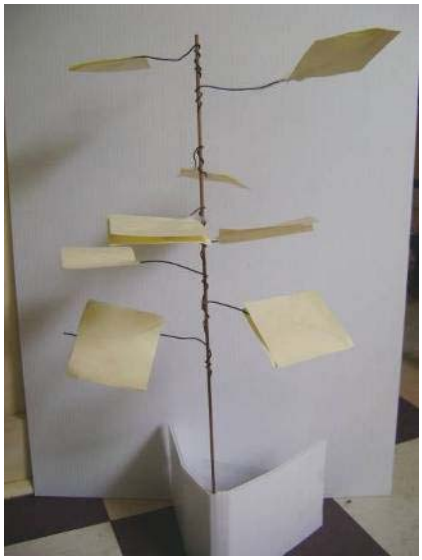
Leaves: Designing Leaf Arrangements on a Branch

Rationale



A superficial observation of trees might lead to the conclusion that the leaves on a tree are randomly arranged. Closer examination suggests that there appears to be some order to the arrangement, but it takes a careful examination to see that the arrangement has an overall design.

The following hands-on activity is a great way to get youth thinking about this characteristic of trees. Provide your group with some simple materials and challenge them to design an arrangement of leaves on a branch of a tree, deciding how the leaves would be placed on this branch. The goal is to have them think about how leaves are spaced on the branch so that they don't overlap and can have as much direct access to sunlight as possible.

A guiding question for this activity is, **How do leaves arrange themselves on a branch to capture the most sunlight?**

This activity is another way of focusing on the function of leaves on trees. It should precede the activity of observing the structure of leaves.

Materials

For each group of 2 or 3 youth

- 1 dowel (1/8 inch in diameter, 3 feet long; include additional dowels if you have time for groups to copy their branches)
- 25–30 self-stick notes (3 × 3 inches)
- 2–3 feet electrical wire (22, 26, or 30 gauge)

For the whole group

- wire cutters, or scissors or pliers that can cut wire
- 1 portable electric light, as shown (shown below; make sure the light has a receptacle and reflector that can be easily be moved)

Photo courtesy Bernie Zubrowski

Portable electric lamp

Preparation

To get a sense of what the youth will have to do, try your hand ahead of the session at designing a branch with leaves. See Introducing the Activity for details.

Review photos of trees that youth have taken previously and choose ones that show the full canopy of a tree. Choose those that allow you to zoom in on some branches to see the arrangement of leaves. You can use these photos during the introduction to the activity. You can also collect some branches from different trees just before you carry out this activity with youth. Choose branches that have different leaf arrangements.

Introducing the Activity

Have the youth recall the observation of the trees on their previous field trips by asking the following questions:

- What do you recall about the arrangement of the leaves on a tree?
- Are they random or is there some order?

Show photos taken previously by the youth and spend some time having them discuss how the leaves appear to be arranged on the trees. Call to their attention that leaves are light gathers; they need to maximize their exposure to sunlight. Given this need, what is the best arrangement of leaves to allow the most exposure to sunlight?

Challenge the youth to design an arrangement of leaves on a branch of a tree. This hands-on exercise can help them think about how leaves are arranged. Point out the materials youth will be using: the dowel, the self-stick notes, and the wire.

Explain to the youth their challenge: **How can you design the leaf arrangement on a branch of a tree using these materials?**

Explain the use of each of the materials The dowel will act as the branch; the wire will be the stem of the leaf; and the self-stick notes will be the leaves.

How can they arrange the leaves so that they don't overlap very much and will be best exposed to the sun? In this situation, the portable light will act as the sun. After they have attached wire and

sticky notes to the dowel, they can shine the light on their branch and see where the light falls and whether most of the leaves are receiving some light.

Organize the youth into groups of two or three. Tell them to take some time to make some drawings before working with the materials. Encourage them to think ahead of how they will attach the wire and the sticky notes.

During the Activity

Observe the youth as they are adding the wire and paper to the dowel. Encourage them to stop occasionally and view the entire arrangement to see how they have aligned their paper leaves.

Testing Their Designs

Some youth may have difficulty keeping the wire from slipping on the dowel. Keep an eye out for this problem and provide some assistance. Youth can use some tape to keep the wire in place.

Also, point out that the lengths of the wires acting as stems do not all have to be the same length.

When each group has reached a point where they think they have added enough leaves to their branch and have arranged the leaves in what they think is a good arrangement, tell them to use the portable light by holding it high as though it were the sun. Then, they should place their designed branch into the light.

Photo courtesy Bernie Zubrowski

A sample of a completed leaf arrangement: from above.

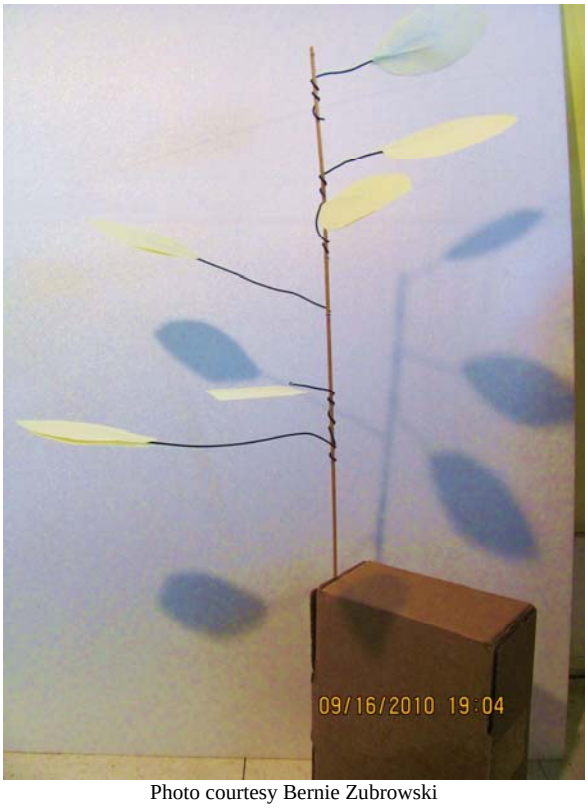


Photo courtesy Bernie Zubrowski

A sample of a completed leaf arrangement: from the front.

As they do this, they need to ponder the following questions:

- Where is the branch on the tree? Is it at the top, in the middle, or on the bottom of the tree?
- When the light shines on the branch, are the leaves exposed to the light or are there some shadows on some leaves?
- Since the sun moves across the sky during the day, how does this movement change how the light hits the leaves? (They can simulate this by moving the light from one position to another while keeping it at the same height.)

After testing, youth should make some rearrangements of their leaves and test with the light again to see if they get a better result. If time permits and there is still a strong interest in the activity, have each group make copies of their branches. They can then test what happens when several of the same branches are placed close to each other as happens in a real tree. How much shadowing occurs from the presence of these other branches?

When all groups have designed and tested, have a general sharing where groups share their branches and report how well their arrangements worked.

Discussions

After the general sharing, ask the youth to reflect on what they have learned from this exercise.

- How important is it for leaves to be spaced apart and have a specific orientation to the sun?
- What arrangements seem to work best to maximize the exposure of the leaves to the sun?
- Does it make a difference where the branches are on the tree?

You should point out that this exercise is an approximation to the situation with real trees. Real trees, as youth have observed on their field trips, have very many branches and are oriented in multiple directions. For instance, some trees have lots of overlapping leaves particularly at the tips of the branches. Given that the sun moves across the sky during the day, different leaves will be exposed to sunlight at different times and at different angles. Some leaves can function well in weaker sunlight. Different trees have developed different strategies to deal with ways of gathering sunlight.

Redesign
If there is interest and time, you could have youth go back and rearrange their self-stick notes as well as add or remove them to see if youth can come up with a better arrangement based on what they observed from their previous designs.

Observing Behavior

This exercise allows you to get a sense of what information has been picked up by the youth on their field trips and how closely they have been observing trees and plants. It also can reveal how they are thinking about the function of leaves.

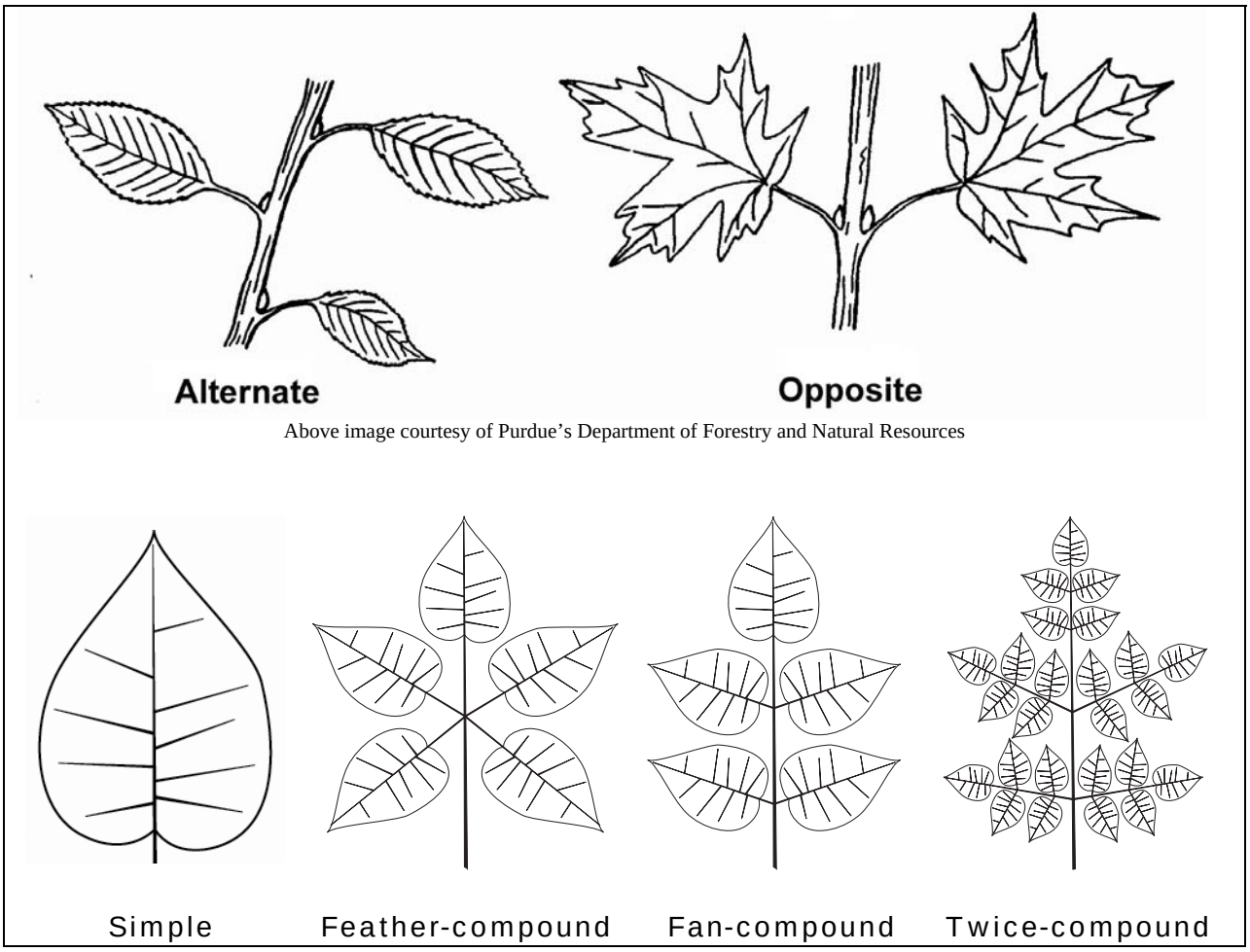
Listen to the youth talk as they go about designing and adding the materials to their branches.

- Do they approach this problem as just a craft project where they are just adding the sticky notes to make it pretty, or are they talking about what is a good arrangement to catch the light?
- When they have added a number of the sticky notes to the dowel, do they stop and consider how these overlap or are spread out?
- When they are using the light to see how it shines on their leaves, do they move the light around to see if it makes a difference?
- Do they make some connection between this exercise and what they have observed with real trees?

Background

Observing the arrangement of leaves on tree branches is useful in tree identification. Field guides to trees will show these arrangements and give a sense of the variation among trees.

Two broad categories of leaf arrangements are opposite/alternate leaves and simple/compound leaves (see figures below).



Above image courtesy of Purdue's Department of Forestry and Natural Resources

Leaves come in two types of arrangements: alternate/opposite and simple/compound.

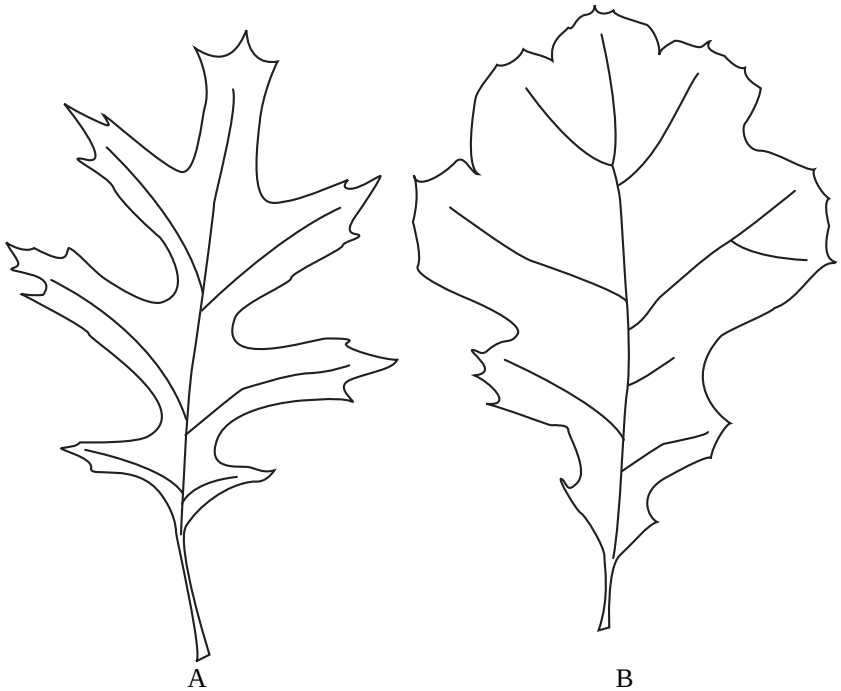
Photo courtesy Bernie Zubrowski

Different-sized leaves on a single branch.

Have youth closely examine leaf arrangements on several different kinds of trees. First, have them observe the sizes of the leaves. Some trees may have leaves of different sizes whereas other trees may have very equally sized leaves (see figure at left).

Then, have them look at the length of the stem of the leaves (petiole). On the same tree, the petiole of the leaves may vary from short to long, particularly when the leaves are very close together. The petiole lengthens in order to help the leaf gain more sunlight.

Leaves on the same tree may also have different shapes. Lobes on leaves act as a way of reducing shading. The space between the lobes allow for light to get through to other leaves on the tree. Sometimes the shape of the leaf changes based on the location on the tree. Black oaks show this type of variation (see figure below).



Leaf variation in the black oak: (A) an upper leaf, exposed to strong sunlight; (B) a shade leaf from a lower branch of the same tree.

Source: Coulter, J., Barnes, C., & Cowles, H. (1911). *Ecology, Vol II*. Woodstock, GA: American Book Company.

For more information on the structure of trees, the shapes of leaves, and other interesting tree topics, visit the Butler Univesity Freisner Herbarium website: http://www.butler.edu/herbarium/treeid/treeparts.html.

For more activities like this, or for more information on how to carry out *this* activity, please go to http://treesandponds.edc.org.

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