WATER OR FOREST

CAN WE HAVE ALL WE NEED OF BOTH?

John D. Hewlett*

Through billions of tiny pores, or stomata, in leaves much of the million gallons of water an acre of forest may take up each year escapes as water vapor. Drawing above shows three stomata.

At six in the morning, the lingering mist rose from the narrow valley, revealing the tree-clad slopes of the Southern Appalachian mountains. The rotor from the resting helicopter stirred the leaves of nearby trees, as the pilot checked over a twenty-foot spraying boom attached to the underside of the ship. Then he gently lifted the flying spray gun into the cool morning air. His target was a nearby experimental watershed densely covered with forest trees. His purpose was to test a new way to increase water yield from our priceless mountain watersheds without damaging the trees and other living things.

MOST PEOPLE KNOW that water is becoming a major concern to our nation. Nearly everyone has heard of efforts to convert the salt sea to fresh water for man's use. But not everyone knows that the forest, which is the source and best protector of much of our water, is also one of nature's foremost water hogs. All plants need water to grow; the denser and larger the plants, the more water they pump from the soil and transpire into the air. To be sure, this water vapor is not truly lost forever, since it re-enters the cycling of moisture from oceans to continents, where it rains upon the earth and eventually returns down the rivers to the sea. However, the evaporation from the earth's oceans and the movement of vapor inland are so great that clouds do not need the moisture transpired by plants to produce normal local rainfall; thus, we think of water drunk up by plants as consumed or "lost" from further use by man.

One acre of forest land can drink up to a million gallons of water every year. In some water-hungry areas men have proposed to cut down all trees and shrubs to keep some of this water on the land, and to capture more of it in reservoirs and ground water. To the eternal danger of our forests, experiments have shown that this is indeed possible under certain conditions. For example, one watershed at Coweeta Hydrologic Laboratory, an experimental forest operated by the United States Forest Service in western North Carolina, began to yield an additional half million gallons per acre per year after careful felling of the forest. As the forest grew back, the stream grew smaller, and the leaves of the full grown trees were once again evaporating and transpiring more water than falls as total precipitation in many areas of the United States.

But must we fell the forest, and thus lose its many benefits, just to get more water? Is there no way to have our forest and extra water, too? Dr. Paul Waggoner, meteorologist with The Connecticut Agricultural Experiment Station, thinks there is. "You see," he says, "the water lost by trees passes out of the leaves through billions of tiny pores called stomata. These pores are complex little devices for letting carbon dioxide into the leaf for the manufacture of plant food, and at the same time letting oxygen and much water vapor out. The pores can open and shut, but they seem to stay open more than necessary to keep the plant growing. If we can find a chemical which will not harm the plant, but will cause these pores to close, we can let plants stand lush and even continue to grow somewhat without using so much water."

And, as it turns out, there are several harmless compounds which have been shown to reduce water loss by plants in small-scale experiments. Dr. Waggoner and his fellow scientists have been studying these chemicals for some time. Knowing of the Coweeta Hydrologic Laboratory and its

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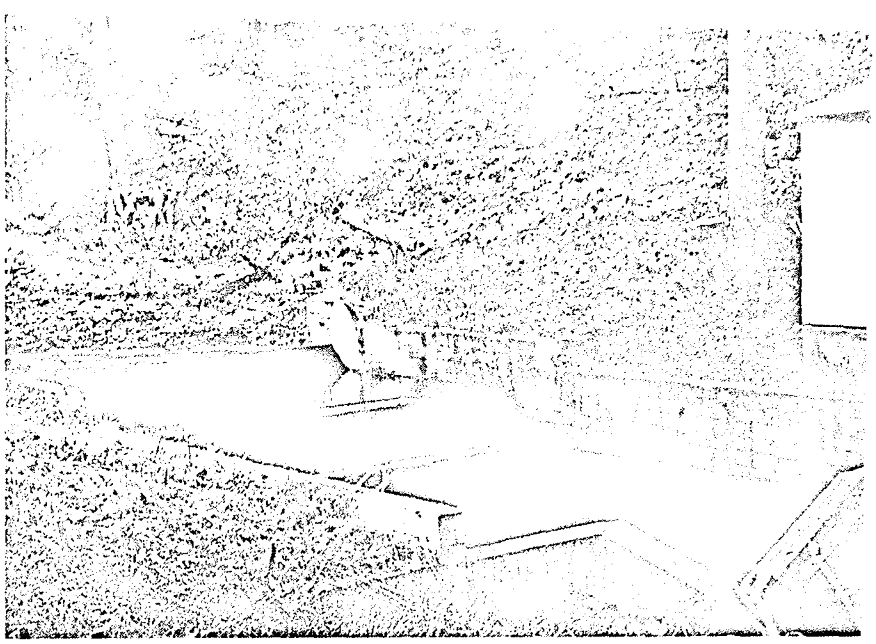
An investigator compares loss of water by individual leaves before and after spraying with a transpiration inhibitor.



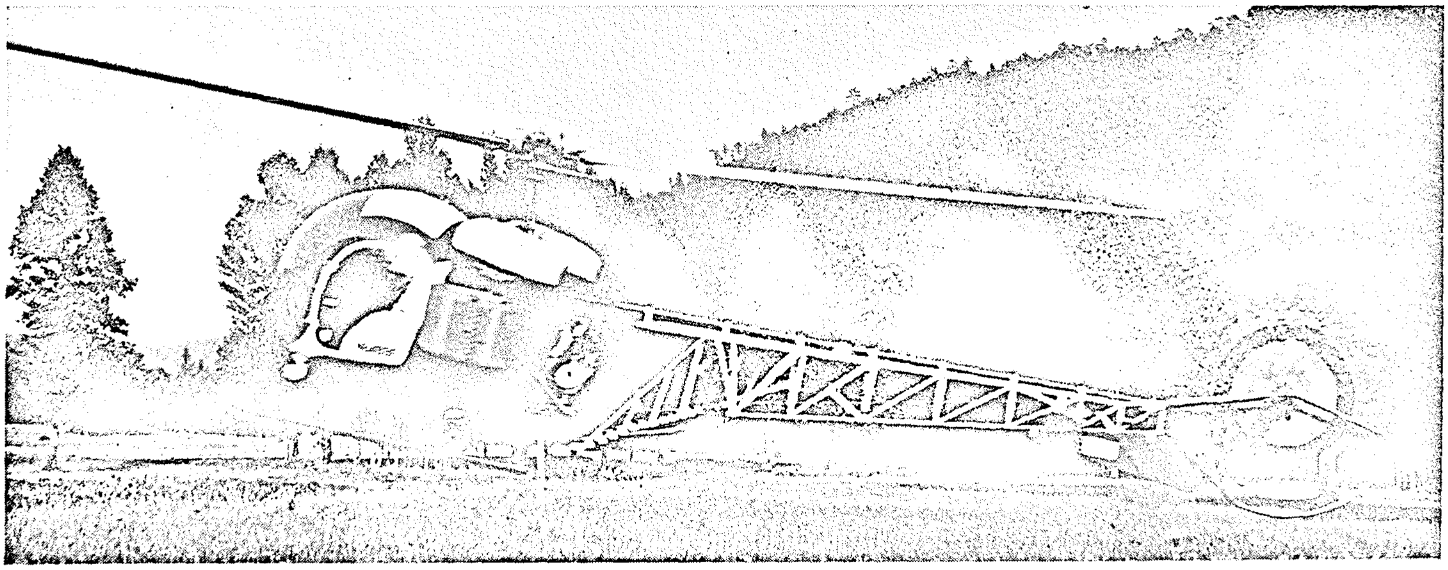
Thirty of these stream gauges, operated since 1934 by the Forest Service at the Coweeta Hydrologic Laboratory, enable scientists to measure water flow.

famous experimental watersheds, he proposed to me that the two experimental stations join forces in a full-scale test of this novel approach to water yield improvement. The plan was to spray the leaves of a forest area with one of the more effective chemicals and to determine through very accurate measurement of streamflow whether the watershed and its trees release more stream water during the following weeks and months.

Accordingly, the first large scale pilot test of a transpiration inhibitor was carried out during June 1964 by The Connecticut Agricultural Experiment Station and the U. S. Forest Service at Coweeta. The Connecticut Station provided the chemicals and the Forest Service provided the trees and watershed for the test. The watershed had to be equipped with rain and stream gauges, and also had to have many years of back records to serve as a base for measuring any change in water yield. A helicopter owned by the Tennessee Valley Authority was rented by the Connecticut Station for the job, and everyone waited for good weather to begin the test. Dr. Waggoner selected one of the more harmless chemicals—a form of decenylsuccinic acid—to mix with a large volume of water and then to spray in a fine mist at treetop level. We hoped that the spray would drift to the underside of the leaves where nearly all of the breathing pores are located. When the helicopter pilot reported fine spraying weather, the job was done in about one hour. Spray-sensitive cards on the ground and in the trees indicated that the 30-acre watershed had been well covered with drops of the spray, but that little had been delivered to the under surfaces of the leaves.

For the rest of the summer the research team anxiously watched the continuously recorded streamflow from the sprayed area to see if there was more water released to the stream gauge below. The results are not in yet; increases in streamflow brought about by reducing evaporation are not sudden and dramatic, but slow and steady. Such increases cannot fill up reservoirs overnight, but might tide over a drought period and help to prevent short, intense water famines from developing in cities and industries.

Whether or not this experiment succeeds, research to find ways to grow forests and crops on less water will continue. If plants can be made to produce the food, fiber, and wood we need on less water, perhaps new areas of water-scarce land can be opened to agriculture, and more fortunate areas with abundant rainfall may release extra water for uses in addition to wood production and agriculture. Dare we look to the day when we can have forests *and* more water, too?



Helicopter-applied spray of decenylsuccinic acid effectively covered upper surfaces
[illegible] the underside of the leaves