# HOW PLANTS TELL TIME

**Caltech biologists develop a new concept of the roles played by light and darkness in plant growth**

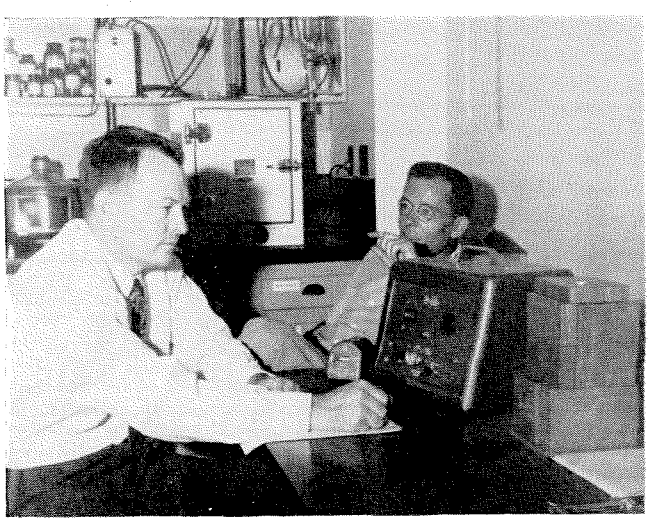
Two Caltech biologists have developed a new concept of the roles played by light and darkness in plant growth which explains how plants tell time.

Drs. James Liverman, Research Fellow in Biology, and James Bonner, Professor of Biology, reported on their work, supported by the National Science Foundation and the Lederle Laboratories Division of the American Cyanamid Company, at a meeting of the American Institute of Biological Sciences at the University of Wisconsin last month.

They found that red light activates a particular protein in plant tissue, enabling it to combine with the essential plant hormone, auxin, to produce growth. It was already an established fact that both the protein (whose chemical composition is now being studied) and auxin are needed for growth; but it had never been clear before which of these was affected by light.

The researchers also found that the effect of red light can be reversed quickly by exposure to infra-red light or, less quickly, by darkness. Infra-red light and darkness, they believe, inhibit growth by breaking apart the auxin-protein combination and de-activating the protein.

These findings suggest the following "growth cycle": Inactive protein is activated by the red component of sunlight and combines with auxin to form a growth-producing compound. In darkness this combination slowly splits apart and the protein must again be activated by red light before the growth compound can be formed.



*Drs. James Liverman and James Bonner counting a radioactive sample of auxin-protein complex.*

Further experiments have indicated that this same cycle applies to seed germination, leaf expansion and the initiation of flowering, as well as to growth. Thus, one simple mechanism forms the basis for an understanding of four previously unrelated processes.

The relation of this mechanism to the "time-telling" activities of plants may be illustrated by flowering, one of many phenomena influenced by light and darkness. Relative day and night length controls the flowering of many plants. Cocklebur, ragweed and poinsettia, for example, grow vegetatively during summer when nights are short, and flower only after one or more long nights in fall.

During the day—on the basis of the proposed growth cycle—the plants accumulate a large store of the auxin-protein growth compound. Some of this compound is destroyed at night, but after a short night enough remains unaffected so that growth continues.

As the nights get longer, more of the compound decays. Eventually a night length is reached during which the amount drops below a critical level. One such night is enough to stop vegetative growth of the cocklebur and to start the plant producing a hormone that causes flower buds to appear. Other plants require two or more long nights before such reactions occur.

In their growth experiments the Caltech scientists used auxin-free sections of oat leaf-sheaths cut from below the tips, which produce the growth hormone. Some of the sections were given auxin and left in darkness, without exposure to red light. These grew very slowly. Others were given auxin before being exposed to red light and some after. All these sections grew rapidly. The scientists concluded that the light acted on the protein, because growth was subsequently stimulated even if the exposure occurred before the sections got auxin.

In similar experiments they found that infra-red light and darkness influenced neither the auxin alone nor the protein alone, but rather inhibited growth by acting on the auxin-protein combination.