# INTERSPECIFIC HYBRIDIZATION AMONG *CORNUS FLORIDA, C. KOUSA,* AND *C. NUTTALLII*[1]

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**Abstract.** A program of interspecific hybridization of plants of Cornus *florida, C. kousa,* and *C. nuttallii* has resulted in the selecton of five $F_1$ interspecific hybrids (*C. kousa* × *C. florida*) deemed worthy of patenting and introduction to commerce. These hybrids are noteworthy for their floral display, high vigor, and resistance to the dogwood borer. Material being evaluated in the field also includes hybrids of *C. florida* × *C. nuttallii, C. kousa* × *C. nuttallii* and hybrids combining genomes of all three species as in (*C. nuttallii* × *C. florida*) × *C. kousa.*

Starting in 1965, bare-root whips of many of the cultivars and/or numbered selections of Cornus *florida* L., *C. kousa* Hance, and *C. nuttallii* Audubon available in the nursery trade were assembled in performance trials at the New Jersey Agricultural Experiment Station, Cook College, Rutgers University. This was the first step in initiating a breeding program devoted to the development of new and superior cultivars of the large-bracted dogwoods through intra- and inter-specific hybridization. This paper describes the breeding value of the plant material, discusses the general approach, goals, and techniques involved in the work devoted to interspecific hybridization, and provides a progress report of those efforts.

## PARENT MATERIAL

Plants of *C. florida* rank as one of the most popular of all small flowering trees throughout the eastern and south-central regions of the United States where this species is indigenous. Prized for the spectacular floral display of the white, pink, or red bracts, plants of this species are noted also for the brilliant autumn foliage coloration, bright red or yellow fruit, and for the winter silhouette of the horizontal branches. Truly, the plants add multiple season interest to the landscape. However, plants of this species are sensitive to several environmental stresses as a result of exposure to unfavorable environmental conditions. In recent years, in many areas of eastern United States, a sequence of drought in summer, followed by very low winter temperatures, and unusually wet spring conditions has weakened plants in the wild as well as in nursery plantings. All too frequently, these conditions have predisposed the plants to attack by the dogwood borer, *Synanthedon scitula* (Harris), and an assortment of pathogenic organisms causing such secondary disorders as cankers and spotting, or blighting, of the foliage. The combined effects of these debilitating factors have produced a severe "dogwood decline" during the

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past 8 to 10 years. Thus, there is a real need for improved clones and/or hybrids of this large-bracted dogwood.

In the vicinity of New Brunswick, New Jersey, the floral display (bracts) of *C. florida* generally starts about May first and extends for a period of 14 to 16 days, with anthesis of the many small flowers occurring throughout the middle 10 days of this period.

Plants of *C. kousa* are native to Japan, China, and Korea. The floral display of the bracts begins after the plants are well foliated (about June 1 in the vicinity of New Brunswick, NJ). Thus, the plants have not been as popular as those of our native *C. florida*. The period of floral display of the bracts, as well as that of anthesis of the true flowers, usually approximates the duration noted for plants of *C. florida*. However, in some years, the white bracts persist through July and August with plants of certain clones, such as 'Summer Stars'. Plants of *C. kousa* are typically vase-shaped when young but exhibit a more rounded, spreading form after 20 years or more. Initially, my interest in utilizing germplasm of this species in interspecific hybridization traced to the observation that the plants are highly resistant to the ravages of the dogwood borer, as evidenced by a very low level of infestation under field conditions. To my knowledge, nothing has been reported regarding the nature of this resistance. It may be that the smooth, exfoliating bark of the trees does not provide good sites for deposition of the eggs of this clearwing moth. At any rate, the low incidence of damage by the dogwood borer among plants of *C. kousa* in conjunction with the severity of "dogwood decline" observed with our native *Cornus florida*, has contributed to a tremendous increase in demand in recent years for plants of *C. kousa* for use in landscaping.

Growers are urged to exercise caution in the selection of their seed source for growing seedlings of this species as the seedling material in commerce today exhibits tremendous variation in plant vigor and quality. It is my belief that seed sources utilized at present, in some cases, represent a relatively narrow genetic base as a result of brother-sister matings among seedlings that trace to a single introduction of seed collected abroad from a limited number of plants. On this point, I can state that I utilized various select plants of *C. kousa* growing at the Victor Morawitz Estate at Syosset, Long Island, NY in intraspecific hybridization. These plants were grown from seed that resulted from open-pollination among a group of seedlings grown from seed collected from western Hupeh province in China in 1907 by E.H. Wilson (3). Ten plants were utilized in 11 different parental combinations and a total of 742 resultant seedlings were grown-on in containers

and later in a seedling field for a total of 15 years. The plant material clearly showed evidence of inbreeding depression as the majority of the trees exhibited low vigor and a pronounced rounded, compact habit of growth with rather spindly branches and small leaves. The reduction in vigor was not as severe as that observed with the few plants of *C. florida*. that I obtained following self-pollination (1). However, after observing the field of *C. kousa* seedlings from a short distance, several New Jersey nurserymen assessed the material as being atypical in conformation for plants of that species.

A native of western North America, plants of *C. nuttallii* are found in coastal areas of California, Washington, Oregon, and British Columbia and are the giants of the large-bracted dogwoods, growing to heights of 60 feet or more in the wild. The flower heads are typically subtended by six large bracts, rather than four as in *C. florida* and *C. kousa*. The flower heads of *C. nuttallii* are much larger and the number of true flowers per flower head much higher than in either *C. florida* or *C. kousa*, but the bracts do not enclose the flower buds during winter as is the case in the latter two species. As a result, the true flowers are subject to "blasting" in eastern U.S. climates. Similarly, plants of *C. nuttallii* are not vegetatively hardy in central New Jersey (U.S.D.A. Plant Hardiness Zone 6a: −10° to 0°F) (2). Thus, the plants utilized in these hybridization studies were maintained in containers and overwintered in a heated structure. The large size of the bracts and the exceptionally high vigor of the plants were the main reasons for including plants of *C. nuttallii* in the program of interspecific hybridization.

One interspecific hybrid ('Eddie's White Wonder'), resulting from a cross of *C. nuttallii* × *C. florida* f. *rubra*, was available in the trade at the time these studies were initiated. Plants of this clone exhibit the upright habit and high vigor of the *C. nuttallii* parent as well as naked flower heads in which the bracts do not enclose the true flowers. As a result, the flower heads are subject to desiccation and/or winterkill in central New Jersey and the floral display of the bracts is typically very poor.

## POLLINATION TECHNIQUES

The first barrier encountered in attempts to hybridize plants of the different species of the large-bracted dogwoods was the lack of coincident periods of bloom under normal field conditions. In the case of crosses involving *C. kousa* and *C. florida*, the latter was used as the staminate parent. The crosses were accomplished with stored pollen of *C. florida* that

had been collected from freshly opened flowers, then held in open glass vials in a desiccator over calcium chloride for 24 hours at 5°C (41°F), after which the glass vials were tightly stoppered and held at −17.7°C (0°F) in the freezer of a household refrigerator until used in pollinations. As the first two or three flowers in a flower head of *C. kousa* reached anthesis, the petals and stamens of all the flowers in the flower head were removed very gently with fine-pointed forceps. Then, the broad flattened end of a wooden toothpick was used to transfer the frozen pollen of *C. florida* from the glass vial to the stigmatic surface of each style on the flower head of *C. kousa*. At times, fresh pollen was available for use in making the desired crosses as coincident periods of flowering were achieved by forcing plants of *C. kousa* in a warm (24°C; 75°F) greenhouse.

When using fresh pollen, I prefer to use plants of *C. florida* as the staminate parent in crosses with *C. kousa* since the stamens of flowers of *C. florida* are easier to handle with forceps than are those of *C. kousa*. Similarly, when working with stored (frozen) pollen, the pollen of *C. florida* is easier to collect, store, and apply, than is the very fine pollen of *C. kousa*.

Plants of *C. nuttallii* presented more of a problem in obtaining coincident periods of flowering as the plants were overwintered in a plastic house held at a minimum of 2°C (36°F). Under those conditions, the plants flowered throughout the winter with the result that most of the flowers were senescent by early spring. Thus, it was necessary to force container-grown plants of *C. florida* and *C. kousa* into flower in a warm greenhouse in mid-winter or very early spring in order to have fresh pollen available from plants of *C. nuttallii*.

In my experience, plants of all three species of the large-bracted dogwoods have been highly self-sterile. Thus, it was not necessary to emasculate the flowers; however, with the crosses conducted in the greenhouse, the petals and stamens of the flowers of the pistillate parent were mechanically removed by forceps as the removal of this "debris" facilitated introduction of the appropriate pollen by either a toothpick or forceps-held stamens.

Seed resulting from the controlled crosses was harvested as soon as half or more of the surface of the enclosing fruit exhibited anthocyanin pigmentation. The fleshy portion of each fruit was removed by hand and the bony stones placed in moist, milled sphagnum moss in low density polyethylene bags. These bags were kept in the crisper (4°C, 40°F) of a household refrigerator until emergence of the radicle was ob-

served with one or more seed (60 to 150 days). At that time, all of the seed were planted in a sand:soil:peat (1:1:1 v/v/v) mixture in wooden flats in a warm (24°C, 75°F) greenhouse. Newly emerged seedlings were pricked-off to the same mixture in 4 in. clay pots as soon as the first true leaves were clearly evident. Subsequently, the plants were transplanted to larger, plastic plant-growing containers until field planted after two or three growing seasons.

## SUCCESSFUL CROSSES

Hybrid progeny was obtained as a result of the interspecific matings listed below:

*C. florida* × *C. nuttallii*
*C. kousa* × *C. florida*
*C. kousa* × *C. nuttallii*
*C. nuttallii* × *C. florida*
*C. nuttallii* × *C. kousa*
*C. kousa* × (*C. nuttallii* × *C. florida*)
(*C. nuttallii* × *C. florida*) × *C. florida*
(*C. nuttallii* × *C. florida*) × *C. kousa*
(*C. nuttallii* × *C. florida*) × *C. nuttallii*
(*C. kousa* × *C. nuttallii*) × *C. florida*
(*C. kousa* × *C. nuttallii*) × *C. kousa*

All three $F_1$ interspecific hybrid combinations (*C. florida* × *C. nuttallii*, *C. kousa* × *C. florida*, and *C. kousa* × *C. nuttallii*) among the large-bracted dogwoods were readily achieved but considerable cross-incompatibilty was evidenced based on the low yield of viable seed. As would be expected, the matings listed above in which one parent was an interspecific hybrid exhibited a much higher level of sterility.

In some crosses, such as *C.* × 'Eddie's White Wonder' × *C. florida* f. *rubra*, little difficulty was encountered in obtaining as many as one or two viable seed per flower head. However, a high percentage of the seedlings exhibited low winter hardiness and/or a high incidence of morphological abnormalities. Based on the report (1) that the *rubra* characteristic in *C. florida* is conditioned by a single recessive gene in the homozygous state, one might expect that a backcross of 'Eddie's White Wonder' (*C. nuttallii* × *C. florida* f. *rubra*) to an unrelated pink- or red-bracted clone of *C. florida* would yield progeny exhibiting 1:1 segregation for white versus pink or red bracts. However, such crosses, in my experience, have not yielded any useful pink- or red-bracted hybrids, presumably as a result of chromosomal and/or genic disharmonies expressed in these advanced generation interspecific hybrids.

A limited number of the advanced generation interspecific hybrids listed above have been fully evaluated under field

conditions; however, seedlings of the primary $F_1$ interspecific hybrids have been field tested for 10 to 15 years.

## HYBRID SELECTIONS

The $F_1$ interspecific hybrids resulting from crosses of *C. nuttallii* × *C. florida* or the reciprocal have yielded vigorous trees of erect habit that more nearly resemble the *C. nuttallii* parent than the *C. florida* parent. Vegetatively, the hybrids are only marginally winter-hardy at New Brunswick, NJ and the flower heads are subject to severe blasting as the floral bracts do not enclose the true flowers in the undeveloped flower heads. As the trees attain a size of 3 to 5 in. caliper at 4 in. above ground level, severe freezing injury (bark split) on the S and/or SW side of the tree trunk has been common. During years when the flower beds are not winter-killed, the period of floral display and anthesis overlaps, but is somewhat later than, that of plants of *C. florida*.

As might be expected, hybrids of *C. nuttallii* × *C. kousa* are typically upright in habit. The period of floral display and anthesis is intermediate, with very little overlap, to that of plants of *C. florida* and that of plants of *C. kousa*. The flower heads are very large, with 62 to 101 true flowers. As with the *C. nuttallii* parent, the floral bracts provide no winter protection for the true flowers and severe blasting of the flower heads during the winter is not uncommon. Vegetatively, the plants exhibit more winter hardiness than do the hybrids of *C. nuttallii* × *C. florida*. However, the trees are subject to freezing damage (bark split) on the S and/or SW side of the trunk during the cold, bright days of January.

The $F_1$ interspecific hybrids of *C. kousa* × *C. florida* offer high potential for direct use as new ornamentals for landscape use. Five clones have been selected for patenting and introduction to the nursery trade. Four of the hybrids are similar to *C. kousa* in growth habit and are intermediate to plants of the two parent species in period of floral display and anthesis. Three of these erect forms exhibit white bracts whereas the fourth produces bracts of a soft pink color. Plants of the fifth clone more closely resemble plants of *C. florida* in having a low, spreading habit of growth and a period of floral display and anthesis sufficiently early to overlap that of plants of *C. florida*.

The bracts of the *C. kousa* × *C. florida* hybrids are similar in size to those of plants of the parent species and, for the most part, are intermediate in shape to those of the parents. Surprisingly, the floral bracts do not enclose the true flowers as tightly as do those of either parent species. These hybrids are more highly sterile than are the hybrids of *C. nuttallii* × *C.*

*florida* or of *C. nuttallii* × *C. kousa*. Many of the plants have been found to be more vigorous than those of either *C. florida* or *C. kousa* and have been found to be highly resistant to attack by the dogwood borer. Vegetatively, these hybrids are fully winter-hardy at New Brunswick, NJ although the floral bracts may show injury following a severe winter, as is true with most cultivars of *C. florida*.

Advanced generation interspecific hybrids resulting from hybridization among plants of *C. florida*, *C. kousa*, and *C. nuttallii* are currently under test at Rutgers University and new hybrids are being generated each year. At present, the five $F_1$ interspecific hybrids of *C. kousa* × *C. florida* described above are being increased prior to introduction to commerce as Rutgers University's answer to dogwood decline.

## LITERATURE CITED


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# PROPAGATING RHODODENDRON CUTTINGS WITH FLEXWATT IN POLY TUNNELS


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**Abstract.** The effectiveness of rooting rhododendron cuttings in poly-tunnels heated with Flexwatt electric heating mats during late winter and early spring was examined. Mats maintained root-zone temperatures above 20.0°C (69.0°F) even when night temperatures dropped to −20.4°C (−4.7°F). Placing a Microfoam insulating blanket over the rooting medium and sticking cuttings through it reduced energy consumption by about 20%, but also reduced rooting and complicated removal of rooted cuttings. Time when cuttings were stuck, as well as length of the rooting period, influenced rooting percentage, root quality, and subsequent growth.


## INTRODUCTION

Rhododendrons are usually propagated by cuttings stuck in September through December in bottom-heated greenhouse

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