Anatomy and Physiology of Plants in Carolinian Canada

Anatomy and Physiology of Plants in Carolinian Canada

A Reference Guide

AMY TURNBULL AND BIOL-3010 STUDENTS

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Contents

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This guide was written by students in Fanshawe College's Chemical Laboratory Technology program as part of BIOL-3010 Anatomy and Physiology coursework.

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Cover Image

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Land Acknowledgement

Land Acknowledgements

Fanshawe College Land Acknowledgement

We acknowledge and honour the Anishinaabe, Lotinuhsyuní and Lenape people of southwestern Ontario as the traditional owners and custodians of the lands and waterways where Fanshawe College is located.

Fanshawe celebrates the continuous living cultures of original inhabitants of Canada and acknowledges the important contributions Indigenous people have and continue to make in Canadian society. The College respects and acknowledges our Indigenous students, staff, Elders and Indigenous visitors who come from many nations.

For more information, please vest Fanshawe's Indigenous Acknowledgement and Welcome website.

Land Acknowledgement for Waawayaataning

The Carolinian Zone

Carolinian Canada Coalition acknowledges that we live on the traditional territories of many nations including the Anishinaabe, the Haudenosaunee, the Lunaapeew, the Wendat and the Mississauga. We acknowledge all Indigenous nations that still call this land home and the many diverse First Nations, Métis and Inuit peoples who have moved here since.

Carolinian Canada acknowledges the inherent and treaty rights of the Indigenous peoples of Turtle Island. We acknowledge the Royal Proclamation of 1763, which serves as the basis for the treaty-making process and is the first legal recognition of aboriginal rights and titles. Carolinian Canada acknowledges all the treaties that have been signed related to this land.

We acknowledge the Two Row Wampum and the One Dish One Spoon Wampum. We commit to the teachings they hold and our duty to learning more.

Carolinian Canada acknowledges the role we must play in Indigenous reconciliation. We are committed to building relationships and working with Indigenous nations. We will continue to create safe spaces for Indigenous and non-indigenous perspectives to meet and discuss the issues that matter to everyone.

For more information about First Nations please referee to the Carolinian Canada's Traditional Territories webpage.

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About This Book

Conspicuous plants found in the Carolinian zone of southwestern Ontario are described in this text. Identification, life cycle, and cultural information are given for each plant, relevant for nature enthusiasts. Cultivation information pertinent to the home gardener is listed. Anatomy based on laboratory analysis is described.

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ANATOMY AND PHYSIOLOGY GUIDE

Section Contents

This guide contains the following sections:

1.1 Claytonia Virginica

AMY TURNBULL

Claytonia Virginica

Author: Amy Turnbull

In this section:

1. Plant Description

Claytonia virginica is also known as Virginia Spring Beauty or Fairy Spuds due to the tiny edible corm.

This plant is a:

- **Perennial:** the plant re-grows each year from the same root
- **Eudicot:** the plant has two seed leaves, although in this genus, only one is dominant in the seed
- **Angiosperm:** this plant flowers and produces seed
- **Herbaceous:** no woody tissues
- **Determinate growth:** The stems are terminated by a bud. In the case of floral stems, floral buds form. Leaves emerge directly form the root.
- **Spring ephemeral:** A loose collection of plants with similar life cycles. Its life cycle occurs prior to deciduous trees leafing out when the forest floor receives sunlight. In Carolinian Canada, this is typically in April-early May (Muma, n.d.).

2. Identification

Location: This plant is found in moist woods and semi-shade meadows (Newcomb, 1989).

Flowering: Flowering occurs in April in SW Ontario. The early flowering and distinctive pink stripes on the petals of most flowers are unique. Flowers are regular symmetry with two bracts, five petaloids and five pink stamens (Figure 1.1). Petaloids look like petals but are derived from different tissue (Milby, 1980). Flowers contain both male and female organs. The style has three parts connected to a six-part ovary. Petals are white with fine pink stripes, ranging from pale to bright pink. Flowers close in darkness and during heavy cloud cover. Flowers are upright when open and nod when closed (Hilty, n.d.).

Leaves: Basal leaves arise singly from the base of the corm and taper to a petiole. Two leaves are opposite each other and about midway up the inflorescence stem and are sessile (no petiole). Distinctively, leaves are narrow, about eight times longer than wide, and are grass-like in appearance (Newcomb, 1989).

In the winter, there are no above-ground parts of the plant. It overwinters as a corm, a fleshy underground root. Leaves and flowers emerge in April. It is one of the first wildflowers to bloom in Ontario. It grows in thick stands, and its bloom can turn the forest floor shades of white and pink.

Figure 1.1 : Inflorescence of C. virginica showing five-petaled flowers with pink strips and showy pink anthers. Narrow leaves are visible in the background. [Click to enlarge]

1.3 Cultivation

Seed germination: Plant in late spring outdoors in a pot. Place in a shady spot and keep moist. The plant will emerge in the following spring. It can be sealed in a bag with a moist medium at 25 C for 60 days, followed by 4 C for 60-90 d, then kept cold until planted (North Carolina State University Extension).

Location: Plant in woodlands, but it will also grow in lawns. Prefers well-drained, moist soil.

Sunlight: Does best in partial to full shade. It will grow in full sun if the soil is consistently moist.

4. Cultural History

All members of the *Claytonia* genus are edible. The leaves can be eaten raw and the fleshy roots can be prepared like potatoes (University of Texas, n.d.). Haudenosaunee used to consume the roots and leaves cooked. The plant grows in dense stands and would have been an important source of energy. Raw roots were consumed as a contraceptive. The plant is called meeautikwaeaugpineeg in Anishinaabemowin language (Wahid, 2014). In the woodland, it is consumed by small rodents, including chipmunks and mice.

5. Life Cycle

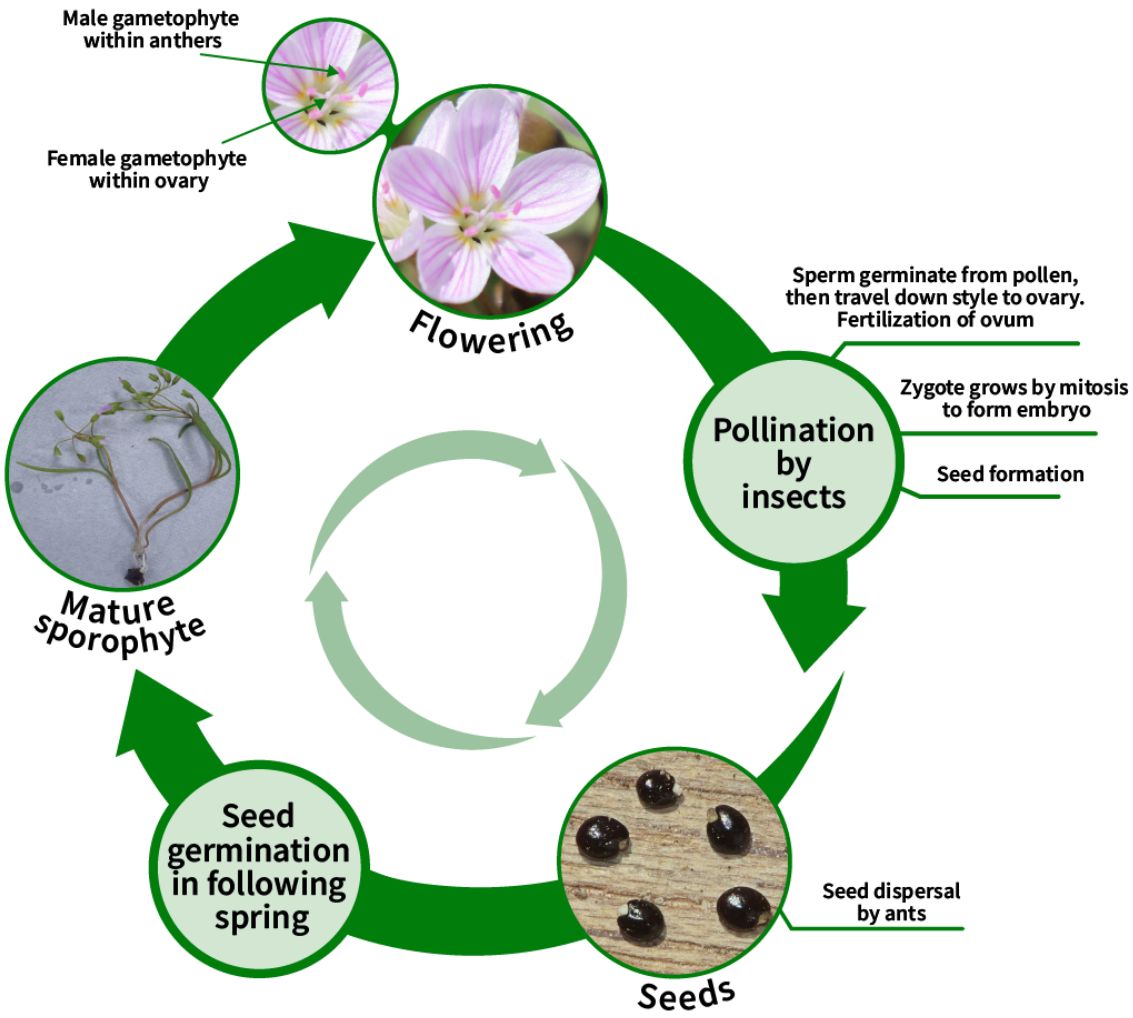

Figure 1.2: C. virginica is an angiosperm, meaning it is a flowering plant that produces seeds. [Click to enlarge]

Flowering

Each flower is open for three days.

- Each stamen is only active for one day.
- The stigma is receptive to pollen for 1-2 days, depending on pollination. Unpollinated flowers can remain receptive for a third day (Milby, 1980).

Meiosis

C. virginica has a complicated chromosomal diversity. It is believed that the original population had a chromosome number of n=6, from which populations of n = 7 and 8 arose, giving rise to n = 12, 14 and 16 plants through the failure of chromosome separation in meiosis. Through the loss of redundant chromosomes, significant populations of n = 11 and 15 developed. The most common population surrounding Lake Erie is n=8, with tetraploid plants south of the region. These plants have broader leaves than other, more southerly populations (Lewis et al., 1967).

Pollination

Flowers are only pollinated by insects (Motten et al., 1981). The seed set can be affected if the weather is rainy during flowering or if flowering occurs very early before pollinators have emerged. Late in the season, the plants increasingly abort ovules due to decreased light on the forest floor as trees leaf out.

Seeds

Seeds are produced within the capsule fruit after flowering. The seeds have a fleshy structure that attracts ants to increase dispersal (Handel, 1978). The plant that arises from the seed is genetically different than the mother plant on which the flower was borne.

Evolution

In angiosperms, flowers typically are formed by two whorls: calyx (sepals) and corolla (petals). *Claytonia* is thought to have evolved from a wind-pollinated ancestor that lost the corolla (petal whorl). On *Claytonia*, the non-reproductive parts of the flower are formed by a single whorl. The bracts are anatomically similar to leaves and are derived from leaf tissue (Milby, 1980).

6. Anatomy and Physiology

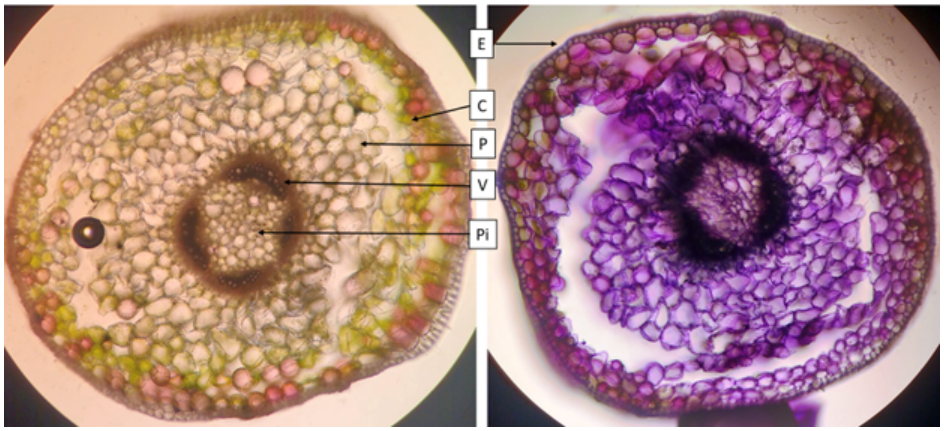

Figure 1.3: Cross-section of stem unstained (left) and stained with toluidine blue O (right) at 400x magnification. (E): epidermal cells are outermost. (C): Photosynthetic chlorenchyma cells are the outer-most ground tissue layer. In the unstained sample, reddish cells are observed from the three pigments produced by the plant. (P): parenchyma cells, (V): vascular bundle where phloem is outermost, and xylem is innermost, although these were not distinguished by staining. (Pi): pith cells at the middle of the stem. [Click to enlarge]

Spring ephemeral plants such as *C. virginica* face several challenges in their life cycle. These plants must grow rapidly and accumulate carbohydrates at an accelerated rate in order to produce mature seeds before deciduous tree leaves shade the plant (Lapointe, 2001). The plants accomplish this during the cool spring weather, when enzyme rates are low and the soil is cool (see the photosynthetic stem, Figure 1.3). Accumulated carbohydrates from photosynthesis are stored in the corm, and this allows next year's buds to form (Figure 1.4). Once sufficient carbohydrates are accumulated, leaves senesce then roots. The main signals causing leaf senescence are increasing temperature and increasing shade from canopy closure. The plant enters dormancy until fall. Cool fall weather allows the plant to break dormancy so it can grow roots and differentiate buds for next season at a slow rate.

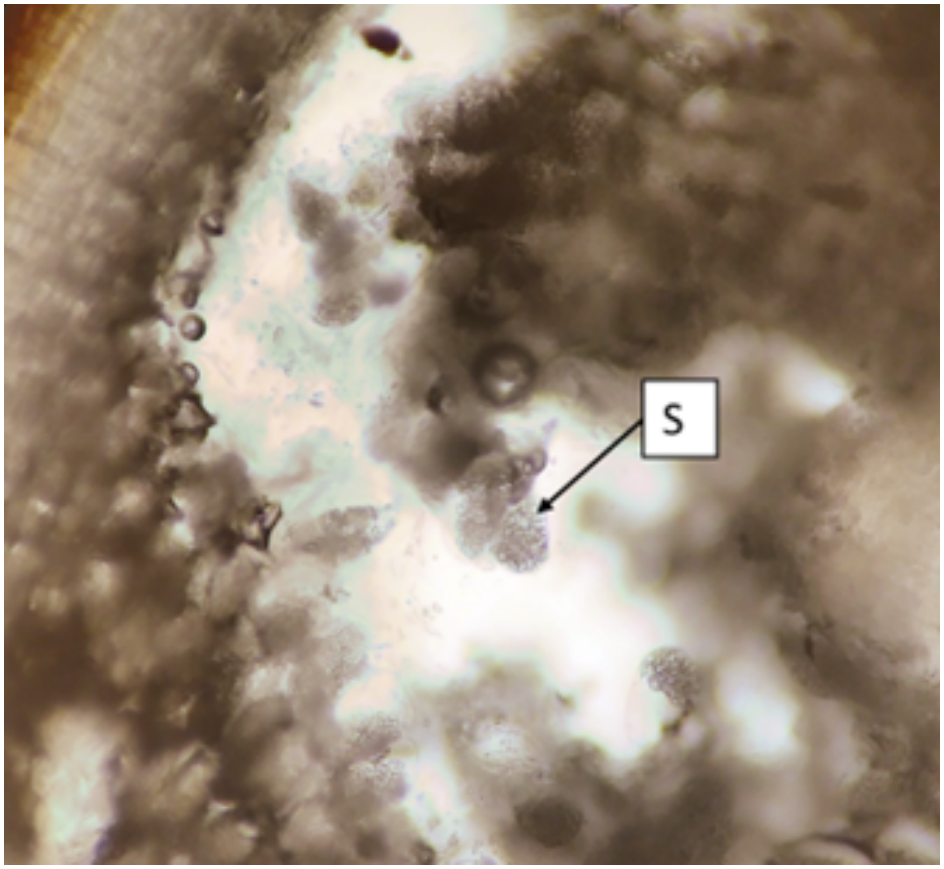

Figure 1.4: Corm cross-section at 400x magnification. Parenchyma cells contained large starch granules within (S). [Click to enlarge]

Nutrients are primarily absorbed during spring growth and allocated to the leaves and corm. Roots grow slowly during fall and winter and do not absorb minerals as nutrient needs are low during this time. Root growth relies on stored carbohydrates from the previous season (Anderson and Eickmeier, 2000).

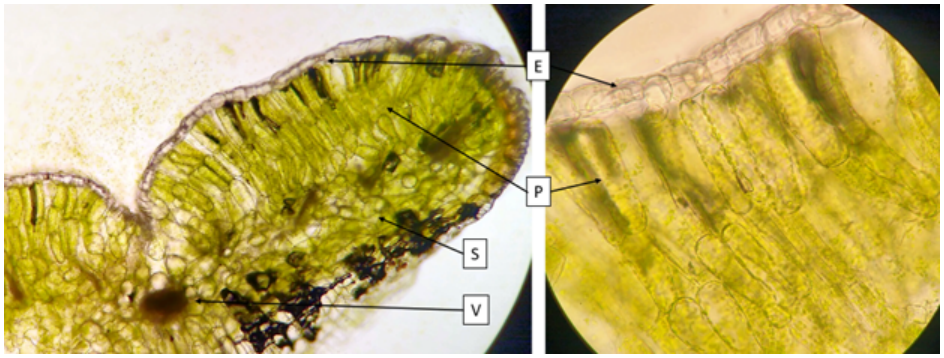

Figure 1.5: Leaf cross-section at 400x magnification. (E): non-photosynthetic dermal tissue, (P): closely-packed palisade parenchyma cells on the upper area of the leaf. (S): loosely arranged spongy parenchyma cells on the leaf underside. (V): vascular tissue in a leaf vein. [Click to enlarge]

As these plants must grow rapidly, they have a high photosynthetic rate (see the leaf dissection in Figure 1.5). Photosynthetic enzymes are made early in leaf development so the leaves are at full photosynthetic capacity once the leaves expand. Since photosynthesis uses water, these plants have an increased water demand in the leaves compared to similarly sized plants. The high photosynthetic rate also means increased gas exchange through the stomata, resulting in increased loss of water through transpiration. This would result in water stress for most plants, however, spring ephemerals grow when the soil is moist from snowmelt. *C. virginica* grows long root hairs to compensate (Lapointe, 2001).

Figure 1.6: Older flowers (left) with the bracts enclosing the capsule and developing seeds within. Unopened flowers (right) with petaloids present. [Click to enlarge]

Once the flower senesces, the petals fall, but the bracts persist (Figure 1.6). The capsule fruit matures within the bracts. As the fruit matures in 10 days, it dehisces to disperse the small, black seeds. Seeds can be dispersed many centimetres from the parent plant. Ants are attracted to the seed's elaiosome and have been shown to disperse the seeds further for *C. virginica* (Handel, 1978). To maintain viability, the seeds cannot dry out. This reflects the moist woodland habitat of the species. In contrast, seeds from western *Claytonia* species from areas that experience regular drought can dry out. Seeds are doubly dormant and require a warm, moist period followed by a cold, moist period. Seed that is produced on a plant this year will germinate next spring.

Figure 1.7: Flower colour variation among flowers in C. virginica [Click to enlarge]

Flower colour varies in *C. virginica* from pale white to mauve (Figure 1.7). The colour intensity and thickness of pink striping on the white background change the overall colour of the petaloid. Floral pigmentation is due to cyanidin, a crimson pigment molecule, and two flavenols, quercetin and kaempferol. As the concentration of flavenols increases, the flower becomes whiter; as their concentration decreases, the flower becomes redder.

Increased flower redness resulted in increased pollination by insects and increased seed production. White flowers are rare and have the lowest seed production due to pollinators. The effect of pollinators is amplified when *C. virginica* is surrounded by other species of white-flowering plants. When a plant has a distinct 'floral signal' (colour in this case), pollinators are less likely to move between species and are more likely to stay within the species with the strong signal to increase their reward.

Herbivore damage and fungal rust infection are related to flower colour, affecting reproductive fitness. Plants that have leaves removed by herbivores are more likely to die, and those that survive will produce smaller leaves the following year. As concentrations of the two flavanols increase, flowers become whiter, and herbivore damage decreases (Frey, 2004). Leaves of red-flowered plants were more likely to be eaten by herbivores (Frey, 2004). This was speculated to increase general defence compounds, which decreased fungal lesions. Thus, red plants were less likely to have fungal lesions as they were expressing antifungal defence compounds resulting from herbivore attacks.

C. virginica has two important pollinators.

- **The specialist *Andrena erigeniae*** (Spring Beauty Mining Bee) visits the flowers for pollen. The bees are 8 mm long, the same size as the flower's diameter.
- **The generalist *Bombylis major*** (greater bee fly). The bee fly visits many species of spring flowers for nectar and also transfers pollen in the process. Bee flies are 12-18 mm large, about

twice the size of the flowers. Bee flies make less contact with flowers than the Spring Beauty Miner bees do, owing to their long mouth part that sucks nectar with minimal flower contact. Both pollinators occur in Ontario.

7. Summary

This small plant has a fascinating history with its variable petal colouration and ant-attracting seeds. It is easily enjoyed in nature and the garden through its early flowering.

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1.2 Cornus Florida

NATALIYA BURGES

Cornus Florida

Author: Nataliya Burges

In this section:

1. Plant Description

5 | 1.2 Cornus Florida

Figure 1.2.1: Flowering dogwood tree (C. florida). Flowering dogwood tree by Steven Martin, CC BY-ND-NC 2.0. [Click to enlarge]

Cornus, commonly known as **Dogwood, is** a varied group of deciduous trees, shrubs, and herbs in the dogwood family (Cornaceae), native to Europe, eastern Asia, and North America (Dogwood, 2022). The dogwood family consists of 15 species in North America and 10 species native to Canada, two of which are herbaceous (Arseneault, 2015). Most dogwoods are shrubs or small trees; however, Pacific (mountain) or western flowering dogwood (*C. nuttallii*), can grow up to 25 m. The smallest and most known species is the Canadian bunchberry (*C. canadensis*), which is found in southwestern Ontario in the Carolinian forest region – a unique area with a very specific ecosystem(Beaulieu, 2022; Government of Ontario, 2022). Bunchberry ground cover is low-growing, deciduous, shrubby with leaves and flowers, and similar to the Flowering dogwood tree but smaller (20 cm)(Beaulieu, 2022). Flowering Dogwood (*Cornus florida*) is native to mixed forests in Canada and the northern US to eastern Mexico(Beaulieu, 2022). The genus *Cornus* comes from the Latin word cornu, which means hard and refers to the wood of the tree, while *florida* comes from the Latin word flos which means "flowery" or "in bloom"(North Carolina Plant Toolbox, n.d.). Flowering Dogwood is perhaps the most popular tree of eastern growing but is becoming increasingly rare in the Carolinian zone of southwestern Ontario due to anthracnose disease(Government of Ontario, 2022). To prevent wildlife species in Canada from disappearing, the Nature Conservancy of Canada (NCC) conserved 1,740 hectares of land, including the Carolinian forest. Species at risk and some of the oldest trees in Ontario were protected.

2. Identification

Flowering Dogwood is a woody, deciduous, flowering understory tree that may grow 4.5 m to 7.5 m tall and 10 to 15 cm in diameter. The trees bloom for a few weeks in the spring, with four large white flower-like bracts before the leaves expand(University of Kentucky, n.d.). In late summer, the tree has bright red berries that are often eaten by birds. Its leaves turn a scarlet red in the fall before dropping(University of Kentucky, n.d.).

Flowering Dogwood is usually found on the edges of the forest; it likes light, moderate, and partial shade to protect it from sunburn(Al, n.d.). If they get full shade, like back deep in the forest, the trees don't flower at all(Al, n.d.). The best place for gardeners to plant their dogwood trees is a location with morning sun and afternoon shade.

Anatomically, The Dogwood flower is a compound of greenish-yellow flowers in the centre, surrounded by modified leaf tissue – creamy bracts which help to attract pollinators (University of Kentucky, n.d.). When every individual flower gets pollinated, it will develop into a red fruit with a hard seed inside.

Figure 1.2.2: A group of flowers in the centre of the four bracts. Dogwood by Tom Potterfield CC BY-NC-SA 2.0. [Click to enlarge]

Figure 1.2.3: The opposite branching pattern with the leaves. [Click to enlarge]

The leaves make a good identifying feature. They are oval and oppositely arranged on the twig, right across from each other, with very prominent venation: on the midrib, there are strong mid roots down the center, where all the veins curve up towards the top of the leaf. Fall leaf colour can be displayed from orange to red to purple. On the older trees, the bark gets very cobblestone-textured (Bernheim, n.d.).

The fruit of the flowering dogwood tree is an important wildlife food – as an attractive red droop, it will be in clusters of usually 3 to 5 shiny bright red berries. Dogwood trees may not produce fruit for the first 10 years. The trees must reach maturity and can flower. This can take up to 6 years in C. florida(McLemore, n.d.). If trees were not grown from seeds, they could produce flowers and berries a lot more quickly (Al, n.d.). Flowering Dogwood fruits are harmful to humans and not to animals, and especially enjoyed by birds from fall through winter (Iupilon, 2021; Missouri Botanical Garden, n.d.).

Figure 1.2.4: The dogwood tree berries. Got mine..., by Michael.PortrayingLife.com, CC BY-NC-ND 2.0. [Click to enlarge]

3. Cultivation

Flowering dogwood prefers well-drained, slightly acidic (optimum pH 5.5 to 6.0) and nutrient-rich soils of lower and mid slopes (Myers, 2023). During the first year of growth, young dogwoods do not need regular fertilizing (Leonard, 2022). Compost would be an excellent choice for boosting the soil with little to no risk of overloading the trees with excess nutrients (Leonard, 2022). Since dogwood

roots are shallow, soil moisture should be maintained during a very dry season or drought, avoiding oversaturation (Al, n.d.). In a location that is overly wet or with soil that floods, the trees will not tolerate waterlogging (Al, n.d.).

Dogwoods are not only a favourite ornamental tree of homeowners, but they are also important to wildlife. Many species of caterpillars feed on their leaves; more than 50 species of birds feed on berries of flowering dogwood in the Backus Woods of Ontario alone. Underneath flowering dogwood is the highest snail diversity in the entire forest (McGlone, n.d.). Since dogwood is good at sequestering calcium out of soil and when the leaves fall, it deposits calcium onto the surface (Government of Ontario, 2021). Snails can eat that and use calcium for their shells. Flowering Dogwood is considered a soil improver and a leaf litter that is an important source of calcium (Government of Ontario, 2021; McLemore, n.d.).

4. Cultural History

The Dogwood fruit is a great source of vitamin C and has often been used in traditional medicine(Masons, n.d.). Native Americans used dogwood for a variety of illnesses. It is rumoured they first started using plants and herbs for healing after watching animals eat certain plants when they were sick. Indigenous people used C. florida to treat colic and fevers, and a medicinal infusion could be made from the bark, flowers, and fruit (United States Department of Agriculture, 2004). Some tribes revered the dogwood tree as a symbol of good luck and masculinity, eating Dogwood berries during religious ceremonies. Dogwood sap is toxic and was used by Native Americans as poison (Native Languages of the Americas, n.d.).

5. Life Cycle

Eastern Flowering Dogwood is a moderately fast-growing tree that lives up to approximately 80 years (Balogh, 2023; Government of Ontario, 2023). Plant flowering dogwood can grow easily from seed in nature. Clean seed that has been cold stratified for over 90 days germinates near 100 percent in the spring or occasionally during the second spring after seeds fall. Seed production begins as early as 6 years of tree maturity and generates a good seed crop every other year (bplant.org, n.d.; McLemore, n.d.). Fruits are shiny, oval red drupes, 13 mm long and in clusters of 3 to 5 berries. Ripened from September to October, Flowering Dogwood seeds are distributed by birds and small animals throughout forests.

Figure 1.2.5 :The dogwood stem. [Click to enlarge]

Figure 1.2.6: Flowering dogwood tree (C. florida). Flowering dogwood tree by Steven Martin, CC BY-ND-NC 2.0. [Click to enlarge]

Figure 1.2.7: The Dogwood flowers in the centre. Dogwood Flowers by Eric Kilby, CC BY-SA 2.0. [Click to enlarge]

6. Anatomy and Physiology

Dogwood's flowers emerge before the leaves in early spring. Its true flowers are visited by butterflies and specialized bees. The "flowers" of the flowering dogwood are one of the most confounding features of dogwood. What people perceive to be the flower is a false flower, and the four large "petals" are involucral bracts (modified leaves) that have the appearance of flower petals (Missouri Botanical Gardens, n.d.). The actual flowers are a cluster of small flowers in the center of the four bracts.

The Flowering Dogwood trees are dicots – the most complex vascular plants. Within the Dogwood's stem, there are three types of tissues: dermal tissues, ground tissues and vascular tissues. The cross-section through the stem (Figure 1.2.10) displays the outer layer of the epidermis, which is the dermal tissue. The epidermis consists of the outer cuticle layer with epidermal hairs that protect the stem. The ground tissue within the stem is divided into the cortex and the pith. The vascular tissues are made up of a ring of vascular bundles. The vascular cambium separates the phloem and xylem: the phloem is exterior to the xylem.

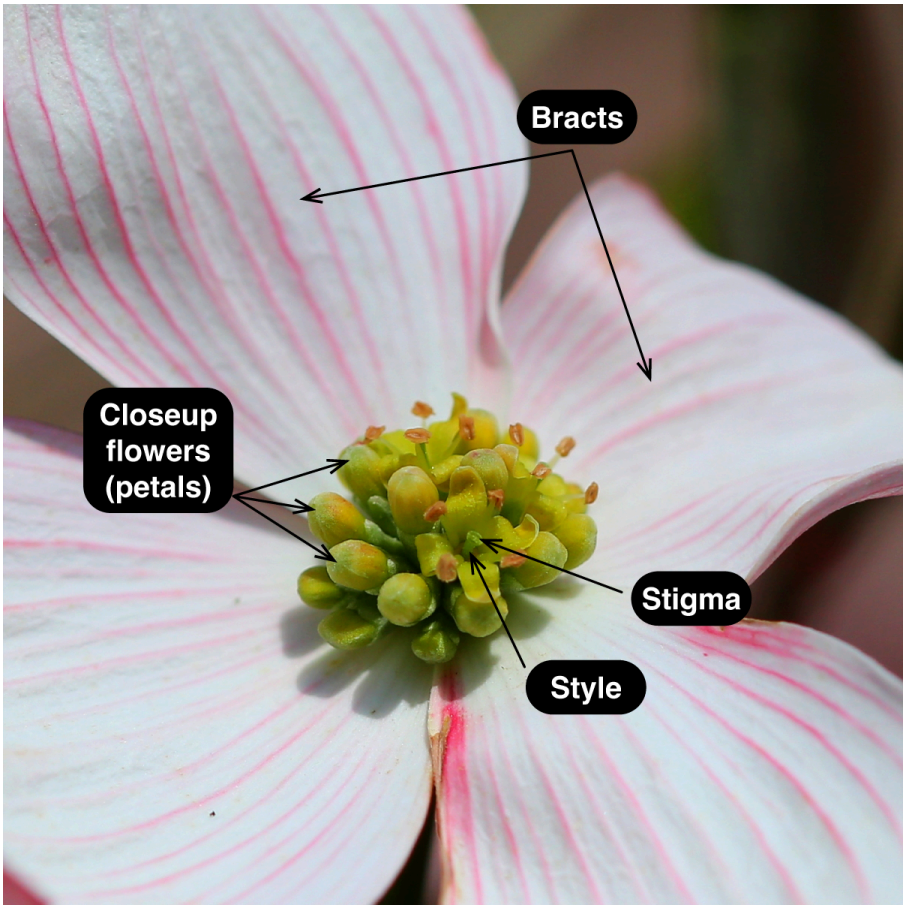

Figure 1.2.8: The Flowering Dogwood Flowers. Dogwood Flower by SETShots, adapted by Fanshawe College, CC BY-NC 2.0. [Click to enlarge]

The xylem is involved in the transport of water from the roots to the stems, while the phloem is involved in the movement of food substances made in the leaves down to all other parts of the plant (Kimball, 2023). The pith is made up of loosely packed parenchyma tissues, whose function is storing nutrients.

Figure 1.2.9: The dogwood stem. [Click to enlarge]

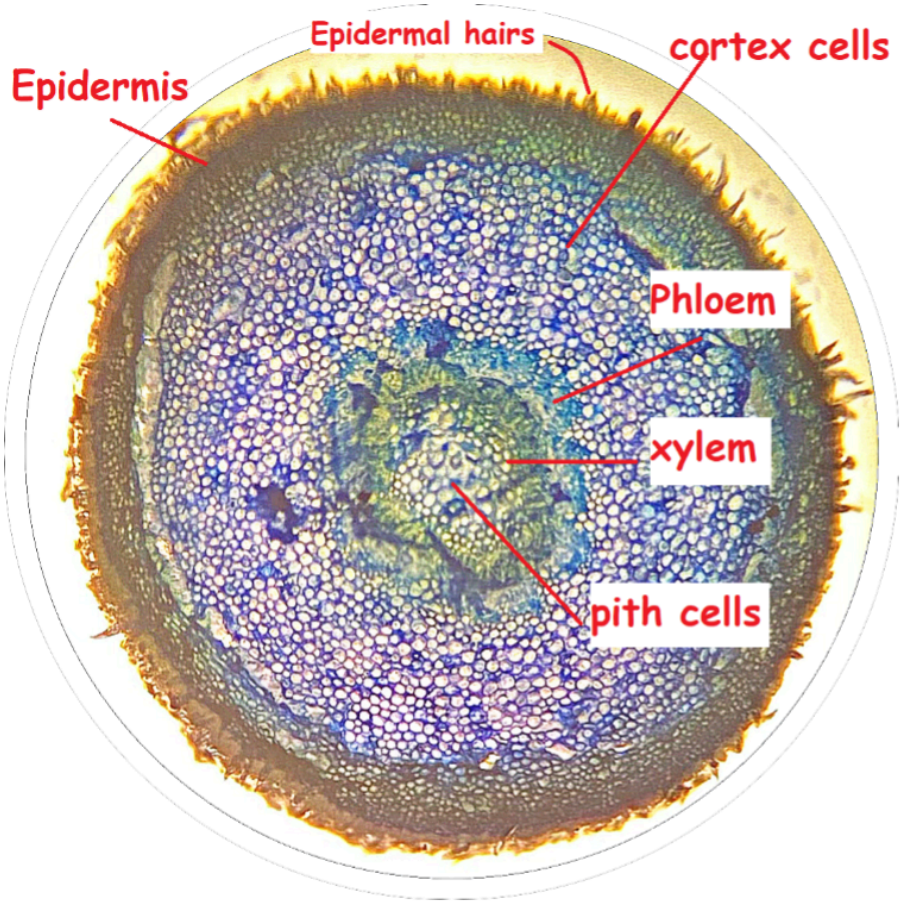

Figure 1.2.10: Anatomy of a Dicot Stem (Dogwood) with a magnification total of 40x. [Click to enlarge]

As the tree grows from a small sapling into a big plant, the leaf size remains almost the same. With the increase of lateral growth of the tree, the leaf size does not increase. The reason is that mature leaves contain permanent tissues, with a lost ability to divide and grow any further. Meristematic tissues, which are diving cells, convert to form parenchyma tissues. The thin walls of parenchyma tissues in the leaf cells make leaves very flexible and can be folded. Parenchyma contains chloroplast and performs photosynthesis to help the plant manufacture its own food (Kimball, 2023). Parenchyma tissue contains a single large vacuole that occupies maximum space and accumulates all the food molecules in it. With additional depositions on the parenchyma cell walls, the tissues get converted to collenchyma tissues, covering the parenchyma cells from the outside(Kimball, 2023). Collenchyma cells have very thickened cell walls, and the thickness is mostly towards the corners. The presence of all the cellular organelles indicates that collenchyma cells are living cells and perform different functions. They provide mechanical support to the plant by giving rigidity to plant organs (Kimball, 2023).

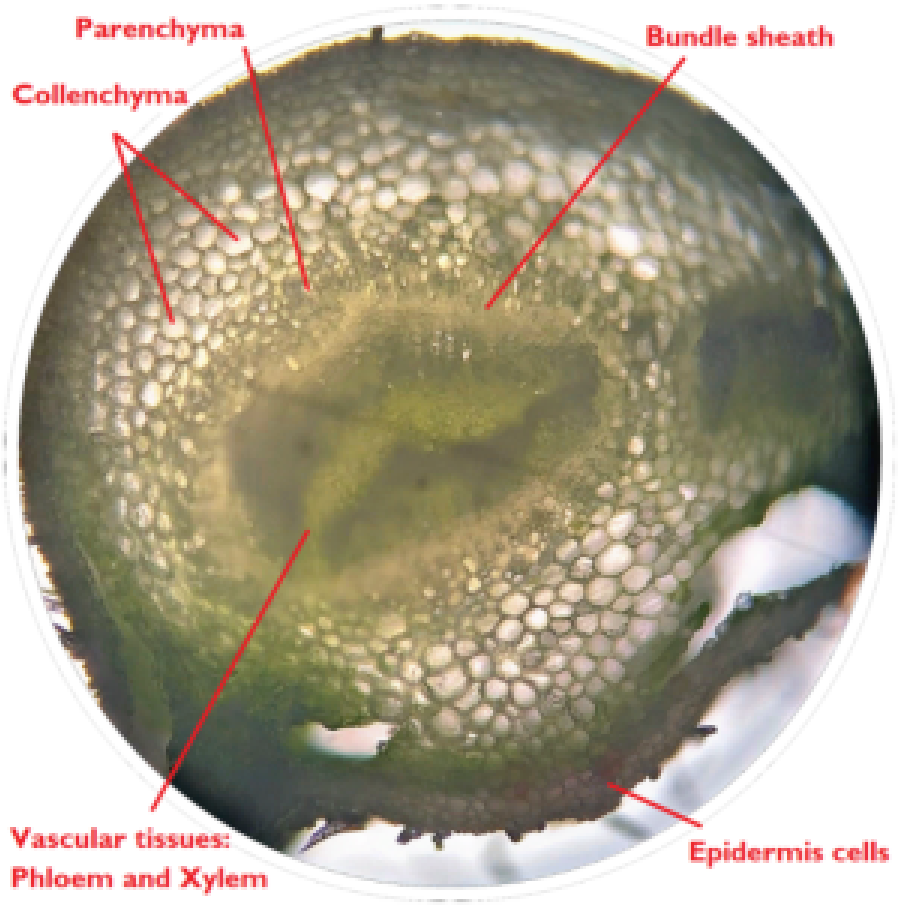

Figure 1.2.11: The transverse section of the leaf under a microscope with a magnification total of 40x. [Click to enlarge]

In the summer, leaves are medium to dark green and a deep red colour in the full (Balogh, 2023). While the fruits develop during the summer, the tree grows new flower buds for next spring to bloom. If someone does not already have Flowering Dogwood and lives in its native range, they might consider this small-scale tree next time they are planning to plant a tree. This plant is an excellent choice for the residential landscape. It is extremely beautiful in any season.

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1.3 Erythronium Albidum

JORDYN SNELL

Erythronium Albidum

Author: Jordyn Snell

In this section:

1. Plant Description

The *Erythronium Albidum* is commonly called the White Trout lily, White Dogtooth Violet, White Fawn lily, or Adder's-Tongue. The Erythronium Albidum is an herbaceous, hermaphrodite, monocot, angiosperm. It's a perennial known as a spring ephemeral, as it blooms between April and May, depending on the location. After flowering, it lasts for approximately two weeks. Not only does it

appear in the Carolinian forest, but it can also be found in multiple places in Eastern North America and in wide strips in Europe and Asia. Its fruit type is a capsule that consists of 3 chambers with two rows of flattened seeds each (*White Trout Lily,* n.d.).

2. Identification

The Erythronium Albidum has a native distribution from Southern Ontario to Eastern Texas. It is commonly found on deciduous forest floors as they prefer humus-rich, moist to dry, acidic to neutral soil with part to full shade coverage.

They typically grow to approximately 15-30cm tall and 7-15cm wide. Erythronium Albidum develops a pair of thick, simple basal leaves with a single bell-shaped white flower consisting mainly of white or pink-tinged petals. The leaves are typically coloured in brown-green or gray-green mottling or have no mottling at all (*White Trout Lily (erythronium albidum), yellow trout lily (erythronium* ...), 2016).

The Erythronium Albidum has nodding flowers that consist of 6 petals and 6 stamens that are either brown or yellow. A larger flower will show with the yellow stamens, while a smaller flower will present brown stamens. The abaxial of the petal can be light blue/lavender in colour, with yellow spots at the base of the adaxial.

There are approximately twenty recognizable erythronium species, such as the Erythronium Americanum. However, these two can be differentiated by their colouring due to the Americanum being rich yellow. Most species in the Erythronium family are easily distinguishable by the colouring and size of the nodding flower and its stamens (*Erythronium,* 2020).

Figure 1.3.1: Erythronium Albidum in wild. Erythronium albidum by Fritz Flohr Reynolds, CC BY-SA 2.0. [Click to enlarge]

3. Cultivation

The Erythronium Albidum is available for cultivation and can be useful for underplanting around large shaded perennials, such as Hostas, Bleeding Hearts and Columbines. Although the Erythronium Albidum can be easily found in their native areas, obtaining them from a reputable nursery is best instead of trying to relocate from the wild. Not only is this due to the fact that removing these plants can disrupt the ecosystem, but many plants, like the Erythronium Albidum tend not to strive outside of natural habitat once moved.

Erythronium Albidum corms should be planted 5-7cm deep and 10-15cm apart in a large location to allow the plant to spread and naturalize. The pointed end of the corms should be planted face down. Once the plant begins to develop, weeding should be done carefully to avoid damaging any offset shoots, as they will form new corms.

The Erythronium albidum prefers partial shade or spots of sunlight in loose humus rush soil that is fairly neutral with an optimal pH range of 6.8-7.2. Shredded leaves and pine straw can be used as mulch for the bulbs overwinter and can be favourable for the plant during growth. Like many species in the Erythronium family, the Albidum needs consistent moisture, especially in times of drought. Any partial shade will allow for more moisture retention in the soil, as well as the addition of natural mulch, such as pine bark. The Erythronium Albidum does not need any fertilizers as long as the soil conditions are optimal for growth. If needed, a layer of compost can be applied during the spring to help growth.

The Erythronium Albidum reproduces and tends to spread well naturally; however, this is easily achieved manually as well. The best time to propagate the Erythronium Albidum is during the fall, using a shovel to dig up the root clumps carefully. From the root clumps, brush away any remaining dirt and separate tiny corms, discarding any that are soft. The corms can be replanted in a new location with similar conditions and techniques as above.

The Erythronium Albidum can be grown from their seed, however, it is a very slow process and can be years before resulting in any flower (Aloi, 2020).

4. Cultural History

The leaves and bulbs of Erythronium Albidum are edible and can be eaten roasted, boiled, or even raw. However, it should only be consumed when lots are present, as removing any of the two leaves can kill the plant. Erythronium Albidum is known to be mildly emetic; therefore, large consumption of these can cause sickness and vomiting.

Medical uses of the plant consist of a compound that can be infused, which was used by the Cherokee to help with fainting. Additionally, the leaves could be crushed and then warmed to result in a juice that was used to pour over unhealed wounds that would not heal themselves. Tea could be made from the roots and could be used to break fevers as well. Not only did the roots provide a medical use but they could be chewed and then spit into the water for fish bait (Mike, 2015).

Another species of Erythronium, the Americanum, was used by Iroquois women as contraception to prevent pregnancy.

5. Life Cycle

Figure 1.3.2: Image of an Erythronium albidum white trout fawn lily. [Click to enlarge]

Germination

The embryo starts to elongate during September due to rainfall, as the Erythronium Albidum requires a moist, cold period to help it grow. The embryo enlarges to fill the space occupied by the endosperm. This is a slow process during the fall as the embryo only reaches half the size of the seed by December. It's thought that the rate of growth is related to the amount of moisture in the soil. Around the end of the year, the radicle is forced through the micropyle and into the soil; this is followed by the stem apex being pushed forward by the elongation of the embryo and stays in a related position to the radicle during the elongation of the cotyledon. The lower part of the cotyledon is elongated in a vertical axis, and it reaches 1-3cm down in the soil; once the endosperm is exhausted, downward elongation ceases. The upper end of the cotyledon is now the zone of elongation and is elevated into the air approximately 8-10cm above the soil. The cotyledon will act as the first foliage leaf with photosynthetic properties, this typically takes place during the summer following that fall and will not be functional until another following spring. The stem apex becomes dome-like through a cavity and is then enclosed by the cotyledon at the base of the foliage

and forms a bud. Due to the first part of elongation of the cotyledon downwards, the stem apex is typically buried deep. This allows for a corm to be developed by the bud. Two more buds will typically form in addition to the main bud and elongate as runners, which eventually form bulbs. The primary root drops down by gravity around the emergence of the cotyledon. The roots will continue to protrude from the base of the corm in the fall. The developing process will repeat in subsequent seasons in order to fully mature the bulb. The total time between germination and flowering is at least six years.

Mature plants

When the Erythronium Albidum is young, it only consists of one leaf. Their second leaf does not protrude until the plant continues to mature and is beginning to bloom. The leaves on the Erythronium Albidum are simple and rise opposite from each other on the stalk. They take an oblong shape and have a tapered point.

The floral shoot is formed from the stem apex and the corm gets developed from a bud at the base of the shoot. The final structure formed from the stem apex is the flower bud. The production of flowers marks maturity and finishes the cycle of development from seed to seed. Due to the continuance of the original stem apex until flowering, there is a series of immature corms formed from runners. After the plant flowers, the vegetative structures become secondary in importance, resulting in a short life so that a new corm can be developed from an axillary bud at the base of the shoot.

Reproduction and Pollination

The main way the Erythronium Albidum reproduces and spreads is by runners; this is more efficient for the plant due to the long time it takes for the seeds to develop. In most species of Erythroniums, the runner starts from the elongation of the root's axillary buds' scales, which forms descending axes. On a horizontal rhizome, a bud will form and stand up vertically at the end of the elongation period of the runner. An additional bulb will form from the terminal bud on the runner and start to produce another flowering plant.

Just like many flowering plants, the Erythronium Albidum has many pollinators. One of the main pollinators for the Erythronium Albidum is both short & long-tongued bees, such as honeybees, mason bees, cuckoo bees, digger bees and more. The long-tongued bees will collect pollen but will also suck the nectar from the base of the flowers. The short-tongued bees and honeybees will only collect the pollen from the flower(*White Trout Lily (Erythronium Albidum*, n.d.).

Another way the Erythronium Albidum disperses is through a process known as myrmecochory. Ants will carry the seed away from the flowering plant, which can allow for germination to take place somewhere else.

Although this has no relation to reproduction, the Erythronium Albidum's leaves are occasionally

eaten by white-tailed deer. However, any damage caused to the plant is typically minor due to the small size and short life of the foliage.

Seeds

The seeds of the Erythronium Albidum mature as the rest of the plant dies off and their establishment is slow and difficult. They tend to be approximately 2.5 cm in size.

When the ovule becomes fertilized, it enlarges rapidly through the growth of the embryo sac. The endosperm develops slowly, causing it to be a layer of lining for the wall of the sac for a long period of time. The endosperm's development is slow due to the germination of the embryo during a low vegetative activity. It then develops as a large mass of cells in the micropylar end of the sac, and as the seed reaches full development, the embryo is filled with hard endosperm made of cellulose. It's thought that the large mass of endosperm is associated with the delayed development of the embryo and the 5-6 years before flowering, which is why those who want to cultivate it use the bulbs/corms (Blodgett, 1910).

6. Anatomy and Physiology

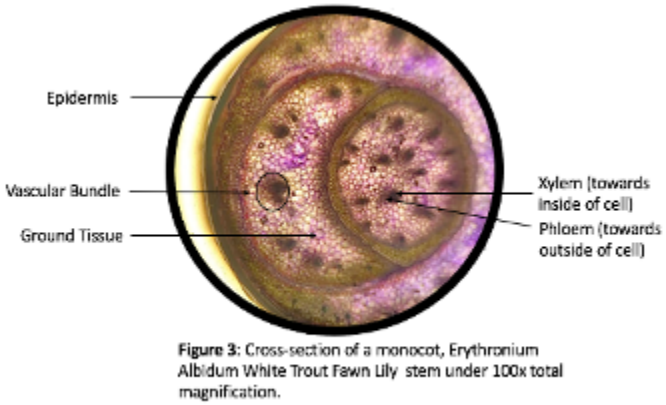

Figure 1.3.3: Cross-section of a monocot, Erythronium Albidum White Trout Fawn Lily stem under 100x total magnification. [Click to enlarge]

The Erythronium Albidum possesses a bulb or corm. Many will call it either or. As it's a member of the lily family, many believe it should be called a bulb. However, others say that it's a corm as it's a fleshy, swollen base to the stem. (*White Trout Lily (erythronium albidum) yellow trout lily (erythronium* ...), n.d.). Nevertheless, this structure allows for the Erythronium Albidum to reproduce underground by rhizomes and runners that are spread from the main bulb/corm. The terminal buds, which eventually formed bulbs, at the tip of these horizontal runners are held vertically. This is due to

the scales of the bud and the cauline tissue being fused together. The fusing causes them to thicken vertically and provides the required support throughout for the plant's entire growth. Without the supporting tissue, the bud would invert on its base, growing along the base of the bud. The inversion would be caused by the friction caused by the runner moving through the soil. That would allow for the fusion of the bud and runner. Because the runners and their buds are the main form of reproduction for the Erythronium Albidum, the fusion of these tissues is important for the proper growth of offspring.

Figure 5: Corm of Erythronium Albidum under stereomicroscope.

Figure 1.3.4: Corm of Erythronium Albidum under steremicroscope. [Click to enlarge]

The cauline tissue in the runners is made up of vascular bundles, which have united with the terminal bud at the tip of the runner to the base of the parent plant. The rest of the runner's tissue is considered to be foliar or apical. Certain types of species of the Erythronium family can have a runner with the structure of an anatropous bud. The whole exterior scale is fused to the runner but causes no issue as the scale of the bud elongates as fast as the cauline tissue. This means that the foliage leaf and stem elongate, and as they fold back along each other, the growth is continuous around the enclosed bud (Blodgett, 1910).

The Erythronium Albidum has very efficient photosynthesis abilities as it take advantage of the high light levels present in the forest. Due to having a strong photosynthesis response, the Erythronium Albidum requires a large amount of water for the process to continue. The high need for water allows for the Erythronium Albidum and many other ephemerals to be able to absorb the water that would usually run off site, typically carrying many valuable nutrients from the soil. However, in times of drought and when this high demand for water cannot be met, the flowering period of the ephemerals tends to be shorter (Steffen, 2018). The Erythronium Albidum serves the purpose of saving soil and runoff during a time when any other plants have yet to start growing. Due to the numerous nutrients absorbed through the short-lived Erythronium Albidum, it's thought that when they decompose, their foliage can effortlessly provide nutrients for other plants that start growing in the later seasons (Steffen, 2018).

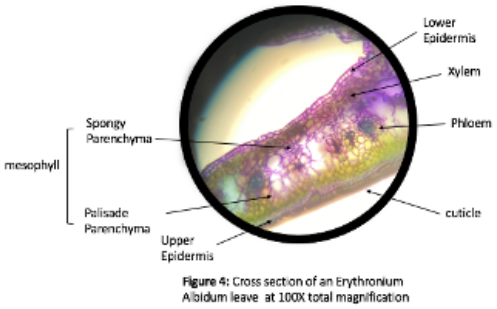

Figure 1.3.5: Cross-section of an Erythronium Albidum leaf at 100x total magnification. [Click to enlarge]

The Erythronium Albidum contains a structure on the outside of its seed called an elaiosome, which acts as a catnip toward ants. This structure is thought to produce a volatile pheromone that triggers a response called the “dead corpse response”. This results in ants grabbing the seed of an Erythronium Albidum but tending to lose interest after carrying it for a while, resulting in them dropping the seed. After a seed has been dropped, no passing ants or other insects seem to take interest in it. This is seen as a chemical trick of the plant in order to have the ants move the seed away from the parent plant but not too close to the ant’s nest. The seed would be dropped in a location that would be favourable for germination and continuous development (Klingaman, 2006).

7. Summary

The Erythronium Albidum is a beautiful, short-lived perennial native to woodlands in Eastern North America. Its slow growth and development are worth it for their flowers and the many beneficial properties it provides to both the ecosystem and humans.

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1.4 Lindera Benzoin

JESSICA DOUGLAS

Lindera Benzoin

Author: Jessica Douglas

In this section:

1. Plant Description

Lindera Benzoin is also known as the Northern Spicebush due to its spicy odour when its leaves are crushed (Kent, 2021). This plant grows throughout North America and in the Carolinian zone (Caldwell, 2019). This plant is a:

- **Shrub:** a small woody plant that has several main stems near the ground
- **Perennial:** persists every season of the year and lives for several years
- **Dicotyledon:** a flowering plant that contains 2 seed leaves
- **Dioecious:** have female and male flowers on separate plants
- **Angiosperm:** a seed plant that grows flowers, and in this case also grows fruit
- **Deciduous:** sheds its leaves annually

2. Identification

While walking through the Carolinian zone, you may come across the Lindera benzoin. It has some known features that will help identify it.

Fruit and Flowers: The flowers bloom in the spring, around March or April. Each flower has about 6 yellow or greenish-yellow sepals. These flowers are typically arranged in dense clusters. The fruit on this plant is glossy-red in colour (Lady Bird Johnson Wildflower Center, n.d.). The fruit and the leaves are aromatic, giving off a spicy fragrance (Lady Bird Johnson Wildflower Center, n.d.).

Leaves: The alternating leaves can be up to 15cm long and 6cm wide (Lady Bird Johnson Wildflower Center, n.d.). Leaves are entire, meaning they have smooth edges. The leaves are also obovate, which are egg-shaped with a wider portion away from the stem (Kent, 2021). The upper surface of the leaf is dark green, while the lower surface of the leaf is a lighter green in colour (Lady Bird Johnson Wildflower Center, n.d.). The leaves then turn a golden yellow colour during the fall (Lady Bird Johnson Wildflower Center, n.d.).

Bark: This shrub has thin bark, usually brown or grey-brown in colour and smooth (Kent, 2021). The bark is full of lenticels that look like a raised white area used for gas exchange (Awesome Native Plants, n.d.).

Habitat: These plants typically live in low, deciduous woods and wetlands (Lady Bird Johnson Wildflower Center, n.d.).

Figure 1.4.1: The image on the left is a Lindera benzoin growing in the wild. The middle image shows the glossy red berries that grow on the Lindera benzoin by R. A. Nonenmacher CC BY-SA 4.0. The image on the right shows the bundles of flowers that grow on the Lindera Benzoin Lindera benzoin by R. A. Nonenmacher CC BY-SA 4.0 [Click to enlarge]

3. Cultivation

Soil: The soil moisture can be anywhere from dry to moist to wet (Izel Native Plants, n.d.). It is able to grow in rich or average soil made of sand or loam (Izel Native Plants, n.d.). The ideal pH of the soil would be 4.5-6 (Plants for a Future, n.d.).

Sunlight: It can grow in full sun, part sun, or part shade (Izel Native Plants, n.d.).

Locations: The plant does best when grown in wetlands.

Seed Germination: The seed has a short life span for when it will be successful and should not be allowed to dry out (Plants for a Future, n.d.). The seeds should be placed in individual pots and grown in a greenhouse for the first winter (Plants for a Future, n.d.). They may root by the spring, and then in the late spring/early summer the seeds can be planted outside (Plants for a Future, n.d.).

4. Cultural History

Teas can be made from the Lindera benzoin's bark, twigs, and berries. In the past, the teas were used as medicine to treat diseases and other conditions. American Indians made tea from the bark and used it as a "blood purifier" to treat sweating, colds, rheumatism, and anemia, while settlers used bark tea to expel worms and treat typhoid fevers (Malone-Brown, n.d.). The settlers also made tea from the twigs of the Lindera benzoin to treat conditions such as colds, fevers, worms, and gas (Malone-Brown, n.d.). Indigenous peoples used tea made from the berries to treat measles, coughs,

cramps, and delayed menstrual cycles, and settlers used it to prevent gas and flatulence (Malone-Brown, n.d.).

Other parts of the Lindera Benzoin were considered useful without being made into tea. The fruit oil was believed to be medicinal as it was extracted and used to treat chronic rheumatism, bruises, muscles, and joints (Malone-Brown, n.d.). Also, the plant leaves contain the chemical camphor, which was used as an insect repellent (Malone-Brown, n.d.).

5. Life Cycle

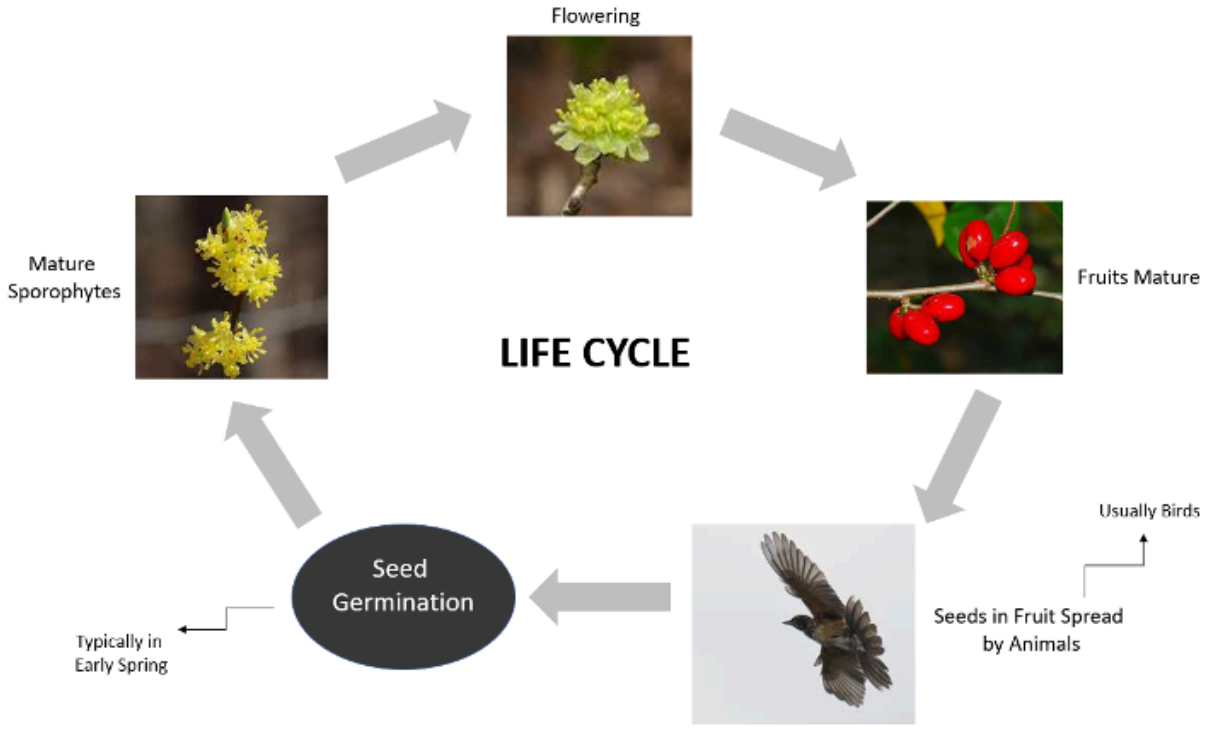

Figure 1.4.2: The life cycle of the Lindera benzoin plant. [Click to enlarge]

Flowering: Dense clusters of tiny, light yellow flowers bloom in early spring. Male plants have flowers that are larger and showier than female plants do (Missouri Botanical Garden, n.d.). The female plants contain pistillate flowers, and the male plants contain staminate flowers (Awesome Native Plants, n.d.). These male flowers have a rudimentary pistil and 9 stamens (Awesome Native Plants, n.d.). The inner 3 stamens contain nectar glands at their base, which are used to pollinate female plants (Awesome Native Plants, n.d.).

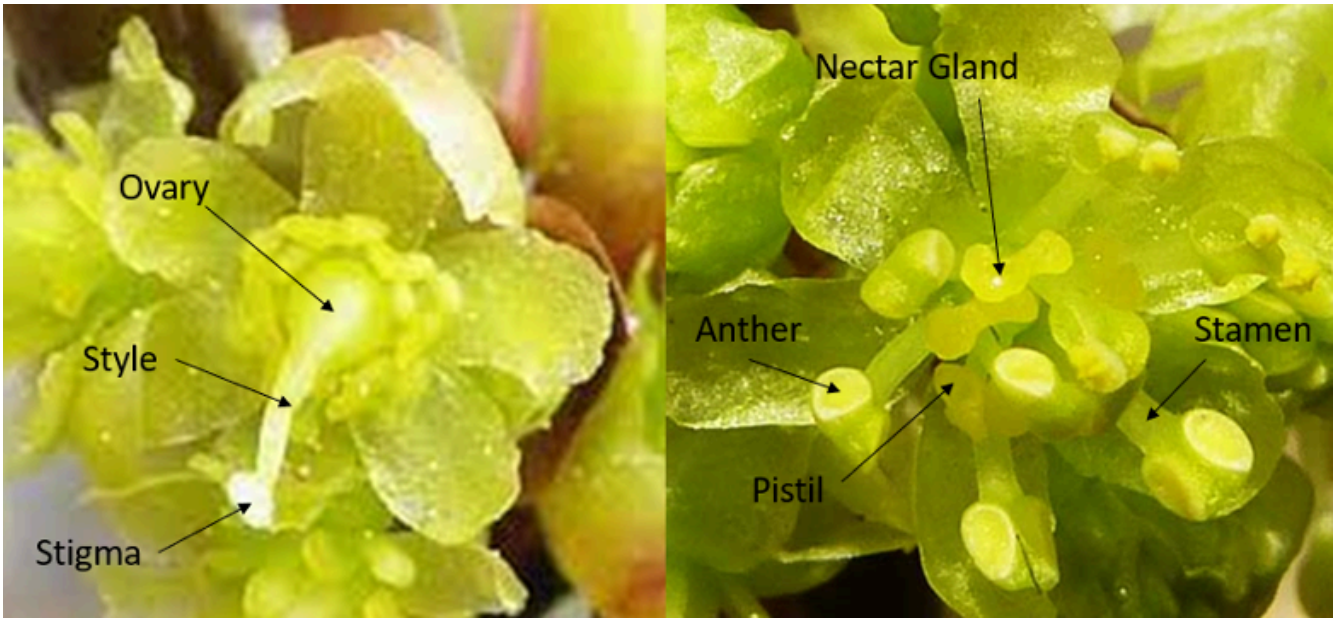

Figure 1.4.3: The image on the left is the female flower of the Lindera Benzoin, and the image on the right is the male flower. [Click to enlarge]

Fruits Mature: Female plants produce glossy red berries, often during the fall and after pollination from a male plant. Each of these fruits holds a single brown seed. The fruit is oblong drupes, meaning they are oval-shaped fleshy fruit with hard endocarp surrounding the seeds (Kent, 2021). The timing of the fruit is important because most of the fruit's seeds are spread by birds, and therefore, it has to coincide with bird migration.

Seeds Spread by Animals: As mentioned above, animals (mostly birds) will eat the fruits from the female plants. The fruits contain seeds that are then dispersed as the animals digest the fruit and release the seeds elsewhere.

Seed Germination: Seed germination refers to the sprouting of a seed. The seed sprouting relies on water absorption, temperature, oxygen availability, light exposure, and other factors. The seeds will wait until the environment is ideal before participating in this sprouting. A large amount of the seeds will be germinated in the first spring; however, some won't be germinated until the following spring (Plants for a Future, n.d.).

Mature Sporophytes: After the seed germinates, it grows into a young sporophyte and then into a mature sporophyte. In the female plant, the mature sporophyte contains an ovary with an ovule inside. Inside the ovule is the megaspore mother cell, which goes through the process of meiosis to produce an egg. In the male plant, the mature sporophyte contains an anther with the microspore mother cell inside. The microspore mother cell undergoes mitosis to produce pollen, which will pollinate the female plant.

6. Anatomy and Physiology

Anatomy of the Stem and Leaf

Phloem and xylem are the vascular cells in the plant, also known as conducting cells. The phloem conducts food such as carbon, and the xylem conducts water, dissolved minerals, and inorganic ions. The epidermis is a layer of specialized cells that cover the outermost layer of the stem/leaf. The cortex is the layer of cells that lie between the epidermis and the vascular cells, which store carbohydrates and other essential substances. The pith cells store water and also produce sugar and ethanol. The cuticle on the outer edge of the stem is responsible for controlling the amount of water that enters and exits the cell. Shoot hairs, also known as trichomes, help to prevent water loss from the stem surface. The collenchyma provides structural support to the plant organs.

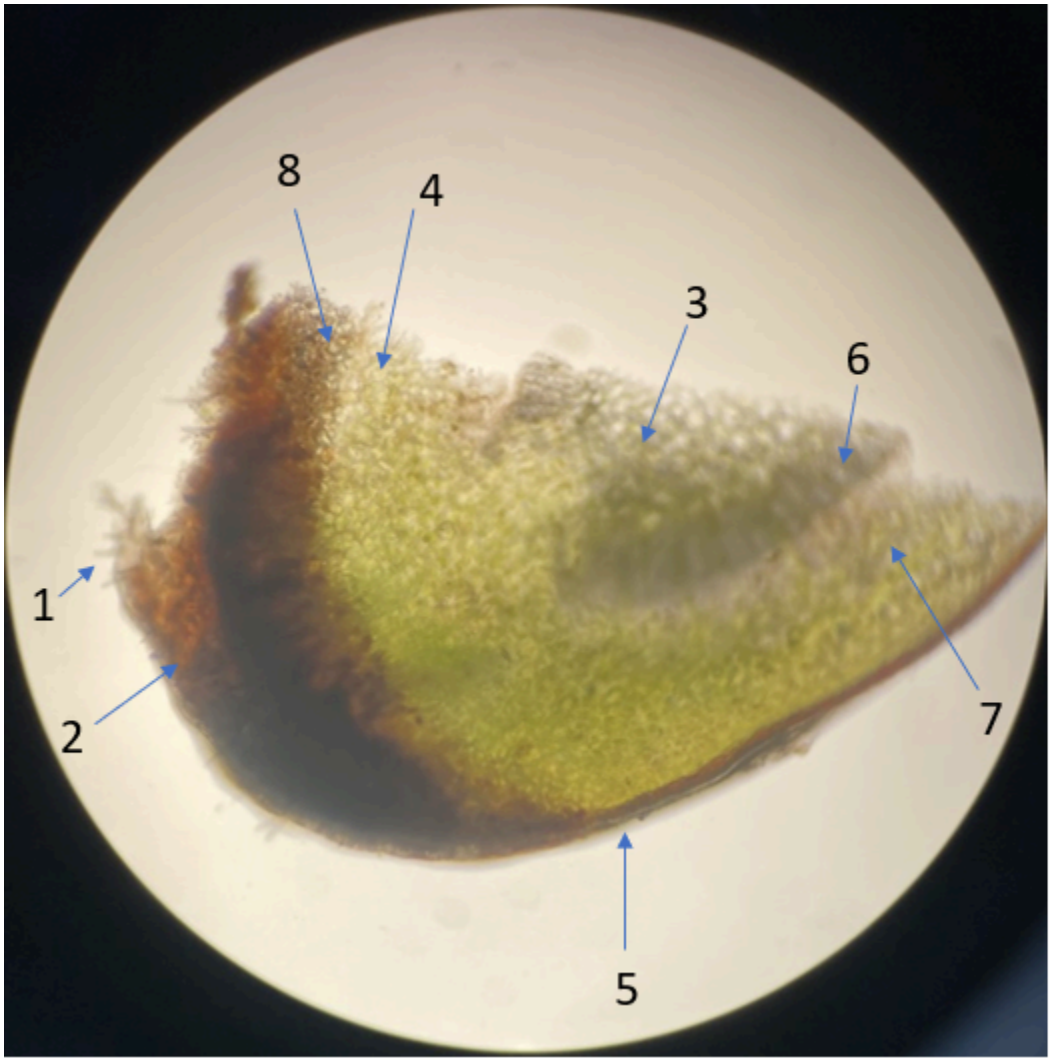

Figure 1.4.4: Stem cross-section of a Lindera benzoin at 400X magnification. 1) Shoot Hair. 2) Epidermis. 3) Pith Cells. 4) Cortex. 5) Cuticle. 6) Xylem. 7) Phloem. 8) Collenchyma. [Click to enlarge]

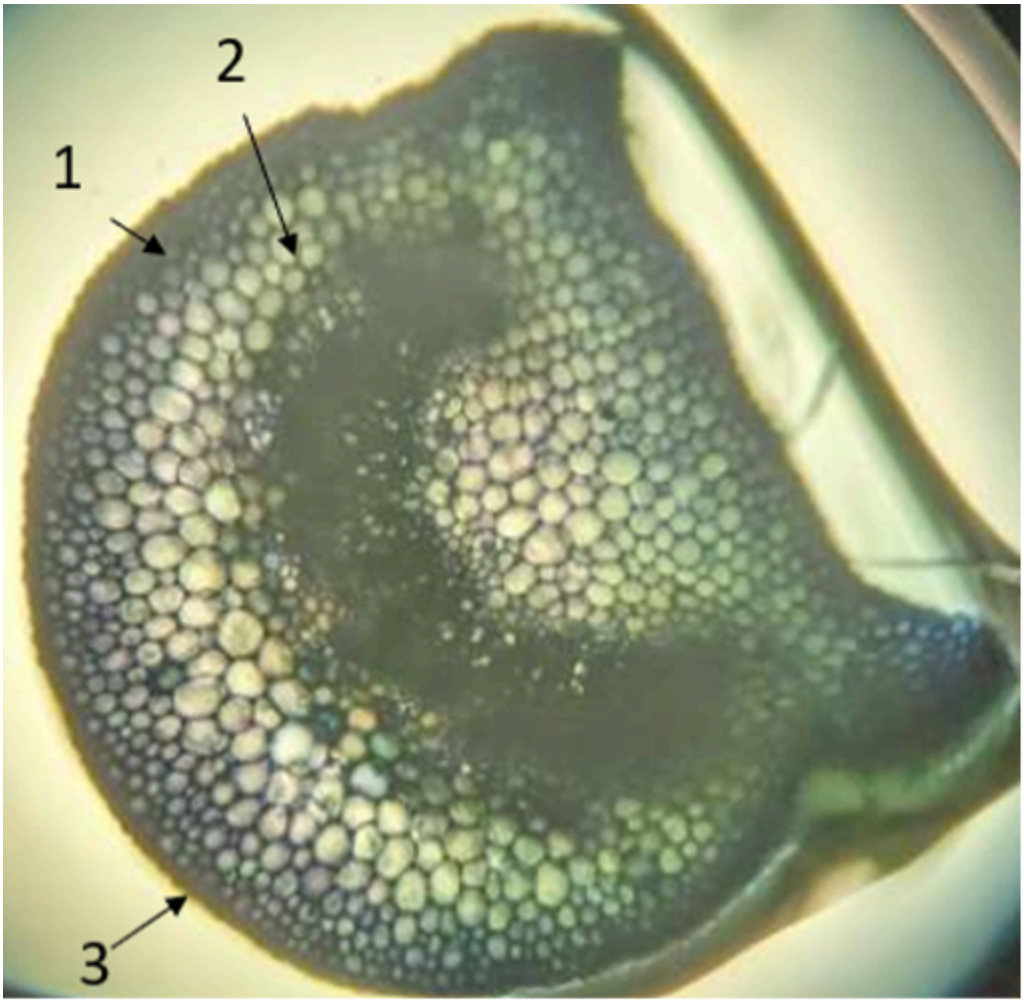

Figure 1.4.5: Leaf cross-section of a Lindera benzoin at 400X magnification. 1) Phloem. 2) Xylem. 3) Epidermis. [Click to enlarge]

Light Availability

A plant's fitness refers to its ability to survive and reproduce. The fitness of the Lindera benzoin relies mainly on light availability. Higher light availability is connected to increased photosynthesis and higher carbon gain, which increases the rate of reproduction (Niesenbaum, 1993). Plants that have less carbon resources have a higher abortion rate than seeds and fruit (Niesenbaum, 1993). It is often the light availability from the previous season that affects the reproduction of the current season (Niesenbaum, 1993). Low light availability from the previous season also results in less flower production per fruit-bearing branch (Niesenbaum, 1993). Fewer flowers per branch would also mean fewer fruits being produced per branch. The fruit contains the seeds that are needed for seed germination and for new plants to be produced. Therefore, lower light availability causes a decrease in reproduction.

Elevated CO2

As mentioned above, carbon is gained through the process of photosynthesis and increases the rate of reproduction. Therefore, when CO2 levels are elevated, it was thought that plant growth would be increased. However, when Lindera benzoin is exposed to increased CO2 levels, stem and leaf growth do not increase (Cipollini et al., 1993). Instead, the extra carbon is stored or used for underground growth (Cipollini et al., 1993).

Secondary Metabolites

Herbivory is when animals and insects eat plants. Lindera benzoin plants experience more herbivory when they are mostly shaded than when they are mostly in sunlight (Ingersoll et al., 2010). This is due to the production of secondary metabolites in the plants in the sun, such as phenolic compounds, which are known to have plant defence mechanisms (Ingersoll et al., 2010). The total concentration of phenolic compounds is found to be higher in plants in the sun than in plants in the shade (Ingersoll et al., 2010). These phenolic compounds are toxic to animals and act as pesticides against insects, decreasing the amount of herbivory experienced (Ingersoll et al., 2010).

Phenolic compounds also act as a defence against pathogens, such as bacteria and fungi, and against environmental stress, such as drought, UV, and salinity (Kumar et al., 2020). These compounds contain antimicrobial and antioxidant characteristics that fight against infections and protect tissues from oxidative stress. There is a rapid upregulation of the genes of these phenolic compounds as a result of environmental stresses (Kumar et al., 2020). Phenolic compounds have different structures containing a number amounts of carbons, which indicate the function of the compound and what it fights against (Kumar et al., 2020).

7. Summary

Lindera benzoin is beautiful to see in the spring and summer when its flowers are in bloom and its glossy-red berries growing in the fall. Ontario is lucky to have to have these plants growing throughout the Carolinian zone.

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1.5 Amelanchier Arborea

AIDEN BRAUN

Amelanchier Arborea

Author: Aiden Braun

In this section:

1. Plant Description

Amelanchier arborea, commonly known as Downy Serviceberry, Common Serviceberry and Juneberry due to the fine “hairs” on the leaves and twigs of the tree and the time of year it flowers. This plant is a:

- **Perennial**: reblooms and resumes growth each year
- **Angiosperm**: A deciduous tree that flowers in the early spring
- **Woody Stem**: Stem, branches and twigs are lignified (woody)
- **Eudicot**: This species has 2 embryonic leaves
- **Roots**: Roots stay relatively close to the surface, good for urban environments and rocky soils
- **Monoecious**: Contains both male and female flowers on the same structure

2. Identification

Location: Commonly found in open rocky forests, forest understory, forest edges, and stream banks (Lady Bird Johnson Wildflower Center, 2023)

Flowering:

Flowering can start as early as March but typically blooms in April in SW Ontario. Flowers are grown near the tips of new leafy shoots in erect clusters known as *racemes,* with 4-10 flowers on each raceme (Minnesota Wildflowers, n.d.). Flowers are white in colour but can also be described as pale pink with a subtle fragrance (Chadwick, 2016). Flowers are star-shaped with 4-5 petals per flower with each petal roughly 8-12 mm in length with a flower diameter of 15-25 mm (Government of Canada, 2015). At the centre of the flower are roughly 20 stamens, with the stamens having brown anthers and white filaments; near the stamens is the pistil with a single style (Minnesota Wildflowers, n.d.). Due to the tree being monoecious, it can be produced asexually and can be hybridized with other trees in the same genus *Amelanchier.*

Figure 1.5.1. Image of flower produced by Amelanchier arborea. In the image, the "star" shape of the 5 petals can be discerned. The stamen, pistil, and sepals can also be clearly discerned from other parts of the flower. [click to enlarge] "Flower Details" by Dcrjsr, CC BY 3.0. [Click to enlarge]

Leaves: The colour of the leaves is green, but in the autumn, the colours can be a variety of colours, such as yellow, burgundy, and orange (North Carolina Extension Gardener Plant Toolbox, n.d.). The leaves are roughly 5-9 cm in length and roughly 3-5 cm in width and are attached with a slender petiole roughly 2-4 cm in length (Government of Canada, 2015; Lady Bird Johnson Wildflower Center, 2023). The leaves grow alternately on the shoot and are described as simple, with an oval shape that comes to a tapered point at the end of the leaf (Government of Canada, 2015; Lady Bird Johnson Wildflower Center, 2023).

The border of the leaf is denticulate, finely toothed, with roughly 25 each side teeth, as the teeth approach the petiole, the leaf tends to become mostly toothless (Government of Canada, 2015). The veins of the leaves are straight and parallel, with roughly 12 veins on each side of the leaf (Government of Canada, 2015). Young leaves are densely covered with wool-like hairs, particularly on the underside of the leaves, and as the tree matures, it becomes less hairy, with leaves looking glabrous on the top while some hairs can remain on the bottom and tend to follow the vascular structure of the leaf (Lady Bird Johnson Wildflower Center, 2023; North Carolina Extension Gardener Plant Toolbox, n.d.).

Figure 1.5.2. Image of the underside of the leaf of Amelanchier arborea. In the image the hairs found on the underside of the leaf are visible. The vascular structure can be seen, as well as the petiole and the "teeth" running along the perimeter of the leaf. [Click to enlarge]

3. Cultivation

Germination: Recommended to plant in Autumn but can be planted during the spring; seedlings can emerge as late as the following spring. Best to be planted in Autumn as the cooler temperature provides a less stressful environment, as heat can cause too much stress for a young plant if not properly managed (Potts, 2020). Seeds can be planted in a medium consisting of equal parts perlite, peat, and vermiculite and be chilled at 4°C for 3 – 6 months. Germinate after being exposed to cool moist conditions. Seeds can remain viable for a few years if kept at near-freezing temperatures (How to grow serviceberry from seed, 2022).

Soil: Prefers moist soil, though is known to be moderately drought tolerant but can also tolerate excess water. Prefers soils with good drainage and pH that's slightly acid to neutral, with a pH range of 5.5 – 7.0 (Chadwick 2016; Lady Bird Johnson Wildflower Center, 2023). Grows in a wide range of soil

types, such as rocky, loamy, sandy, and clay soils (Chadwick, 2016; North Carolina Extension Gardener Plant Toolbox, n.d.).

Sunlight: Best to be planted in full sun (6+ hours of light) to light shade (2 – 6 hours of light).

Growth Expectation: *A. arborea* has smooth light grey bark, and oftentimes verges off into multiple trunks. It will typically grow 4.5 – 8 m tall with a trunk diameter of 15 – 45 cm (Amelanchier arborea, 2022). The tree has a medium growth rate, with an expected growth of 2.7 – 3.0 metres in a 5 – 8-year period. It is recommended to have 3.5 – 7.5 metres of growth space allotted for the tree canopy so as not to have any issues occur as the tree grows and matures.

4. Cultural History

A. arborea gets its name from North American colonizers, who used the tree to determine when to bury dead bodies after the winter (Potts, 2020). Since the flower bloomed in early spring, cemeteries used the tree blooming to determine when the permafrost melted and the ground was soft enough to dig; hence the flowers blooming were synonymous with funeral services (Potts, 2020). *A. arborea* produces edible berries from May but don't typically ripen until late June to early August. Berries are comparable to blueberries in shape and first, appear to be green and fleshy and will turn red to purple-black in colour when ripe (Potts, 2020). Berries can and have been used by Aboriginals to be used to make jams, wines, jellies, or puddings (Bernheim Arboretum and Research Forest, n.d.; Government of Ontario, 2023; The Tree Pages, n.d.). The berries are a staple food for wildlife, with raccoons, squirrels, bears, chipmunks, and birds being frequently known to snack on the fruit produced (Bernheim Arboretum and Research Forest, n.d.; Pollen Library, n.d.). White-tailed deer are also known to snack on the leaves and twigs of the tree, making the tree a good barrier for protecting other plants or gardens (Backyard Ecology, 2018). The tree is also a host plant for some species of butterflies and moths (Backyard Ecology, 2018).

Figure 1.5.3. Image of mature berries produced by Amelanchier arborea. [click to enlarge] Photo by wenzlerdesign, Pixabay Licence. [Click to enlarge]

5. Life Cycle

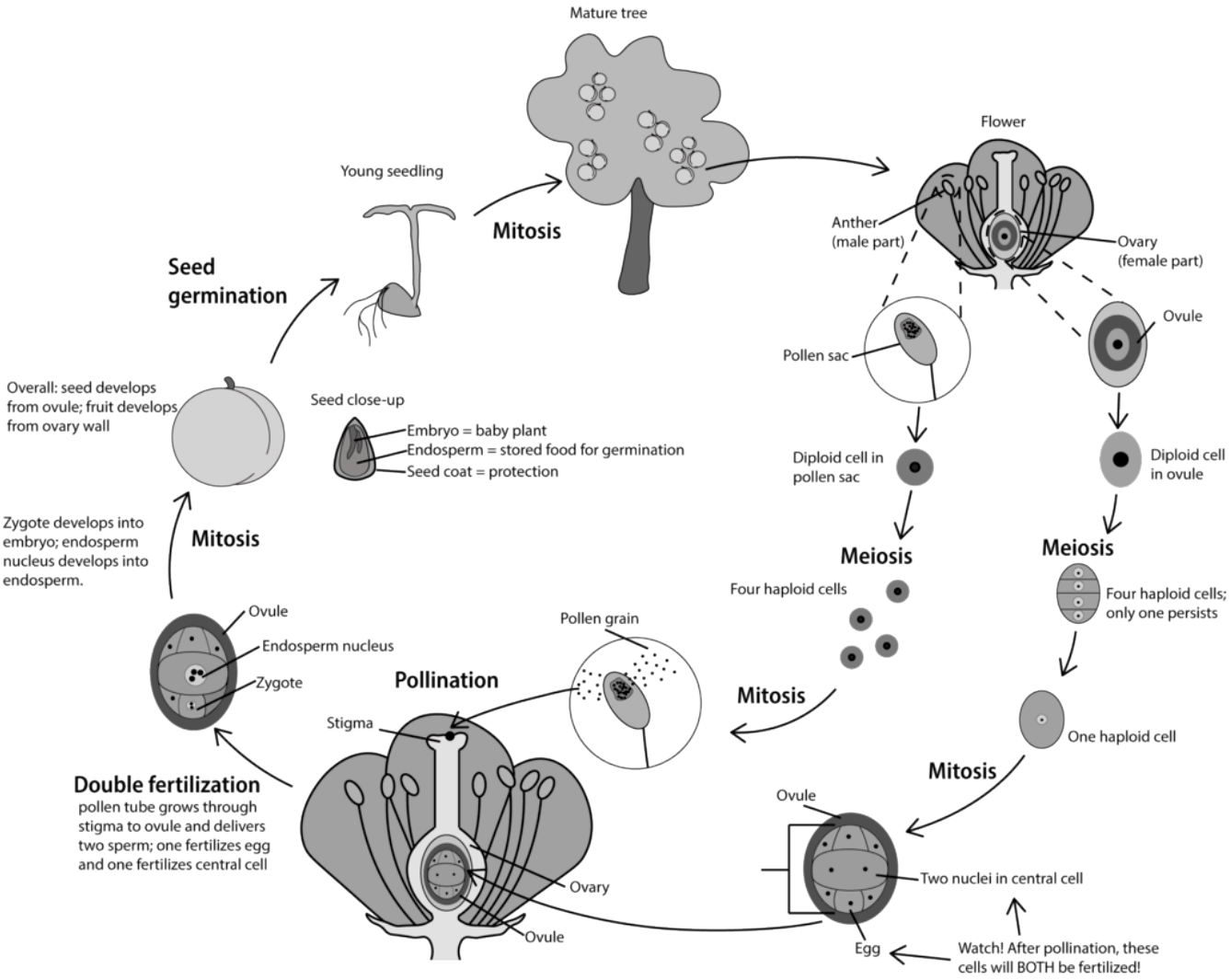

*Figure 1.5.4. The life cycle of an angiosperm, meaning a plant that flowers and/or produces fruit *Pictures shown in the diagram are not of Amelanchier arborea, but since Amelanchier arborea is also an angiosperm it would follow the same cycle shown. "Angiosperm Life Cycle" by Sarah Greenwood, CC BY-SA 4.0. [Click to enlarge]*

Flowering: Flowering takes roughly 13 days, occurring from April to May (Honey Plants Calendar, n.d.). The flower itself only stays open for 3 – 4 days for pollination; afterwards, it starts to wilt.

Pollinators: Due to the early flowering of *A. arborea*, it provides an early source of nectar and pollen for a variety of insect species. It provides an early source of pollen and nectar for honey bees and other bee species, as well as some species of flies, butterflies, moths, and beetles, which subsequently help pollinate when feeding on the nectar produced (Potts, 2020).

Seeds: Seeds are produced by the fruit of the tree, and each berry has 4 – 10 seeds per fruit (Government of Canada, 2015). The sweet berry primarily attracts birds, which eat the fruit and help

disperse seeds over a wider range (The Tree Pages, n.d.). The offspring of the mother plant are genetically different, but self-pollination is possible; however, internal measures such as separation of the stamen and pistil are taken by the plant to reduce self-pollination (The Biology Primer, n.d.).

Reproduction: *A. arborea* produces microsporocytes that will go through meiosis to produce haploid (n) microspores. These microspores will divide by the process of mitosis, producing sperm, known as pollen. Microsporocytes are housed in the anther, which is seen on top of the filaments of the flower, making the pollen accessible to pollinators. The carpel, which houses the ovary, forms a tube known as a style (The Biology Primer, n.d.). Atop the style is the stigma, which is where the pollen is held once it is deposited by a pollinator (The Biology Primer, n.d.). The ovules inside the ovary contain a megasporangium, which is a diploid (2n) megasporocyte within the megasporangium which meiosis producing four haploid (n) megaspores (The Biology Primer, n.d.). The surviving megaspore undergoes mitosis, which will produce an 8-celled female gametophyte known as the embryo, also known as eggs (The Biology Primer, n.d.). Two sperm cells are deposited in the embryo, and one sperm and egg fuse, creating a diploid (2n) zygote, which will develop into an embryo (The Biology Primer, n.d.). The second sperm fuses with the diploid polar nucleus, forming a triploid (3n) cell that develops into a food storage for the developing embryo, known as the endosperm (The Biology Primer, n.d.). This process is known as double fertilization, which only occurs in angiosperms.

Evolution: Angiosperms evolved 125 – 100 million years ago in the Cretaceous Period (Boundless, n.d.). Angiosperms did not evolve from gymnosperms but rather evolved parallel to each other, and the common ancestor and type of plant that would become angiosperms is unknown (Boundless, n.d.). It is debated that angiosperms evolved from small bushes or tropical grasses (Boundless, n.d.). Angiosperms are divided from other plants because they produce gametes in separate organs, called flowers, as they provide a stable structure and environment (Boundless, n.d.). Angiosperms are able to protect the embryo while also increasing genetic variability and range (The Biology Primer, n.d.; Boundless, n.d.).

6. Disease

Blight diseases are fungal or bacterial pathogens that infect the leaves, flowers, and shoots of plants, causing black or brown spots (Gilman & Watson, 1993, Your Leaf, n.d.). To avoid infection, prevent over-fertilization and prune infected parts of the plant (Gilman & Watson, 1993). An example of a disease that infects *A. arborea* in Southern Ontario is Powdery Mildew and Fire Blight (Gilman & Watson, 1993; Your Leaf, n.d.). Other diseases include Leaf Spot and Rust Diseases (Your Leaf, n.d.).

7. Anatomy and Physiology

A protein called “CONSTANS,” referred to as CO, is responsible for blooming. *A. arborea* starts the bloom process using CO using the increasing length in days to determine when to transcribe CO. *A. arborea* undergoes a conformational change using phytochrome, which regulates the transcription

of CO. This is done at lower temperature in *A. arborea* compared to other plants, hence why it grows much earlier relative to most plants.

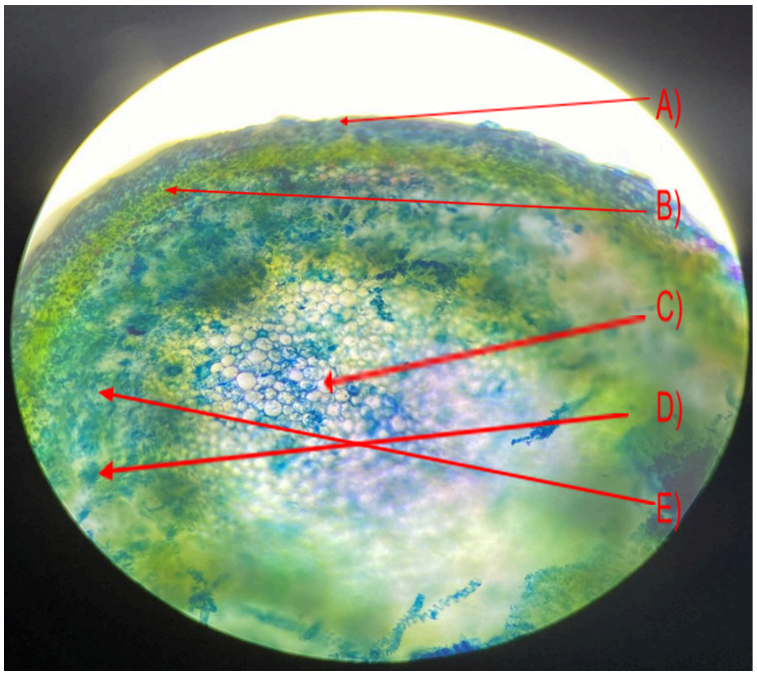

Figure 1.5.5. Cross section of the stem from under 40x magnification with lignified tissues stained blue. A) Epidermis cells are found on the outermost part of the branch. Stained blue to the lignified tissue (bark). B) Collenchyma, the outermost ground tissue, is non-photosynthetic. C) Pith cells, found at the centre of the stem D) Vascular Bundle, used for the transport of water and nutrients. Phloem is the outermost while xylem is the innermost bundle. E) Cortex, unspecialized cells that lie between the epidermis and vascular tissue. [Click to enlarge]

Meristems: Plant growth happens laterally and vertically, meaning there many loci of meristematic tissue, such as the Apical Meristem (grows the plant length from roots and shoot) and the Lateral Meristem (grows the root and shoot diameter, increasing the size of the plant laterally, known as secondary growth). Apical meristems form organs such as leaves, stems, flowers, and fruits, while lateral meristems increase the diameter of the root and shoot. In woody plants, such as *A. arborea,* the lateral meristem also forms the cork and vascular cambium.

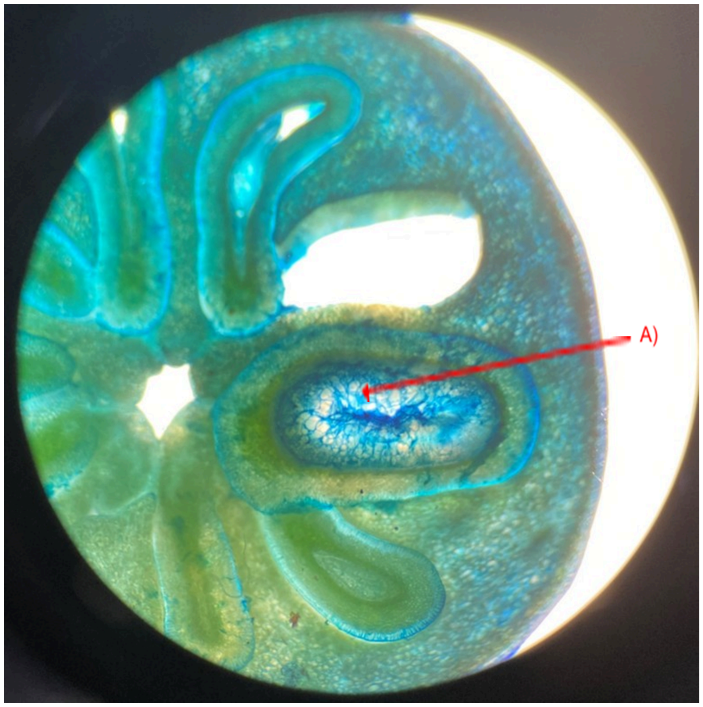

Figure 1.5.6. Picture of a cross-section of the fruit produced by A. arborea under 40x magnification. Berry consists of a fleshy pericarp with many seeds. A) a seed is seen, with believed endosperm stained blue. [Click to enlarge]

Ground Tissues: Ground tissue is defined as not being dermal or vascular tissue but rather tissue that fills in between the 2. Parenchyma is the outermost layer of cells under the dermal tissues and is used for the storage of carbohydrates. Parenchyma can also be referred to as chlorenchyma if photosynthetic, but in the case of *A. arborea* this layer of tissues does not photosynthesize and therefore is called Parenchyma. Collenchyma is a support structure that supports other organs and tissues as it grows. Sclerenchyma is the most internal of the ground tissues and is responsible for tissue strength. Sclerenchyma uses lignin to lignify tissues to build more internal strength and support for the plant.

Vascular Tissue: Vascular tissue is reasonable for the transport of water and nutrients throughout the plant. The main vascular tissues are the xylem and phloem, with the phloem being the outermost tissue and the xylem being the innermost tissue relative to the centre of the plant. The xylem is composed of vessel elements and tracheid, with the volume of liquid/second moving in a column proportional to the radius of the xylem. Bulk flow is much faster than diffusion but requires the input of energy. Phloem transports sucrose, which is actively pumped out of source cells and into sieve tubes then water enters sieve tubes by osmosis, and pressure increases and drives transport. Sucrose is actively pumped out at the sink, water exists by osmosis, and pressure decreases.

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Versioning History

This page provides a record of edits and changes made to this book since its initial publication. Whenever edits or updates are made in the text, we provide a record and description of those changes here. If the change is minor, the version number increases by 0.1. If the edits involve a number of changes, the version number increases to the next full number.

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Version	Date	Change	Affected Web Page
1.0	January 11, 2024	First Publication	N/A