Flower Initiation

Experiments show there is more than one gene group in a plant that can make it bloom

A Caltech researcher in biology has added some important new information to scientific knowledge on the genetics of flowering. Wesley O. Griesel, visiting associate in biology and professor of botany at California State College at Los Angeles, working with *Cestrum* in Caltech's Earhart Plant Laboratory, has determined that there is more than one simple inheritable system that can act in the flowering of a plant, and that any one of these systems can take over and perform independently of others under certain conditions.

It was only in this century that scientists began the study of what makes a plant bloom—what growth processes cause a plant to stop producing leaves and stem and to begin developing flowers. The first important work in flower initiation was recorded in the early 1900s by U.S. Department of Agriculture scientists who were looking for the causes of flowering in Maryland Mammoth tobacco after plants failed to bloom under the usual conditions. Their research showed that the most significant factor initiating flowering is not the size or age of the plant, as had been supposed, but the length of time the plant is exposed to light each day (the day-length or photoperiod). For example, the spinach plant, which flowers only during the long days of summer, does so because it must have lengthened periods of light to start flowering. On the other hand, zinnias, which will bloom only when exposed to shorter light periods, flower in the shortening days of fall.

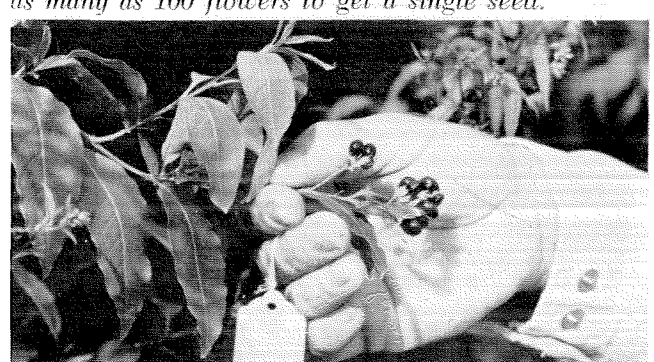
The leaf plays the major role in reacting to day-length. When certain patterns of light and darkness are imposed, the leaf synthesizes a hormone which is transmitted to the bud, directing it to stop putting out leaves and begin initiating flowers.

Day-length patterns are known for many species of plants today. Caltech plant biologists have made many contributions to knowledge in this field, particularly since the climate-controlled rooms in the Earhart Laboratories became available in 1949. However, even though a tremendous amount of data has been collected on flowering, very little is known about the inheritance of the factors involved—how the information is passed from one generation to the next.

Dr. Griesel began to investigate the problems of inheritance in 1961. Using *Cestrum* (the genus which includes the familiar night-blooming jasmine, *Cestrum nocturnum*) he found that not one but a series of independent gene groups—each capable of responding to a different photoperiod—exists in a

Pollen from one species of jasmine is carefully picked up with the tip of a fine watercolor brush to be placed on the stigma of the blossom of another species.

Because of problems of incompatability between some individual plants it is often necessary to cross-pollinate as many as 100 flowers to get a single seed.

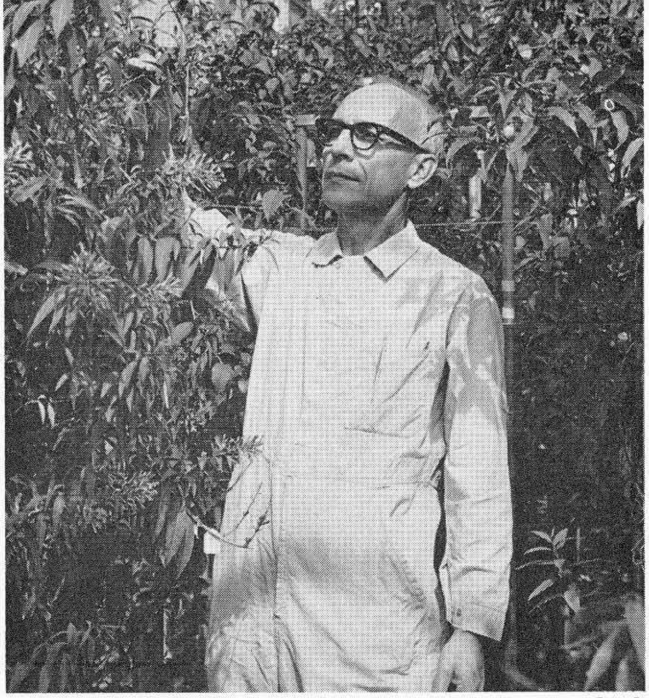


single species. The combination of these genes, in crossbred plants, results in a blooming capability that is sensitive to different combinations of daylength.

The *Cestrum* project initially made use of two of these species. *C. nocturnum* and *C. elegans* were tested under seven basic light patterns, ranging from four hours of light to continuous light. Plants of the first and second generation and backcrosses to each parent were similarly tested. Temperatures were maintained at a constant 23° C in daylight and 19° C in darkness in all of these experiments. The conditions under which the plants began to flower were recorded. In *C. nocturnum* it was found that a single dominant gene was activated by growing the plant on 16 hours of light and then shifting it to a day of 8 hours of light (called a long-short day). A recessive gene or genes responded when it was exposed to 16 hours of light (long-day) for a long period of time. In *C. elegans* a series of independent gene groups responded to various photoperiods, the combination of which resulted in flowering on all photoperiods.

The discovery of more than one gene group capable of initiating flowers in a single plant raises several interesting questions: Is there a single hormone, or are there various hormones each capable of initiation? To what extent is the vegetative bud capable of responding to or rejecting these hormones? And, to what extent is the bud able to begin flowering independent of leaf action?

To find answers to these questions, Dr. Griesel is continuing his research, supported by a National Science Foundation grant. One aspect of his work involves a complex grafting experiment. Grafted *Cestrum* plants are placed under photoperiod and temperature conditions known to synthesize a flower-producing hormone in the leaves of one of the two grafted plants. The leaves of the receptor plant are removed. If the receptor "accepts" the hormone, it will produce blossoms.

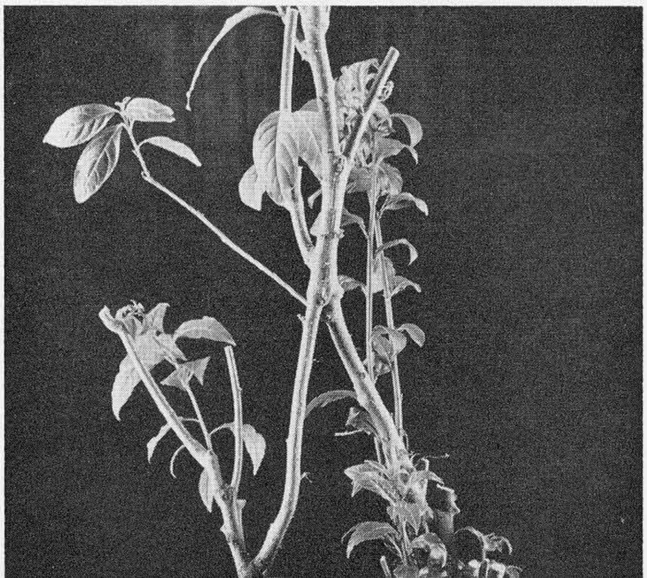


Wesley O. Griesel, Caltech visiting associate in biology, checks each of his 2,000 plants twice weekly.

In one experiment involving three *Cestrum* species grafted in various combinations, some puzzling results were obtained. One species received hormones through a graft union from both of the other species. However, neither of these two could induce each other to bloom. The evidence suggests that more than one hormone is present in the three species and that their buds possess the ability to accept or reject various of the substances.

If further research determines that what is true of *Cestrum* is true of other plants, agriculturalists may be able to develop food-producing plants by selective hybridization that have specific flowering patterns which will produce fruit in areas of the world where such production is not now possible because of lack of flowering.

Research assistant Marilyn Chase prepares a Cestrum nocturnum and a Cestrum elegans for grafting by stripping a slice from each stem and binding the two wounds together with thin onionskin tape.



The successful result of a grafting has outgrown its binding and healed its scars; when it has sprouted four feet of growth, it will be ready for the hormone-testing part of the experiment.