Malécot, Gustave

Introductory article

doi:10.1002/9780470015902.a0005707

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Gustave Malécot (1911–1998) was one of the founders of mathematical population genetics.

Gustave Malécot was born on 28 December 1911, and grew up in a rural, mining region of the department of Loire, France. The son of a Protestant chief mining engineer, he went to grade school with miners' children. He had an early interest in botany and geology, using flora and geology books to explore the countryside on bicycle. He also showed a talent in mathematics, finishing his secondary education in St Étienne. This was at a time when political philosophies ranged widely from communist to fascist, in a region having a diversity of immigrant groups. Malécot always considered himself a humanist.

In 1932, he began study at the renowned École Normale Supérieure. There, professors who had considerable impression on him included Émile Borel, Élie Cartan, Georges Darmois and Maurice Fréchet. He also became familiar with other intellectual centers in Paris such as the Sorbonne. After attaining a mathematics degree in 1935, he began graduate studies at the Institut Henri Poincaré of the University of Paris. Characteristically, he chose to study a problem that was important to biology as well as requiring mathematical creativity. He determinedly studied for 2 years the notoriously difficult 1918 R. A. Fisher article, which was the first serious attempt to reconcile the biometrical problem of inheritance of quantitative traits with the rediscovery of Mendelian inheritance in 1904. Two features of his dissertation foreshadowed his later career. First, he developed a conditional probability approach to the genetic correlations among relatives, in a completely rigorous mathematical treatment. Second, he 'found some problems' with Fisher's mathematics, which placed him at odds with fervent followers of one of the founders of population genetics. (***See*** Fisher, Ronald Aylmer; Pearson, Karl.)

Malécot benefited from a fine and long tradition of mathematics in France. He also absorbed the mathematical basis for probability theory, and had studied Markov processes and knew Kolmogorov's results. The conditional probability approach of Bayes fortuitously centered his attention. This approach proved to form the proper basis not only for interpreting genetic correlations in pedigrees but also as rigorous mathematical models of the genetic basis of evolution of populations. (***See*** Diffusion Theory; Markov Chain Monte Carlo Methods; Population Genetics; Population Genetics: Historical Aspects.)

In 1939 he taught mathematics at the secondary school at St Étienne, in 1942 held the position of *Maître de Conference* at the University of Montpellier under the mentorship of Émile Borel and in 1945 joined the faculty of the University of Lyon, where he remained until his retirement in 1981. During the late 1930s and the 1940s, Malécot developed many seminal probability models of genetics. However, these included some that conflicted with Fisher's 1930 landmark book *The Genetical Theory of Natural Selection*. Fisher's book was widely perceived as having definitively reconciled Darwin's theory of evolution with population genetics. Malécot found much that was mathematically incorrect, even though he admired Fisher's work. The French Darwinian intellectual scene, centered in Paris and strongly 'Fisherian', mostly viewed Malécot's models as 'anti-Darwinian'. Moreover, Europe at the time was impassioned with conflicting political ideas for which the theory of human evolution was important. For example, Social Darwinism interpreted Darwin's idea of survival of the fittest as meaning that competition among people was natural. Malécot felt that the French Darwinians held communist ideas to an extent that would seem remarkable today, and in many respects that he was an outsider. (***See*** Darwin, Charles; Fisher, Ronald Aylmer; Fitness and Selection; Malthus, Darwin, and Social Darwinism.)

Also by the late 1930s and into the 1940s, the work of Sewall Wright had become widely known for its development of covariances among relatives as well as measures of the degree of inbreeding. Malécot was inspired by Wright's creative genius, and as a result he developed the first proper basis for inbreeding coefficients. Malécot created the concept of probabilities of identity by descent. Following a strict definition of probabilities, he examined the probabilities that two genes in a pedigree were identical because they descended from the same ancestral gene. This was a key concept in the development of many of his works that followed. Malécot's approach generalized inbreeding coefficients to nearly all pedigrees, whereas Wright had difficulty to generalize his measures and was reduced to illustrating derivations for special cases. Around the same time, Malécot also developed the ideas of kinship chains, which formed an explicitly genealogical relation among genes. It formed the basis of the 'chain-counting' method, which is still widely used today as the preferred method of calculating inbreeding coefficients, and it still forms much of the basis for 'coalescence' approaches to genealogies. (***See*** Inbreeding; Kinship and Inbreeding; Population Genetics: Historical Aspects; Wright, Sewall.)

Throughout the remainder of Malécot's career, he focused on applying probability models to evolutionary genetic processes at the population level. It turned out that his very interpretation of pedigrees favored extension to the population level. He developed measures of the degree of relatedness among individuals in populations, as well as among genes in populations. His measures of kinship and consanguinity formed much of the proper mathematical basis for the field of population genetics. He was prescient in developing the 'infinite alleles model'. He also developed models of gene frequency change. In 1948, Malécot published a landmark book that compiled some of those works, and it was translated into English in 1969. It is still considered a definitive text. Much of his later works developed mathematical models for isolation by distance. That is the theory of how random processes (genetic drift) result in genetic similarities among neighboring populations, and how the degree of relatedness decreases and genetic isolation increases as the distance among populations increases. (***See*** Population Genetics: Historical Aspects.)

Malécot developed many of the most rigorous early models of population genetics processes, as well as many of the basic concepts still used today. Nonetheless, it has only been recently that the scope of his contributions has become widely recognized. His methods were elegant and usually exact. They were also often compact, abstract and published in French journals that were not widely distributed. While many leaders in the English-based literature early recognized them, wider recognition of Malécot's achievements spread in a slow, branching trickle. Nonetheless, he was honored with a number of awards, including: *Prix Montyon de l'Académie des Sciences; Officier des Palmes Académiques; Chevalier de la Légion d'Honneur*; and *Officier de la Légion d'Honneur*.

See also

Fisher, Ronald Aylmer
Population Genetics: Historical Aspects
Wright, Sewall

Further Reading

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