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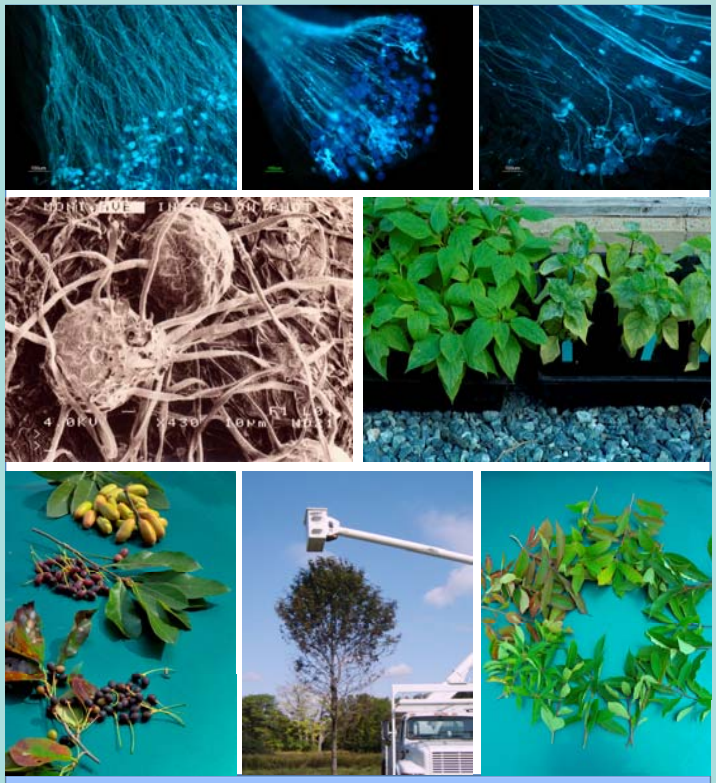
Breeding Urban Trees for Pest and Disease Resistance at the US National Arboretum

Background: The U.S. National Arboretum has one of the only sustained, urban tree breeding programs in the country, and as such, plays an important role in providing, new, disease and pest resistant tree cultivars to the nursery industry for planting the urban forest. Historically, the program has concentrated on major diseases and pests of a few, important tree genera, notably elms (*Ulmus*), plane trees (*Platanus*), and maples (*Acer*).

Since 2006, the urban tree program has diversified to include new, underutilized genera and added additional objectives, including breeding smaller trees for height-restricted plantings in urban and sub-urban applications and developing non-invasive selections to minimize impacts from introduced tree species. The urban tree breeding program takes a systematic approach to developing new tree cultivars for the nursery industry, beginning with the identification and establishment of novel germplasm as breeding stock. This germplasm is evaluated for tolerance to abiotic stresses, resistance to specific diseases and pests. Breeding objectives and goals are established for priority genera, which may include testing interspecific and intergeneric crossabilities, elucidating breeding barriers and mechanisms for overcoming them, the development of polyploids and interploid hybrids to limit invasiveness, the development of molecular markers for verifying hybridity and determining modes of inheritance for resistances and ornamental traits. Hybrid progeny are evaluated for desired ornamental traits and stress tolerances, with elite germplasm distributed to academic and industry cooperators for evaluation, selection, and introduction as novel urban tree cultivars.

***Catalpa* projects:** Established a long-term *Catalpa* breeding project to develop powdery mildew resistant, cold-hardy *Catalpa* and ×*Chitalpa* cultivars. In 2006, germplasm from doctoral work at NCSU transferred to the USNA to form the core collection, with nearly 50 accessions. Several thousand crosses have been conducted to elucidate self-compatibility, interspecific and intergeneric compatibilities and ploidy barriers. Resynthesized interspecific crosses (*C.* ×*galleana* and *C.* ×*erubescens*) to broaden diversity of breeding stock. Generated triploid ×*Chitalpa* by backcrossing tetraploid ×*Chitalpa tashkentensis* (*Chilopsis linearis* × *C.* ×*erubescens*) to the powdery mildew resistant *C. ovata* parent. Currently developing leaf disk assays for evaluating powdery mildew host-plant responses and resistance in *Catalpa* germplasm. Advanced interspecific hybrids and triploid ×*Chitalpa* will be screened for inheritance of powdery mildew in 2010.



Top row: Crossing studies in *Catalpa* and *Chilopsis,* pollen staining with aniline blue and viewed with epifluorescence at 12 hours after pollination. Left, intraspecific *Chilopsis linearis* cross, showing uniform germination and directed growth of pollen tubes. Center, intersectional *Catalpa* cross, *C. longissima* (sect. *Macrocatalpa*) × *C. ovata* (sect. *Catalpa*), with good pollen germination and pollen tube growth. Right, intergeneric cross, *Chilopsis linearis* × *C. bignonioides* 'Koehnei', showing haphazard pollen tube growth and orientation. **Middle row**: Powdery mildew in *Catalpa*. Left, scanning electron micrograph of *Erysiphe elevata*, with distinctive appendages. Right, putative mildew resistant triploid ×*Chitalpa* (left) with susceptible open-pollinated *Catalpa bignonioides* 'Nana' (right). **Bottom row**: *Nyssa* breeding. Left, *Nyssa ogeeche* (top), *N. ogeeche* × *N. sylvatica* (center), and *N. sylvatica* (bottom) fruits. Center, collecting fruit from elite F1 *Nyssa* hybrids growing in isolation blocks at Glenn Dale, MD. Right, foliage from segregating F2 population of *N. ogeeche* × *N. sylvatica,* showing variation in susceptibility to leaf spot, *Mycosphaerella nyssaecola.*

***Nyssa* projects:** Resurrected a stalled *Nyssa* (black gum) breeding program, directed towards leaf spot resistance, improved branch architecture and habit, and autumn color. Novel *Nyssa* hybrids were created by Louise Riedel (USDA-ARS USNA, retired) under the direction of Frank Santamour, Jr. (USDA-ARS USNA, deceased) in the 1990's. Generated interspecific hybrids between *Nyssa sylvatica* and *N. ogeeche,* and *N. sylvatica* with *N. sinensis.* Currently growing large F2 populations, from controlled pollinations and open-pollinated isolation blocks of elite F1, that are segregating for desired traits. Collaborate with Dr's. Amy Rossman and Drew Minnis (USDA-ARS Systematic Mycology and Microbiology) on the molecular identification and characterization of the leaf spot organism affecting *Nyssa*. Identified organism as *Mycosphaerella punctiformis sensu latu;* however, molecular data indicates re-elevating to a host-specific species*, M. nyssaecola.*

***Chionanthus* projects:** Preliminary investigations into *Chionanthus* breeding, looking at species relationships and potential areas for improvement. Molecular markers derived from Chinese fringetree (*Chionanthus retusus*) by Reneé S. Arias et al (USDA-ARS Genomics and Bioinformatics Research Unit) will be used to determine genetic diversity and relationships in cultivated and native populations of *Chionanthus* as well as to clarify pollination and reproductive biology in the genus and related genera. The USNA has the most extensive *C. retusus* germplasm collection in the U.S., including inland populations from Yunnan, China, with upright, vase-shaped habit, and yellow fall color. Selecting male trees for reduced invasive potential, as well as tolerance to foliar anthracnose, a new leaf disease which has jumped host from *Fraxinus.*

Future Directions: Continue to reengage the nursery industry, identifying industry needs and significant threats to urban trees and tree production. In FY 2010, the urban tree breeding program and the germplasm unit of the National Arboretum will be under the direction of R. Olsen. The integration of germplasm collection and management, with a breeding program, facilitates long-term research directed at the systematic improvement of important tree genera for the nursery industry. Research emphasis will transition between genera, as achievement of short-term goals in one genus, allows investigation of new genera during long generation and evaluation times in trees.

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