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‘Rebecca’s Appalachian Angel’: A Cultivar of Flowering Dogwood (*Cornus florida*) with Large Leaves and Floppy White Bracts

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Flowering dogwoods (*Cornus florida* L.) are relatively small deciduous trees that are popular as landscape ornamentals and native to the eastern United States and Canada. *Cornus florida* is classified in the red-fruited, big-bracted dogwood clade, which also includes *C. nuttallii* Audubon ex Torr. and A. Gray) (Pacific dogwood) and *C. kousa* F. Buerger ex Hance (Kousa dogwood; Asian dogwood) (Call et al. 2016; Eyde 1988; Mantooth et al. 2017). Flowering dogwood cultivars have showy bracts in spring, brilliant red foliage in fall, distinct red berries into winter, and graceful year-round architecture that has earned them a reputation for four-season appeal (Cappiello and Shadow 2005). *Cornus florida* has achieved the status of state flower or tree in North Carolina, Virginia, and Missouri (Missouri Botanical Garden 2023; NC State Extension 2023). In 2019, cultivars of flowering dogwood ranked third in value for deciduous flowering trees in the U.S. and generated more than $31 million in wholesale and retail sales from 1.2 million trees. Tennessee leads the United States in the number of dogwood plants sold, selling almost twice the number of trees as Oregon, the state ranked second in the country (US Department of Agriculture National Agriculture Statistics Service 2020).

Although flowering dogwoods are well known for their year-round appeal, they are best recognized for their spring display of inflorescences where the large white to pink to red “floral” bracts subtend a collection of 20 to 30 small, less conspicuous flowers. The bracts are commonly referred to as petals but are modified leaves (Cappiello and Shadow 2005). The ornamental interest of *C. florida* also extends to the developing leaves, which vary in color by cultivar. Some leaves are various shades of green, whereas others have either red-pigmented, some degree of red pigment, or variegated leaves. The pink and red colors in the vegetative tissues of dogwoods are a result of anthocyanin biosynthesis (Wadl et al. 2011).

Cornus florida is native to eastern North America and ranges from Massachusetts to Florida and northwest into Ontario, Canada, and south to Texas (Little 1979). In addition to being a significant ornamental species, this understory tree also plays a large ecological role, especially with calcium in the soils of forest habitats. *Cornus florida* leaves and fruits are high in calcium, making the leaves especially important for the calcium cycle in forests (Thomas 1969) and landscapes. Flowering dogwood fruits are small, single-seeded (occasionally dual-seeded) drupes that develop in clusters of up to 12 on the inflorescence disc and range in color from orange to red. In addition to a high concentration of calcium, the fruits also contain abundant fats and proteins, which makes them an important source of nutrients for wildlife (Halls 1977). Various mammals and birds feed on the berries of *C. florida* and use the trees as habitat (Eyde 1988; Stiles 1980). Pollination is affected by a variety of insects, but the main groups are andrenid and halictid bees as well as cerambycid beetles (Rhoades et al. 2011).

Cornus florida blooms in late March/early April in the southern United States with its leaves emerging either shortly before or after or concurrently with flowering depending on the location and cultivar. Flowering is affected by physical location of the tree and is considerably delayed in the northern United States and Canada compared with the southern United States. The bracts vary from round to narrowly ovate to cordate and cover the true flowers throughout the winter. The timing of flowering depends on air temperature (De La Pascua et al. 2020; Reader 1975), making the early emerging bracts of *C. florida* susceptible to frost damage and subsequent infection by *Elsinoe cornii* Jenkins and Bitanc. (spot anthracnose). This malady causes the bract tissues to produce red-purple lesions, which cause only cosmetic damage and presents no future consequences for the tree.

Pests and diseases have plagued *C. florida* in the past few decades. The main pest of *C. florida* is the common dogwood borer (*Syanthedon scitula*) but can largely be mitigated with cultural techniques (Fulcher et al. 2012). The emergence of dogwood anthracnose (caused by *Discula destructiva* Redlin) in the mid-1970s devastated natural populations of *C. florida*, especially in the cooler climates and mountains of the eastern United States (Hadziabdic et al. 2010; Pais et al. 2020; Redlin 1991). However, dogwood anthracnose has not been a major concern for nursery production in recent years (Fulcher et al. 2012) because of prophylactic chemical control measures, lack of conducive environments (cool, wet, and shady) for disease development in the nurseries, and the introduction of the only anthracnose resistant cultivar, ‘Appalachian Spring’ (Windham et al. 1998). Furthermore, many locations with a favorable environment for disease development now lack dogwoods. The primary disease problem with *C. florida* for the nursery industry as well as homeowners and the landscape industry is the annual epidemic of powdery mildew caused by *Erysiphe pulchra* (Cooke and Peck) U. Braun and S. Takam (Klein et al. 1998; Li et al. 2009; Windham et al. 2005). This disease emerged in the United States in approximately 1994

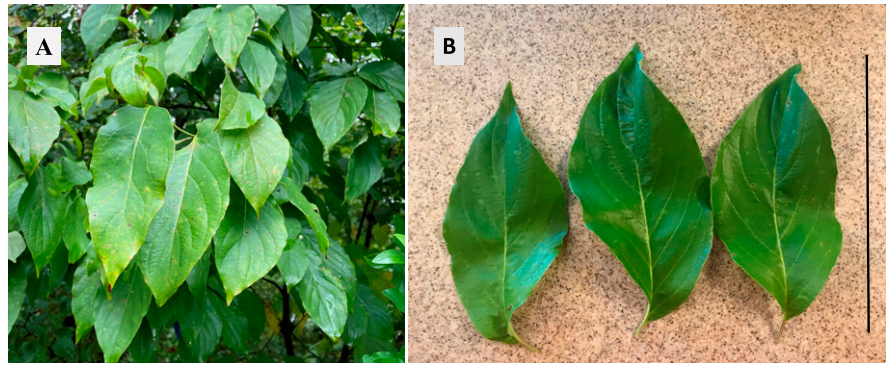

Fig. 1. Leaves of *Cornus florida* ‘Rebecca’s Appalachian Angel’. (**A**) Large and smaller leaves on the same tree. (**B**) Large detached leaves. Black line = ~8 inches or 20 cm.

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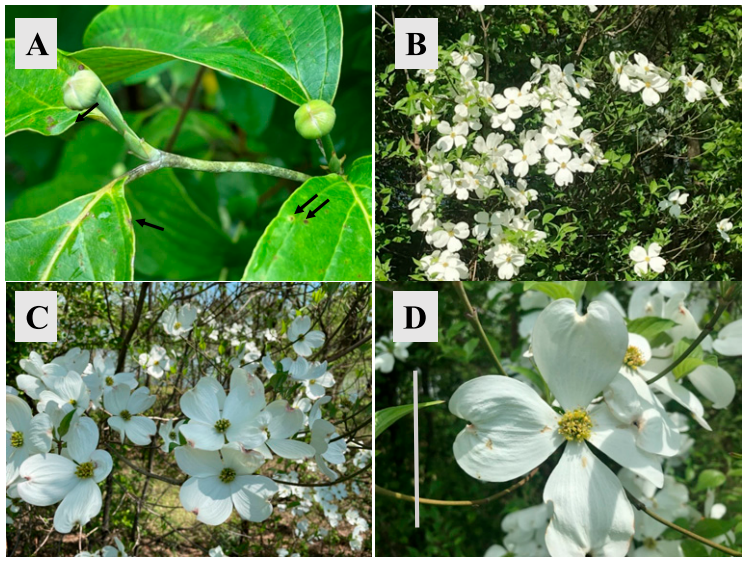

Fig. 2. Flower buds and inflorescences of *Cornus florida* 'Rebecca's Appalachian Angel'. (**A**) Flower buds. Black arrows indicate possible diseased tissue. (**B**) Cluster of inflorescences and not fully expanded leaves. (**C**) Various sizes of fully expanded inflorescences. (**D**) Large inflorescence composed of cordate-shaped, nonoverlapping bracts. Gray line = ~3 inches or 8 cm.

and, although not fatal to trees, caused the destruction (unsalable) of tens of millions of dogwoods in production at the time. The presence of powdery mildew has caused the management costs of dogwoods to skyrocket from only $120/ha/year to $1975/ha/year (Li et al. 2009). The Appalachian Series of *C. florida* including 'Appalachian Joy' (PP 18,238 P2) (Trigiano et al. 2016), 'Jean's Appalachian Snow' (13,099 P2), 'Karen's Appalachian Blush' (13,165 P2) and 'Kay's Appalachian Mist' (13,098 P2) (Windham et al. 2003) and 'Erica's Appalachian Sunrise' (unpublished, 2020; PP32468) are resistant to powdery mildew and have somewhat mitigated the higher cost of production.

Origin and Description of 'Rebecca's Appalachian Angel'

All flowering dogwoods released by the University of Tennessee are members of the 'Appalachian' series. 'Rebecca's Appalachian Angel' was found in Apr 2018 as a solitary tree growing on a steep bank along a bike/walking path in Alcoa, TN, USA. It had three main shoots, probably because of mowing activity, that were each ~10 to 12 feet (3 to 4 m) in height and with smooth, dark gray bark (N187B). Subsequent measurements are reported as the mean of 20 samples, and colors were compared with the panels in the Royal Horticultural Society (2001) Color Chart. The tree was very noticeable because many of the leaves were very large and measured up to 8 inches (20 cm) in length and 5 inches (13 cm) wide (Fig. 1A and B). Most leaves had a very pronounced yellowish midvein (154B), whereas the remainder of the immature leaf was green-yellow (1B) eventually becoming dark green (140A) when mature and fully expanded. Some spot anthracnose and other spots of unknown causes were present on the leaves throughout the growing season (Fig. 2A). Dogwood anthracnose and powdery mildew were not observed in any of the four growing seasons (years), which could be a consequence of no other dogwoods growing nearby or lack of inoculum. Closed flower buds were yellow-green (144C) to green (N144B) (Fig. 2A) and when open revealed a mean of 26 flowers per inflorescence. The pedicle had a mean length of 1.3 inches (3.4 cm). Anthers were yellow-orange (3B). A mean of four deep red (60A) mature fruits (drupes) per inflorescence were formed by late summer and fall.

Along with its unusually large leaves for a flowering dogwood cultivar, some inflorescences of 'Rebecca's Appalachian Angel' have very large bracts (Fig. 2B–D). With these, the superior cordate-shaped bracts averaged ~2.5 inches (6.5 cm) long and 2.2 inches (6.5 cm) across the apex, whereas the inferior cordate-shaped bracts averaged 2.2 inches (5.7 cm) in length and 1.8 inches (4.4 cm) wide. The longest dimension of the inflorescence including the floral disk (Fig. 2C) was ~5.8 inches (14.7 cm), whereas the shortest was ~2.5 inches (6.3 cm) in length and 2.3 inches (6.0 cm) wide. The apex of the pure white (no color number) bracts were notched (elongated semicircle or 'teardrop') (Fig. 2D) and some tissue around the notch had some faded red-purple (61 C) color on the upper surface but was more pronounced and richer on the bottom surface of the bracts. Color intensity varied with the year. Bracts were very thin and floppy and moved in the slightest breeze, which reminded the authors of angel wings, hence the name of the cultivar.

Hundreds of axillary buds from the original tree in Aloca, TN, were harvested in 2019, 2020, 2021, and 2022, and graphed onto native *C. florida* rootstocks in September at Hidden Hollow Nursery, Belvidere, TN, USA, and Walnut Hill Farms, Belvidere, TN, USA. Graphed trees grew well with a strong central leader and produced leaves characteristic of 'Rebecca's Appalachian Angel'. Thirty-one dormant 36- to 48-inch bareroot trees were potted at the University of Tennessee in early March

Table 1. Simple sequence repeat locus codes, Genbank accession numbers, primer sequences, repeat motifs, and expected bps of products.

Locus	Genbank accession code	Primer sequence (5′-3′)	Repeat motif	Expected base pairs
CF48[i]	ED651732	F: GCTTTGACATCCTCTTTGCTTCTC R: AAGAGGCTTCACAAGACAATCAGC	$(TG)_9$	144
CF51[i]	ED651735	F: GGGCTAGTAGGTCGAGTGATCAAA R: CATTGCTTGGTGGTGATCTCTAAA	$(AG)_7(GT)_{10}$	153
CF55[i]	ED651738	F: TGGAGTAGGGCAAAAGATCAAGAG R: TCCAGGGAATGTTCGGTAGATTAG	$(GT)_7T(TG)_{10}$	155
CF105[i]	ED651781	F: CTCATCACATCACCAGTTCCAAGT R: CCAGGGTTTCAATTCAGTTAAACAA	$(TC)_{10}(AC)_8$	150
CF213[ii]	ED651874	F: TGCAAATGGTTATTGATTGCTCTC R: ATTTGTTTCCCATGACCTGAAAGA	$(CT)_9(GT)_{12}$	129
CF581[ii]	ER870603	F: GGGGCAGTAAGAAAACACATTC R: TGTAACCTGCACATAGACAGCA	$(GT)_6(GT)_5(TG)_9$	145
CF585[ii]	ER870607	F: AACGAAGCAAGCAAAACAATC R: ACCCCACCACTTCATCTCTCT	$(AT)_7(GT)_{11}$	163
CF597[ii]	ER870619	F: AAGTCAGATCATTTCAGATTAACA R: CGAATTGACGATAAATACAAAATA	$(AC)_{13}$	107

[i] Wang et al. (2009).
[ii] Wadl et al. (2008).

Table 2. Characterization of *Cornus florida* cultivars using simple sequence repeats (SSRs).

	SSR products (base pairs)							
Cultivar	CF48	CF51	CF55	CF105	CF213	CF581	CF585	CF597
Rebecca's Appalachian Angel 1and 2	154:154	–[i]	155:155	151:156	268:268	148:231	177:188[ii]	100:114
Appalachian Spring 1 and 2	148:154	162:178	155:162	156:156	268:268	–[i]	170:184	108:118
Jean's Appalachian Snow 1 and 2	154:154	–[i]	155:155	149:173	262:268	231:234	163:174	91:105
Karen's Appalachian Blush 1 and 2	148:154	153:162	155:155	161:167	268:268	148:231	163:184	108:120
Kay's Appalachian Mist	148:154	–[i]	158:158	156:161	–[i]	148:231	163:170	100:100
Erica's Appalachian Sunrise	154:154	153:162	158:158	156:168	268:278	148:231	163:170	100:114
Cherokee Brave	154:154	153:162	158:158	156:168	268:278	148:231	163:170	100:114

[i] No amplification product (null allele).
[ii] Unique allelic pair to 'Rebecca's Appalachian Angel' in this comparison.

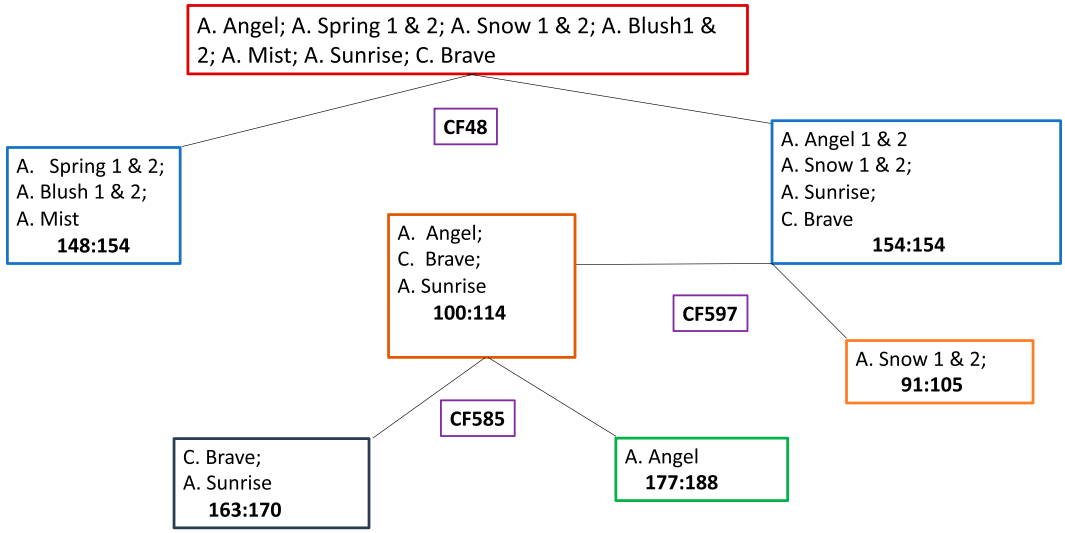

Fig. 3. Diagrammatic scheme using simple sequence repeats (SSRs) for identification of *Cornus florida* cultivars. In the larger boxes, A = 'Appalachian' and C = 'Cherokee'. Numbers are SSR base pair products. Letters and numbers in the smaller boxes represent SSR primer codes (Table 1). 'Rebecca's Appalachian Angel' is distinguished from the other cultivars in the study using the following three SSR primers: CF48, CF585, and CF597.

2023, maintained in a greenhouse, and later transferred to a bowhouse. All trees produced large leaves that are characteristic of this cultivar. A few flower buds were present on the trees, and some had the large bracts described earlier, which is also typical of 'Rebecca's Appalachian Angel'. The nursery producers did not observe powdery mildew on the clones, and it was not detected at the University of Tennessee. However, no claim powdery mildew resistance for 'Rebecca's Appalachian Angel' is made because this will require more extensive trials and observations.

Genetic Characterization of 'Rebecca's Appalachian Angel'

Genomic DNA from two independent leaf samples of 'Rebecca's Appalachian Angel', 'Appalachian Spring', 'Jean's Appalachian Snow', and 'Karen's Appalachian Blush' and one sample of each 'Kay's Appalachian Mist', 'Erica's Appalachian Sunrise', and 'Cherokee Brave' were isolated. The DNA from each sample was amplified using polymerase chain reaction using the primers listed in Table 1 and products identified in Table 2 according to the methods listed in Wadl et al. (2008) and Wang et al. (2009). Duplicate samples of some cultivars were included to assess reproducibility of the amplification process and provided consistent and faithful results (Table 2). Using the information in Table 2, a "decision tree" scheme was developed to identify some of the cultivars in the evaluation and specifically 'Rebecca's Appalachian Angel' (Fig. 3). Additionally, 'Rebecca's Appalachian Angel' also could be identified among this group of arbitrarily selected cultivars with unique products amplified by the primer CF 585.

'Rebecca's Appalachian Angel' cannot be patented because it was discovered growing wild in an uncultivated area. However, all *C. florida* cultivars released by the University of Tennessee have "Appalachian" as part of the designated cultivar name and are typically prefaced with a person's name. The novelty of 'Rebecca's Appalachian Angel' is its large, white bracts and leaves. For more information contact R.N. Trigiano (rtrigian@utk.edu).

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