

### Topic Three: **Monocots and Dicots.**

#### Botany lesson:

A “cotyledon” is contained in the seed of a flowering plant and emerges as a new shoot grows from a seed. As the seedling starts to grow, the cotyledon or “seed leaf” is visible on the stem before the true leaves appear. The monocotyledons or monocots have one seed leaf and the dicotyledons or dicots have two seed leaves (figures XX and XX). The word “monocot” comes from “mono(one)-cot(seed leaf)” and same for “dicot” (two seed leaves). These two groups make up the entirety of flowering plants.

Let’s start with monocots. The grass family, *Poaceae* (formerly *Gramineae*), is the most familiar group of monocots. Here are some grass categories with which you may be familiar: bamboo, sugarcane, maize (corn), sorghum, wheat, oats, barley, milo, rye, rice, millet, hay, pasture grasses, turf, ornamental grasses, prairie grasses, pampas grasses, weed grasses, arctic grasses, and alpine grasses. A pretty extensive family — it occurs in many habitats in almost every region of the world.

Besides the grass family, here are some other monocots: sedges (including papyrus), rushes, pondweed, palm trees, philodendrons, spiderworts, pineapples (bromeliad family), asparagus, onions, chives, garlic, leeks, shallots, ginger, bananas, lilies, daylilies, hostas, irises, flowering bulbs, and orchids.

Dicots are an even more extensive group — there are about 200,000 species of dicots (as opposed to 60,000 species of monocots). The term “dicot” is descriptive and does not denote a single group of related plants. The dicots have diverse lines of ancestry, the largest and most recently-evolved group being the “eudicots” which includes many familiar plants we see every day — about 70% of flowering plant species. Examples include: sunflower, dandelion, forget-me-not, cabbage, apple, rose, buttercup, maple, beech, birch, and oak.

Before the advent of eudicots, there was a horizontal branch on the family tree leading to the “basal angiosperms,” an ancient and diverse plant group with only a few hundred species. Examples include water lilies and other aquatic plants, and woody aromatic plants such as star anise.

Another pre-eudicot horizontal branch was the “magnoliids,” a much larger group of species than the basal angiosperms. This group includes familiar trees such as the magnolia and tulip tree.

Classification of dicots into orders and families is currently (year 2020) a topic of controversy among botanists. New research techniques such as electron microscopy and DNA studies have allowed classification to be “phylogenetic,” meaning that plants are grouped in accordance with how they evolved over time. Geographical distribution studies have always been important for determining genetic relationships, and those have been enhanced by new computer methods (Geographical Information Systems or GIS).

#### Group inquiry:

So, which evolved first — monocots or dicots? The monocots seem to be simple plants, so maybe the dicots evolved from monocot ancestors. Or, maybe the dicots were already going strong and the monocots diverged as an off-shoot of the dicots. Don't forget that both monocots and dicots came from the gymnosperms that preceded them.

Let's take a vote. Take a slip of paper, write your vote, and fold it in half. If you think monocots came first, write “monocot.” If you think dicots came first, write “dicot.” Don't put your name. If you had botany in college, don't whisper the answer to your neighbor. At the end of the class, we will count the votes. When the voting is finished, we will proceed.

Ready? If the voting is finished, then we will proceed to find the answer.

One of the chief differences between monocots and dicots is that dicots have a cambium, and sometimes a “cork cambium” as well. In Topic 2, we discussed xylem and phloem that transport materials inside the plant. As it turns out, these vessels are positioned differently in monocots and dicots. In the stem of a monocot, the xylem and phloem are grouped into “vascular bundles,” but in a dicot plant the phloem and the xylem are concentric rings on either side of the cambium (not always, but generally speaking). The cork cambium is the layer that produces the bark on the outside of the stem in dicots. Monocots are never woody, but they can still be very strong and sturdy (such as a palm tree which is a monocot).

Look at figures XX and XX of monocot stems. The vessels are grouped into bundles, right? Then look at figures XX and XX of dicot stems and you see the concentric arrangement. Also, monocots have parallel veins

on their leaves, and dicots have branching veins (see figures XX and XX). What clue does that give us? Do you want to change your vote?

You might think that one comes before two and therefore monocot must come before dicot. But here's the thing. Gymnosperms have cambium (plural of cambium). We've already learned that monocots do not have cambium, and that dicots do have cambium. Perhaps the development was gymnosperms to monocots to dicots, but then we have a puzzle. Did the plants forget how to make cambium and then remember again? (The next time you have ten minutes to spare, look up "Occam's Razor" in Wikipedia.)

Now we finally come to the answer.

It turns out that monocots are specialized dicots that split off on their own. The early dicots came first, and both dicots and monocots are descended from them. This split came early in the development of dicots, possibly the Early Cretaceous period, about 140 million years ago (MYA). To put this in perspective, it is about midway between the Devonian Explosion (when forests of tree ferns, cycads, and conifers developed on dry land, 360 MYA), and the extinction of dinosaurs, 66 MYA. If you voted for monocots, don't despair — you will have a chance to vote for monocots again in Topic Six when we each choose our favorite group of plants.

So, we have established that gymnosperms and dicots can be woody, and monocots cannot. If you are stacking firewood, the gymnosperms such as pine and hemlock look similar to the dicots such as maple, oak, birch, and beech. On a microscopic level, however, the structure of the wood is very different (see figures XX and XX).

#### Botany trivia:

Which member of the Plant Kingdom is structurally the strongest? Douglas fir and western hemlock are the lords of the lumber industry, or perhaps it is the mighty oak, the redwood, or a titan of the tropical rain forest. Those trees must be strong to hold up such massive weight, wouldn't you say?

Actually, the strongest plant is bamboo. Bamboo? Yes, I kid you not. Bamboo is not a plant but a group of plants — 1,462 species in 115 genera, in fact. Bamboo has a higher specific compressive strength than wood, brick, or concrete, and a specific tensile strength that rivals steel.

Asian contractors use bamboo for scaffolding (figure XX). And, guess what? Bamboo is a kind of grass, a monocot. Wow.

Since Topics 4, 5, and 6 are mostly about dicots, let's explore the monocots a bit.

Bonus material — Further details about monocots:

In the textbook *Integrative Plant Anatomy*, Professor Dickison relates the following:

“J. C. Schleip was an active piano maker in Berlin between 1816 and 1850. Schleip used woods of as many as 10 species in the construction of a single piano....Especially interesting is Schleip's use of rattan palm (*Calamus*) “wood” for his hammer shanks. This is the earliest known instance of a Southeast Asia/Pacific Rim forest product being used in a Western musical instrument and is an almost unique use of monocotyledonous material.”

The monocotyledons get around, don't they? As with all monocots, palm trees do not have “wood” and “bark” in the usual sense, but they do have means of thickening and strengthening their stems.

The world's largest crop by tonnage harvested is sugarcane — a group of related species used commercially to produce sugar, molasses, ethanol, paper, and many other things. And sugarcane is, you guessed it, a member of the grass family (hurray for monocots). See figure XX.

The sedges are also monocots — they look like grasses but belong to a different family. The most famous of the sedges is the genus *Cyperus*, consisting of 700 species including the papyrus used in Ancient Egypt and common indoor plants such as umbrella plant and dwarf umbrella-sedge. Purple nutsedge, sometimes called “the world's most noxious weed,” belongs to this genus, as well as its cousin yellow nutsedge which is common in lawns and gardens in North America. You can spot this weed easily because it has a triangular stem (typical of all sedges, figure XX).

Once I was exploring a wild meadow in Connecticut and noticed that the thorny vine “greenbrier” (also called “bullbrier”) has parallel veins on the leaves. Sure enough, greenbriers are monocots (even though they look like dicots). See figure XX.

The largest monocot family is the orchid family with about 20,000 species.

The monocots are pretty impressive, don't you think? They are only a small part of the Plant Kingdom family tree, but have a huge role in the life of humans.

Intergenerational activity:

Senior Citizen: tell a story from your past about a kind of monocot or dicot plant. Take time to think of a really good story. (Monocot Examples: you saw forty kinds of palm tree in a botanic garden in Florida, you remember reading about Laura and Mary Ingalls jumping on haystacks on the banks of Plum Creek, or you wore a leek in your hat in a Shakespeare play in college. Anything goes.)

Here is a story about a dicot plant from *The Voyage of the Beagle* by Charles Darwin (the dates of the voyage were 1832-1836). Here is a brief excerpt from Chapter VII about a rural region of Argentina:

“When the thistles are full grown, the great beds are impenetrable, except by a few tracks, as intricate as those in a labyrinth. These are only known to the robbers, who at this season inhabit them, and sally forth at night to rob with impunity. Upon asking at a house whether robbers were numerous, I was answered, ‘The thistles are not up yet’ — the meaning of which reply was not at first obvious. There is little interest in passing over these tracts, for they are inhabited by few animals or birds, excepting the bizcacha and its friend the little owl.”

Here is a monocot story. In 1969, I worked on a dairy farm in Delaware County in the Catskills of New York State. The farmer wanted to grow some sweet corn for his family, but he knew that raccoons love sweet corn. So, he planted a row of sweet corn in the middle of a field of silage corn (he called it “cow corn”). It didn't fool the raccoons one bit. The raccoons came out of the woods, walked past twenty rows of cow corn, stripped every ear of sweet corn, and went back to the woods again!

Group activity:

Growing ginger root, *Zingiber officinale* (monocot)

Ginger is a perennial plant that is with cold hardiness down to 25 degrees F. It grows 2 to 4 feet tall with stiff, angular stems and long, thin, pointed leaves. Enjoy outdoors or in!

Steps:

1. Purchase ginger root from a supermarket produce department, selecting large, plump ones with well-developed “eyes.”
2. Fill a 12-inch pot with potting mix up to 3 inches below the rim of the pot. Lay the root on its side in the pot, cover with 1 inch of potting mix, and keep warm and moist until sprouted.
3. General culture: Keep evenly moist and fertilize monthly.
4. Growing outdoors or in:  
Outdoors: Put in light shade. In late fall, bring indoors and grow as a houseplant.  
Indoors: Provide bright light, warm temperatures, and high humidity.

End of Topic Three