

Do plants “sweat”?

A laboratory experiment
from the
Little Shop of Physics at
Colorado State University

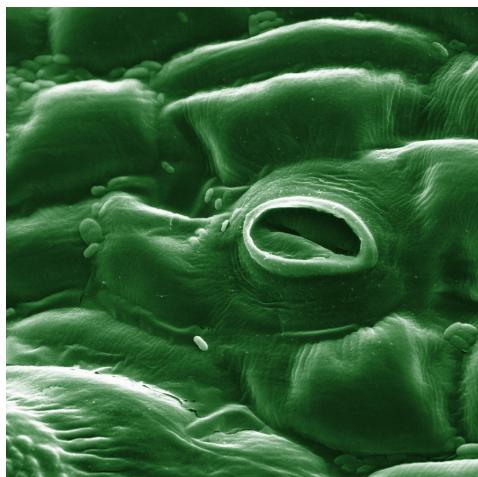


Overview

Years ago, I attended a workshop in Las Cruces, New Mexico in the middle of July. I would do a morning run with some of the locals, who told me their rule of thumb for the temperatures: 60 degrees at 6, 70 degrees at 7, 80 degrees at 8, 90 degrees at 9, 100 degrees at 10. They were more or less correct. Once the sun came up, the cool desert mornings rapidly turned hot. By mid morning, it was too hot to be outside.

In the green rolling hills of east Texas, at a similar latitude, the sun is just as hot, but the temperature rise is much less extreme. The days start much warmer, but then rise much more slowly, so that temperatures in the middle of the day are about the same as in New Mexico.

You know that sweating keeps you cool—the conversion of liquid water to water vapor requires energy. And the difference between these two climates results from the same phase transition. The source of the water? Plants. The green hills are covered with grasses and other plants that *transpire*, converting large amounts of water in the leaves into water vapor into the atmosphere, moderating the temperature rise as they do so.



Stomates on a tomato leaf as seen by a scanning electron microscope

Necessary materials:

- 1 clear glass bowl or fish tank per group
- Several different types of ground cover: grass, bare dirt, water, etc.
- Source of heat and light—this can be a heat lamp or the sun.

This experiment isn't picky - any glass container will do the trick. We have successfully used fish tanks as well as dessert bowls from a local department store.

Theory

Plants have many pores on their leaf surfaces (and, to some degree, on stems, flowers, and roots) called *stomates* or *stomata*. When the stomates open to admit carbon dioxide for respiration, water vapor can leave through these same openings.

The more big leafy plants populate an area, the more water vapor is expelled into the air. Consider the tropical rain forests of the world. You might bring to mind an image of an explorer pushing aside leaves larger than herself so make way on an adventure. This is an area where the day to night temperatures will vary but not nearly as much when compared to areas without this type of vegetation.

Doing the Experiment

Divide your student into small groups and give each a glass bowl or fish tank. Instruct them that they will be using this container to get a qualitative measurement on how much humidity is being produced by the system contained underneath it. Ask them to make predictions about what they might observe. Will there be more or less humidity when the container is placed over grass or water? Students can do this indoors with a heat lamp and containers of the different types of ground cover, or they can do this outside on a sunny day and use whichever types of local ground cover are available. Have students record their data and report to the group.

You may find that although the container becomes fogger when placed over grass than when placed over water. The water will eventually fog up the container but the evaporation process for it to do so is actually slower than the transpiration process exhibited by the grasses—an interesting surprise that illustrates the importance of transpiration.

Summing Up

This experiment illustrates one important aspect of the interaction of the biosphere and the atmosphere. What happens above us is very tightly coupled to what is happening below us.

For More Information

CMMAP, the Center for Multiscale Modeling of Atmospheric Processes: <http://cmmmap.colostate.edu>

Little Shop of Physics: <http://littleshop.physics.colostate.edu>



There is more condensation on the glass over the grass (right) than over the cup of pure water (left)