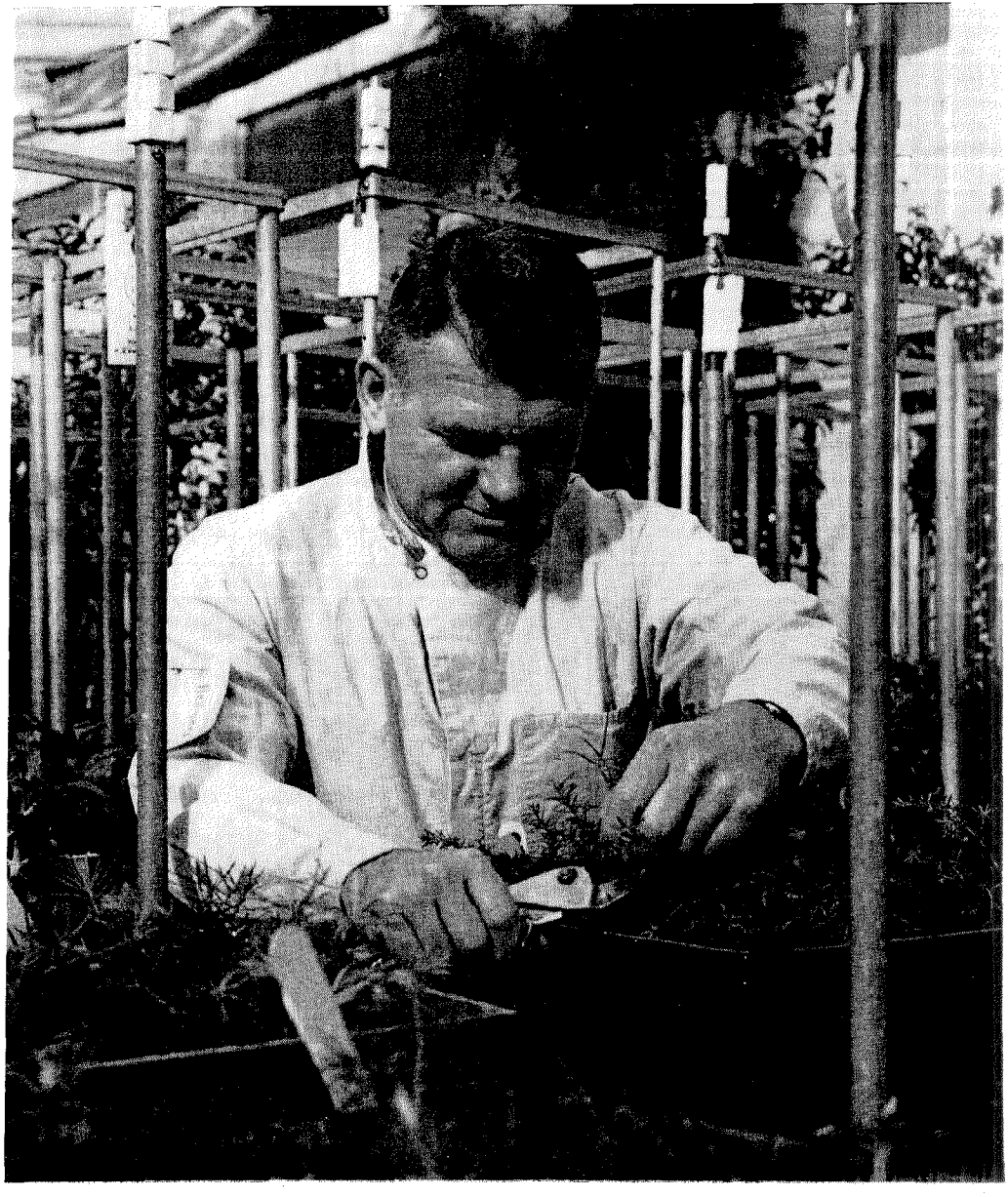


Henry Hellmers, senior research fellow in biology, trims a dwarf stand of coniferous trees to force them to form a dense canopy. These stands are used in measuring light and its effect on photosynthesis in a forest.

PHOTOSYNTHESIS AND GROWTH

Why aren't plants more efficient photosynthesizers? Caltech researchers are looking for the answers.

The National Science Foundation this month granted $83,000 to Caltech to continue for three years a broad investigation of photosynthesis – the process by which plants use the sun's energy to make plant material.

The results of this research, being carried out by James Bonner, professor of biology, and Henry Hellmers, senior research fellow in biology, could be useful in selecting the most suitable trees for replanting timbered and fire-ravaged forests, and also for revegetating watersheds.

The biologists are working with ponderosa pine and Douglas fir in Caltech's climate-controlled plant physiology laboratories. The study is aimed at determining the relative importance of temperature, light intensity, and carbon-dioxide concentration to photosynthesis.

The researchers already have determined the effects of low night temperature on photosynthesis. The cooler the night, the lower the subsequent rate

of photosynthesis and the longer the time required for the tree to resume its normal manufacturing processes.

Photosynthesis in the late fall and winter largely produces food that is stored in the tree for use in the burst of new growth in spring.

Why aren't plants more efficient photosynthesizers? Why is it that wild forest trees appear to be more efficient users of the sun's energy than are pampered crop plants? These are some of the questions the Caltech scientists are hoping to answer.

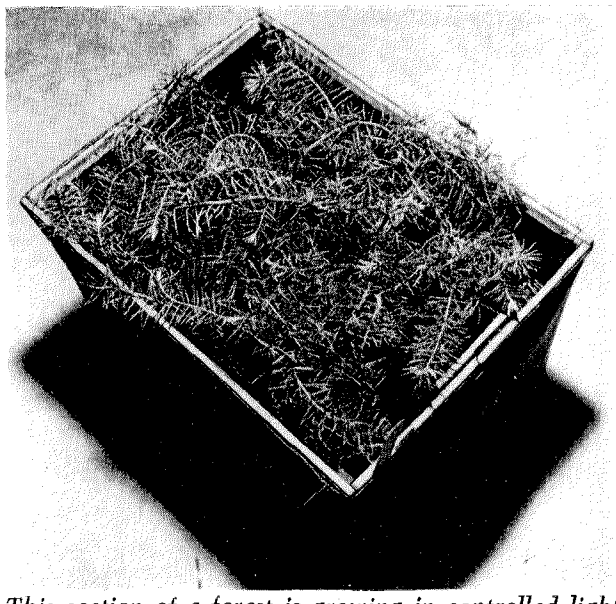
Forest trees make use of only about 2-1/2 percent of the sunlight that reaches them – but this is still 20 percent more than many domesticated plants and trees use. Why?

Dr. Hellmers, who is assigned by the U.S. Forest Service to Caltech, has developed an explanation for this puzzle.

The photosynthetic mechanism of agricultural plants and trees is the same. The differences between the two vegetation types must be in quantities of photosynthetic material or in some factor of the environment.

Communities of trees in a forest arrange their upper branches so as to form a canopy of leaves some five layers deep that covers them like a huge, green umbrella.

This living roof tends to concentrate beneath it one of the vital raw materials of all plants – carbon dioxide. Curtail this gas and a plant's photosynthesizing machinery slows down. Give it plenty of gas, and the machinery accelerates.



This section of a forest is growing in controlled light in Caltech's plant physiology laboratories. The container allows only about 5 percent side light to reach the trees, resulting in a dense layer of growth in the upper portion of the canopy.

Research assistant Eddy Schuurmans shows the density of the crown of the miniature forest, and the self-pruned lower portion of the trees.

Carbon dioxide is given off by the plants themselves, as well as by all living creatures, as a waste product of metabolism. It even comes up from the ground, given off by creatures living in the ground.

At night, when the photosynthesizing factories are shut down (the moon and stars do not provide enough light to operate this mechanism), the carbon-dioxide content of the air builds up. The forest canopy reduces air movement and thus prevents the gas from escaping. Crop plants behave similarly but, being shorter than trees, they entrap a smaller volume of air and therefore less carbon dioxide.

With the coming of dawn, light triggers photosynthesis. The built-up reserve of carbon dioxide under the forest canopy increases the rate of photosynthesis and the formation of plant material.

Dr. Hellmers now is testing his theory in the Caltech plant physiology laboratories, where climate, temperature, and light can be rigidly controlled.

Could the production of orchard trees be increased by allowing them to develop a closed canopy? Dr. Hellmers doesn't think so. He points out that an orchard with a closed canopy would probably cause more height growth and would put virtually all of the fruit near the top of the trees. This might be more of a boon to birds than to people.