INSIGHT

How plants share water

In the dark of night, they pull moisture from deep in the earth and spread it around

CAROL KAESUK YOON
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TRACKING THE GLOBAL cycling water from sky to earth and back again scientists had thought they could count on at least one thing. The movement of water through plants, it seemed, was simple: up into the roots and out through the leaves as vapor.

But now they are discovering that plants are not the passive water vaporizers they had been thought to be. Instead, researchers have found an unsuspected detour in the routing of the precious liquid H_2O.

And this discovery may enhance the understanding not only of how plants interact with one another but how ecosystems function and even how climate can change.

It turns out that in the darkness of night, many plants have been pulling up water from deep in the earth and, rather than holding on to it to pass through their leaves the next day, these plants are flushing it out through their shallow roots into the ground around them.

Biologists say that plants ranging from sagebrush in the arid regions to sugar maples in the rainy forests appear to be acting as subterranean watering systems, drenching the soil and their thirsty neighbors.

Todd Dawson, a plant ecologist at Cornell University who recently discovered that this phenomenon, which scientists are calling hydraulic lift, also occurs in sugar maples, said that while transporting water out through a root system might not seem a particularly shocking thing for a plant to do, it was at first hard for biologists to believe.

Why, they wondered, would a plant give up precious water?

In fact, researchers studying the movement of water through plants using theoretical models had predicted hydraulic lift before it was observed. Water always flows from wet to dry areas; therefore, the scientists had reasoned that at night, when water doesn't evaporate from plants' leaves, any water that the deep roots pull from underground should flow into the shallower roots and from there into the dry soil near the surface.

But biologists, by and large, did not believe the models. John Baker, a soil scientist at the United States department of agriculture, who did the original laboratory work a few years ago to show that Bermuda grass was, indeed, a hydraulic lifter, explained that the question is not so much why a plant would leak water but how it could keep itself from leaking it.

Around the same time, researchers found evidence that sagebrush in Utah were watering the hot, dry soils of the steppes. They were so surprised, they assumed something had gone wrong with their instruments.

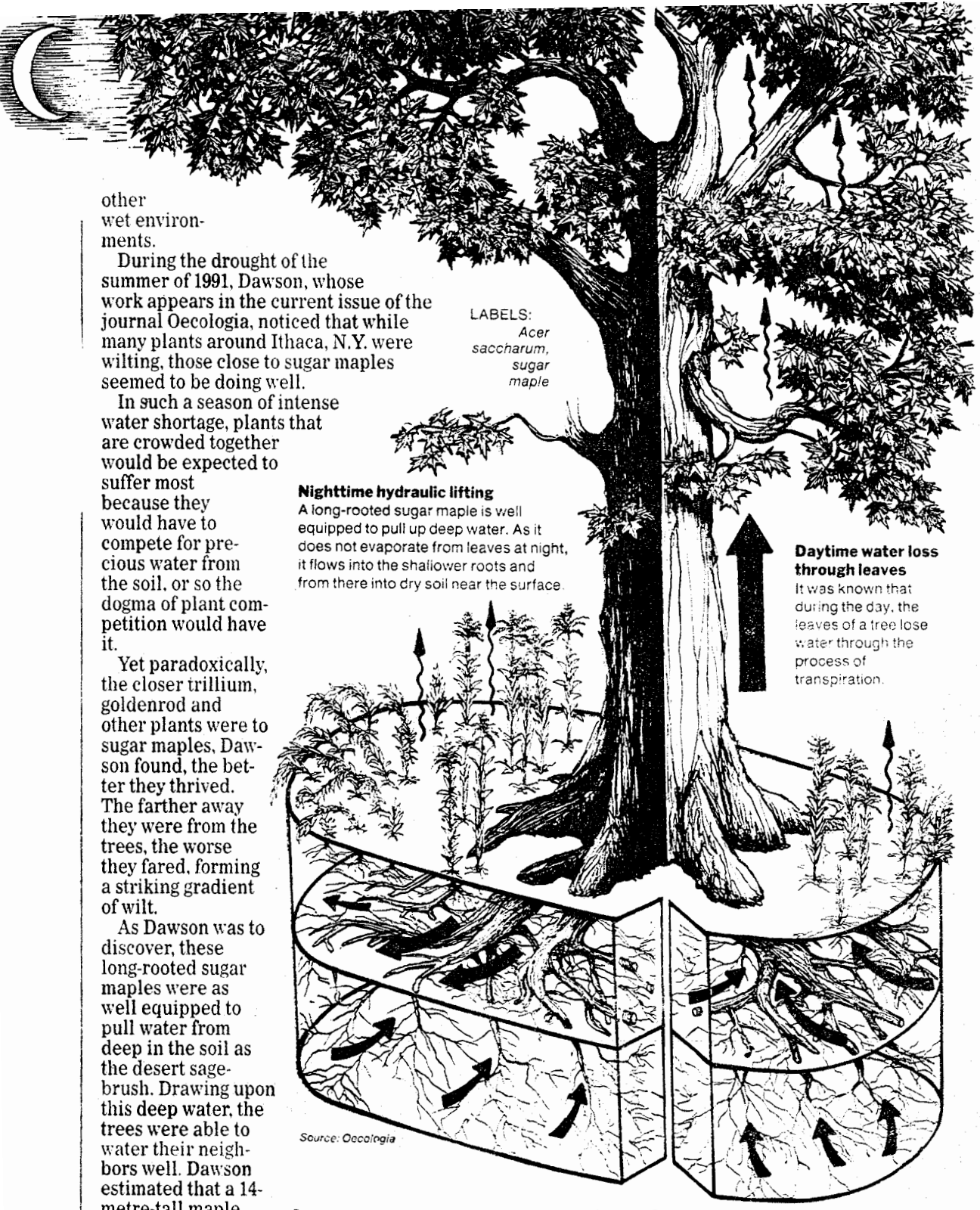
Jim Richards, a plant ecologist at the University of California at Davis, and colleagues were looking to measure long-term seasonal fluctuations in the steppes' soil moisture.

To their surprise, these researchers found their sensors telling them that each night the soil around the sagebrush was moistening as if watered and then drying again during the day.

After checking and re-checking their instruments, the researchers discovered that these small shrubs were, in fact, taking up as much as a litre of water each night and moistening the high desert and the thirsty, tussock grasses living nearby.

"It was very surprising, something that we didn't expect at all," said Richards. "We're just beginning to really investigate the actual physiology of what's going on and the ecological implications."

Meanwhile, scientists are finding the same phenomenon not only in arid-land plants, like sagebrush and the oaks of the California chaparral, but also in alfalfa, barley and maize, which can grow in much wetter climates, and even in plants like the sugar maple, which grows in upstate New York and



other wet environments.

During the drought of the summer of 1991, Dawson, whose work appears in the current issue of the journal Oecologia, noticed that while many plants around Ithaca, N.Y. were wilting, those close to sugar maples seemed to be doing well.

In such a season of intense water shortage, plants that are crowded together would be expected to suffer most because they would have to compete for precious water from the soil, or so the dogma of plant competition would have it.

Yet paradoxically, the closer trillium, goldenrod and other plants were to sugar maples, Dawson found, the better they thrived. The farther away they were from the trees, the worse they fared, forming a striking gradient of wilt.

As Dawson was to discover, these long-rooted sugar maples were as well equipped to pull water from deep in the soil as the desert sagebrush. Drawing upon this deep water, the trees were able to water their neighbors well. Dawson estimated that a 14-metre-tall maple was able to deliver between 150 and 230 litres of water to the upper soil layers every night.

Though of great interest to scientists, water, as ubiquitous as it is, can be difficult to track. Dawson was able to see just who was using whose water by taking advantage of the subtle differences between groundwater held deep below the surface and rainwater fresh from the sky.

There are two different forms that the element hydrogen can take, heavy or light. As a result, H_2O, which is made up of hydrogen and oxygen, can be either heavy or light, depending on which hydrogens it carries.

Dawson found that he could distinguish water stored deep in the ground from summertime rainfalls because rain was richer in the heavier water.

By looking to see what kind of water the nearby trillium and other plants were carrying, Dawson was able to see whether they were taking advantage of the lighter groundwater, which had been drawn up by the sugar maples, and not the heavier rainwater in the soil.

In fact, many of the plants growing near the sugar maples were making good use of their proximity to these trees, using the water they were releasing to grow bigger and healthier.

Terry Chapin, an ecosystem ecologist at the University of California at Berkeley, said this water sharing turns ideas of plant competition on their head.

Not only might it not be so bad to be near other plants, but in terms of getting enough water and dissolved nutrients, it clearly might be good. ❑

A new view of how trees obtain and share water

Scientists are finding that plants that draw water from deep in the soil share the water with nearby plants. In a drought, the closer plants like trillium, lillies and goldenrod were to thirsty sugar maples, the better they did. Most of the tree's root system is above the hard fragipan layer of soil, with only a few roots penetrating to tap the deep water supply.