Genes make the difference

Genetic studies of plant species continue to shed light on genetic processes, says S.Ananthanrayanan.

Gregor Mendel, in 1866, laid the foundation of the field of genetics with his study of the inheritance of traits in the pea plant. The journal ***Nature***, in the last two weeks, has reported advances involving the genome of a family of small flowering plants and their distant relative, the papaya.

Gregor Mendel

Mendel was an Augustinian monk, scientist and High School teacher in Austria, who discovered that there was a pattern in the way traits of pea plants passed from one generation to the next. Mendel patiently cross bred thousands of pea plants and recorded the frequency of the parent features in offspring. He discovered that the features passed in 'factors' or units – one for each specific trait, with equal contribution from each parent.

The factors did not combine, but were passed intact and whether the child had the features of a parent depended on which factors it had received from each parent – with rules of when features were ***dominant*** or ***recessive***, how a feature could skip a generation but appear in the next and so on – and the rules were soundly established in the statistics of some 29,000 observations of pea plants.

Genetic research

It was after many years that the seminal nature of Mendel's work was realized and today it is Mendel's factors that are known as ***genes***. We have discovered the DNA, the giant chain molecule that contains the genetic blueprint of each cell and that the links in this long chain are individual genes, each of which controls a particular property of the cell.

Research is now at a micro level, where scientists are able to study the individual genes that make up the DNA, and to work out which ones affect individual aspects of how the organism behaves. Some genes that lead to specific diseases have been identified and cures, by introducing cells that have the right genetic features, are being developed. Study of the evolution of genes, in species that are related, throws light on which genes are responsible and how they change during evolution. The recent papers in ***Nature*** describe the work on a group of plants called ***Arabidopsis*** and the papaya, a related genus

Resistant species

Arabidopsis (rockcress) are small flowering plants related to cabbage and mustard plants. The most well known in the group is thale-cress (Arabidopsis thaliana), a plant extensively used in genetic research and whose whole genetic chain (genome) has been worked out.

While A thaliana is thus celebrated because it has been used in research, researchers at the University of Heidelberg compared its genome with that of a close relative, Arabidopsis halleri. A.halleri, it is found, is able to take up heavy metal pollutants, zinc and cadmium, from the soil and store them in its leaves, a trick that A.thaliana cannot do. Halleri can then thrive in badly contaminated soils.

The Heidelberg scientists have worked out the genetic changes that have brought about this adaptation, which could help in developing technology based on genetics. Comparison of the genome of the two species shows that A. halleri, which is metal accumulating, has two copies of the gene HMA4, against only one copy in A.thaliena.

It is also found that A. thaliana acquires metal tolerance when transplanted with HMA4 from A.halleri.

HMA4 sets up a pump that loads heavy-metal compounds from the soil into the root system, and probably originally evolved to rectify trace-metal deficiencies in the plant. These genetic features appear to help the plant to survive under hostile conditions.

The papaya

The papaya, originally from Mexico, is now cultivated in most countries with a tropical climate. Apart from its use as fruit and in cuisine, papaya is known for many medicinal uses. The fruit and seeds are found to have contraceptive qualities and the seeds also have use against skin diseases and as a fungicide. The seeds and leaves also help as a heart tonic, analgesic and to treat stomach ache.

Papaya is also a plant that is extensively used for studying genetics and evolution. Magsudul Alam and an international team of collaborators write in their paper in ***Nature*** of their comparison of the Papaya genome with that of a distant relative, ***Arabidopsis***, or ***rockcress***. The scientists find that the papaya genome is three times larger but contains fewer genes - which could provide clues about the evolution of seed-producing plants. The genetic sequence carries clues to understanding how the plant adapted to length of the tropical day, how it attracts seed-dispersal agents and also how it creates the volatile compounds responsible for its delicious flavour.