HOW DO PLANTS QUENCH THEIR THIRST?

Confused geraniums

Mrs. Westwood lives in a small, calm village. She has been in retire for two years now thus she has plenty of time for her hobby – gardening. She is very proud especially of her geraniums which are admired by all the inhabitants of the village. Mrs. Westwood has the geraniums on all her window ledges and also hanging on the fence so that everyone walking by can see them.

This June has started very tough time for the village. Due to the closure on nearby highway a road diversion has been going through the village. All the noises and smells of fumes produced by cars and tracks have affected the calm life of villagers very much.

At the end of June, Mrs. Westwood noticed that her always so beautiful geraniums had started to wilt even though she watered and manured them as usually. And moreover, Mrs. Westwood also noticed that the water level in flower boxes stayed the same for many days. "Why the geraniums don't drink when there is obviously lack of water in them?" That was a real mystery for Mrs. Westwood…

Can you think of a reason why the geraniums don't absorb any water despite of the fact that they are wilting?

Cite this work as:
Bílá, Jana and Mourek, Jan (2014). How do plants quench their thirst? pp. 1-8. Available at http://comblab.uab.cat

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein Project N. 517587-LLP-2011-ES-COMENIUS-CMP

Useful to remember:

1. As well as other living organisms on Earth, plants need water. What is the role of water in plants? Which physiological processes require water in their reactions?

_____
_____
_____
_____

2. Match the following terms (action – part of plant – process) so that the triplets describe water economy of plants.

Intake of water	Stomata, cuticle	Absorption
Water transport	Vascular tissue	Transpiration
Water loss	Root hair	Transpiration stream

3. Which environmental factors have an influence on the transpiration? What is the mechanism of the influence?

_____
_____
_____
_____
_____

4. Which physical quantities could you measure for confirmation of transpiration in plant? How would the quantity change in time?

_____

_____

_____

_____

_____

5. There are two ways of transpiration. Water vapour can be lost either through the stomata or directly from the epidermal cells through the cuticle.

   ➔ Which type of transpiration has a bigger proportion of total water loss? Compare young and mature leaf.

_____

_____

_____

_____

_____

6. Human activities produce emissions which can be very harmful to plants. In which way can emissions influence plant transpiration?

_____

_____

_____

_____

_____

Experiment: transpiration of plants – barometr

Task: Explore an effect of clogged stomata on transpiration rates.

Questions:

1. What are your expectations about changes of transpiration rate after clogging of stomata? Explain.

_____

_____

_____

_____

2. Blockage of stomata means complications in other plant processes. Which ones?

_____

_____

_____

_____

Materials and devices:

- Sensor of air pressure (barometer) + connector
- Datalogger or computer with an appropriate software
- Green leaves: horse chestnut/maple/…
- Valve
- Plastic tube (36-42 cm long)
- Ring stand
- 3 utility clamps
- Scalpel (or razor blade)
- Vaseline
- Plasticine (not necessary)
- Paper tissues
- Toothpick (for applying the vaseline)
- Hair spray
- Sink or large bowl with water

Procedure:

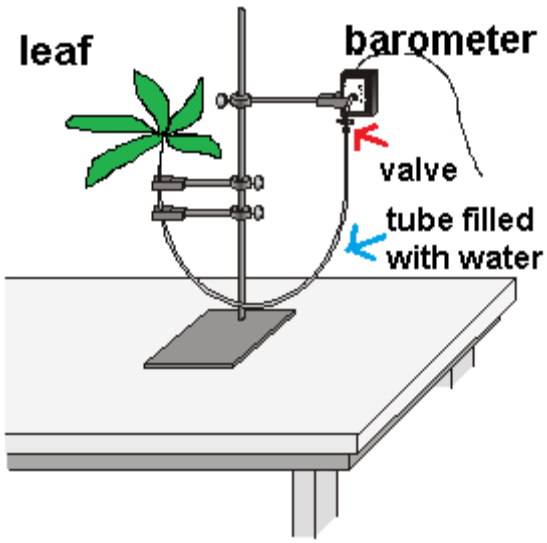


Fig. 1: Apparatus for exploring plant transpiration (Redding & Masterman, 2007 - adapted).

1) Attach the utility clamps to the ring stand as shown in Fig. 1.
2) Attach the barometer to the top clamp.
3) Connect the leaf to the tube. Work **under the water** (in a sink or large bowl with water):
    a. Place the plant under water against a hard surface and make a cut at a 45° angle in the part of the petiole which has approximately the same diameter as the tube. Make sure the blade of the leaf is above the water surface all the time.
    b. Fill the whole tube with water by putting it into the water from one end. You can see how the water pushes the air out of the tube. Stop filling the tube when there is 1-2 cm of air at the end of the tube. Insert this end with air to the closed valve as shown in Fig. 2. **Attention!** Water must not get into the exit of the valve since the barometer wouldn't work.
    c. Under the water, insert the petiole to the tube.

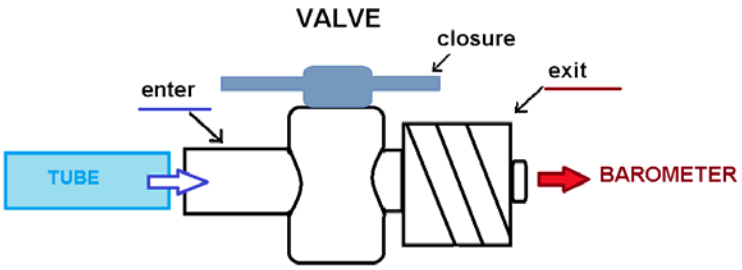


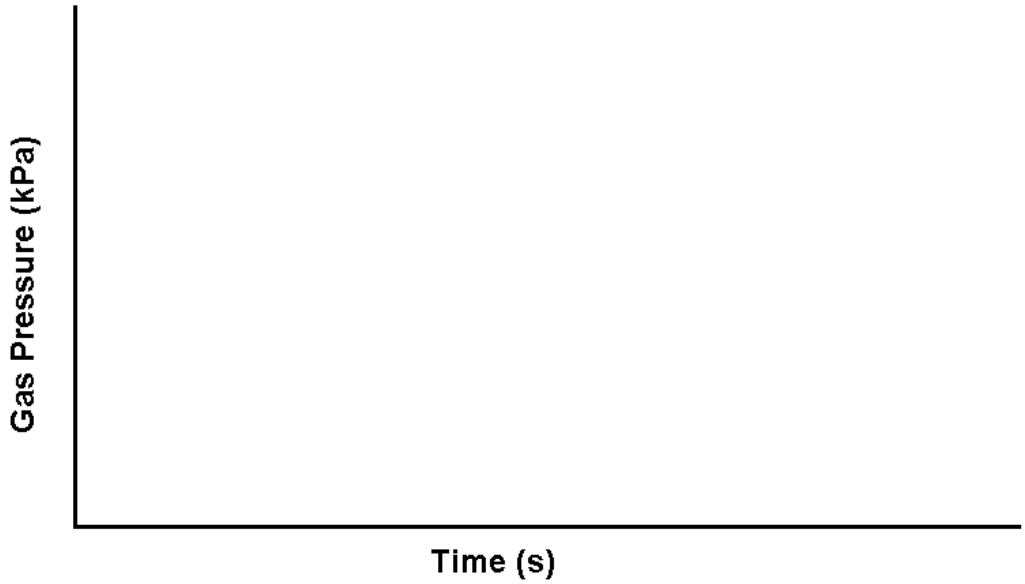
Fig. 2: Diagram of connection of tube to the valve and the barometer (Bílá, J.).

4) Above the water surface, seal up the end of the tube with the leaf using the vaseline and plasticine (if the petiole is much thinner than the diameter of the tube). If the valve is closed, the water is hold in the tube. By opening the valve, you can test if the sealing up was successful. Otherwise, use more vaseline. Then, close the valve again.
5) Fix the tube to the ring stand so that its end with the leaf is ca. 5 cm under the level of water surface in the other end of the tube connected to the barometer (shown in Fig. 1).
6) Connect the barometer to the computer.
7) Run the computer interface for collecting data from sensors.
8) Open the valve.
9) Wait approximately 5 minutes for sensor equilibration.
1) Start 15 minutes (900 s) data collection. Note the first measured value of gas pressure to the table in section *Data*.
10) Stop the data collection and note the value of gas pressure for time=900 s to the table in section *Data*.
11) Renew the pressure in the apparatus:
    a. Close the valve and disconnect it.
    b. Open the valve for ca. 10 seconds and close it again.
12) Apply the hair spray all over the lower (abaxial) epidermis of the leaf. Let it get dry for one minute. Control the sealing as written in step 4.
13) Connect the closed valve to the barometer. Open it and wait ca. 5 minutes for sensor equilibration
14) Start 15 minutes (900 s) data collection – chose the option '*add new data to the end*'. Note the time (*t*=…… s) and the value of gas pressure in the beginning of the new measurement to the table in section *Data*.
15) After 15 minutes, stop the data collection. Note the value of relative air humidity in time *t+900* s to the table in section *Data*.
16) Count the difference between the beginning and the end of each measurement. Note the results to the table in section *Data*.
17) Find the rate of transpiration (kPa/s) for your leaf: record the slope of the lines for the two phases in your graph.
18) Save your data.
19) Clean and dry the apparatus

Data:

Write your data into following table. Then, draw a shape of the curve of measured data to the empty graphs. Don't forget to mark on the x-axis also the conditions of measurement.

	Initial value of gas pressure [kPa]	Terminal value of gas pressure [kPa]	Difference [kPa]	Slope [kPa/s]
Leaf with free stomata				
Leaf with clogged stomata				



Conclusions:

1. How did the value of gas pressure change during the first phase of measurement? Why?

_____

_____

_____

2. What was the result of clogging of stomata? Why?

_____

_____

_____

3. Do your expectations match with the measured data? If not, why it could be?

_____

_____

_____

4. Write to Mrs. Westwood a short message. Explain to her what probably happened to her precious geraniums.

_____

_____

_____

_____