Johann Gregor MENDEL
b. 22 July 1822 - d. 6 January 1884

Summary. Mendel was definitively recognized as the originator of genetics only in the 1930s. He was one of the first to apply statistical methods in biology.

Mendel was born in 1822 in Heinzendorf, Austria (now Hynčice, Czech Republic) into a peasant family of German–Czech origin. In 1834, having been an able pupil of a village school, he was moved to a local gymnasium. From 1838 he had to support himself by tutoring and he graduated in 1840. In 1843, after mental crises caused by strained circumstances and an uncertain future, he completed a two-year course at the Olmuetz (Olomouc) Philosophical Institute whose curriculum included mathematics (with some combinatorial analysis) and physics. Mendel was now entitled to study at a university; instead he entered the monastery in Brünn (Brno) (1843), thus freeing himself of financial worries and finding conditions for further study. He took the name Gregor, adding it to his Christian name, Johann.

In 1848 Mendel became curate but his sensitivity hindered his duties and in 1849 the Abbot appointed him substitute gymnasium teacher of mathematics, Latin and Greek. In 1850, nervous and lacking university education, he failed one of the examinations of teaching competence, and the monastery was advised to send him to Vienna. Mendel indeed studied mathematics and the natural sciences there (1851-1853). In 1854 he was appointed teacher of physics, zoology and botany at the Realschule in Brno and continued to carry out some ecclesiastic duties. In 1856 he failed his second teaching examination, this time only because of his bad health, but remained a highly respected (substitute) teacher. In 1868 Mendel was elected Abbot and gave up teaching. Ultimately he died of a kidney disease and cardiac hypertrophy in 1884.

Mendel held liberal views and in 1848 he co-signed a petition for granting civil rights to members of religious orders. From 1875 he objected to the unjust (in his opinion) taxation of his monastery.

During his lfe, Mendel participated in local agricultural affairs. His free advice on growing plants and fruit trees and on beekeeping (an occupation where he achieved practical progress, if not the desired confirmation of his theory in the animal kingdom) was greatly appreciated and his varieties of plants were grown locally for many decades. He was an active member of several provincial and national agricultural societies and a founding member of the Austrian Meteorological Society. In 1857 he began recording meteorological data. He promoted weather forecasting for farmers and he correctly explained the origin of tornadoes in 1871, although it went unnoticed at the time.

Between 1856 and 1863, Mendel studied the hybridization of peas, first testing 34 of their varieties for the constancy of traits, and selecting 22 of them. He always examined a large number of plants to eliminate "chance effects" and thoroughly planned his experiments.

Suppose A and a are the dominant and recessive alleles (possible genes) at a single locus of a plant, the phenotype (appearance) of whose seeds (say a round or angular pea) depends on the genetic composition at this locus. The possible genetic compositions (genotypes) are thus AA, Aa, and aa, but Aa seeds have the same appearance as AA, and only the double-recessive seeds aa have different phenotype. If we suppose that alleles A and a are equally represented in the genetic pool, random union of these to form the next generation of genotypes can be represented by $(A+a)^2 = AA + 2Aa + aa$, so that the genotypes AA, Aa, aa are in the ratio $1 : 2 : 1$, but the two distinguishable phenotypes are in the ratio $3 : 1$. This reasoning is an application of Mendel's First Law (of independent assortment of alleles). Now suppose another locus with alleles B, b determines another phenotypic feature (say yellow or green in peas), with b recessive. Then the structure of the genetic material before random union can be represented by $(A+a)(B+b) = AB + aB + Ab + ab$, so that the 4 kinds of gametes exist in equal proportions. This reasoning is an application of Mendel's Second Law (of independent assortment). Random union of gametes then gives genotypic structure according to $(AB + aB + Ab + ab)^2$. The resulting genotypes $AABB, AaBB, AABb, AaBb, AAbb, Aabb, aaBB, aaBb, aabb$ are thus in the ratios $1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1$, but the distinct phenotypes (involving two physical characteristics) are in the ratios $9 : 3 : 3 : 1$. Mendel wrote out segregation ratios such as this even for seven pairs of different traits.

In the 1900's and, finally, in the 1930's, Mendel's work was recognized as marking the beginnings of genetics. And he was one of the first to apply the statistical method, to use algebraic notation and elements of combinatorial analysis in biology. Alexander Humboldt, at the beginning of the century, initiated another branch of biology - of botany - namely the geography of plants, intrinsically connected with statistics. Other predecessors of Mendel were Alphonse De Candolle (also in geography of plants) and even Maupertuis (see Glass, 1959).

Mendel could not have properly understood all the aspects of his findings, but he justified the existence of discrete hereditory factors (genes, as well as alleles and gametes, being later terms) and discovered the principles of their random segregation and recombination. He aimed at achieving practical results, but a simultaneous study of heredity could well have been at the back of his mind. Now we know that individuals of the same species usually have differing sets of genes, so that their offspring are (intraspecific) hybrids. Mendel's experiments with hybridization were therefore crucial for the latter purpose. After acquainting himself with Darwin's *Origin of Species* not later than 1863, he stated in 1866 that research such as his own was important for "the history of evolution of organic forms". Indeed, Darwin himself felt that he did not adequately explain evolution, and Mendel stated that something was lacking in his system.

Darwin did not hear about Mendel and would hardly have been able to understand his contemporary. He never used mathematical language and even wrote "elongated" triangles rather than "isosceles" ones. Indeed, biologists did not grasp Mendel's work at least up to the turn of the century; no wonder that his posthumous manuscripts at the monastery were burned. Biometricians did not recognize Mendel either; even in 1930 Karl Pearson (q.v.) considered it a largely unproven theory. They were interested in measuring correlation between parent and offspring with regard to some trait rather than studying the theory of heredity. However, according to a recent study (Magnello, 1998), Pearson in 1909 suggested a synthesis of biometry and Mendelism. Later, in 1926, Bernstein (q.v.) proved that under wide assumptions the Galton law of inheritance of quantitative traits was a corollary of the Mendelian laws (Kolmogorov, 1938).

The trustworthiness of Mendel's experiments had been questioned. Fisher (q.v.) (1936) concluded that Mendel had correctly described their layout, but that their data were biased. van der Waerden inferred that Mendel had followed a sequential procedure, so that Fisher's opinion was only partly correct and that Mendel was honest. Later authors noted that some biological facts (e.g. the failure of some seeds to germinate) exonerated Mendel still more. And indirect evidence including his meteorological work indicates that Mendel meticulously recorded his observations.

By 1935, the Soviet Union became a leading center of Mendelian research. Then, however, genetics was called an idealistic science contrary to dialectical materialism and rooted out. Even Kolmogorov was criticized for his defense of its principles. The situation did not change until the 1960's.

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