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Taming the Wild Stewartia©

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SUMMARY

The Polly Hill Arboretum (PHA) began working with native stewartia in 1967. Our founder, Polly Hill, was devoted to growing trees from seed. In 2006, the Polly Hill Arboretum was recognized as the Nationally Accredited Collection holder for stewartia. This status has guided our collection development, particularly on focused seed expeditions, which began in 2007. The PHA has been successful growing both species from seed, however, overwintering survival and transplanting of juvenile plants has proved more challenging. New insights into winter storage of seedlings is beginning to shed light on this problem. Experimentation with overwintering rooted cuttings has revealed that plants have preferred temperature and chilling requirements. These new overwintering protocols have thus far yielded positive results. Recent work with tissue culture has also shown promising results with both species. Future work includes grafting superior clones of our native stewartia onto Asiatic species in an effort to overcome the problematic issues of overwintering, transplantability, and better resistance to soil borne pathogens. Our Plant Collections Network (PCN) development plan outlines our next phase work with stewartia over the upcoming several years. The results of this work will be shared in future years as we continue to bring these exceptional small flowering trees into commercial production.

INTRODUCTION

The commitment to building Polly Hill Arboretum's (PHA) stewartia collection is based on our founder Polly Hill's history with the genus and our own desire to encourage the cultivation of these superb small-flowering trees in home gardens. Polly Hill began her experimentation with mountain camellia (*Stewartia ovata*) in 1967 with wild seed sent from Colonial Williamsburg, Williamsburg, VA. In 1982, she began propagating and cultivating the silky stewartia (*S. malacodendron*). These two species represent the only extant stewartia in North America, as the center of diversity for this genus is eastern Asia.

PARTNERSHIP LEADS TO NATIONAL COLLECTION

In 2006, Polly Hill Arboretum's Stewartia collection was recognized as a Nationally Accredited Collection by the North American Plant Collections Consortium, now known as the Plant Collections Network (PCN). Administered by the American Public Garden Association, the PCN is a recognized standard of excellence in plant collection management. Accreditation as a national collection demonstrates a garden's enduring commitment to global efforts to save plants. Today, over 70 stewartia trees representing 22 taxa can be found in PHA's collections, many of them Polly Hill introductions.

PHA director emeritus Stephen Spongberg produced the monograph on the genus *Stewartia* in 1974. This publication served as the authoritative resource for much of our work. In 2015, then curatorial intern Victoria Stewart used Steve's monograph to develop a web-based pictorial key creating a comprehensive resource for the genus. This work, combined with our efforts to research, collect, and grow the collection, resulted in the International Society for Horticultural Science appointing PHA as the international cultivar registration authority for the genus. This designation positions us to work with plant breeders, commercial growers, and other arboreta to further expand the availability and use of this beautiful group of trees (Boland, 2017).

SPECIES PROFILES

Stewartia malacodendron. Silky stewartia is native to the coastal southeastern states,

occurring from Texas to Virginia. Although this species is Globally Secure (G4), its limited distributed in some states has yielded local designations of Vulnerable (S3) in Mississippi, Florida, North Carolina, and Virginia, Imperiled (S2) in Louisiana, Alabama, and Georgia, and Critically Imperiled (S1) in Texas and Arkansas (Nature Serve, 2019). Spongberg (1974) notes that although *S. malacodendron* is found primarily within the coastal plain in the southeastern U.S., it can also be found in some piedmont localities as well as in the mountains. It prefers low rich woodlands and is typically growing along stream banks and slopes of ravines. In our experience, silky stewartia grows poorly in deep shade, and flower/seed production suffers as a result. It has been hypothesized that this species would have been more widespread historically, but its natural propensity to grow in rich floodplain terraces conflicted with the favorability of these same sites to European settlers and farmers. Thus, many populations are presumed to have been destroyed when land was cleared for agriculture. This is similar to the now (functionally) extinct family member, *Franklina alatamaha*.

Flowering of silky stewartia occurs primarily between May and June, and this species is noted for its purple-colored anthers. Spongberg (1974) notes that *S. malacodendron* is remarkable uniform across its range, much unlike *S. ovata* and other Old-World species. Pollination is performed by insects, particularly bees, but individuals of most stewartia species appear self-fertile and even isolated specimens are capable of producing viable seeds.
To read about the singular cultivar that Polly Hill selected of the silky stewartia see:
http://www.pollyhillarboretum.org/plants/stewartias-2/stewartia-malacodendron/

Stewartia ovata. Mountain stewartia, much like silky stewartia, is concentrated to the southeastern states. As its name suggests is more concentrated in mountainous sites. Also listed as Globally Secure as a species, state conservation status for *S. ovata* includes designations as Vulnerable (Kentucky, Georgia, North Carolina), Imperiled (Alabama, South Carolina, Virginia) and Critically Imperiled (Mississippi). The species is often listed in Florida, where it is classified as ‘not ranked/under review’, however the only known specimen from Florida is from

a cultivated (nursery) site. *Stewartia ovata* is typically found in partially shaded, moist ravines and gorges from 200-1100 meters. The challenging terrain of these sites make them less amenable to land-use conversion, but habitat loss and fragmentation remain the greatest threat to this species.

The flowering window for *S. ovata* is shifted approximately one month later than *S. malacodendron*. There appears to be little, if any, sympatric populations of the two species that are extant, and no hybrids have been reported. Some variation exists in the flowers of *S. ovata* however, and anther color may vary between white, yellow, and purple.

Polly Hill selected three cultivars based on anther and filament variations; see: http://www.pollyhillarboretum.org/plants/stewartias-2/stewartia-ovata-mountain-stewartia/ Although the name *S. ovata* var. *grandiflora* has been published on the basis of flowers having 5-8 petals and purple filaments, it is generally not recognized as a distinct taxonomic unit, but rather as typical phenotypic variance.

In the landscape, *S. malacodendron* grows as a large shrub with a rounded crown, whereas *S. ovata* is a small to medium sized tree. Both species have rather ordinary bark in comparison to the multicolored, papery, and exfoliating bark of many Asian species such as *S. monadelpha* and *S. pseudocamellia*. Some degree of hybridization appears to be possible within stewartia, for example *S. pseudocamellia* has been crossed with both *S. monadelpha* and *S. ovata*. Nevertheless, *S. malacodendron* remains a phylogenetic outlier, distantly related to all the other deciduous taxa (Lin et al., 2019). The subtropical evergreen cohort of stewartia (formerly known as *Hartia*) are in fact nested between *S. malacodendron* and all other species.

SEED EXPEDITIONS

On our past trips to the southeastern United States over the last 12 years, only a small percentage of seed has germinated, and only a few have made it into the collections. Seed propagation is difficult: the woody seeds rarely germinate within a year of collection. They require 3-5 months of warm stratification followed by 3 months of cold stratification to

overcome internal dormancy mechanisms (Dirr and Heuser, 2006). Polly Hill understood this lengthy process and sowed seeds directly in the ground, patiently letting nature do its work.

Our beginning work with seed propagation of Stewartia began in earnest in 2007 with the opening of a new greenhouse. The same year, PHA Executive Director, Tim Boland was introduced to plantsman Jack Johnston, of Clayton, GA. Mr. Johnston has nearly 40 years of stewartia observations throughout the Southeastern United States. He has an uncanny ability to spot trees along the river ledges where their naturally occur. Using a hooked walking stick he has mastered the art of pulling down sun-soaked branches to harvest seeds. Jack grows several trees in his home garden as well as a northern property he owns in Macon County, North Carolina.

The Polly Hill Arboretum is part of an informal collaborative Stewartia Working Group (SWG) which consists of the following members: Mt. Cuba Center, Delaware; Birmingham Botanical Gardens, Alabama; Yew Dell Gardens, Kentucky; and Smithgall Woodland Garden (Atlanta Botanical Garden), Georgia. The primary objective is to collect both species from throughout their natural range. Jack Johnston has guided many of these expeditions.

INTERNATIONAL CULTIVAR REGISTRATION AUTHORITY

In 2016, the International Society for Horticultural Science appointed the PHA as the international cultivar registration authority (ICRA) for the genus. This designation positions us to work with plant breeders, commercial growers, and other arboreta to further expand the availability and use of this incredibly beautiful group of trees (Boland, 2017). Currently, the PHA has four registered cultivated varieties of the two native Stewartia species with plans to registered more recent discoveries.

SEED PROPAGATION

Woody capsules of both species open and release seeds under dry conditions, which naturally occurs between late September and early November. Individual seeds become sclerified before natural dehiscence for both species. For harvesting purposes, collecting is best accomplished by gathering capsules just prior to natural dehiscence, and storing them in a paper

bag until seeds are released. It has been noted that seed of *Stewartia malacodendron* and *S. ovata* require a warm/cold stratification period for dormancy breaking and germination (Dirr and Heuser, 2006). Seed sowing has traditionally relied upon two methodologies: directly sowing seeds into the ground or sowing directly in free draining Anderson flats. In general, germination is irregular and the majority of seedlings emerge after the second winter, roughly 20 months after sowing the first fall. Given this extended stratification period, it is advantageous to use fine, wire-screened cages to exclude rodent seed-predators.

VEGETATIVE CUTTINGS

The other principal method of growing our native Stewartia is stem cuttings. We have had success rooting cuttings taken between mid-June and July using 8000ppm Hormodin 3® (IBA) rooting powder. Cuttings are placed in Anderson Flats using a 1:1 ratio of perlite and peat. Although we have had success rooting cuttings, overwintering survival is a challenge noted by many growers. Temperature and duration of chilling are two important factors of overwintering, and previous studies have helped elucidate the optimal protocols for stewartia. For example, Nair et al. (2008) found that overwintering Japanese stewartia (*S. pseudocamellia*) at 5°C resulted in 65% survival, while stem cuttings held at -30° and -12° C experienced 100% mortality. Furthermore, 22% of cuttings survived when held at 21° C, effectively lacking cold storage altogether (Nair et al. 2008). These results are further clarified by experimental analysis of *S. ovata*, for which chilling at 6° C (for 0, 2, 4, 6, 8, or 10 weeks) was positively correlated with overwintering survival (Curtis et al. 1996). At PHA we have adopted these ostensibly optimal conditions (~12 weeks at 5° C) for species and cultivars of *S. malacodendron* and *S. ovata* with 70-100% cutting survival. There is also evidence that fertilization of stem cuttings with 200 ppm N results in greater shoot growth following overwintering, but N addition has no effect on survival (Curtis et al., 1996). We have observed best results when allowing cuttings to remain in their original rooting container and medium for the overwintering period. The cuttings are then transplanted to a new container well after bud-break the following year.

TISSUE CULTURE

PHA has been working cooperatively on stewartia propagation with Heather Gladfelter, a researcher at the Warnell School of Forestry at University of Georgia in Athens. We sent Heather seed of *Stewartia ovata* 'Red Rose' and *S. malacodendron* 'Delmarva' in 2013. She extracted the embryos and grew them in a Petri dish using plant growth regulators to encourage the formation of roots and shoots. This process has shown very promising results and we plan on further collaborative experiments with UGA in the future. [See link to Gladfelter, H.J. et al., 2019. Propagation of *Stewartia* for the Nursery Industry: Somatic Embryogenesis of Rare Species and Elite Cultivars. *Comb. Proc. Intl. Plant Prop. Soc.* 69 (In press)].

FUTURE WORK WITH STEWARTIA

This past July the PHA began a new phase of Stewartia propagation with a look towards further optimizing overwintering and transplanting stem cuttings of key cultivars. In a collaborative partnership with Heritage Seedlings and Liners Inc, Salem, Oregon, PHA sent its most vigorous and best flowering selections to be chip budded this past August onto Japanese Stewartia, *Stewartia pseudocamellia*. Japanese stewartia has seemingly broad soil adaptability and is less prone to soil borne pathogens than our native species (Mark Krautmann, personal communication). Additional wood will be sent to be dormant grafted this winter season. The results of this next phase of experimentation will be reported at a later date. Moving forward with our efforts involving the Plant Collection Network; a recent published plan has been developed that further defines our mission by advancing botanical research, plant conservation, curatorial excellence, and collaborative partnerships working with this fantastic group of trees (Rounsaville, 2019). It is our hope that this next stage of testing, and our continued efforts to sample wild stewartia from across their ranges will help bring new cultivated varieties into the marketplace.

Acknowledgements

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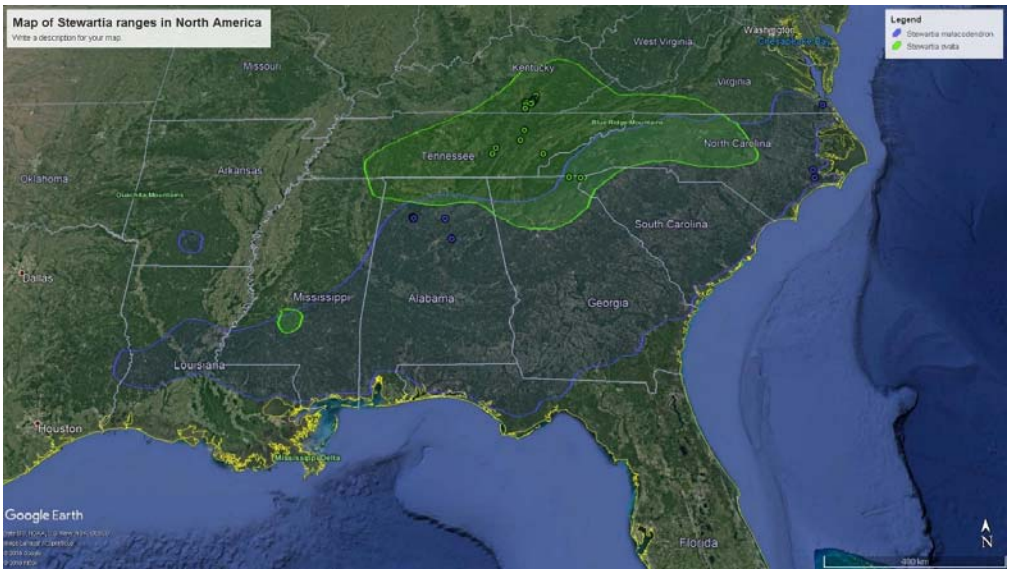

Figure 1. Approximated range map of *Stewartia malacodendron* and *Stewartia ovata* in the United States. Points represent populations that were sampled by Polly Hill Arboretum (PHA), with specimens currently active in the living collection.

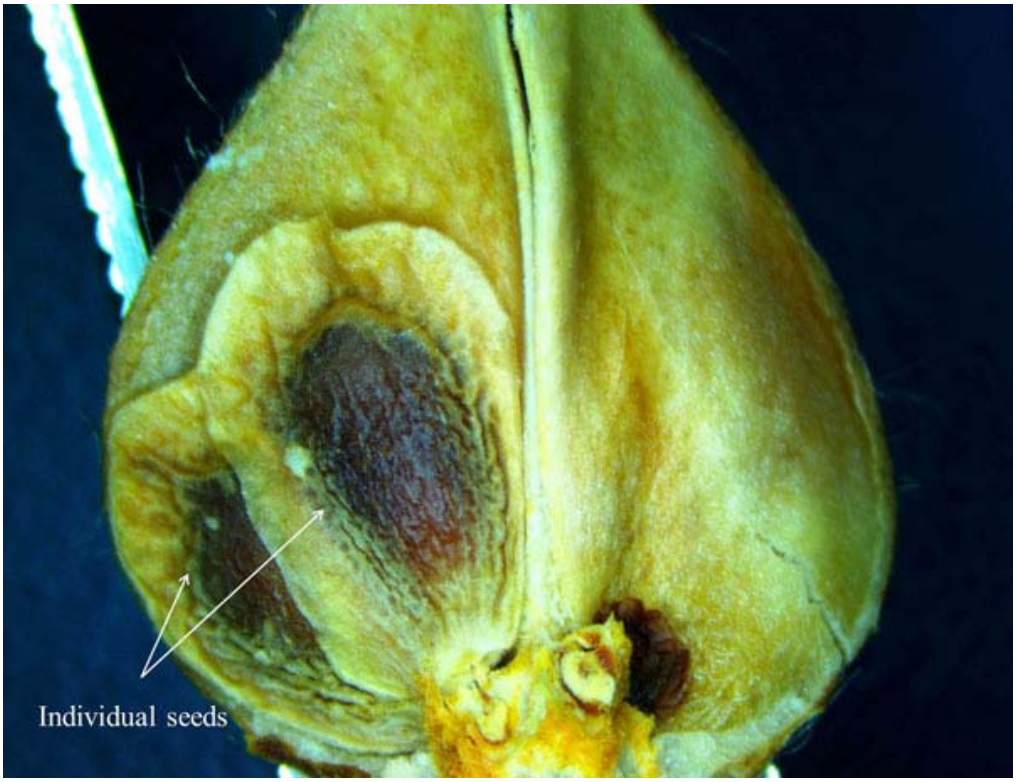

Figure 2. *Stewartia ovata* capsule with seed.

Figure 3. *Stewartia ovata* seed.

Figure 4. *Stewartia ovata* capsule with forked locule apex (persistent styles).

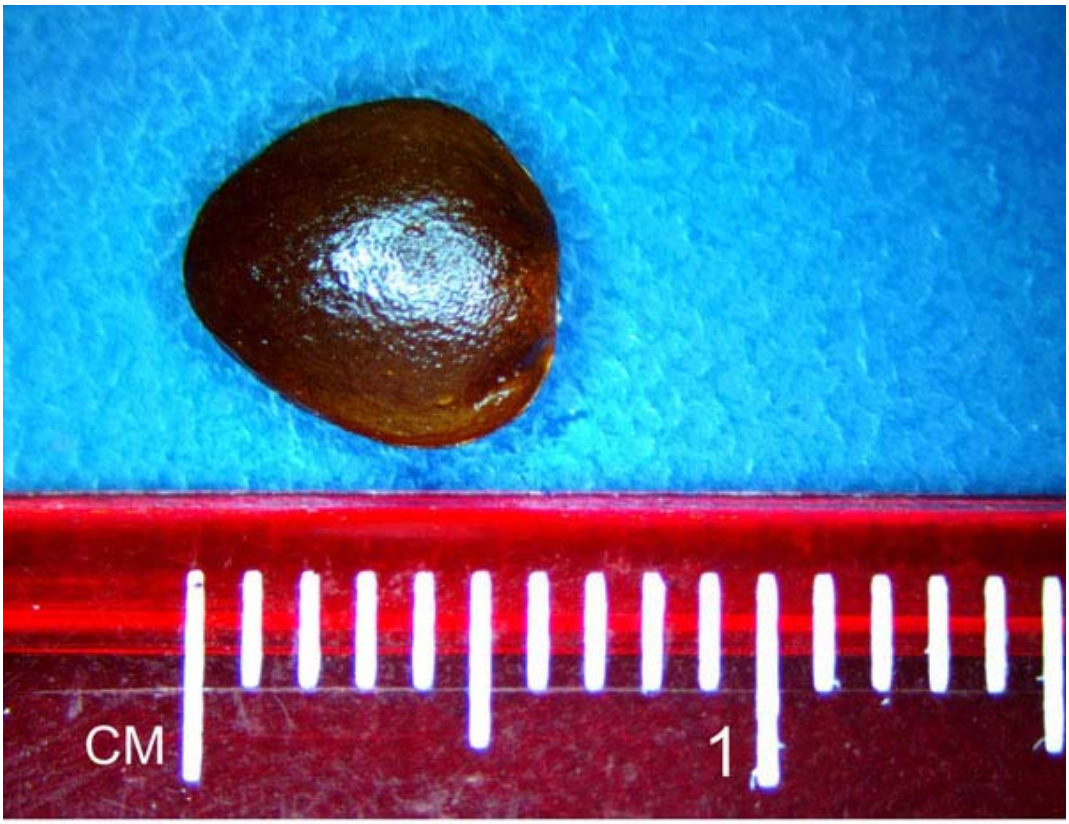

Figure 5. *Stewartia malacodendron* seed.

Fig 6. *Stewartia malacodendron* capsule.

Figure 7. *Stewartia ovata* flower.

Figure 8. *Stewartia malacodendron* flower.