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×*Schimlinia floribunda* (Theaceae): A New Intergeneric Hybrid between *Franklinia alatamaha* and *Schima argentea*

Thomas G. Ranney[1, 2] and Thomas A. Eaker[3]
Department of Horticultural Science, Mountain Horticultural Crops Research and Extension Center, North Carolina State University, 455 Research Drive, Fletcher, NC 28732-9244

Paul R. Fantz[2]
Department of Horticultural Science, North Carolina State University, Raleigh, NC 27695-7609

Clifford R. Parks[2]
Department of Biology, The University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3280

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***Abstract. Franklinia alatamaha* Bartr. ex Marshall represents a monotypic genus that was originally discovered in Georgia, but is now considered extinct in the wild and is maintained only in cultivation. Although *Franklinia* is very ornamental, with showy flowers and crimson/maroon fall foliage color, it tends to be short lived when grown as a landscape tree and is known to be susceptible to a variety of root pathogens. *Schima argentea* Pritz is an evergreen tree that is native to Asia and is valued for its glossy foliage, late-summer flowers, and broad adaptability in mild climates. Hybridization between these genera could potentially combine the cold hardiness and desirable ornamental characteristics of *F. alatamaha* with the greater adaptability, utility, and genetic diversity of *S. argentea*. Controlled crosses between *F. alatamaha* and *S. argentea* resulted in new intergeneric hybrid progeny. A morphological comparison of parents and the progeny is presented. ×*Schimlinia floribunda* Ranney and Fantz (mountain schimlinia) is proposed as the name for these hybrids and is validated with a Latin diagnosis.**

A small population of *Franklinia alatamaha* Bartr. ex Marshall (Theaceae D. Don) was discovered by John and William Bartram along the banks of the Altamaha River in Georgia in 1765 (Fry, 2000). Seeds were collected from these trees over a number of years, but the species has not been seen in the wild since 1790. Although *F. alatamaha* is considered extinct in the wild, it persists in cultivation and makes an attractive landscape tree. This species is valued for its showy white flowers and bright crimson/maroon fall foliage color. Considering its southern nativity, it is surprising that it tolerates winter temperatures as low as –38 °C (Dirr, 1998). However, *F. alatamaha* tends to be short lived in the landscape and is known to be very susceptible to *Phytophthora cinnamomi* Rands and *Phymatotrichum omnivorum* (Duggar) Hennebert (Horst, 2001; Koslow and Peterson, 1980; Peterson et al., 1975), thus limiting its usefulness in the landscape. *Franklinia* is considered to be a monotypic genus (Griffiths, 1994; Krüssman, 1986; Liberty Hyde Bailey Hortorium, 1976; Prince and Parks, 2001).

Schima Reinw. ex Bl. is a genus of evergreen trees and shrubs native to warm temperate and tropical regions of southern and southeastern Asia that are often used for fodder, fuel, poles, and timber (Hillier Nurseries, 1992; Tamrakar, 1992). *Schima* sp. have a broad distribution, are common forest species, and are often used for afforestation due to their adaptability and tolerance to a wide range of environments, including dry sites, infertile soils, and clay soils (Corlett, 1999; Wang et al., 1983; Wu et al., 1999). Some *Schima* sp. are utilized for medicinal purposes where the astringent corollas, known to contain hydrolyzable tannins (e.g., schimawalins), have been used to treat uterine disorders, hysteria, and as an ointment to treat smallpox (Yoshida et al., 1991). *Schima* sp. have been found to be resistant to fire and can be planted as forest firebreaks (Li-Zhen and Li, 1997).

Taxonomy of *Schima* at the species level is controversial. Bloembergen (1952) concluded that *Schima* is a monotypic, complex, polymorphic genus and recognized *Schima wallichii* (DC.) Korth as the only species. This conclusion was based primarily on a study of Indonesian taxa. Keng (1978) also reduced all Malayan species into *S. wallichii*. Since that time, other authorities have further taken this single species to represent the entire genus (Liberty Hyde Bailey Hortorium, 1976; Mabberly, 1987). Griffiths (1994) has apparently adopted this treatment and recognizes only one species, *S. wallichii*. However, the Missouri Botanical Garden (2002) currently lists 25 species of *Schima* with numerous varieties. Tsou (1997) reported embryological and developmental differences among three species of *Schima*. Deng and Baas (1990) found a broad range of variation in wood anatomy among six species of *Schima*. A recent phylogenetic study of the Theaceae provided additional molecular data to support recognition of multispecies Schima (Prince and Parks, 2001). The English translation and revision of the Flora of China is currently ongoing; however, the draft treatment of the Theaceae tentatively recognized 13 species of *Schima* native to China alone and treated *S. argentea* Pritz. as a species separate from *S. wallichii* (Ke et al., 2002). Therefore, we are adopting this treatment and consider *S. argentea* to be a distinct species.

Schima argentea is an evergreen tree that is native to western China, Assam, and Taiwan that is valued for its glossy foliage, late summer flowers, and as a landscape plant in mild climates (Hillier Nurseries, 1992). This species has been observed to be undamaged by winter temperatures as low as –9 °C in Chapel Hill, N.C. (C.R. Parks, personal observation).

Minimal genetic diversity (all existing plants originated from one small population) limits the potential for plant breeding and improvement within *F. alatamaha*. However, some attempts have been made to develop intergeneric hybrids using *F. alatamaha*. Ackerman and Williams (1982) conducted extensive crosses between *F. alatamaha* and *Camellia* L. sp. and produced two intergeneric hybrids, but their growth was weak and extremely slow. Orton (1977) reported successful hybridization between *Gordonia lasianthus* (L.) Ellis and *F. alatamaha*; however, all of the seedlings died within 2 years of germination. Although hybrids between *Franklinia* and *Schima* have not been reported, some taxonomic and systematic studies have suggested a close alliance between these genera (Prince and Parks, 2001; Spongberg, 1974).

Hybridization between *Franklinia* and *Schima* could potentially combine the cold hardiness and desirable ornamental characteristics of *F. alatamaha* with the greater adaptability, utility, and genetic diversity of *Schima*. The objective of this report is to describe the history of and to validate intergeneric hybrids that resulted from crossing *F. alatamaha* with *S. argentea*.

Materials and Methods

Controlled crosses were made between *Franklina alatamaha* (female parent) and

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[1]Corresponding author. E-mail address: tom_ranney@ncsu.edu .
[2]Professor.
[3]Research Specialist.

Schima argentea (male parent) in Aug. and Sept. 1999 and 2000 at the Mountain Horticultural Crops Research Station, Fletcher, N.C., under the direction of Thomas G. Ranney. Pollen was collected from a specimen of *S. argentea* (accession 1999-098). This particular clone of *S. argentea* was provided by Clifford R. Parks and was propagated by seeds that he had collected near the Yunnan-Sichuan boarder in China. Flowers of *F. alatamaha* (accession 1998-450) were emasculated and hand pollinated. About 150 flowers were pollinated over 2 years. Seeds were collected in September, the year following pollination, stratified in moist media for 90 d at 6 °C, and germinated under greenhouse conditions.

Results and Discussion

A total of 83 hybrids were propagated from seed in 2000 and 2001. Growth was fast and many of these progeny attained heights greater than 2 m and flowered within 9 months of germination. Characteristics of the progeny clearly demonstrate their hybrid nature (Tables 1 and 2; Fig. 1).

Franklinia and *Schima* are distinct in many regards. Tsou (1997) reported that *Franklinia* and *Schima* differ embryologically as well as morphologically. *Franklinia* has anatropous ovules that lack epidermal proliferations and have a thick raphe. *Schima* exhibits campylotropous ovules with epidermal proliferations and lacks a raphe. Morphological character differences, summarized in Table 1, were obtained by comparing generic descriptions (Griffiths, 1994; Huxley et al., 1992; Krüssman, 1986; Liberty Hyde Bailey Hortorium, 1976). Leaf bases in both genera are cuneate-attenuate to the point of insertion on the twig, leading to interpretation of sessile vs. petiolate by different authors. Flower diameter is large in both genera, but can be nearly twice as broad in *Franklinia* as compared to *Schima*. Bracts are caducous, but can be observed in the early bud stage. The stamens are in three to five whorls with filaments of different length. A comparison of the longer filament lengths with the shorter filament lengths provides a higher ratio in *Franklinia*.

Progeny are similar to *Franklinia* for leaf shape (leaves long-tapered at the base and broadest above the middle), lamina length, lateral vein number, elongated bracts, petal width, and with the perianth bearing a silky pubescence on the abaxial surface of the sepals (Table 2). Progeny are similar to *Schima* with conspicuously stalked inflorescences, often bearing more than one flower (subracemose), small subequal sepals, elongate peduncles, the number of flowers per inflorescence, abaxial pubescence of the petals, and smaller filament ratio. Progeny exhibit intermediate traits in the length of the tapered leaf base, leaf apex, abaxial leaf pubescence, flower diameter, the free sepal and petal length, sepal width, filament lengths, and filament length ratio. Progeny are typically very floriferous (Fig. 2) and exhibit an abundance of flowers (10–90) per shoot, exceeding either parent (2–4 in *F. alatamaha* and 10–15 in *S. argentea*). Therefore, this character

Table 1. Comparison of the hybrid with the parent genera.[z]

Characteristic	*Franklinia*	Hybrid	*Schima*
Leaf duration	Deciduous	Evergreen - semievergreen	Evergreen
Leaf widest point	Above middle	Above middle	Near middle
Leaf tapered base	Elongate	Elongate	Short
Inflorescence stalk	Short, subsessile	Elongate	Elongate
Flowers per inflorescence	Solitary	1 to 4	1 to 4
Flower size	Large	Large to small	Small
Perianth dorsal pubescence	Silky, dense	Glabrate, silky basally	Glabrate, silky basally
Sepal size	Unequal	Subequal	Subequal
Sepal length vs. width	Length > width	Width ≈ length	Width > length
Bracts (caducous)	Elongate	Elongate	Short
Filament length ratio[y]	Ratio 1:4	Ratio 1:2.5	Ratio 1:2

[z]References for generic descriptions: Griffiths, 1994; Huxley et al., 1992; Krüssman, 1986; Liberty Hyde Bailey Hortorium, 1976.
[y]Ratio of the shorter filament lengths to the longer filament lengths.

Table 2. Comparison of hybrid progeny from *Franklinia alatamaha* (female) and *Schima argentea* (male).

Characteristic	*Franklinia alatamaha* (female)	Hybrids	*Schima argentea* (male)
	Leaves		
Leaf shape	Oblanceolate	Oblanceolate	Oblong-elliptic
Leaf Apex	Obtuse, apiculate	Short acuminate	Acuminate
Lamina length	9–15 (20)[z] cm	(8) 11–14 cm	5–9.5 cm
Lamina width	3.5–6 (8) cm	2.5–4.5 (5) cm	2–4 cm
Lamina tapered base	20–30 mm	13–20 mm	7–10 mm
Lamina lateral vein number	9–11	9–11	7–9
Lamina lower surface	Pale green	Pale green to glaucous	Glaucous
Lamina pubescence below	Dense, silky	Scattered strigose	Glabrate
	Inflorescence		
Peduncle & rachis	3–6 mm	9–25 mm	10–20 mm
Bract length	10–13 mm	10–13 mm	4–5 mm
Flowers borne	One	One to four	One (to four)
	Flowers		
Flower diameter	6–7 cm	4–7 cm	3–4 cm
Calyx lobe length	8–10 mm	5–6 mm	2 mm
Calyx lobe width	6–9 mm	5–6 mm	4 mm
Calyx pubescence	Dense, silky	Dense, silky	Glabrate, silky basally
Petal length	26–30 mm	20–30 mm	13–16 mm
Petal width	17–21 mm	18–21 mm	10–14 mm
Petal pubescence	Dense, silky	Dense, silky	Glabrate, silky basally
Filament length	4–15 mm	4–15 mm (malformed, petaloid)	3–6 mm
Filament ratio	1 to 4	1 to 2	1 to 2
Style length	7–12 mm	8–12 mm	5–6 mm

[z]Numbers in parentheses indicate extreme ranges, but uncommon occurrences. Values for progeny are based on 15 individuals.

Fig. 1. Flowering shoots of *Franklinia alatamaha* (**left**), ×*Schimlinia floribunda* (**center**), and *Schima argentea* (**right**).

Fig. 2. Floriferous shoot of ×*Schimlinia floribunda*.

trait provided the origin of the epithet chosen for the hybrid progeny.

A formal study has not been conducted on the fertility of the hybrids, but the majority of progeny appear to be sterile. The filaments of the hybrids often are malformed and sometimes flattened, enlarged, and petaloid in appearance. Anthers of the hybrids often are nonexistent or malformed and rarely produce pollen. Pollen has not been tested for viability.

Conclusion

Intergeneric hybridization between *Franklinia alatamaha* and *Schima argentea* was achieved and constitutes the first intergeneric cross involving *Franklinia* and *Schima*. The nothogenus ×*Schimlinia* Ranney and Fantz is proposed for the generic name in accordance with Article H.6.2 (Greuter et al., 2000) that requires the nothogeneric name of a bigeneric hybrid to be a combination of the parents' generic names. The new hybrid species is described as follows: Nothospecies ×*Schimlinia floribunda* Ranney and Fantz [*Franklinia alatamaha* (female) Bartr. Ex Marshall ×*Schima argentea* (male) Pritz.] *distinguibili pedunculi et bracteae elongatis*, *sepala longitudino subaequalo latitudo*, *pubescentis sericeis abaxialibus*, *petala glabrato abaxialibus cum pubescentis sericeis basaliter et flores unis ad quartis per inflorescentia*.

Trees, 4 m tall after two growing seasons. Leaves are simple, alternate, sessile, dark green and reticulate adaxially, pale green, and scattered strigose abaxially; lamina elliptic obovate, (8)11–14 cm long, 2.5–4.5 (5) cm wide, margin serrate-crenulate, apex short acuminate, acumin 1–7 mm, base tapering, entire, elongate cuneate-attenuate to insertion point, tapered portion distinct, 13–20 mm long by 3 mm wide at insertion point, and lateral vein pairs 9–11. Inflorescences axillary, subracemose, bearing 1–4 flowers, to 5 cm long, densely grayish-white puberulent; pedicels 7–15 mm; bracts 2, caducous, 10–13 mm long, 4–5 mm wide, puberulent adaxially. Flowers 4–7 cm wide, fragrant; sepals 5, connate basally, subequal, suborbicular, 5–6 mm long, 5–6 mm wide, silky pubescent abaxially with trichomes to 1 mm, apex obtuse, ciliolate; petals 5, white, subequal, 20–26 mm long, 18–21 mm wide, glabrate abaxially, base narrowed, 5–7 mm, silky pubescent. Stamens numerous; filaments white-bright yellow, unequal, 4–9 mm long, ca 0.7–0.8 mm wide, ratio of shortest to longest ca 2; anthers yellow when present, ≈1.8–2 mm long. Pistil 1, style ca 8–10 mm long; stigma bilobed. Fruit not observed. Holotype: Container plant, progeny H2001-084, Mountain Horticultural Crops Research Station, Fletcher, N.C., 6 Sept. 2002, *Fantz and Ranney 6942* (NCSC). Isotype: NA.

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