The Floral Charms of St. John's: A Survey of Botanical Communities

Stephen G. Saupe
Biology Department
College of St. Benedict/St. John's University
Collegeville, MN 56431

&

Paul Melchior
Biology Department
North Hennepin Community College
Brooklyn Park, MN 55445

Abstract

St. John's is a "landscape paradise" in central Minnesota. Although no complete checklist of vegetation exists for the campus, various surveys reveal a diverse flora. This floral wealth is the result of several terrestrial biomes (Figure 1) converging on campus – prairie, savanna, deciduous forest, and coniferous forest – as well as diverse aquatic habitats including both lakes and wetlands. A 56-acre restored prairie at the entrance of St. John's is dominated by big blue stem (*Andropogon gerardii*) and little blue stem (*Schizachyrium scoparium*). A savanna has been restored to the north and east of the Gemini Lakes and is characterized by bur oaks (*Quercus macrocarpa*) scattered among prairie grasses and forbs. Minnesota's oldest pine plantation occurs on campus near the Preparatory School. Common campus pines include red pine (*Pinus resinosa*), Scotch pine *(Pinus sylvestris*) and white pine (*Pinus strobus*). More than half of the Arboretum is comprised of deciduous forests dominated by either sugar maple (*Acer saccharum*) and basswood (*Tilia americana*) or oak (*Quercus* sp.). Cattails (*Typha* sp.) and an assortment of sedges and rushes are common in the large, restored wetland that occurs on the north end of campus. Our campus lakes support pondweeds (*Potamogeton*), milfoil (*Myriophyllum*) and even carnivorous plants (*Utricularia sp.)*. European buckthorn (*Rhamnus cathartica*) and other invasive species, such as earthworms, threaten the long-term health of St. John's plant communities.

The Floral Charms of St. John's: A Survey of Botanical Communities

A state as far north as Minnesota might be supposed to be unfavorable to the development of a fascinating flora – yet even this corner of "God's country" has its charms, modest though they be when compared with other countries.

Alexius Hoffmann, O.S.B.
Natural History of Collegeville *(1934)*

Introduction

Father Alexius Hoffmann's unpublished manuscript, "Natural History of Collegeville," which he began in 1926 and completed in 1934, is the first major effort to document the plants, animals, and geology of St. John's. This excellent treatise provides a detailed baseline for subsequent biological studies and more importantly, provides a glimpse into the early history of our campus. Although he was an incredible scholar (Maiers, 2006), Father Alexius admitted to having "very little science in my head." In fact, he originally tried to recruit a "scientific gentleman" at St. John's to write this work, but was unsuccessful. Consequently, he decided that if his "dream of a natural history on a larger scale" were to become a reality, he would have to write it himself. Father Alexius was certainly correct that some people might assume that Minnesota and perhaps even the St. John's campus might not be good places for botanical study. As you will see, nothing could be further from the truth.

Father Bruno Riss who staked out the original land claim for St. John's in 1856 described finding ". . . thickets along the banks of the Watab, and here it was, that I struck upon the splendid pastures of Sec. 31 [note: Sec. 31 is the modern-day St. Wendell Township Section 31, which includes the college entrance road, wetland/prairie restoration, oak savanna, and the Gemini lakes] irrigated by the northern branch of the Watab. . . The Indians had burned bush lying toward the south in the previous year. . . To the west, as far as my eye could reach, I could see nothing but dense forest. . . Despite its scorched hills, Section 31 pleased me, because it furnished water and meadows with fine grass (Riss, 1889)." The vegetation today, primarily deciduous forest with scattered wetlands and lakes, is not too much different than it was a century and half ago. The remainder of this chapter will provide an overview of the plant communities that a visitor today will find at St. John's. By the end of the chapter, we hope that, like Father Alexius, you, too, will appreciate the charms of the St. John's flora.

The Indian Bush

According to Father Alexius (1934), the forested areas at St. John's and the "woods between here and St. Joseph used to be called. . .the 'Indian bush.'" He suggested that the name was derived from the Australian word 'bush' which refers to an area with trees. However, Robbins (2005) argues that "Indian bush" refers to the "previous inhabitants [who] . . .gathered the sweet sap from the [sugar maple] trees" (see Figure 2). Whatever the origin of the term, it's clear that St. John's originally had considerable areas of forest – and still does. Just as Father Bruno Riss noted, a large portion of St. John's land holdings, in fact more that half (61%), is deciduous forest. According to Michael Lee, one of the MN Department of Natural Resources botanists who worked on the biological inventory of Stearns County in 1997, "St. John's woods represents the largest tract of undeveloped forest in the county and likely in a several country area. . .It stands out as the largest remaining 'island' of forest amongst a sea of agriculture and development (Peterson & Schwietz, 2000)."

Collegeville lies in the Eastern Broadleaf Forest Province of the state that roughly runs from the southeast corner of the state to the northwest corner near Lake Itasca (Clearwater County). This province, which is characterized by deciduous trees, forms a transitional zone between the coniferous forests to the northeast and the prairie to the west and south. Collegeville lies on the southern fringe of the province in an area known as the Hardwood Hills ecological subsection. It is characterized by hummocky moraines that were deposited at the end of the last glacial period. Forests in this region are mesic to dry and dominated by northern red (*Quercus rubra*) and white (*Quercus alba*) oaks. To the south, the area known as the Big Woods forest type (subsection) once extended from northern Wright County southeast to Rice County (Fig 1). Although only remnants of this great ecosystem remain, some of the forest areas at St. John's are strikingly similar to the Big Woods. In fact, the deciduous forests of St. John's form a collage of forest subsets and are an interesting mixture of both.

The dominant tree and herbaceous species in a forest are, in large part, the result of climate, soil makeup, moisture, natural disturbances and other features of the landscape. With different environments come subtle changes in the forest community. For example, our deciduous forests in low-lying areas with moist soils are dominated by black ash (*Fraxinus nigra*). Red maple (*Acer rubrum*) and green ash (*Fraxinus pennsylvanica*) also occur in these lowland forests and are accompanied by shrubs such as dogwood (*Cornus* sp.), willow (*Salix* sp.) and alder (*Alnus incana*). Excellent examples of these lowland forests exist near Lake Hilary and along the southern edge of the restored wetland near Interstate 94. Approximately 150 acres of lowland deciduous forest exists at St. John's.

At the other end of the spectrum, the dry and mesic oak forests at St. John's, dominated by towering white oak (*Quercus alba*) and northern red oak occur on drier sites with gravel-rich and well-drained soils. These forests comprise nearly 50% (700 acres) of the forested land on campus and are highly prized for their excellent lumber. Since their arrival, the monks have primarily used northern red oak for furniture and other needs. Red oak remains the most common wood used by the Carpenter Shop, accounting for everything from church pews to the doors in the Quad. Because of its importance to the Benedictine's history and culture at St. John's, much effort goes into nurturing these oak forests. Because these forests are difficult to regenerate, oak woodlands may decline at St. John's without the intervention of land managers. This situation is largely due to the shade intolerance of oak seedlings, which require direct sunlight to thrive. Thus, most oak forests begin after a fire or other major disturbance that removes the bulk of the forest cover to provide light for seed germination and seedling establishment. Such natural fires are a rare occurrence today.

Father Paul Schwietz, the founder of the St. John's Arboretum, stated that "cattle were grazed in the [St. John's] woods over the years and it has been suggested that along with fire they are a major reason for the fine stand of red oak. . .today (Peterson & Schwietz, 2000)." Although cattle no longer roam the woods, the St. John's Arboretum staff have employed a number of techniques to foster oak forests. Controlled burning of the forest understory to remove shrubs and other vegetation, as well as cutting select areas create open areas where new oak seedlings can thrive. A good example of a mesic-dry oak forest is along the west side of the road to the footbridge.

Near the middle of the deciduous woodland spectrum at St. John's is the upland or mixed hardwood forest that makes up about 447 acres (about 30%) of the deciduous forest at St. John's. These forests are intermediate in soil moisture between the mesic-dry oak and lowland forests and usually occur on somewhat hilly sites. The dominant species of this forest type include northern red oak and white oak in addition to other species such as American basswood (*Tilia americana*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), box elder (*Acer negundo*), yellow birch (*Betula allegeheniensis*) and black cherry (*Prunus serotina*). In contrast to the oaks, sugar

maple and basswood seedlings are shade-tolerant and able to grow under a dense canopy. Consequently, many of the mixed hardwood areas on campus have experienced an increase in these shade-tolerant species at the expense of the oak population. The reason for this shift in the community lies in the oak's fire tolerance and need for direct sunlight in early life when compared to that of the maples and basswoods. In addition to their ability to grow in the shade, maples and basswoods are susceptible to fire, especially when immature. In centuries past, such fire-sensitive species have been evicted from oak forests by periodic ground fires. However, these fires have been largely absent in this region for many years, primarily due to human suppression. A good example of an upland hardwood forest can be seen on the west side of County Road 159 on the south exit from campus.

Aspen forests currently grow on about 50 acres (approximately 3%) of campus. Quaking aspen (*Populus tremuloides*) and big-tooth aspen (*Populus grandidentata*) dominate these forests. Aspen, also called popple, tend to form large clones. This results from a single individual that sends out "suckers" which in turn send out other suckers ultimately colonizing large areas. A beautiful aspen stand lines the road from the four-way stop near the Warner Palaestra to the St. John's Preparatory School.

A variety of herbaceous plants make their home in our deciduous forests. Some common spring wildflowers found on campus include bloodroot (*Sanguinaria canadensis*), baneberry (*Actaea rubra*), wood anemone (*Anemone quinquefolia*), Jack-in-the-pulpit (*Arisaema triphyllum*), and liverleaf (*Hepatica americana*). As the growing season progresses, these species fade from view as wild columbine (*Aquilegia canadensis*), wild geranium (*Geranium maculatum*), wild sarsaparilla (*Aralia nudicaulis*), honewort (*Cryptotaenia canadensis*), Canada mayflower (*Maianthemum canadense*), hog peanut (Amphicarpaea bracteate), sweet Cicely (*Osmorhiza* sp.), lopseed (*Phyrma leptostachya*), zig-zag goldenrod (*Solidago flexicaulis*), and white snakeroot (*Eupatorium rugosum*) begin their bloom. This flowering progression of herbaceous species is due, in part, to the changing light conditions on the forest floor. Spring-flowering species require a lot of light and must complete their life cycle before the trees leaf-out. Once the canopy has filled-in, the amount of light reaching the ground is only about 1% of the amount that reaches the top of the canopy. Relatively few herbs can tolerate such low levels of light and those that do have a variety of adaptations to allow them to survive. For example, to help them gather the limited amounts of light that are available, white snakeroot and zig-zag goldenrod and many of the other later summer species usually have larger and thinner leaves containing more chlorophyll than their counterparts that bloom in the spring.

The Pine Curtain

St. John's has long been associated with pines. In fact, pines are so common on campus and such an integral part of the St. John's tradition that they provide the name for the annual student festival, Pinestock. In addition, it is common to hear St. John's described as "Behind the Pine Curtain." This phrase, which was likely adapted from the term 'Iron Curtain' that Churchill coined to describe the line between communist and western Europe (Brogan, 1999), originated in the late 1940's to describe the original pine-lined entrance road into St. John's. The pines along this road, which leads from the footbridge over I-94 to the St. John's Preparatory School, were planted during the Depression (Peterson & Schwietz, 2000).

Although there are many pines on campus, their presence at St. John's is a relatively recent phenomenon. When the monks arrived, there were probably few, if any, pines in the area. Conifers, which are cone-bearing trees such as the pines, spruces, firs, and tamaracks, are more characteristic of northern Minnesota forests (Fig 1). This conclusion was confirmed by studying the original U.S. government land survey notes for campus from 1857 and 1858 (Melchior, 2001). These notes did not indicate any conifers on campus with the exception of tamarack, which was common in wet

areas. In contrast, Father Alexius said that "the tallest trees found hereabout were pines – they are all gone I think. The tallest ones, in the hollow behind the reservoir may have measured 60 feet." Lorraine Cofell (1977) speculated that "[p]ines could have been overstory trees as found in several other places in central Minnesota such as Pine Grove in Little Falls and one stand in Granite Ledge Township in Benton County." Despite the suspicions of Father Alexius and Ms. Cofell, it is unlikely that many pines occurred in the area prior to European settlement. This conclusion is supported by studies of the pollen in the sediments of Lake Hilary by Dr. DG Brown (College of St. Benedict/St. John's University Biology Department). Dr. Brown uses pollen analysis to reconstruct the vegetation history of an area. His work showed that although conifer pollen, and thus likely conifers, was present shortly after the last glacial period (*ca*. 10,000 years ago), it was rare at the time of European settlement.

Regardless of whether pines originally grew at St. John's or not, what is certain is that nearly all of the conifers now growing on campus were "hand planted by monks of past generations" (Barry, 1993) to "recreate the flavor of their coniferous German homeland" (Bogan, 1999). Fathers John Katzner and Adrian Schmitt, and later Br. Ansgar Niess, developed a nursery to raise seedlings and supervised the regular planting of a great variety of evergreens (Tegeder, 1987). Father Adrian "planted the first pines on the shores of Lake Sagatagan and is responsible for the interest that was taken in forestry in later years" (Rolfson, 1945). After a major tornado in 1894 levelled the area near what is now the Preparatory School, Father Adrian sought advice about reforesting it from relatives who were government foresters in Austria. They sent him conifer seeds and Father Adrian established a nursery of thousands of seedlings by Stumpf Lake. Numerous red pine (*Pinus resinosa*), Scotch pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*) seedlings were then planted south of the Prep school and are now the oldest pine plantation in the state (Peterson & Schwietz, 2000). Father James Katzner ". . .began work with evergreens in 1900. He attempted to raise them from seed, a most delicate and difficult task. He lost thousands of little plants through 'damping out' and freezing, but on the other hand, succeeded in raising several thousand too" (Rolfson, 1945).

The group of Scotch pine along the current entrance road in front of the football stadium are called the "Swayed Pines" for their windblown appearance, which is caused by the predominant westerly winds. These stately trees, which were planted in 1906 (Peterson & Schwietz, 2000) lent their name to a now-defunct fiddle and craft festival, Swayed Pines Folk Festival, that was held on campus each spring from about 1974 until 2000. Pine Knob (on the north end of campus, between the soccer pitch and restored wetland adjacent to I-94) and areas near Stella Maris chapel on Lake Sagatagan were planted in 1922 (Peterson & Schwietz, 2000). These plantings were supervised by Brother Ansgar. In all, there are approximately 146 acres of conifers growing at St. John's.

In addition to red pine, Scotch pine and Norway spruce, other commonly planted conifers include white pine (*Pinus strobus*), white spruce (*Picea glauca*), and Jack pine (*Pinus banksiana*) – all natives to Minnesota's northern reaches – as well as Colorado blue spruce (*Picea pungens*) and Douglas fir (*Pseudotsuga menzeseii*), which are native to the subalpine forests of the western states. The St. John's Arboretum has a self-guided conifer walk to the inner campus area for anyone wanting to study the diversity of campus conifer species.

Conifers have many special adaptations for winter survival. Their evergreen needles allow for photosynthesis anytime temperatures permit, which extends their growing season. Since the needles are retained, conifers do not require as many mineral nutrients from the soil as do deciduous trees which must grow new leaves each season. Thus, conifers can grow readily in nutrient-poor soils that are particularly common in northern areas where the cool temperatures slow microbial decomposition

and nutrient cycling. The needles of conifers are waxy and have stomata (pores for gas exchange) in sunken chambers to reduce water loss; this is a major concern since the plants are unable to replace any water that is loss during the frozen winter months. This is one reason why homeowners make certain that conifers are well-watered before winter to prevent "winter burn" from drying out. Another adaptation to reduce water loss is that they have thin water transport cells to minimize breaking of water columns in freezing conditions. The soft flexible branches of most conifers also allow them to shed snow (Saupe 2004).

One of the more interesting conifers that grows on campus is tamarack or larch (*Larix laricina*). It commonly occurs around the margins of bogs and wet areas and can be seen near the shores of Lake Hilary and Stumpf Lake (north of the picnic grounds). These conifers are unique because they produce needles in clusters on short spur shoots. The needles turn gold in the autumn and fall at the end of the growing season, making tamarack the only annually deciduous conifer native to our region. When the monks arrived at St. John's there must have been more and larger tamarack than there are today because they used tamarack logs to build the first cabin to validate their land claim. The name Watab, an old name for Stumpf Lake as well as the stream that traverses campus, comes from the Ojibwa term for tamarack, "this being the name given by the Ojibwas to the long threads obtained by splitting tamarack roots, used by them in sewing their birch canoes" (Meinberg, 1945).

A stroll through the pines at St. John's will turn up very few herbaceous plants. Relatively few herbs are able to grow on the forest floor beneath a canopy of conifers because of poor light availability and the low pH of the soil. So little light penetrates the dense evergreen canopy that few herbaceous plants are able to grow. In addition, as the needles decompose they release organic acids that result in greatly lower soil pH. Acidic soil with low light is a combination that is too difficult for most plants to overcome.

St. John's Prairie

A 56-acre prairie on the north-end of campus, at the intersection of County Road 159 and Interstate 94, welcomes visitors to St. John's (Figure 3). To the uninitiated observer, a prairie can be a boring, uniform expanse of grass. Closer inspection will reveal an incredible diversity of both grasses and forbs (non-grass herbaceous plants). More than 350 species can grow in a single acre of undisturbed natural prairie. Over 250 species that have been identified in the St. John's prairie (Arboretum Website). Of these, approximately 80% are native to Minnesota (McGreevy, 1999). There are at least 25 different grass species growing in the St. John's prairie, the most common of which are big blue stem (*Andropogon gerardii*), little blue stem (*Schizachyrium scoparium*), and Indian grass (*Sorghastrum nutans*). Common prairie forbs include gray-headed coneflower (*Ratibida pinnata*), butterfly weed (*Asclepias tuberosa*) and prairie clover (*Dalea* sp.).

The diversity of the St. John's prairie is especially remarkable considering that little, if any, prairie existed on campus when the monks arrived. Although prairie is the dominant vegetation type south and west of Collegeville (Fig 1), neither land survey records nor early writings mention prairie. Additional evidence that there originally was little prairie on campus comes from a summer research project by Steven McGreevy (1999) in which he compared plants currently growing in the St. John's prairie with specimens in the CSB/SJU Bailey Herbarium. A herbarium is a repository of pressed, dried, labelled and identified plants; in short, a herbarium is a reference library of plants (Saupe, 2000). McGreevy hypothesized that if prairie originally existed on campus then the early monastic botanists such as Father James Hanson, who was a thorough and careful collector, would have collected and deposited representative samples in the herbarium. However, when McGreevy examined herbarium specimens from prior to 1900 he found that there were no records for more than half (54.2%) of the species that currently grow in the St. John's prairie. In other words, only 45.8% of the plants

currently growing at St. John's prairie had been collected and prepared for a specimen prior to 1900. Further, there were no specimens of very common prairie plants including big bluestem (*Andropogon gerardii*), switch grass (*Panicum virgatum*), cord grass (*Spartina pectinata*), sideoats grama grass (*Bouteloua curtipendula*) and blazing star (*Liatris* sp.). By 1950, the number of prairie species for which there are herbarium records increased to 80.3%.

The primary reason that prairie did not occur on campus is because it is too hilly and wet. Both of these conditions would have prevented prairie fires from burning in this area. Fire is an essential part of prairie ecosystems. With the exception of thicker-barked species like bur oak, fire kills most trees by destroying their growing cambium layer. To survive periodic burns, prairie species evolved numerous adaptations, including vegetative buds and apical meristems that form underground. Protecting this vital tissue from fire allows them to re-sprout quickly, unlike young trees and other non-prairie species. Equally critical is the ability of fire to recycle nutrients and to remove the heavy layer of dead plants from the soil, which in turn allows quicker penetration of water. In addition, the fire-blackened soil and plant remains absorb sunlight and provide a more rapid warming of the soil in spring. Remarkably, fire and smoke stimulate the germination of seeds of some prairie plants.

Fire is not the only peril for grassland plants. Prairie plants must be adapted to hot and dry summers and cold, windy winters. As a result, many species, such as lead plant (*Amorpha canescens*) have long tap roots for mining water from deep in the dry prairie soils. Leaves that curl up as they dry, hairy leaves that trap water vapor, and reduced numbers of stomata (the pores in the leaf that allow for gas exchange) are among the common adaptations that help prairie plants to reduce water loss. Fibrous mats of roots, which the settlers cursed as they tilled the unbroken prairie sod, efficiently absorb any rain that falls. Still other species, including grasses like big blue stem, have unique modifications of photosynthesis (C4 pathway, CAM metabolism) that enable them to use water more efficiently.

Grazing is another important feature of the ecology of the prairie. To discourage grazing, prairie plants evolved a variety of herbivory deterrents that include packing leaves with large amounts of silica or poisons to make them unpalatable, or lacing tissues with chemicals such as lignin that limit the ability of an animal to digest its food. An added bonus of having the apical meristems below the ground is that not only are they protected from fire, but it enables the plant to resprout quickly after serving as a meal for a hungry bison, elk, or deer.

The area now occupied by prairie at St. John's was likely a wet meadow at the time of settlement. This area was once cropped. In 1990, Father Paul conceived and initiated a project to restore the abandoned fields to prairie. He contracted Prairie Restorations Inc. (Princeton, MN), to do much of the site preparation and supply plant materials. The site was seeded with two different mixes. On drier soils the seed mixture included big bluestem, little bluestem, side oats grama, Canada wild rye (*Elymus canadensis*), Kalm's brome (*Bromus kalmii*), Indian grass, giant hyssop (*Agastache foeniculum*), butterfly milkweed, black-eyed Susan (*Rudbeckia hirta*), leadplant, and prairie clover. Big blue stem, switch grass (*Panicum virgatum*), bottle gentian (*Gentiana andrewsii*), tall blazing star, boneset *(Eupatorium perfoliatum*), and blue vervain (*Verbena hastata*) were among the species planted on moister areas. Grass seeds were planted with a Truax seed drill, while wildflower seed was broadcast by hand. In addition, thousands of nursery-grown seedlings were transplanted to the prairie including more than 26,500 wildflower and grass seedlings in mesic areas, nearly 11,000 seedlings in wet areas, and 12,000 seedlings in dry areas (McGreevy, 1999). The initial plantings included about 90 species which has nearly tripled in the past 15 years. To maintain the prairie, prescribed burns are conducted annually. Typically, a third of the prairie is burned so that each section gets burned on a three-year rotation. The burns

are conducted in either spring or fall depending on the weather conditions and whether it is necessary to stimulate the growth of grass or forb species. Spring burns encourage the development of grasses while fall burns favor forbs.

The St. John's Savanna

A savanna is characterized by bur oaks (*Quercus macrocarpa*) scattered among prairie grasses and forbs; in other words, it is a prairie with scattered trees (Figure 4). Savannas are one of the rarest natural habitats in Minnesota and they form a transition zone between true prairie and deciduous forest. Few trees grow in a savanna because they are killed by fire. Bur oak is able to survive because it has thick, fire-resistant bark. It's not clear if there was savanna on campus when the monks arrived, but land survey records mention the presence of bur oak. Regardless, the St. John's Arboretum has restored an 11-acre area to the east of the Gemini Lakes. A botanical survey of this area by Rebecca Guza (2001) reported 80 species in this relatively small area.

Aquatic Plants

Aquatic habitats, including wetlands, streams, and lakes, abound at St. John's (Figure 4). Many of these areas are today nearly as pristine as when St. John's was settled and provide wonderful examples of aquatic ecosystems typical of central Minnesota. More than 200 acres of St. John's land holdings are considered wetlands, not including the lakes on campus. Many of these wetlands are interconnected, while others are isolated basins.

Wetland and shallow lakes are lush with plant life. This belies some significant challenges to survival for plants. Making a living while rooted in the mucky soils of a St. John's marsh is more difficult than it looks for a plant. Plant roots are composed of living tissue that requires a lot of oxygen. Terrestrial soils have ample airflow between particles of sand, silt, clay, and organic matter that compose them, providing plants with a constantly replenished oxygen source. However, when the spaces between soil particles are filled with water, the availability of atmospheric oxygen plummets. While oxygen readily dissolves in water, its concentration in water is orders of magnitude less than in a similar volume of air. Furthermore, the relatively small amounts of oxygen in the soil-saturating water is quickly removed by living roots and resident bacteria. In short, the biggest obstacle to life for plants rooted in wet soils is that they simply cannot acquire enough oxygen from the soil to survive.

Plants rooted in wetland or shallow lake substrates have evolved some unique strategies for getting oxygen to their roots. A common adaptation is the growth of aerenchyma tissue throughout the shoot and roots. This porous tissue is built with enormous open spaces and pockets that interconnect throughout the plant. Oxygen that enters above-water leaves through stomata can meander downward to the submerged shoot and root tissue. Aerenchymous tissue is common to most emergent hydrophytes and dramatically improves root oxygenation (Vartapetian, 1997; Evans, 2003). Many of these plants also waterproof shoot and root surfaces with a thick, waxy cuticle. This protects the plant's aerenchymous tissue from filling with water, which would kill the plant.

Aquatic ecosystem names are loosely based on their hydrologic properties. Lakes are typically large, open bodies of water with at least some wind swept shoreline. Wetlands vary widely in their hydrology and have unique plant communities as a result. Open marshes are highly productive and are dominated by emergent species which are rooted in the soil and send shoots into the air above the water. Common plants in these areas include cattails (*Typha* sp.), bur reed (*Sparganium* sp.), arrowhead (*Sagittaria sp.*) and an assortment of sedges (*Carex* sp. and *Cyperus* sp.) and rushes (*Scirpus* sp.). A few remote basins such as Lake Hilary even have thriving stands of wild rice (*Zizania palustris*). An excellent example of an open marsh wetland can be seen in the large habitat restoration area near the I-94 entrance to the campus.

Shallower marshes and ephemeral ponds are often dominated by reed canary grass (*Phalaris arundinacea*), a circum-global species that has both native and highly invasive European strains. The later was imported for forage because it has fewer toxic alkaloids and tastes better to livestock. This strain has outcompeted other plants, forming large monocultures. Prairie cord grass (*Spartina pectinata*) is another common native grass at the edge of wetlands at St. John's.

One of the more unique wetlands at St. John's is a poor-quality fen that lies in the woods west of Stearns County Road 159 and north of Lucent Lane. The pH of this basin's water is typically between 4.5 and 5.0. This acidic environment thwarts the growth of many typical marsh plants. However, peat moss (*Sphagnum* sp.) thrives here, covering nearly the entire basin in a thick mat. Sphagnum mosses thrive in and contribute to such acidic environments. In turn, the mat of both living and slowly decomposing moss serves as a substrate for the growth of other species. Tamarack trees (*Larix laricina*) dot the basin, achieving heights of only fifteen to twenty feet. Rattlesnake manna grass (*Glyceria canadensis*), cottongrass (*Eriophorum sp.*), and woolgrass (*Scirpus cyperinus*) are common community members on the mat, as well as water arum (*Calla palustris*), boneset (*Eupatorium perfoliatum*), marsh aster (*Aster novae-angliae*) and water horehound (*Lycopus* sp.). Steeplebush (*Spirea tomentosa*) and marsh cinquefoil (*Potentilla palustris*), with their burgundy and pink flowers, are two distinctive shrubby plants that thrive here.

Not all wetlands have standing water. In fact, many wetland communities on campus have constantly saturated soil, but little or no obvious surface water. Often, these areas are dominated with moisture-loving shrubs such as red osier dogwood (*Cornus serecia*), speckled alder (*Alnus incana*), and a variety of willows (*Salix* sp.). These so called "shrub carrs" are often found in the zone between upland forests and open water marshes. In late march, sprigs of green and yellow cowslip, also called marsh marigold (*Caltha palustris*), punctuate the otherwise dreary brown landscape. These buttercup relatives are harbingers of the lush growth to come in the warmer weeks ahead.

Where do wetlands end and lakes begin? Perhaps that is a question for philosophers. Indeed, anyone who has ventured to the far shores of Sagatagan in a canoe has notice the near impossibility of finding the shoreline. Much of the 'backwater' of the shallow lakes on campus would certainly be considered marshes if they were isolated from the lake. These areas illustrate how difficult it is to place nature's diversity into human categories. Clearly, Sagatagan is a lake. While many definitions for lakes exist, limnologists often cite criteria such as large areas of open water with wind swept shore as indicative of 'lake status'. Much of the emergent flora around the major lakes at St. John's is no different than that of its marshes. However, several groups of lake hydrophytes have adaptations unique to their deeper water environs. A diverse group of plants such as water lily (*Nymphea odorata*), spatterdock (*Nuphar lutea*), water shield (*Brasenia schreberi*), and floating pondweed (*Potamogeton* sp.) have opted for rooting in the lake bottom and sending long, flimsy petioles or shoots to the surface where their photosynthetic leaves float. Some of these species solve their root oxygen problem by transporting oxygen from the atmosphere all the way to the roots through aerenchymous tissue. A few - and likely many – floating plants use the sun's energy to warm the air that has entered the leaves. This causes higher convective air pressure in the leaf, forcing the molecules downward toward the root (Dacy, 1987; Armstrong, 2005). At the other end of the spectrum, the duckweeds and watermeal (*Lemna* sp, *Spirodela* sp. and *Wolfia* sp.) have opted to float, but dangle only tiny vestiges of roots into the water. These nearly microscopic plants are some of the smallest flowering species on Earth and often cover the surface of calm waters.

Other submerged species remain rooted, but have evolved leaves that are wispy and thread-like, or highly dissected. These leaves have few anatomic similarities to those of their land dwelling kin. However, their enormous surface area allows them to acquire adequate dissolved oxygen from the water. Common water-milfoil (*Myriophyllum sibiricum*), water marigold (*Megalodonta beckii*), and many of the pondweeds share these features. Interestingly, such plants often send a periscope-like inflorescence above the water surface during flowering.

Still some plants, like the bladderworts (*Utricularia* sp.) neither root nor float on the surface. They exist almost entirely under water, floating below the surface and drifting wherever conditions take them. These species have long been considered 'carnivorous' – somewhat a misnomer – because of their capacity to trap small crustaceans and insects in their bladders. Some research has suggested that these plants keep their 'prey' alive in these bladder traps not for the purpose of digestion, but to collect their nitrogen-laced waste; a sort of nutrient-producing personal aquarium (Richards, 2001).

Plants lacking charm

Not all of the plants that grow at St. John's are as charming as those in our deciduous forests, prairies, and wetlands. Some unwelcome plants include the weeds and poison ivy. Although a precise definition for a weed is difficult, most would include plants that evolved elsewhere and now grow where they are not wanted. These "aliens" were transported here from other parts of the world and because they have no natural checks and balances on their populations, typically dominate the landscapes they inhabit. These plants grow in flower beds, along roadsides and pathways, at the margins of buildings, and just about anywhere else that has been disturbed by human activities. Weeds are great at exploiting disturbance.

There are many dozens of weeds on campus. Two particularly noxious weeds are common ragweed (*Ambrosia artemisiifolia*), the source of pollen that causes misery for so many people, and dandelions (*Taraxacum officinale*), the bane of a well-groomed lawn. These plants share a number of attributes that make them especially successful in disturbed habitats – they are able to tolerate poor soil conditions and they produce many small, easily dispersed seeds. These plants are adapted to moving from site because they do not compete well with other plants so they must be prepared to move on to other uncolonized disturbed areas.

Although a native species, western poison-ivy (*Toxicodendron rydbergii*) grows in roadside ditches, margins of the forest, and along trails. Poison ivy is easily recognized by its leaves with three, slightly shiny leaflets ("leaftlets three, let it be"), with a reddish-tint (especially in the spring), and cream-colored berries. All parts of the plant produce urushiol, a chemical that causes dermatitis in sensitive individuals. Although physical contact with the plant causes dermatitis, the most serious cases of poisoning result from inhalation or contact with smoke and soot particles when the plant is burned.

Invasive species are those that out-compete established native vegetation. Once established, these species overrun and degrade our natural landscapes in part by diminishing biodiversity. As a result, the land managers at St. John's must be constantly vigilant for invasive species and remove them before they become established. The biggest threat to our deciduous forests is European buckthorn (*Rhamnus cathartica*). These shrubs, which are native to Eurasia, were widely planted throughout Minnesota because they make an excellent hedge. Unfortunately, birds disperse their blackish berries and these plants have invaded forests throughout the state. Once buckthorn becomes established it reduces the amount of light to the forest floor, killing native herbs. In some places, buckthorn forms an almost impenetrable thicket beneath the canopy. The St. Benedict's woods is currently highly infested. St. John's is more fortunate, though there are some isolated plants. In the fall, volunteer groups are

mobilized to remove buckthorn on both campuses. Another potentially devastating invasive plant for our area forests is garlic mustard (*Alliaria officinalis*). The herbaceous mustard can quickly carpet the forest floor in the spring. This situation, which has occurred in many Minnesota forests south of Stearns County, dramatically diminishes native herbaceous diversity. In addition to blocking vital sunlight for native species, garlic mustard has the ability to stunt the growth or inhibit germination (allelopathy) of natives plants (Prati, 2004). Although no sign of garlic mustard has been found at St. John's, it is only a matter of time. Once established, this prodigious seed producer is nearly impossible to eradicate or control.

The St. John's prairie is continually under attack by a variety of invasive species. Some of the worst are the sweet clovers, both yellow (*Melilotus officinale*) and white (*Melilotus alba*). Burning the prairie regularly is one way to help control these weeds because they are susceptible to the heat of the fire. Even with fire, it is often necessary to hand-pull or mow these plants to knock them back and prevent them from making seeds. Spotted knapweed (*Centaurea maculosa*) and flowering spurge (*Euphorbia corollata*) are two newcomers to St. John's that have the potential to rapidly spread. Unfortunately, these species are not killed by fire so the Arboretum staff is attempting to control them with herbicides. One drawback of this treatment is that there is some collateral damage; welcome prairie species in the vicinity may also be killed.

Common reed grass (*Phragmites communis*) is an impressive plant that can grow to over eight feet tall. It thrives in wetlands where it can form large colonies much to the detriment of wildlife and other plants species. There are both native and introduced populations of this species in Minnesota. The latter are especially invasive and spread rapidly. There is one population of this plant on the shores of Lake Hilary. Fortunately, a recent study by students at North Hennepin Community College showed that it is the native strain (Nguyen, 2007). We can breathe a sigh of relief that this particular population will not cause trouble elsewhere.

Where have all the flowers gone?

In 1934 Father Alexius noted that ginseng (*Panax quinquefolia*), a medicinal herb highly-prized by the Chinese, was once relatively common on campus. Today, few plants remain. Similarly, few spring wildflowers now grow in areas on campus where introductory biology students (Concepts of Biology) used to conduct a laboratory exercise on floral diversity. Furthermore, a recent study of campus orchids identified several species [*e.g.*, ram's-head lady's-slipper (*Cypripedium arietinum*)] that have not been collected, or even seen, for a century (Saupe, 2006). So, where have the flowers gone?

Ginseng was harvested to near extinction. Father Alexius (1934) reports that "Stearns County farmers. . . used to pay their stove bills with Ginseng." Although humans are directly responsible for the demise of ginseng populations, the disappearance of spring wildflowers and other plants is probably due to a combination of factors. Habitat loss may account for the loss of the ram's-head lady's-slipper. According to the St. John's Landscape Management Plan (Peterson & Schwietz, 2000), the "old north cranberry bog was reclaimed as an extensive athletic field to make a baseball diamond." This project may have destroyed some of the prime habitat for this orchid. Browsing by deer is another likely cause for the decline of campus plant populations. Deer eat many plants and can have a devastating effect on species diversity in native plant communities. This problem is magnified on our campus because of the large deer populations. As a consequence, the Arboretum instituted a deer hunt as a control measure (Evenson, 1999; Halbur, 1998). A less obvious, but equally insidious, threat to wildflower populations are earthworms. University of Minnesota scientist Dr. Cindy Hale (2007) and her colleagues have shown that earthworms are not native to Minnesota. Like dandelions and European house sparrows, they have been

introduced to the state either accidentally or intentionally by anglers, gardeners and others. Although earthworms help improve soil tilth in our gardens, they wreak havoc in our forests. Earthworms eat seeds and change the structure of the soil making it less favorable for seed germination and seedling survival. In 2004, Ben Rith-Najarian, a natural science major, sampled a variety of sites in the Arboretum and discovered that all were infested with earthworms and that their numbers decreased as you moved away from Lake Sagatagan. His data suggest that anglers are largely responsible for the presence of earthworms on campus. Dr. Lee Frehlich (2005), a forest ecologist at the University of Minnesota, laments that the combination of deer browsing and earthworm damage is a 'doubly whammy' for native wildflowers - deer eat the larger plants, while worms finish off smaller ones.

Plant diseases are yet another threat to our native plant populations. For example, at the time of European settlement, there were a significant number of American elm (*Ulmus americana*) trees in this area. However, these trees, at least the larger ones, have been nearly eliminated in North American and on our campus because of Dutch elm disease. This disease, which is caused by a fungus that is moved from tree-to-tree by bark beetles, was accidentally introduced to the United States from Europe in infected logs. The emerald ash borer, oak wilt, and sudden oak death are but a few diseases on the horizon that worry plant lovers.

How Many Plants?

No one knows exactly how many different kinds of plants grow at St. John's. In her study of just the upland vegetation at St. John's, Cofell (1977) listed about 65 species. During the 1997-1998 field season for the Minnesota County Biological Survey of Stearns County, DNR botanists Michael Lee and Karen Myhre (1998) reported observing more than 150 species on campus. Students participating in CSB/SJU Plant Taxonomy (Biol 308) class field trips regularly see more than 250 species and the St. John's Arboretum reports more than 250 species in the prairie, alone. The CSB/SJU Bailey Herbarium is in the process of preparing a thorough checklist of campus vegetation. Until this listing is complete, we can assume that there are significantly more than 250 species that call St. John's home.

Conclusion:

St. John's is clearly blessed with a "charming" and diverse flora. In fact, according to Father Vincent Tegeder (1999), "So outstanding has the site been that monks and students early glorified in the cry: "The school in the heart of a landscape paradise."

Literature Cited

Anon. Habitat Restoration in the Oak Savanna at Saint John's Arboretum http://www.csbsju.edu/arboretum/land_steward/student_research/oaksurvey.htm. date accessed: 21 July 2006. St. John's Arboretum Website.

Armstrong, W and J Armstrong (2005) Stem Photosynthesis not Pressurized Ventilation is Responsible for Light-enhanced Oxygen Supply to Submerged Roots of Alder (*Alnus glutinosa*). *Annals of Botany* 96:591-612.

Barry, Colman (1993) *Worship and Work: Saint John's Abbey and University 1856-1992.* Third edition, Liturgical Press, Collegeville (MN).

Brogan, Grace (2004) Saint John's historic "Pine Curtain." *Sagatagan Seasons* 7 (1):2. Winter.

Cofell, LW (1977) *A Study of the Vegetation in the Upland Forest of St. John's Abbey and University, Collegeville, Minnesota*. MA Thesis, St. Cloud State University.

Dacey, J. W. H. (1987) Knudsen-transitional flow and gas pressurisation in leaves of Nelumbo. *Plant Physiology* 8:199-203.

Evans, DE. (2003) Aerenchyma Formation. *New Phytologist,* 161:35-49.

Evenson, Alex (1999) Third controlled deer hunt to be held in November. *Sagatagan Seasons* 2 (3): 2, Autumn.

Frehlich, Lee (2005) Combined attacks by deer, earthworms endangering hardwood forests in state. *Minnesota Plant Press* 24(4): 1. (Summer)

Halbur, Adam (1998) Successful deer hunt at St. John's. *Sagatagan Seasons* 1 (1): 2, March.

Hale, C (2007) *Earthworms of the Great Lakes*. Kollath+Stensaas Publishing, Duluth, MN.

Hoffmann, Alexius O.S.B. (1934) *Natural History of Collegeville*, unpublished manuscript. Available at http://www.csbsju.edu/arboretum/land_steward/images/History_Hoffman_1934.pdf.

Lee Michael & Karen Myhre (1998) "Plants of St. John's," unpublished document, Minnesota Department of Natural Resources.

Maiers, Brennan (2006) Alexius Hoffmann, OSB, St. John's Renaissance man. *The Abbey Banner* 6 (1): 9; Spring.

McGreevy, Steven R (1999) A Century of Prairie, unpublished manuscript, summer.

Meinberg, Clodoald (1945) Sagatagan saga. *Scriptorium,* Vol V, No 2. Summer, pp 25 – 38.

Melchior, Paul (2001) Analysis of land survey records for St. John's. Unpublished manuscript.

Myhre, Karen. Aquatic Plant Survery Sagatagan Lake. St. John's Arboretum Webstie, accessed July 21, 2006. http://www.csbsju.edu/arboretum/land_steward/student_research/lakesagsurvey.htm

Nguyen, A, W. Menzel, E. O'Brien and P. Melchior (2007) Haplotype Determination for an Isolated *Phragmites australis* Population in Central Minnesota. Poster Session, Undergraduate Research Symposium, North Hennepin Community College.

Peterson, D and Paul Schwietz, OSB. (October 2000 and subsequent updates) Land Management Plan for St. John's, Collegeville, Minnesota. Available at http://www.csbsju.edu/arboretum/land_steward/images/June%202006%20land%20management%20plan.pdf

Prati, D and O. Bosdorf (2004) Allelopathic Inhibition of Germination by *Alliaria petiolata* (Brassicaceae). *American Journal of Botany* 91(2): 285-288.

Richards, JH (2001) Bladder Function in *Utricularia purpurea* (Lentibulariaceae): Is Carnivory Important? *American Journal of Botany* 88(1):170-176.

Riss, Bruno, OSB (1889) The Earliest years of St. John's Abbey. Part 3. *The Record,* April. available at http://www.saintjohnsabbey.org/archives/Riss/begin03.html

Rith-Najarian, Ben (2004) "Impact of Exotic Earthworms on Soil Properties in the St. John's Arboretum." Abstract, annual meeting of the Society for Conservation Biology (Grand Rapids, MN).

Rolfson, Gunther (1945) Our scientific endeavour. Part II: Ramblings in biology. *Scriptorium* Vol V (2): 18 – 24. Summer

Saupe, SG (2004) How do they do it? *Sagatagan Seasons* 7(1): 3. Winter.

Saupe, SG (2007) Plants to Know. Course handout for Plant Taxonomy, Biology 308). http://www.employees.csbsju.edu/ssaupe/biol308/plants_to_know.htm

Saupe, SG (2006) Orchids in the herbarium. *Sagatagan Seasons* 9 (4): 3, Autumn.

Tegeder, Vincent (1987) In *A Sense of Place. Volume 2: The Benedictines of Collegeville*. CJ Barry, ed. The Liturgical Press, Collegeville, MN. pp 219 – 228.

Vartapetian, BB, and MB Jackson (1997) Plant Adaptations to Anaerobic Stress. *Annals of Botany*, 72: 3-20.

Figure 1. Map of Minnesota showing major vegetation types (included with permission)

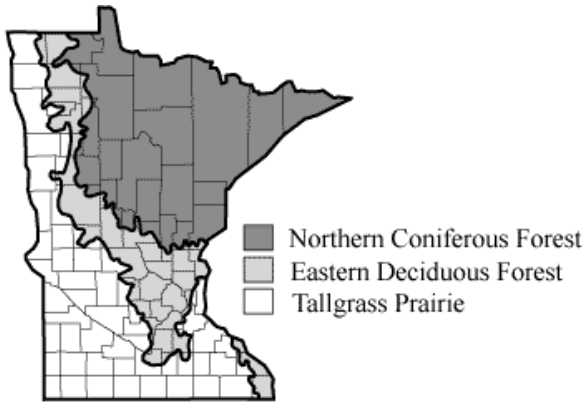

Figure 2. The St. John's sugarbush in the autumn (image by S Saupe)

Figure 3. The St. John's savanna (image by P Melchior)

Figure 4. The prairie and wetlands at St. John's (image by S Saupe)