Autumn ‘Leaves’

To many, the season of autumn is a time of lower back pain due to loads of raking, but have you ever wondered why do the leaves of some trees turn color and fall, while the leaves of others do not?

PRACTICAL SCIENCE WITH PHIL FREDA

Autumn is truly a special season.

As the temperatures start to fall and the days become shorter, trees start to exhibit the beautiful hues of yellow, orange, brown, and purple that are synonymous with the harvest season.

For others however, the mass accumulation of dead leaves is just a bother.

Have you ever stopped and wondered why this phenomenon happens and how?

Deciduous vs. evergreen trees

First, we need to define two important biological terms involving trees.

In the northern latitudes, there are two types of trees, evergreens and deciduous trees.

Trees are considered deciduous if they shed their leaves for the winter months.

In the northern parts of the globe, the deciduous trees are almost all comprised of angiosperms. Angiosperms (“vessel seed” in Greek) are the flowering plants.

Angiosperms produce seeds that are covered and produce flowers and fruits in order to reproduce.

Examples of angiosperm trees are

- oaks
- maples
- dogwoods

Sometimes angiosperms are called “broad-leaf” trees or “hardwoods”.

Conversely, almost all of the evergreen trees in the north are comprised of the gymnosperms.

Gymnosperms (“naked seed” in Greek) do not produce flowers or fruits.

Within the gymnosperm category are the trees we know as the conifers.

Conifers, or softwoods, produce scaly or needle-like leaves instead of the large, broad trees that are found on the angiosperms.

Some examples of conifers are

- pines
- cedars
- spruces
- firs

Conifers are evolutionarily more ancient than the flowering plants and their seeds are not enclosed in an ovule. Instead, the conifers produce cones that are necessary for reproduction.

In is important to understand that the term “evergreen” is not synonymous with gymnosperms. In tropical climates, a plant may be evergreen but also be an angiosperm.

It just so happens that in northern climates, most angiosperms are deciduous and most gymnosperm trees (conifers) are evergreen.

Why do the leaves of deciduous trees change color and fall?

This is a very complex question with an equally complex answer.

As the autumn months roll in, so does a steady decline in temperatures and available sunlight.

Trees can “sense” these changes and produce a response to these environmental changes through hormones and chemical signaling.

Just as you body tells you that it’s time to eat, trees know when it comes time to prepare for winter.

According to the Michigan Forests Forever website, in response to decreases photoperiod (sunlight), trees increase the production of a hormone called abscisic acid.

This hormone slows done processes that help the plant grow.

This process is very similar to the process that hibernating animals undergo before their long winter sleep. One of the consequences of these chemical changes is the breakdown of chlorophyll molecules located in the leaves.

If you remember from a previous article, chlorophyll is an important molecule involving in photosynthesis, the chief metabolic pathway in plants.

Since light from the sun is required to upkeep the process of photosynthesis and days are getting shorter, chemical changes in the plant start to breakdown the molecule.

Because of this, other plant pigments begin to be seen.

These others pigments include the yellow and orange carotenes and xanthophylls.

According to Michigan Forests Forever, the scarlet colors (reds and purples) are brought on by hard frosts, which affect residual sugars stored in the leaves.

As the leaves continue to decay, special cells form scar tissue where the leaf and branch attach. This action seals up the area and also separates both organs.

Wind and the force of gravity do the rest, resulting in the leaves falling from the tree.
Aside from a response to the loss of light, plants also achieved this adaptation because of winter to drought conditions.

During the winter months, the air is actually very dry.

As a general rule, all things move from an area of higher concentration to an area of lower concentration. This is known as generally known as diffusion, but when we are talking about water and plants, the term is transpiration.

In the winter, very little water vapor is present in the air.

Leaves have much more water in them than the air outside during the winter.

If angiosperm trees did not shed their leaves, the water would be literally pulled out of them by the surrounding air.

So, leaves are actually a liability in dry climates.

Since the tree has a hard enough time finding liquid water during the winter, the added loss due to the leaves would be too much to handle.

Why do evergreens keep their leaves?

Conifers actually do lose some leaves during the transition from fall to winter.

Conifers keep the majority of their leaves in the winter because of adaptations to drought conditions.

Needle-like leaves have the ability to curtail water loss in the winter months through two important mechanisms.

- The first is a thick, waxy coating of a chemical called cutin. This coating inhibits water passing through it similar to how sealant does.
- The second adaptation is stomatal control.

Stomata are openings in the leaf surface that are controlled by specialized cells called guard cells.
By controlling when, and how often, these openings open and close with greater precision than other trees, conifers are able to control how much water can escape.

Having needles in the winter allows conifers to exploit the few hours of sunshine that are available and turn it into usable energy.

The only down side is, since the presence of needles allow for snow accumulation on the branches and surface area to interact with winds, loss of limbs are a possibility.

Alright, I understand that knowing why trees lose their leaves doesn't make raking them up any easier, but maybe now at least it will be a little more interesting.

Think about it!

About this column: An educational, science-minded column

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Have some great examples of autumn's magnificent colors? Share your pictures right here, by clicking on the "Submit Your Photos" above. Tell us in the comments.