Georges-Louis LECLERC, Comte de BUFFON
b. 7 September 1707 - d. 16 April 1788

Summary Author of the monumental *Histoire Naturelle*, Buffon also introduced several original ideas in probability and statistics, notably the premier example in "geometric probability" and a body of experimental and theoretical work in demography.

Georges-Louis Leclerc was born in Montbard, Burgundy, the son of a councillor in the Burgundian Parliament, who took the title of seigneur de Buffon in 1717. Following his secondary studies at the Jesuit college in Dijon, he studied for a degree in Law, possibly with the aim of following in his father's footsteps, but his interests were more inclined to mathematics. It would appear that he had read the *Elements* of Euclid, the *Analyse des infiniment petits* of the Marquis de l'Hôpital, and rediscovered Newton's binomial formula. His early correspondence with Gabriel Cramer (1704-1752), professor of analysis and geometry at the University of Geneva dates back to 1727. Buffon acknowledged that he owed to Cramer "part of his first knowledge" of mathematics, in particular the calculus of probabilities. During a visit to Geneva in 1731, Cramer acquainted him with the problem first posed by Nicolas Bernoulli (q.v.) to Pierre-Rémond de Montmort, commonly known as the St Petersburg problem (Weil, 1961). Buffon suggested a solution which foreshadowed the future concepts of moral expectation and of utility function. In 1728, he moved to Angers, where he attended lectures in medicine. These were interrupted as the result of a duel, and he later studied botany.

In 1733, wishing to demonstrate that "chance falls within the domain of geometry as well as that of analysis" Buffon presented his paper "Solution de problèmes sur le jeu du franc-carreau", to the Académie Royale des Sciences. In it, he applied infinitesimal analysis to the calculus of probabilities, thus initiating the study of geometrical probability. It contains a mention of the "Buffon needle problem" for which his name persists in probability theory.

In January 1734 he was elected Adjunct Member to the Royal Academy in the Mechanics Section; in March 1739 he was transferred to the Botany Section of which he became an Associate Member in June 1739. Meanwhile, his main interests had shifted to forestry (Hanks, 1966), and, more broadly, plant physiology; in 1735, he translated the *Vegetable Staticks* of Stephen Hales, originally published in English in 1727. In his Preface to this work, Buffon praised the merits of Newton's experimental method, whose fecundity

in physics had been demonstrated. Buffon specifically obtained a series of observations, from which he attempted to establish the laws of resistance of wood by a comparable method. However, as Hanks (1966, p.210) points out, these researches suffered from a lack of statistical methods for determining the significance level for the differences between sample observations on the one hand, and the theory and empirical data on the other. It should be pointed out that some years later, in the first volume of his *Histoire naturelle*, Buffon advocated the use of statistics "when subjects are too complex to allow us to apply to advantage calculations and measurements".

In 1740, he published *Méthode des fluxions et des suites infinies* a translation of Newton's work after the English text of Colson, with a preface in which he adopted a position on the Leibniz-Newton controversy about the discovery of the infinitesimal calculus, and developed his views on the mathematical notion of infinity. Eight years later, he communicated his *Réflexions sur la loi d'attraction*, to the Academy, replying to Clairaut's suggestion that Newton's law of gravitation be modified, and got into a controversy on the relation of mathematics to reality.

In July 1739, he was named Superintendent of the King's Garden by his patron, the minister Maurepas, and entrusted with the task of producing an account of the King's Natural History collection. He broadened the project considerably and worked for 10 years in collaboration with Daubenton to write the first volumes of his monumental *Histoire naturelle générale et particulière avec la description du Cabinet du Roy* consisting of 15 volumes published between 1749 and 1767. It enjoyed great success, and provided Buffon with fame and honours: he became a member of the Académie Française in August 1753, and spent the main part of his subsequent researches in extending his *Histoire Naturelle*. There followed *l'Histoire naturelle des oiseaux* (in collaboration with Guéneau de Montbeillard and the abbé Bexon), then the *Supplément à l'Histoire naturelle*, 7 volumes, 1774-1789, including the *Epoques de la Nature* and *l'Histoire naturelle des minéraux* in collaboration with Faujas de Saint-Fond, 5 volumes, 1783-1788. The Count of Lacépède continued Buffon's enterprise after the latter's death.

A number of Buffon's articles provide an account of his probabilistic and statistical analyses , as well as his philosophy of mathematics. The discourse in "De la manière d'étudier et de traiter l'histoire naturelle", with which Buffon began his *Histoire naturelle*, gave him the opportunity of presenting his method and putting forward a theory of knowledge influenced by English thought, particularly that of Newton and Locke. He affirmed the role of

the senses and the supremacy of experience in systematizing and presenting the laws of nature. Buffon drew a distinction between mathematical truths "which are only truths of definition" and thus arbitrary, and physical truths "which, instead of being based on assumptions we have made, are based only on facts". The certainty of a physical truth is to be measured by the probability of the corresponding facts. Buffon was to refine this epistemological thought in his "Essai d'arithmétique morale" of 1777 (within *Supplément à l'Histoire naturelle*, vol. IV), which is concerned with "the measurement of uncertain things". But, more broadly, the work is devoted to reflections on the concept of measurement, and the way in which it can provide information on reality. In it Buffon develops his thoughts on probability, which are dominated by the distinction between physical and moral viewpoints, that is between what is applicable to natural phenomena, and what counts in human affairs. It was in the light of this distinction that Buffon had interpreted the results of his probability table for life expectancy in the paper "De la vieillesse et de la mort", showing that the first 15 years of an individual should be "morally" considered as non-existent. It was equally in the light of this distinction that the "Essai d'arithmétique morale" attempted to obtain a numerical and probabilistic estimate of degrees of certainty, of which the minimal limit was the moral certainty. Beyond this lay the field of probabilities which were negligible in practice. Applying these considerations to the study of the St Petersburg problem, Buffon appealed for the first time to statistical experiment to test calculations against reality, and suggested an estimate of the "moral value" of money, which led to a solution of the problem similar to that given by Daniel Bernoulli (q.v.). Buffon had already fallen back on statistical methods in his paper "De la vieillesse et de la mort" in Volume II of the *Histoire naturelle*, in which he had studied human mortality in general, and praised the excellence of the work of A. Deparcieux (1703-1768). It was on the latter's *Essai sur les probabilités de la durée de la vie humaine* of 1746 that he had prepared a report of 1745 for the Academy, in collaboration with Nicolle, while expressing regret that the population included only persons of private means. That was the reason why Buffon used Dupré de Saint-Maur's mortality tables, which included 3 Paris parishes, and 12 country parishes in which there had been 23,994 deaths. The statistical parameter chosen to define the probability of life expectancy was the median. These tables, published by Buffon, were taken up by Moheau in his *Recherches et considérations sur la population de la France* in 1778. In 1777, in his article "Des probabilités de la durée de la vie" in Volume IV

of the *Supplément à l'Histoire naturelle*, Buffon refined this statistical work, correcting the raw data, particularly the anomalies observed in the ages corresponding to whole numbers. Using a moving average method, he took advantage of the comments in the work of Deparcieux, and thus obtained his probabilities of life expectancy, whose knowledge he wrote "is one of the most interesting topics in the natural history of man". Buffon added to his "Probabilities de la durée de la vie", a paper on the "Etat général des naissances, mariages et morts dans la ville de Paris" for the period 1709-1766, as well as for the main towns of Burgundy for 1770-1774. From these, he tried to establish the fertility rate of marriages, the ratio of births and deaths by sex, the rates of births and deaths, and the evolution of marriages and deaths year by year. Using the whole of these data, he endeavoured to compare mortality in Paris and in the country, then made a comparison of mortality in France and London, in which he took a position in the controversy about the respective healths of the cities of London and Paris.

These statistical and demographic works of Buffon have attracted widely diverging judgments from different authors; in particular the reader might consult M. Fréchet (in Piveteau, 1954, pp. 435-436), L. Badey (1929), K. Pearson (1978, pp. 188-197), and J. and M. Dupâquier (1985, pp. 174-175 and 232).

Buffon's writings influenced Thomas Jefferson's *Notes on the State of Virginia* (1782), and the two met in Paris during Jefferson's sojourn (1784-1789) as U.S. Minister to France.

References

[1] Badey,L. (1929). Buffon, précurseur de la science démographique. *Annales de géographie,* May, 206-220.

[2] Buffon, G.L., (1749-1804). *Histoire naturelle, générale et particulière*, 44 volumes, Imprimerie Royale [later Plassan], Paris. [This is the original complete edition. The most authoritative subsequent edition is that published in 1884-1885 (14 volumes in-8), annotated and preceded by an introduction by J.L. Lanessan, followed by the general correspondence of Buffon, collected and annotated by Nadault de Buffon, Librairie A. Le Vasseur, Paris,].

[3] Dupaquier, J. and M. (1985). *Histoire de la démographie.* Perrin, Paris.

[4] Gayon, J., (1992). *Buffon 88*, Actes du colloque international Paris-Montbard-Dijon, 14-22 June 1988, under the direction of J. Gayon, Vrin, Paris,. [Contains a detailed bibliography of Buffon's works and his published opus from 1954 to 1991.]

[5] Hanks, L., (1966). *Buffon avant l'"Histoire naturelle"*, P.U.F., Paris.

[6] Pearson, K. (1978). *The History of Statistics in the 17th and 18th Centuries.* Griffin, London.

[7] Piveteau, J., (1954). *Oeuvres philosophiques de Buffon*, edited by J. Piveteau, Corpus général des philosophes français, Volume XLI, Paris, PUF.. [Contains in particular the paper "De la manière d'étudier et de traiter l'histoire naturelle" and "Essai d'arithmétique morale". Apart from an introduction to the philosophical work of Buffon by J. Piveteau and a study of his mathematical philosophy by M. Fréchet, this work contains a very detailed bibliography of works on Buffon and his opus up to 1954].

[8] Weil. F., (1961). La correspondance Buffon-Cramer, *Revue d'histoire des sciences*, Volume XIV, pp. 97-136. [Annotates the text of all known letters between these two scholars from 1727 until Cramer's death in 1752.]

Yves Ducel, Thierry Martin