The Ashes (Genus *Fraxinus*) of Central Pennsylvania:

A Summary of their Characteristics and a Key to Identification.

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Introduction

One of the most ecologically and economically important genera of trees in the world is the genus *Fraxinus* in the family Oleaceae, comprising the sixty-five species known in English as the ashes (Hunt, 1963). At least three native species in this genus (white ash, green ash, and black ash) are commonly found in central Pennsylvania, along with several introduced species and many cultivars (Rhoads, 2005). This genus includes some of the most common landscaping trees in the United States, several important timber species, and even some species that are vitally important in indigenous cultures. Because the members of this genus are so important, and are currently threatened by the emerald ash borer (*Agrilus planipennis*), it is fitting that we should research the unique characteristics of each species in the hope of protecting them for future generations.

White ash

The white ash, *F. americana* L., is perhaps the most representative specimen of this genus. Its specific epithet, *americana*, means “of America” while *Fraxinus* is the Latin word for ash (U. of Nebraska, 2007; Rhodus, 2007). The common name “white” is derived from the microscopic papillae on the underside of the leaf, whose high light reflectivity gives the leaf a whitish appearance that is not common in other ashes (Wright, 1959). It has many cultivars, most of which have been bred for distinctive fall colors, such as ‘Autumn Applause’, ‘Autumn Blaze’, ‘Autumn Purple’, and ‘Rosehill’ (Geneve, 2007). There are also many wild phenotypic variations, such as trees with 9 leaflets, narrow leaflets, blunt leaflets, purple samaras, and several others (Wright, 1959). These variations are genetically controlled and evenly distributed throughout the range (Wright, 1959).

The form and growth pattern of the white ash is rather unusual among the American ashes because of its size. White ash forms a very spreading, broad crown with age and is usually between 50-80 feet tall (Seiler, 2007). The form exhibits strong apical dominance except when the terminal leader is removed, and even then a new leader will still develop as the tree self-prunes (Daniels, 1977). Pruning of the many terminal leaders and strong opposite branches is necessary to achieve the rounded shape desirable in landscaping (Gilman, 1993). Some specimens are more than 5 feet thick, and the national champion in Palisades, New York, is 25.3 feet in circumference (Daniels, 1977: U. of Nebraska, 2007). The root system is usually fairly deep, except where rocks or a fragipan layer prevent this, and the tree prefers a low water table on well drained sites (USDA, 1907). Its bark is most often tan to gray-brown, with light lenticels on upper branches (Figure 1) (Rhoads, 2005). It becomes roughly furrowed into a diamond-like pattern with age (Rhodus, 2007). The twigs of this species can be gray to olive green, and are hairless with a large, leathery dark-brown terminal bud with two flanking lateral buds at the top (Figure 2) (Seiler, 2007). The twigs are notched with lateral buds in the notches (at each leaf) and have concave leaf scars (like the letter U) on their upper sides (Figure 3) (Rhoads, 2005: Rhodus, 2007; Seiler, 2007). The pith is white and the wood itself is very strong and hard, with a specific gravity of 0.60 (Gilman, 1993: Rhoads, 2005). Very little imagination would be needed to look at the terminal bud and see the head of some science-fiction monster with sideways teeth and a snake-like appearance.

The leaves and foliage of white ash are less evocative but more practical for species identification (Figure 4). Like all ashes, its odd pinnately-compound leaves are
oppositely arranged along the twig and tend to possess 5-9 leaflets, each about 2-3 inches long (Rhoads, 2007). These leaflets have a well-developed and easily visible petiolule as well as whitened undersides and a few hairs along the midrib (Rhoads, 2007). The margins, which are important for identification, are entire or serrulate, never appearing as toothed as *F. pennsylvanica* (Gilman, 1993). The fall color is almost always mixture of yellow and deep maroon-purple that is extraordinarily spectacular, though this varies with different cultivars (Geneve, 2007). This color tends to develop in stages, starting as golden or reddish and ending in burgundy or purple (Rhodus, 2007).

White ash possesses a typical two-inch, symmetric ash samara with a wing that extends 1/3 of the way up the seed (Figure 5) (Rhoads, 2005; Fewless, 2007). One could almost imagine it as a maple samara that had seen the error of its crooked ways and decided to straighten up. It develops from the flowers of the female tree, which occur before the leaves emerge in April and tend to have open green or purple inflorescences (Rhoads, 2005; Rhodus, 2007). The inflorescences are green and purple, usually appearing in April (Rhodus, 2007). Each female flower has a small calyx at the base, like most members of the genus, as well as a single ovary with two stigma branches and no petals (Rhoads, 2005). Male flowers tend to be denser; they have 2-4 stamens as well as a little four-lobed calyx (Rhoads, 2005). As the female trees only bloom once every 2-3 years, more males will bloom than females in any given year (Wright, 1959). Unlike some of its relatives, white ash is completely dioecious with no variation in sex conditions except for the number of flowers produced each year (Hunt, 1963). The ratio of males to females is 1:1 and there is no sexual dimorphism, except for a tendency for male trees to achieve greater height and diameter than females, due to a smaller expenditure of reproductive energy (Hunt, 1963). Most cultivars are males, so samaras cannot be relied upon for identification in an urban setting (Rhodus, 2007). Attempts have been made to vegetatively propagate white ash from stem or pith cuttings of genetically superior specimens, but it has not shown any propensity to reproduce in this manner (Doyle, 2001). Samaras are abundant in 3-5 year cycles and the seedlings can grow up to a foot in their first season (USDA, 1907). Seeds are wind dispersed for distances up to 450 feet (Wright, 1959). Hybridization between this species and its nearest relative, green ash, is relatively rare, possibly because of habitat seclusion (Taylor, 1972).

White ash is typically associated with upland or dry sites, as a pioneer in old fields and fencerows, or a component of a mixed hardwood forest (Rhoads, 2005). It is found throughout the eastern United States and southern Canada naturally, from Nova Scotia to Minnesota and south to Texas, but it can be viably planted anywhere in the continental United States with adequate irrigation (Gilman, 1993; Geneve, 2007). It needs between 30-60 inches of annual rainfall, and between 120-280 days without frost per year (Wright, 1959). It can tolerate a pH range between 5 and 7.5, and is a major species in two Society of American Foresters forest types and 26 cover types (Wright, 1959). Maximum elevation is about 3,450 feet in the Cumberland Mountains (Schlesinger, 2007). It has an almost unlimited tolerance of different soil conditions, can take a lot of salt, and can withstand moderate drought (Gilman, 1993). Despite this tolerance, it is not particularly fond of urban settings or soil compaction, which is why green ash is usually preferred as a landscaping tree (Rhodus, 2007). Though seedlings are somewhat shade-tolerant, adults are shade-intolerant and maintain their presence in a
stand by overtopping the other species (USDA, 1907). The most important macro-
nutrients needed for its growth, in order, are nitrogen, calcium, and sulfur (Schlesinger,
2007). However, phosphorus is often a limiting nutrient in many soils and the height and
biomass of seedlings is directly correlated to the phosphorus supply (Smalley, 1975).

There are three distinct ecotypes based on latitude, the northernmost ranging from
41 degrees northward, and the southernmost from 39 degrees southward (Daniels, 1977).
The northern ecotype is distinguished by its diploid (2N = 46) chromosome count, non-
glossy leaves, winter-hardiness, mostly purple fall color, and a fibrous root system, while
the southern ecotype has a tetraploid or hexaploid (2N = 92 or 138) chromosome count,
glossy leaves, severe mortality in a harsh winter, yellow fall color, and a taproot (Wright,
1959: Daniels, 1977). Other ways that the northern ecotype differs include a larger
percentage of viable seed, narrower seeds, larger samaras, seeds that are longer in relation
to the samara, and a longer wing border along the seed (Daniels, 1977). The middle
ecotype between 39-41 degrees combines the characteristics of both, so that a gradient
may be seen from north to south (Daniels, 1977). Biltmore ash (F. biltmoreana) is a very
similar species distinguished by the velvety hairs along the midrib and leaf underside;
some consider it to be a variety or subspecies of white ash rather than a separate species
(Cowen and Sydnor, 2007).

The ecological role of white ash is rather unusual, as it is neither a climax
dominant species nor a typical early-succession pioneer. It can be forced out of a given
ecosystem by excessive deer browsing, and the seeds are eaten by many birds and
squirrels (Wright, 1959: Rhoads, 2005). The seeds tend to germinate in moist conditions
and can only remain dormant for about 2 years, so they rely on an external seed source
rather than dormancy within the seed bank (Daniels, 1977). It has been shown that white
ash seedling survival is much higher in canopy gap situations than it is in full shade or
even in full sun (Billock, 1991). It has also been shown that the position of the seedlings
within the gap affects survival, because even within the canopy gap the seedlings that
receive full sun do not survive well (Billock, 1991). This would seem to indicate that
white ash is a middle-successional species, and is not nearly as suited to colonizing
disturbed sites or forming a climax stand. In my experience, white ash is quick to
become established and overtop the developing forest in an early successional setting,
even when other pioneer species, such as pines, have already been planted. It is subject
to a variety of pests that are shared with most ashes, such as the ash flower gall mite
(Aceria fraxiniflora), oyster-shell scale (Lepidosaphes ulmi), tent caterpillar
(Malacosoma spp.), brown-headed ash sawfly (Tomostethus multicinctus), anthracnose
(Gloeosporium aridum), many different borers including the infamous emerald ash borer
(Agrilus planipennis), a variety of fungi (like Mycosphaerella fraxinicolae) and rusts
(Wright, 1959: Gilman, 1993).

White ash may have many different potential uses dependent on the
circumstances. Its strong light wood makes it preferable for uses where the wood must
be tough but light enough to handle, such as handles of sports equipment or tools
(Rhoads, 2005). It is the most valuable of the American ash species and is the primary
wood used in making the famous Louisville Slugger baseball bats (Geneve, 2007). Other
uses include anything from bowling alleys to church pews, and early colonists thought it
had the power to ward off snakes (Geneve, 2007). Native Americans used it for
medicinal purposes (the seeds were thought to prevent obesity!) and many of these uses were adopted by the European settlers (Rhoads, 2005).

Green ash

Green ash, *F. pennsylvanica* Marshall, is a much more adaptable and widespread species than white ash, but is not nearly as numerous or important. It was first described as independent from *F. americana* by Marshall in 1785, and the variety *lanceolata* (thought to be a separate species in 1800) was described as such in 1894 (Neill, 1978). For a long time, the green ash variety was the subspecies *F. pennsylvanica lanceolata* while the red ash variety claimed the main species status (Rhodus, 2007). Other former names for this species include *F. viridis* Michx. and *F. lanceolata* Borkh (Hu, 1989). The current names of the varieties (*lanceolata* for red and *subintegerrima* for green) date back to Radford, Ahles, and Bell in 1968 (Neill, 1978). The specific epithet *pennsylvanica* is translated “of Pennsylvania” or “of Penn’s woods” making this “ash of Pennsylvania” (Rhodus, 2007). The common name “green” is a reference to the color of the leaf underside, as opposed to the leaf of white ash (Wright, 1959).

The form of green ash is like that of white ash, but with subtle differences. It reaches a maximum height of about 75 feet with a less regular crown than white ash and a spread of 45-50 feet (Gilman, 1993: Rhoads, 2005). The National champion is in Missouri and measures 4.4 feet in diameter and 106 feet in height (Wright, 1959). Average height growth is about 1.3 feet per year, though young trees in warmer climates have been known to grow 6-10 feet per year with adequate water (Wright, 1959, Gilman, 1993). Specimens in exceptionally wet or periodically flooded conditions tend to develop swollen or buttressed trunks (Silberhorn, 1994). The bark is grayish brown, with the same regular diamond pattern as white ash (Figure 1) (Rhoads, 2005). The twigs can be covered with pubescent hair or glabrous, which is the main factor used to split them into the geographic varieties of red and green ash (Fewless, 2007). The twigs sometimes display a tendency to lean downwards and then curve up at the tip (Gilman, 1993). The pith is a solid white (Rhoads, 2005). The buds are almost exactly the same as white ash; they have the same large, dark, pointed terminal bud joined with rounded lateral buds in the shape of a monster’s head (Figure 2) (Rhoads, 2005). Buds are occasionally sub-opposite rather than completely opposite (Fewless, 2006). Their distribution along the twig appears fairly consistent; lateral buds are most common near the end of the twig, inflorescences in the middle, and aborted buds near the base (Bartlett, 1997). The wood, which is marketed as white ash, has a specific gravity of 0.56 (Gilman, 1993; Rhoads, 2005).

Green ash leaves are one of the main features that set them apart from other members of this genus (Figure 4). They are pinnately compound and 6-10 inches long, usually with 5-9 leaflets with long acuminate points and many serrate teeth above the middle, some with almost a lanceolate or triangular shape (Rhoads, 2005). The leaflets are 2-4 inches long and very close to completely sessile, with almost no petiolule, and D-shaped leaf scars (Gilman, 1993: Rhoads, 2005). The fall color is a strong lemon yellow (Gilman, 1993). Very young seedlings may have simple leaves though the leaflet shape is the same (Fewless, 2006).
The samaras of green ash show a number of distinctive traits (Figure 5). They are winged to or past the middle of the seed, giving it a much more pointy appearance than white ash (Rhoads, 2005). The seed cavity is also much thinner than in white ash, appearing like a continuous part of the samara rather than like a round handle to the samara (Fewless, 2006). Male flowers shed pollen for 3-5 days, and the amount of pollen shed is subject to several year cycles and decreases with age, though three males bloom for each female in a given year (Neill, 1978). Green ash flowers at the same time as white ash and is also wind pollinated (Wright, 1959).

Green ash is found over a wider area than any other North American ash (Hu, 1989). It is found from the Maritime Provinces of Canada to Manitoba, south to eastern Texas and all along throughout the eastern states, with the exception of north-central Pennsylvania and parts of New York and New England (Rhoads, 2005). It is usually associated with wetlands, riparian forests, or alluvial plains (Rhoads, 2005). This association is strong enough to classify it as a Facultative Wetland Plant (FACW), making it a wetland indicator (Silberhorn, 1994). It is also one of the most commonly planted trees in the U.S., and can frequently be seen planted in parking lots, sidewalks, highway medians, and urban neighborhoods (Gilman, 1993, E. Burkhart, Field Dendrology instructor, Penn State, personal communication). The precipitation over its range varies from 15-60 inches, with a growing season of 120-280 days and up to 100 inches average snowfall (Neill, 1978). It is known to prefer moist well-drained soils, but is not often found on these sites due to a stronger competitive advantage on poorer sites (Rhodus, 2007). This is because of its well-known ability to withstand air pollution, saturated or compacted soil, and dry conditions (Gilman, 1993). This tolerance for anaerobic reducing conditions allows it to have a deeper root system than many trees (about 4.5 feet in certain soils), so with proper guidance its roots will not dislodge sidewalks or subject it to wind-throw (Wright, 1959; Neill, 1978; Gilman, 1993). The drought tolerance of this species does not imply that photosynthesis and normal metabolism is not severely limited by drought, but it seems that desiccation of the leaf tissue is not fatal, possibly because it is tolerated by the meristematic tissue (Davis, 1988). The dormancy of this species is also more sensitive to temperature than to photoperiod; prolonged daylight cannot increase the growing season of green ash (Ying, 1971). Photoperiod is important, however, because a longer photoperiod has been shown to cause an increase in average sapling height growth (Craig, 1970).

Like most trees with a large range, green ash can be divided into ecotypes. The border between Nebraska and Kansas appears to be a dividing line between the northern and southern Great Plains ecotypes; the southern ecotypes have a distinctly longer growing season and faster growth rates (Ying, 1971). A cline exists in the size of the fruits, seeds, and samara wings from the northern to the southern ecotypes (Craig, 1970). It has been noted that northern ecotype samaras germinate faster and weigh more than their southern counterparts, to go along with bigger leaves and root systems (Wikum, 1965). The simple leaves on seedlings tend to persist longer in northern specimens (Wikum, 1965). On the basis of these characteristics (though all have 2N = 46 chromosomes), the three basic ecotypes that are recognized are found in New England, the southern states from the coast to the Mississippi, and the Great Plains (Wright, 1959: Wikum, 1965).
Green ash is seldom common enough to play a large ecological role. It is similar enough to white ash to have no discernable difference in pests or diseases (Gilman, 1993). It could be considered an early-succession riparian species, as it is usually out-competed by species like American sycamore (*Platanus occidentalis*), Sweetgum (*Liquidambar styraciflua*), or Cottonwood (*Populus deltoides*) by age 30 (Neill, 1978). Interestingly, green ash is the only one of these three ash species that continues growing when flooded, giving it more potential for growth in temperate swamps than even Black ash (Cloutier, 1999). Green ash forms Vesicular-Arbuscular Mycorrhizae (VAM) with fungi in the genera *Glomus*, *Gigaspora*, and *Acaulospora* and these associations are critical to supplying the tree with the necessary phosphorus (Lamar, 1986). There is some evidence that pumpkin ash (*F. profunda* Bush.) is a polyploid true-breeding hybrid of a diploid green ash and a tetraploid white ash (Wright, 1959).

The uses of green ash are not nearly as widespread or common as those of white ash. Native Americans formerly used the inner bark to treat depression and fatigue (Rhoads, 2005), which means I will have to try some next time I see one. The cambium can be scraped off, boiled, and eaten (Rhoads, 2005). Because the wood is marketed as white ash, it is used for almost everything white ash is used for, including sports equipment and tool handles (Geneve, 2007).

**Black ash**

Black ash (*F. nigra* Marshall.) is one of the few ash species that could be considered a specialist. Both the Latin and common names (which mean the same thing) are thought to be references to the color of the buds (Rhoads, 2005).

The form of black ash is seldom distinct and recognizable, due to its habitat and its similarity to other ashes. It tends to reach a maximum height of about 75 feet, with the same thick opposite branching of the other ashes and a narrow crown (Rhoads, 2005). The roots are very shallow and fibrous, as an adaptation to saturated conditions (Touchet, 2000). The base of the trunk has also been observed to swell, due to an increase in summer-wood cell production, in saturated conditions (Gates, 1925). Its bark differs considerably from green or white ash; instead of a braided pattern of interweaving ridges forming diamond shapes, it tends to form a homogeneous mass of randomly-oriented grey-white bumps (Figure 1) (Eric Burkhart, pers.comm.). These have a distinct corky texture and can be found even on saplings more than three inches thick (Fewless, 2006). The bark also varies considerably in mature trees; in some the ridges stick out almost like tread on a tire, while on others the bark is almost perfectly smooth (Eric Burkhart, pers.comm.). The twigs are hairy on young growth but tend to lose this hair with age (Rhoads, 2005). The buds are dark brown to black and maintain the same general shape as the other ashes, except that the terminal bud tends to be more long and pointy and may be clearly separated from the rounded lateral buds at the tip of the twig if the branch has good lateral growth (Figure 2) (Fewless, 2006). The wood is softer than that of other ashes and tends to have a very coarse grain (Rhoads, 2005).

The leaves of black ash are one of its most important distinguishing characteristics (Figure 4). They possess far more leaflets than most other ashes (usually between 9-11) and the leaflets are sessile, with absolutely no connective stem between their base and the main leaf stem, except on the terminal leaflet (Rhoads, 2005). The leaflets are also strongly serrate, with visible teeth all the way around the margin and
without the variability seen in the previous species (Rhoads, 2005). The leaves are extremely frost-sensitive, making them one of the last species to leaf out in the spring and one of the first to turn yellow-brown in the fall (Fewless, 2006).

Equally unique are black ash samaras, which do not really resemble a samara at all (Figure 5). They develop from typical ash flowers, which appear with or before the leaves in May or June, but the resemblance ends there (Touchet, 2000). They have an almost invisible seed cavity hidden in a 1-1½ inch wing that extends to the base of the cavity (Rhoads, 2005). The samara is also often notched at the apex and tends to develop a strong twisted shape (Rhoads, 2005, Eric Burkhart, pers.comm.). They are dispersed both by wind and by water (Eric Burkhart, pers.comm.). Because the seeds are dormant (due to impermeable seed coats, immature embryos, and endosperm enzyme inhibitors) they usually do not germinate until the second spring after their dispersal (Touchet, 2000). This can be overcome by continued exposure to warm wet conditions, though the seed remains viable for 8 years (Touchet, 2000). They can germinate in a maximum depth of 2 centimeters of soil and the seedling does not develop compound leaves until its second year (Touchet, 2000).

Black ash is most commonly found in swamps. It is distinctly a tree of wet, marshy lowlands with poor drainage (Rhoads, 2005). Due to the fact that it is found in wetlands between 67-99% of the time, it is a national wetland indicator, according to the U.S. Fish and Wildlife Service (Touchet, 2000). It is the defining member of the black ash-red maple-American elm forest association (Touchet, 2000). It apparently has a much higher cold tolerance than all the other ashes, because it is found no farther south than Pennsylvania, Northern Ohio, and parts of West Virginia, and is quite common in Canada (Rhoads, 2005). It is found from southeast Manitoba to Newfoundland and from North Dakota to Northern Virginia, reaching its lowest latitude as it follows the Appalachians down to southern West Virginia (Touchet, 2000).

The specialized habitat and site preferences are a large part of the reason that black ash is seldom important on a large ecological scale. It is shade intolerant and is considered sub-climax, often being replaced by northern white-cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), and American elm (*Ulmus americana*) at an early age (Touchet, 2000). The seeds are eaten by rodents, songbirds, wild turkeys (*Meleagris gallopavo*), and wood ducks (*Aix sponsa*), and the saplings are heavily browsed by deer and moose (Touchet, 2000). Pathogens for this species appear to be similar to those for the other ash species, such as the oyster-shell scale (*Lepidosaphes ulmi*) anthracnose (*Gloeosporium aridum*), nectria canker (*Nectria spp.*), and rusts (Touchet, 2000).

Black ash is perhaps the least utilized of all the native ashes. Its bark and roots formerly supplied Native Americans with the ingredients for a foot bath to treat rheumatism and urinary problems (Rhoads, 2005). It does not provide much for the wood products industry, but it is the preferred choice for traditional basket-making in the Iroquois and Algonquin cultures, and as such provides an important source of revenue to these tribes even in modern times (Touchet, 2000). High-grading of black ash stands for basket-making is one of the main reasons for black ash decline in
New York (Touchet, 2000).

Brief descriptions of other ashes (less frequent in central Pennsylvania)

**Blue ash**

Blue ash (*F. quadrangulata* Michx.) is named for its unusual four-sided twigs and the blue color of its inner bark. Its bark is similar to other ashes, but with a slightly more irregular appearance. The samaras are shorter, squarer, and blockier than other ash samaras (Figure 6) (Seiler, 2007). The twigs have strong angles that make them look almost square (Figure 7) (Ambrose, 1982). The combination of these characteristics makes it unlikely that this tree will be confused with any other species common in Pennsylvania. Blue ash is a species of the Midwest from Tennessee to Kansas, and it is not common anywhere east of Ohio, though isolated pockets can be found in Lake Erie islands (Ambrose, 1982). This species has the highest drought tolerance of all the ashes, which is surprising given that it is often found in sub-climax forests perpetuated by floods (Ambrose, 1982). It has dual habitat preferences, as it is found on dry ridge-tops and swampy lowlands, but usually not between (Ambrose, 1982). Because this species is monoecious, inbreeding is possible and it can easily maintain outlier populations in states outside of its normal range (Ambrose, 1982). In Pennsylvania, it may be found in isolated sites in the southwest, and occasionally planted in landscapes (Rhoads, 2005, Eric Burkhart, pers.comm.).

**European ash**

European (common) ash (*F. excelsior* L.) and its cultivars are probably the most common introduced ashes in the area. It is a fairly large ash (between 60 and 80 feet) and it has 9-11 serrate acuminate leaflets, which resemble black ash rather closely (Gilman, 1993). It can be distinguished from black ash by the lack of the distinctive corky bark, by the long soft hairs along the midrib (rather than the wooly fuzz of black ash) and by the fact that it is almost always planted, while black ash is almost never (Cowen, 2007). There are many different cultivars of this tree that may be more commonly seen; one of them actually has a simple leaf (Cowen, 2007). Because it is tolerant of most urban stresses, it is commonly planted in parking lots and road medians, which is where it can be found in Pennsylvania (Gilman, 1993).

**Pumpkin ash**

Perhaps the strangest native ash is the pumpkin ash, *F. profunda* Bush. As previously mentioned, there is speculation that it is a true-breeding hybrid of green ash and white ash, but its characteristics are not really similar to either (Wright, 1959).
bark is divided into braided ridges like its parents, but these ridges are light gray and flat topped, with a blocky appearance (Rhoads, 2005). The buds are shaped like those of black ash, with clearly separate laterals on the side of the terminal bud, but they are blunt, red, and hairy (Rhoads, 2005; Seiler, 2007). Its leaf has 7 to 9 ovate hairy leaflets, but each leaflet is between 3 and 6 inches long with little or no teeth, making it the biggest overall leaf of our ashes (Seiler, 2007). The samara can reach three inches long and has a distinct rounded sail that extends at least halfway up the seed cavity (Seiler, 2007). All in all, it looks like a white ash on steroids. The distribution of this tree is very patchy; the endangered Pennsylvania population is isolated from the next closest population by the width of Ohio and the pockets in Virginia and North Carolina are also population islands (Rhoads, 2005). Although it has been planted, Pennsylvanians are not likely to find it anywhere outside of swamps and wetlands around Lake Erie (Rhoads, 2005).
Pictorial Key to Pennsylvania Ash Identification

white ash (Baskauf)  green ash (Baskauf)  black ash (Fewless)
white ash (Ohio Trees)  green ash close-up (Ohio Trees)  black ash (Seiler)

Figure 1. (Comparison of bark on older specimens)
There is an obvious difference between black ash bark and that of white and green ash, though the former is quite variable and the latter two are not distinct from each other.
(Courtesy of Steve Baskauf, Gary Fewless, “Ohio Trees” and John Seiler). The sapling bark of the ashes is not distinctive between species at a very small stage, as can be seen in this young white ash (Courtesy of Steve Baskauf).

Figure 1. continued (bark on younger sapling)

![Figure 1. continued (bark on younger sapling)](image)

![white ash](image)  ![green ash](image)  ![black ash](image)

Figure 2. (Bud comparison)
The black ash terminal bud is often longer and pointier, with the terminals separate, while white and green are not discernable from each other (courtesy of Gary Fewless).
Figure 3. (Leaf Scar comparison)

Note the crescent shape on white ash, while the others are D-shaped. (Courtesy of Gary Fewless).

Figure 4. (Leaf Comparison)

Leaves of the most common species, white, green, and black, can be distinguished by the number of leaflets, the presence or absence of teeth on the margin, and the presence or absence of petiolules on each leaflet. Note that white ash and green ash both have 5-7 leaflets; the difference in this picture is not consistent except black ash always has more (9-11). White ash is the only one with petiolules and few or no teeth.
The samaras, though only present on female trees, are the easiest and surest way to identify these species.

In addition to the above morphological characteristics, Taylor (1972) identifies several other ways to distinguish white ash from green ash, which should be used to confirm an initial guess based on the above characteristics. It is unlikely that these traits will be consistent and obvious enough to sway your opinion, but they can strengthen it once it is formed.

- The crown of white ash is symmetrical and apical dominant, while green ash has an asymmetrical crown with low apical dominance (applies only to open-grown trees).
- The upper branches of white ash are smoother and less noticeable than in green ash, where the bark of upper branches becomes almost corky.
- The lenticels on the young bark of a white ash are less conspicuous than in green ash.
- White ash leaf scars retain the strong opposite arrangement of the branches, while green ash leaf scars are often sub-opposite.
- The styles of a white ash tend to be reddish-purple, while green ash styles are green.
- White ash fall color ranges from yellow to maroon or purple, varying between different cultivars and sometimes even on the same tree, while fall color in green ash appears uniformly yellow.
- White ash is far more common in dry upland sites than green ash and it is almost never found in saturated soils. It is also planted less, due to its decreased
tolerance for urban stresses. One consolation for struggling Dendrology students is that because of this habitat isolation between the two species, there is a strong breeding barrier and natural hybridization is rare.

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