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RESEARCH NEWS

Development of flower in plants

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The mystery of the development of flowers in plants has fascinated poets like Goethe and also biologists for a long time. In a recent article in *New Scientist* (25 April 1992) Enrico Coen and Rosemary Carpenter have described the attempts being made by molecular biologists like themselves and others to look for genes that control the development of flowers.

It is well known that it is possible to grow whole plants in tissue culture from a tip of their shoots, but this technique does not produce whole animals from animal tissues. This is because unlike animals, where there is only a limited period of embryonic development, plants never stop developing. They constantly produce stem, branches and leaves, but this production is often halted by the development of organs that make up a flower. These organs reside in a series of concentric rings or whorls–starting from outside–sepals, petals, stamens and carpels. In a normal flower, each of these organs first emerges as a bulge on the flanks of a meristem, the sepals developing first and the carpels last. In mutant flowers, which sometimes appear, this arrangement is upset and the wrong organs appear in these whorls. The hidden hand of the plant genome, therefore must instruct the cells of each whorl not only to adopt the appropriate character of these organs but to do so at the correct time during development.

Most of the work designed to trace the genes that perform these jobs has been carried out on the snap-dragon (*Antirrhinum majus*) which has the advantage of being vegetatively propagatable and having large flowers that are easy to emasculate and cross. The genome of *Antirrhinum* also contains some well-characterized jumping genes, or transposons.

Coen and Carpenter cultivated *Antirrhinum* in their thousands in order to find one that had a mutation in the genetic switch and was therefore unable to flower. After five years and cultivating 80,000 plants they found a single *Antirrhinum* which was unable to flower but continued to make leafy shoots. After another three years they traced this curious anomaly to a defect in a gene called *floricuala* (*flo*). The defect was found to be due to one of the plant's transposons becoming lodged inside the *flo* gene and inactivating it. The presence of this transposon, whose DNA sequence is known, enabled the scientists to fish out this transposon by hybridization techniques. The transposon came out with *flo* DNA joined to its two ends, and from this the *flo* gene was isolated and its sequence worked out. It turned out that *flo* became active inside the plants meristem just two days after the plant's leaves receive the environmental stimulus to flower. *Flo* thus appeared to act as a masterswitch in flowering.

The clue to the mechanism of this switch came from genetic studies of flowers with developmental abnormalities–carpels in place of sepals, stamens in place of sepals, etc. These abnormalities were assumed to be caused by a defect in one of three cellular functions a, b, and c. The genes act after *flo* and possess a stretch of code similar to stretches found in regulatory genes discovered in humans and yeast. The proteins encoded by these genes act by binding to DNA. Their job is probably to regulate genes lower down *in the cascade of genetic events* that produce the flower: the genes which ring the cellular changes that seal the fate of each whorl of the flower.

The whorl pattern of the flower appears to be similar to the segmental pattern of development of the fruitfly, *Drosophila melanogaster*, in which each segment carries specific structures–wings, legs, antennae, etc. One of the important differences between the plant and the fruitfly is that the former develops sequentially, e.g. whorls, while the latter develops synchronously.

The findings described above have great implications in agriculture and horticulture, since flowers are the source of fruit, grain and seed for propagation. It should be possible to genetically engineer genes such as *flo* so that they can be activated earlier or later in the year than usual, enabling farmers to produce more varieties of fruit and seed for longer periods of the year. In addition, these findings would be useful to workers in plant tissue culture who sometimes find that plants raised by their method fail to flower or give seeds.

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