Survival, Growth, and Fertility of *Carpinus* Hybrids

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The need for a wider choice of small trees maturing at 10 to 13 m in height and capable of enduring the stressful environments of urban landscapes prompted my interest in the hornbeams (*Carpinus*). The first control-pollinated hybrids in *Carpinus* were made in 1973 and 1974 (Santamour, 1978). The chromosome numbers of the individuals used as parents were *C. betulus* L. ($2n = 8x = 64$), *C. japonica* Blume ($2n = 2x = 16$), *C. orientalis* Mill. ($2n = 2x = 16$), *C. tschonoskii* Maxim. ($2n = 4x = 32$). True hybrids, verified by chromosome counts, were obtained from *C. orientalis* × *C. tschonoskii* ($2n = 3x = 24$), *C. betulus* × *C. orientalis* and reciprocal ($2n = 5x = 40$), and *C. betulus* × *C. tschonoskii* ($2n = 6x = 48$). No interspecific hybrids were obtained from crosses of *C. japonica* with the other three species. Sargent (1896) recognized two botanical sections in *Carpinus*, with *C. japonica* being classified in Sect. *Distegocarpus* and the other species in Sect. *Eucarpinus* (= Sect. *Carpinus*). Self-pollinations were made in all four parental species, but intraspecific crosses were limited to three species because I had only one plant of *C. orientalis*.

Seed set from selfing was extremely low, indicating a high degree of self-incompatibility in these species. Only in *C. betulus* were the selfed seedlings vigorous enough to grow to outplanting size in 2 to 3 years. Also, in *C. betulus*, two different intraspecific crosses gave about the same seed set, but only one cross produced seedlings.

The loss of several hybrid seedlings severely limited the numbers of plants available

for long-term testing, but a representative planting was made in 1977. This planting was established on an impoverished clay soil, with virtually no topsoil, at our test site in Beltsville, Md. Spacing was 3 m between trees and rows, with only a modest attempt at replication within this small plot. No fertilization, watering, or other cultural practices were used, thus simulating the neglect common to many urban plantings.

The trees in this planting were measured in Nov. 1991, when the plants were 18 to 19 years old from seed (Table 1). The hybrids between *C. betulus* and *C. tschonoskii* and the intraspecific *C. japonica* progeny were outstanding in survival, growth, and adaptability to adverse site conditions. Survival of *C. betulus*, including the selfed progeny, was also high, but the trees were much slower growing and had still not reached sexual maturity when data were taken. The combination of *C. betulus* and *C. orientalis* produced trees with inferior survival and growth characteristics, and these progenies also were not sexually mature. The failure of *C. tschonoskii* to survive without repeated dieback was disappointing, because this species would have been a "new" introduction for urban landscapes. The possibility that the parents of this intraspecific progeny were siblings may have contributed to their

lack of adaptability, but the selfed progeny of *C. betulus* did not exhibit signs of inbreeding depression.

Branches with elongating male catkins from the hexaploid ($2n = 48$) trees of *C. betulus* × *C. tschonoskii* and the sole triploid ($2n = 24$) plant of *C. orientalis* × *C. tschonoskii* parentage were brought into the laboratory in late Mar. 1992 to force pollen production. Pollen of the hexaploid averaged 37.2μ in diameter, and 95% of the grains were stainable with acetocarmine. Pollen of the triploid also appeared to be potentially functional (82% stained) and the grains averaged 32.4μ in diameter. Trees of *C. japonica* also were flowering but none of the *C. betulus* flowered in 1992 or 1993.

As a straight species, *C. japonica* may have some merit as a small tree for curbside plantings under telephone lines. When young, the trees are somewhat vase-shaped but become flat-topped with increasing age. According to Wyman (1965), leaves of this species may exhibit a red autumn coloration in some climates. Young trees of *C. tschonoskii* have an oval crown but also become flat-topped as they mature. It will require another decade of growth before anyone can determine whether the hybrids between *C. betulus* and *C. tschonoskii* also will develop a flat-topped crown. The proven crossabilities among certain *Carpinus* species and the apparent fertility of the interspecific hybrids may allow advanced generation breeding if and when such work is warranted.

Literature Cited

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Table 1. Survival and growth of *Carpinus* progenies at 18 to 19 years of age.

Parents		Survival ²	Ht (m)	Stem diam (cm) ³
Female	Male			
<i>C. betulus</i>	<i>C. tschonoskii</i>	9/9	5.6	14.3
<i>C. japonica</i>	<i>C. japonica</i>	3/3	5.1	10.1
<i>C. betulus</i>	<i>C. betulus</i>	6/6	3.5	6.0
<i>C. orientalis</i>	<i>C. tschonoskii</i>	1/1	3.7	6.6
<i>C. betulus</i>	Self	3/4	3.4	5.0
<i>C. betulus</i>	<i>C. orientalis</i>	2/7	2.9	3.8
<i>C. orientalis</i>	<i>C. betulus</i>	1/7	2.8	3.5
<i>C. tschonoskii</i>	<i>C. tschonoskii</i>	0/4	---	---

²Complete survival, with no dieback.

³Diameter at 30 cm above ground level.

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