METASEQUOIA GLYPTOSTROBOIDES IN URBAN FORESTRY

by John E. Kuser, Assistant Professor
Department of Horticulture and Forestry, Cook College
New Jersey Agricultural Experiment Station, Rutgers University
New Brunswick, New Jersey 08903

ABSTRACT.--Metasequoia, fast-growing and relatively free of diseases and insect pests, is well adapted to a broad area in the eastern U.S. and is becoming a popular amenity tree. Much work remains to be done to determine the range of genetic variation in growth rate, rootability, and adaptability to different urban conditions. Fifty of the largest specimens are listed.

Metasequoia glyptostroboides, the "dawn redwood" thought extinct for 20,000,000 years until it was found alive and well in the mountains of central China in 1941, is on its way to becoming a popular shade and amenity tree in America's urban landscape. About 10,000 a year are planted and the number has been rising, according to Mr. R. Henkel of Princeton Nurseries, Resistant to air pollution (Petsch 1978), this handsome, sun-and moisture-loving relative of California's redwoods has adapted well to a broad area of the eastern United States from central Alabama to southern New England (Kuser 1982). In Maplewood, New Jersey Metasequoia has been successfully used as a street tree since the early 1950's, when it was first planted by Mr. R. Walter, Director of Parks and Shade Trees. In its native China, it is one of four main species involved in urban forestry (National Academy of Sciences 1975). Fast-growing and nearly disease-free, it has grown as tall as 104' in 34 years since its introduction into the Western world in 1948 (Table I).

Not enough is known of the range of genetic variation in Metasequoia. Trees growing in the U.S. appear to have originated from seed received in January 1948 by Dr. E. Merrill of the Arnold Arboretum from W. C. Cheng in Mo-Tao-Chi, Hupeh Province, China. There is no record of introductions from

elsewhere in the 450-mile-long by 50-mile-wide range in western Hupeh, northern Hunan, and eastern Szechwan provinces, where vast forests of the species are reported by Dr. K. Ching of Oregon State University to grow in an area as yet little exploited by man. U.S.-grown trees vary in at least seven characteristics: form, branch angle, crown density/shade tolerance, resistance to Dothiorella canker (Santamour 1977), rootability of different clones, bark roughness, and growth rate.

Metasequoia's reproductive behavior is characterized by trees' attaining female before male sexual maturity. Usually macrosporangiate strobili (female conelets) are produced when trees are 30' - 50' high; in the absence of pollen, these mature into normal-appearing cones containing empty seeds. Microsporangiate strobili are produced when trees are 60' - 90' high on catkins similar to those of baldcypress. At New Brunswick, New Jersey, these release pollen between March 15 and March 30 and are then shed by the tree. Catkins cut March 3 this year at Rutgers and forced in water indoors produced pollen March 7, but those cut February 8 and February 22 were not far enough advanced at cutting to do so. At time of pollen-flight, the emerald-green female strobili are 4-5 mm long and pollen readily sticks to them. Pollination appears to be relatively ineffective at distances of more than 100 meters, and inbreeding depression is evident in the poor seed germination and lower vigor of progeny from isolated trees (Kuser 1983).

Young Metasequoias are usually planted as container-grown stock although sometimes as larger B & B specimens. There appear to be no records of bare-root planting. The tree grows fast in its first few years after planting; in New Jersey mean height of 21 trees grown from the Arnold Arboretum's 1948 seed was 25.3 m at the end of the 1981 growing season, indicating mean growth of 0.74 m/yr up to age 34. One in my lawn at Princeton, NJ grew from six feet to 12 feet tall in its second summer after planting.

Few pests and diseases affect Metasequoia. In the Washington, DC area, Dothiorella canker caused by common apple white-rot fungus (Botryosphaeria ribis) has been a problem (Stipes et al. 1971), but in 75 other areas surveyed in 1981-2, no diseases and few insect pest were reported. Three survey respondents listed attacks by Japanese beetles.

Maintenance problems reported so far are minimal. The tree has a tendency to form "armpits" on its trunk below lower branches, but in Maplewood, Metasequoias trimmed up to 8' have not done this. Trees grown in competition with

others have generally produced straight, clean trunks, while open-grown specimens with many lower branches have not. No sidewalk heaving has been reported at Maplewood, but more trials may be needed to confirm this, because the tree is a heavy and shallow rooter.

Much research on Metasequoia remains to be done. Range-wide provenance testing is strongly desirable to determine the nature and extent of genetic variation in the species' morphology, growth rate, hardiness, and wood specific gravity. Decay resistance testing of heartwood needs to be done, to find whether Metasequoia ranks with its relatives Sequoia, Taxodium, and Cryptomeria and deserves attention as a potential timber species. In China, it is reported to be decay-resistant (Liu et al. 1978) and the nature of some of its heartwood extractives has been determined (Enoki et al. 1977).

Work should be done in the following nine areas:

1. Provenance testing for growth rate, hardiness, and wood specific gravity.
2. Decay resistance testing; all of us on the Metasequoia committee should be on the lookout for a heartwood log measuring 30-45 cm (12"-18") in diameter which can be sent to the Forest Products Laboratory for testing. This might become available from a tree cut for roadbuilding, construction, etc.
3. Progeny testing to find which trees produce the fastest-growing seedlings (I'm doing this).
4. Rootability testing to find which clones are easiest to root, and how much difference exists (I'm doing this).
5. Follow-up testing of Santamour's Dothiorella-resistant clones.
6. Evaluation of the currently popular, widely-propagated clone "National" vs. others for form, growth rate, and disease resistance under urban conditions.
7. Testing whether pruning up to 8 feet does indeed prevent "armpitting."
8. Testing in several locations of tendency to heave sidewalks.
9. Testing in several locations with different soil and drainage conditions, of size of cutout area

in pavement or between sidewalk and street, needed for survival and vigorous growth.

10. Hybridization could be explored. Metasequoia, like all other members of Taxodiaceae except Sequoia, has a haploid chromosome number n=ll (diploid 2n=22). Although neither Dr. S. Krugman's attempt to cross Metasequoia with Sequoia (both ways) nor Dr. K. Chambers' attempt to cross it with Sequoiadendron succeeded, other possibilities remain. If the Chinese can cross Taxodium with Cryptomeria (Kellison et al. 1982) and the British can cross Cupressus and Chamaecyparis (accidentally), surely we should try some crosses between Metasequoia and related taxodiads.

Table 1. Height, circumference, and crown spread of the 50 largest metasequoias reported in the 1981/82 survey.

Location	Date Planted	Height	Circumference at 4½'	Spread	Points
Bailey Arboretum, Locust Valley, New York	1949	79'	12' 10"	40'	243
College of William and Mary, Williamsburg, Virginia	1949	104'	9' 6"	45'	229
Auburn University, Auburn, Alabama	1952	90'	10' 3"	51'	226
Princeton University, Princeton, New Jersey	1949	85'	10' 6"	40'	221
Winterthur Gardens, Winterthur, Delaware	1949	78'	IO' 9"	40'	217
Willowwood Arboretum, Gladstone, New Jersey	1950	82'	IO' 0"	42'	212
Smith College Botanical Garden, Northampton, Massachusetts	1949	72'	IO' 0"	42'	202
Morris Arboretum, Philadelphia, Pennsylvania	1953	70'	8' 9"	40'	185

Location	Date Planted	Height	Circumference at 4½'	crown Spread	Points
Oregon State University, Corvallis, Oregon	1949	76'	8' 5"	31'	185
Longwood Gardens, Kennett Square, Pennsylvania	1949	70'	8' 8"	36'	183
University of California Botanical Garden, Berkeley, California	1949	90'	7' 1"	24'	181
Biltmore House, Asheville, North Carolina	1950	81'	7' 6"	30'	179
Peter Finnerty, Princeton, New Jersey	1949	83'	7' 1"	36'	177
Marquand Park, Princeton, New Jersey	1949	71'	8' 0"	30'	175
Carleton Goff, Barrington, Rhode Island	1949	76'	7' 3"	39'	173
Alexander St., Princeton, New Jersey	1949	72'	7' 8"	36'	173
Duke University Gardens, Durham, North Carolina	1949	66'	8' 0"	38'	172
Arnold Arboretum, Jamaica Plain, Massachusetts	1949	70'	7' 10"	24'	170
Broadmead, Princeton, New Jersey	1949	98'	5' 6"	24'	170
Burnet Woods, Cincinnati, Ohio	1948	79'	6' 9"	39'	170
Peavy Arboretum, Corvallis, Oregon	1949	67'	7' 8"	40'	169
University Botanic Garden, Cambridge, England	1949	75'	7' 1"	27'	167
Coker College, Hartsville, South Carolina	1952	71'	7' 4"	32'	167

Location	Date Planted	Height	Circumference at 4½'	crown Spread	Points
UCLA Botanical Garden, Los Angeles, California	1948	94'	5' 6"	22'	165
J. J. Willaman, Plymouth Meeting, Pennsylvania	ca. 1950	83'	6' 4"	24'	165
Botanische Tuinen, Utrecht, Netherlands	1949	60'	7' 0"	23'	160
Forest Research Institute, Rotorua, New Zealand	1950	51'	8' 2"	38'	158
Samuel Humes, Lawrenceville, New Jersey	ca. 1950	73'	6' 4"	24'	155
Los Angeles State and County Arboretum, Los Angeles, California	1948	85'	4' 9"	12'	145
Missouri Botanical Garden, St. Louis, Missouri	1950	65'	5' 9"	28'	145
Dawes Arboretum, Newark, Ohio	1950	58'	6' 7"	10'	140
National Arboretum, Washington, D.C.	ca. 1949	53'	6' 8"	25'	139
University of Washington Arboretum, Seattle, Washington	1954	71'	5' 2"	18'	138
Scott Horticultural Foundation, Swarthmore, Pennsylvania	1949	60'	5' 11"	22'	137
Ladham House, Kent, England		59'	5' 10"	c 32'	137
Brooklyn Botanic Garden, Brooklyn, New York	1954	67'	5' 2"	24'	135
Rutgers University, New Brunswick, New Jersey	ca. 1950	70'	4' 9"	24'	133
Children's Hospital, Boston, Massachusetts		60'	5' 4"	36'	133
Secrest Arboretum, Wooster, Ohio	1949	69'	4' 8"	15'	129

Location	Date Planted	Height	Circumference at 4½'	Crown Spread	Points
Mount Auburn Cemetery, Cambridge, Massachusetts	?	62'	5' 0"	23'	128
Hoyt Arboretum, Portland, Oregon	1964	56'	5' 4"	24'	126
North Carolina State University, Raleigh, North Carolina	?	51'	5' 9"	22'	125
Callaway Gardens, Pine Mountain, Georgia	1961	70'	4' 0"	25'	124
Mrs. R. P. Nash, South Euclid, Ohio	ca. 1954	70'	4' 0"	25'	124
Royal Horticultural Society Garden, Wisley, England	1948	70'	3' 6"	30'	119
Bernheim Forest Arboretum, Clermont, Kentucky	1964	55'	4' 9"	20'	117
Ayrault House, Newport, Rhode Island	ca. 1949	61'	3' 7"	28'	111
Beacon Hill Park, Victoria, B.C., Canada	ca. 1949	52'	4' 2"	20'	107
University of Connecticut, Storrs, Connecticut	1963	69'	2' 6"	24'	105
Strybing Arboretum, San Francisco, California	?	34'	5' 3"	27'	104

Data are reported for only the largest tree at each location. Points are determined by the ranking system followed in "National Register of Big Trees" (American Forestry Association, 1982): one point for each foot of height, one point for each inch of circumference, and one-quarter point for each foot of crown spread.

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