

the applicability of these methods also to reticulocyte ribosomes.

In a second paper, Martin and Wool (*ibid.*, 151) show that active hybrids of 60S and 40S subunits from different kinds of ribosome can be formed in an analogous manner to the various active hybrids from bacterial systems. Rat muscle and rat liver ribosomal subunits were successfully combined, and so also were those of rat and rabbit muscle. Ribosomes from these sources show a curious difference in behaviour, in that at 4° C the tendency of the 60S particle to form dimers of 90S is strikingly greater in the one than the other. Likewise hybrids containing the rat 60S subunit show increased formation of 114S dimers at 4° C.

More remarkable is the hybridization of ribosomes from rat muscle and the protozoan, *Tetrahymena pyriformis*: the large subunit of the former with the small subunit of the latter gives 80S ribosomes, active for phenylalanine incorporation, and the inverse combination appears also to occur, though with less efficiency. Clearly the adherents of bacterial systems will no longer have all the fun.

#### PHOTOPERIODISM

## Flowering Rhythms and Light

from our Plant Physiology Correspondent

RESEARCH into the photoperiodic control of flower initiation has, to a large extent, been directed towards understanding the mechanism by which plants respond to the length of the night. This is an indication of the time of year and therefore of the most effective time to flower. Flowering is initiated by a night length greater than a certain critical amount in short-day plants (SD) or by a night length less than a certain critical amount in long-day (LD) plants. A third group of plants has no particular response to day length, and is called day-neutral.

Exactly how a plant can measure the length of a period of darkness is not known in any detail, but there is nothing simple about it. Takashi Hoshizaki and Karl Hamner of the Space Biology Laboratory, University of California, have recently summarized the results of several years' work on the photoperiodic induction of flowering in the SD plant *Pharbitis nil*. Their data clearly indicate that at least three separate components can operate in the timing mechanism. Two of these are rhythmic in nature, and the third is an hourglass or linear timer (*Photochem. Photobiol.*, **10**, 87; 1969).

*Pharbitis nil* is extremely sensitive to photoperiodic induction. One dark period lasting sixteen hours is sufficient to induce the maximum flowering response. The accuracy with which the plant can measure this sixteen hour period is evidence for the hourglass type of timer. This timer, however, is temperature sensitive. Below 20° C it takes longer to induce the full flowering response. This slower flowering response in lower temperatures has been used to demonstrate one of the rhythmic components in the response. The plants were grown under constant illumination for four days, then given a non-inductive dark treatment followed by a period of light. The plants were then given inductive dark treatments of various lengths. Flowering increased

with the length of the dark period, but in a stepwise manner, each increase being separated from the next by about twenty-four hours. This is clear evidence of an interaction between the hourglass timer and an endogenous circadian rhythm of flowering, initiated by the beginning of the light period. This has been called the light-on rhythm (Takimoto and Hamner, *Plant Physiol.*, **39**, 1024; 1964). Other experiments have shown that a similar circadian rhythm in flowering response is initiated by the end of the light period—the light-off rhythm. Flowering in a short-day plant can be inhibited by giving the plant light during an inductive dark period. Maximum inhibition of flowering occurred in *Pharbitis nil* when the dark period was interrupted eight and thirty-two hours after the beginning of darkness (Takimoto and Hamner, *Plant Physiol.*, **39**, 1024; 1964).

Much of what is known about circadian rhythms in plants has been deduced from observations of leaf movements. Recent results suggest that the flowering rhythm and the leaf movement rhythm are closely linked. Brest has obtained evidence in biloxi soybean that, depending on the time in the cycle at which it is given, light may either interact with the rhythm or may shift the phase of the rhythm (thesis, University of California, 1968). This means that light may inhibit flowering when given at the appropriate time in an inductive dark period without affecting the basic rhythm, indicated by no change in the pattern of leaf movements. On the other hand, if light is given elsewhere in the dark period, both the flowering rhythm and the leaf movement rhythm may be phase-shifted, that is to say the clock has been reset. It is clearly essential that the possibility of such subtle interactions is taken into account in analyses of the complex and sophisticated experiments that modern photoperiodic research requires.

G. Engelsma of Philips, Eindhoven, has proposed that photoperiodic induction in long-day plants may be analogous to some features of the synthesis of phenolics in gherkin seedlings (*Acta Bot. Neerl.*, **18**, 347; 1969). Alternating light and dark periods result in a series of maxima in the concentration of phenylalanine deaminase (PADase), a key enzyme in phenolic synthesis. These peaks of enzyme activity are quickly lost unless each succeeding light period is longer than that before it—that is, there is an apparent loss of light sensitivity. Engelsma has attributed this to an accumulation of hydroxycinnamic acids in the cells which represses PADase synthesis. The conditions in which phenolic synthesis occurs are similar to those for induction of flowering, but the two processes do not seem to be causally related. Engelsma wondered, however, what would happen if the end product did not accumulate in the cell, but was transported to some other part of the plant, as might be the case with a flowering hormone. It seems possible that a single light treatment could cause a series of peaks in the concentration of the enzyme as a result of the alternating increase and decrease of end product inhibition. Such an oscillation would appear as a series of alternating light-sensitive and light-insensitive periods. This could account for some aspects of the photoperiodic control of flowering, but it must be kept in mind that the keystone of the argument, the synthesis and transport of a hormone specific to flower initiation, is still very much a hypothetical concept.