bias rather than by science.

For Buffon to admit the concept of family, it would have to correspond to a reality. Thus:

If these families really existed, they could have been formed only through the crossing, successive variation, and degeneration of original species; and if one once concedes that there are families of both plants and animals, that the donkey is of the horse family and only differs because it has degenerated, one could also say that the monkey is a member of the family of man and is merely a degenerated man, that man and monkey have a common origin just like the horse and mule, that each family… has only one founder and even that all animals came from one single animal which, with the passage of time, by simultaneously perfecting itself and degenerating, produced all of the races of the other animals [*ibid., Histoire naturelle de I'âne*, p. 355B–356A].

Because he rejected the concept of family and denied the value of making classifications, Buffon also rejected, at the beginning of his work, the hypothesis of generalized transformism offered by Maupertuis in 1751 in the *Système de la nature*. Buffon's theory of reproduction and the role he attributes to the "internal mold", as the guardian of the form of the species, prevented him from being a transformist.

This same theory of reproduction did not prevent Buffon from believing in the appearance of varieties within a species, however. Buffon believed in the heredity of acquired characteristics; climate, food, and domestication modify the animal type. From his exhaustive research for the *Histoire naturelle des quadrupèdes*, Buffon came to the conclusion that it was necessary to reintroduce the notion of family. But he attributes to this word—or to the word *genus*, which he also uses—a special meaning: a family consists of animals which although separated by "nature", instinct, life style, or geographical habitat are nevertheless able to produce viable young (that is, animals which belong biologically to the same species, e.g., the wolf and the dog). What the naturalist terms species and family, then, will thus become, for the biologist, variety and species. Buffon was thus able to write, in 1766, the essay *De la dégénération des animaux*—in which he showed himself to be a forerunner of Lamarck—while he continued to affirm the permanence of species in the two *Vues de la nature* (1764–1765) and *Époques de la nature* (1779).

Buffon's final point of view concerning the history of living beings can be summarized as follows: No sooner were organic molecules formed than they spontaneously grouped themselves to form living organisms. Many of these organisms have since disappeared, either because they were unable to subsist or because they were unable to reproduce. The others, which responded successfully to the essential demands of life, retained a basically similar constitution— Buffon affirms unity in the plan of animals' composition and, in variations on that plan, the principle of the subordination of organs. Since the earth was very hot and “nature was in its first stage of activity”, the first creatures able to survive were extremely large. The earth’s cooling drove them from the North Pole toward the equator and then finally caused their extinction. Buffon offered this in explanation of the giant fossils discovered in Europe and North America, which he studied at length (to the point of becoming one of the founders of paleontology). The organic molecules which were left free in the northern regions formed smaller creatures which in turn moved toward the equator, and then a third and fourth generation, which also moved south. Originating in Siberia, these animal species spread out to southern Europe and Africa, and toward southern Asia and North America. Only South America had an original fauna, different from that of other continents.

In the process of migration, the species varied in response to environment. There are few varieties of the large mammals because they reproduce slowly. The smaller mammals because they reproduce slowly. The smaller mammals (rodents, for example) offer a large number of varieties because they are very prolific. The same is true of birds. Going back to the basic types, quadrupeds may be divided into thirteen separate species and twenty-five genera. But Buffon was not a transformist, because he believed that these thirty-eight primitive types arose spontaneously and simultaneously from an assembly of organic molecules.

As a naturalist and as a paleontologist Buffon was forced to uphold the variability of animal form; as a biologist he had to admit the permanence of hereditary types. He was never able to resolve this difficulty, although he stated the problem quite clearly.

“Love of the study of nature”, Buffon wrote, “implies, in the human mind, two attributes which appear to be opposed, the broad outlook of an ardent spirit that grasps everything in one glance and the minute attention of a hard-working instinct that concentrates on only one point” (*ibid., Sur la manière*… p. 7A). Buffon liked to deal with great biological and zoological problems, but his work is above all a detailed description of quadrupeds, birds, and minerals. To him, the “true method” is “the complete description and exact history of each thing in particular” (*ibid*., p. 14B). This “history” goes beyond simple morphological description:

The history of one animal should be… that of the entire species of that particular animal; it ought to include their procreation, gestation period, the time of birth, number of offspring, the care given by the mother and father, their education, their instincts, their habitats, their diet, the manner in which they procure food, their habits, their wiles, their hunting methods [*ibid*., 16A–B].

Physiological characteristics allow species separated by habitat or mores to be grouped together biologically; conversely, the habitats or habits of each animal permit distinctions between species or varieties. The description should also include a study of animal psychology, in particular that of social species (as monkeys and beavers). Buffon’s method became more and more comparative, and in some works, he drew up genealogical tables of the varieties of each species. Buffon tried always to observe personally the animals he discussed. Nevertheless, pure description became boring to him, and he entrusted it to his associates.

In the *Histoire naturelle de I’homme*, published in 1749 (*Histoire naturelle*, II, III), and in many of his other works as well, Buffon studied the human species by the same methods that he applied to animal species, including the psychological, moral, and intellectual life of man. At the same time that he proclaimed the absolute superiority that the ability to reason gives man over animals, he demonstrated how the physiological organization and development of the sensory organs make reasoning possible. Throughout his work Buffon specifies that reason developed only through language, that language grew out of life in society, and that social life was necessitated by man’s slow physiological growth (since man is dependent on his mother long after birth). For the same reason, the elephant is the most intelligent of animals, while social life makes beavers capable of astonishing work.

It was, therefore, as a physiologist and as a naturalist that Buffon studied man and his reason; and it was as a biologist that he affirmed the unity of the human species. Aside from a few safe formulas, theology never comes into the picture. According to the *Époques de la nature*—and, in particular according to its manuscript—it is clear that the human species has had the same history as the animals. Buffon even explains that the first men, born on an earth that was still hot, were black, capable of withstanding tropical temperatures. Through the use of the resources of his intelligence and because of the invention of fire, clothes, and tools, man was able to adapt himself to all climates, as animals could not. Man is therefore the master of nature; and he can become so to an even greater degree if he begins to understand “that science is his true glory, and peace his true happiness” (*Époques de la nature*, p. 220).

Buffon’s work is of exceptional importance because of its diversity, richness, originality, and influence. Buffon was among the first to create an autonomous science, free of any theological influence. He emphasized the importance of natural history and the great length of geological time. He envisioned the nature of science and understood the roles of paleontology, zoological geography, and animal psychology. He realized both the necessity of transformism and its difficulties. Although his cosmogony was inadequate and his theory of animal reproduction was weak, and although he did not understand the problem of classification, he did establish the intellectual framework within which most naturalists up to Darwin worked.

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