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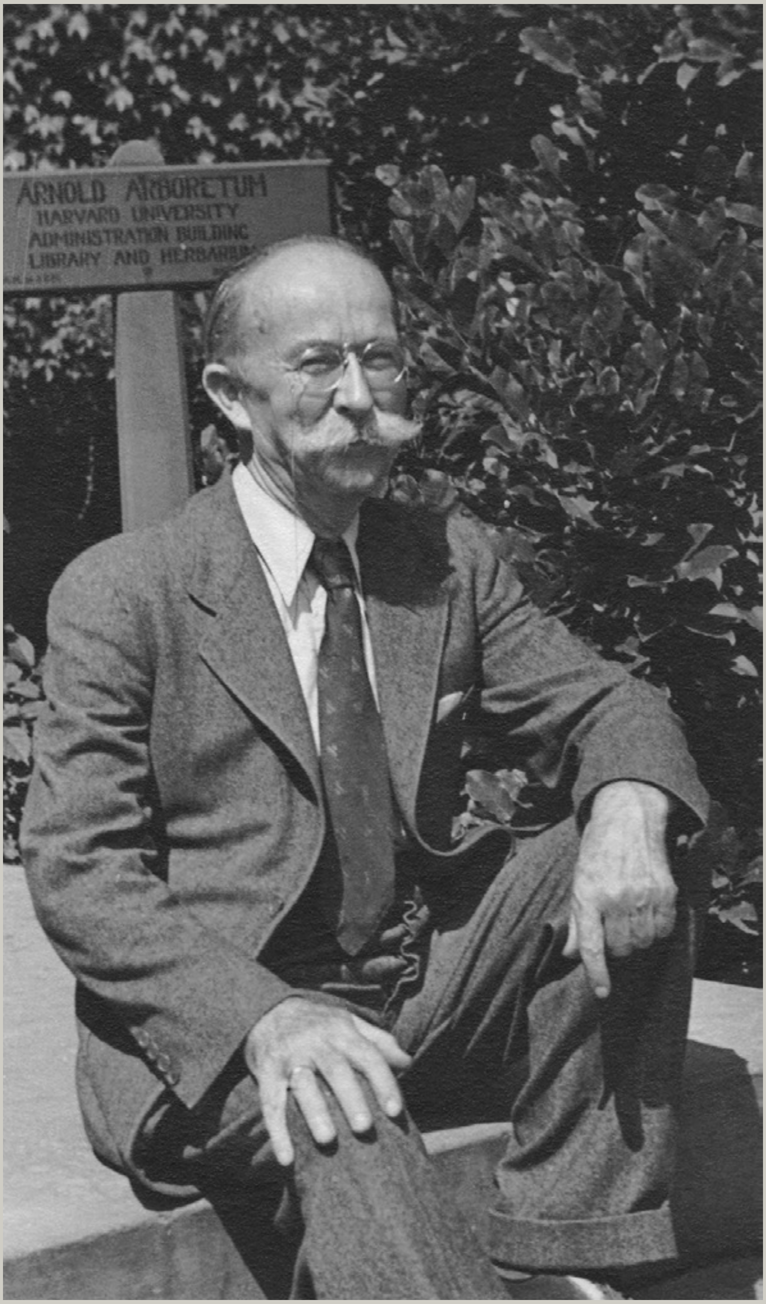
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The ARNOLD ARBORETUM of HARVARD UNIVERSITY

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Front cover: The maple (*Acer*) collection at the Arnold Arboretum is a hotspot for colorful autumn foliage, including this *Acer pubipalmatum* (accession 320-2004-A) grown from seeds wild collected in China. Photo by Kyle Port.

Inside front cover: Alfred Rehder posed on the steps of the Arboretum's Hunnewell Building on September 1, 1933, during a celebration in honor of his 70th birthday. Photo from the Archives of the Arnold Arboretum.

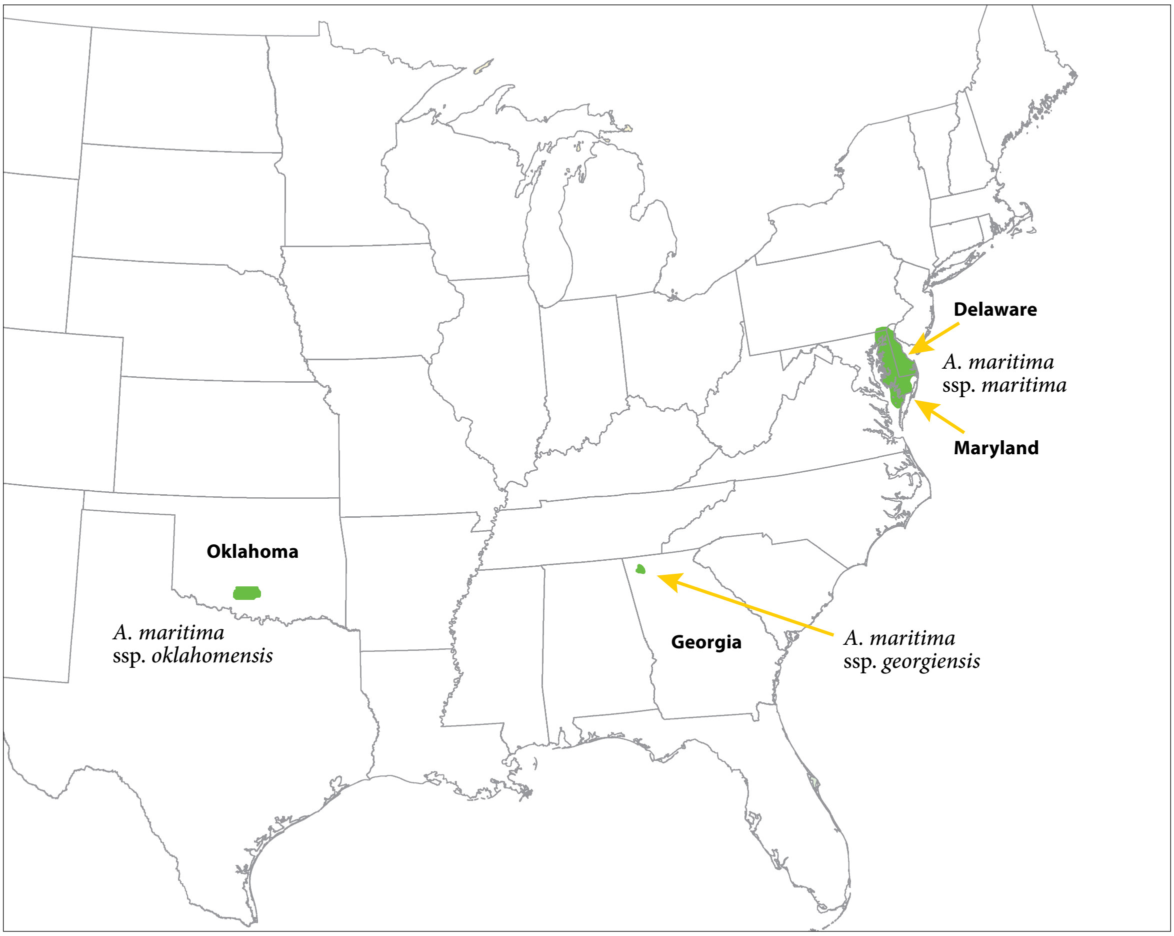
Inside back cover: The distinctive form of *Tilia cordata* 'Swedish Upright', an Arnold Arboretum introduction, is seen in this 1989 photo by István Rácz and Zsolt Debreczy. Photo from the Archives of the Arnold Arboretum.

Back cover: A sugar maple (*Acer saccharum* accession 12565-C) in golden autumn foliage glows in the Arboretum's maple collection. This plant was collected in the wild near Malden, Massachusetts, by Arboretum propagator and superintendent Jackson Dawson in October 1883. Photo by Kyle Port.

The Strange Range of Seaside Alder

J. Matthew Jones

Plant species exhibit considerable variation in their native ranges. Some species, such as the North American white oak (*Quercus alba*), are abundant and have a continuous range across half the continent. Other species, like the dawn redwood (*Metasequoia glyptostroboides*) in China, are rare and natively restricted to a small location in the wild. In addition to being rare, some species exhibit disjunct, or widely separated, populations. Disjunct populations can arise either by unusual dispersal events, or can be remnants of a formerly more widespread range that has since retracted. Disjunct populations of a given species are often highly isolated from one another, which can reduce the likelihood of pollen and seed dispersal (and thus gene flow) among populations. Consequently, isolated populations are more prone to inbreeding and random selection, which, over time reduces genetic diversity and a population's ability to adapt to environmental change. Therefore, studying disjunct



Seaside alder (*Alnus maritima*) comprises three small, widely disjunct populations in Maryland, Georgia, and Oklahoma.

populations is important for understanding how habitat fragmentation affects biodiversity and species' long-term viability, as well as for helping to assess conservation strategies that maintain genetic diversity.

ROBERT H. MOHLENBROOK, USDA-NRCS PLANTS DATABASE

Foliage and catkins of *Alnus maritima.*

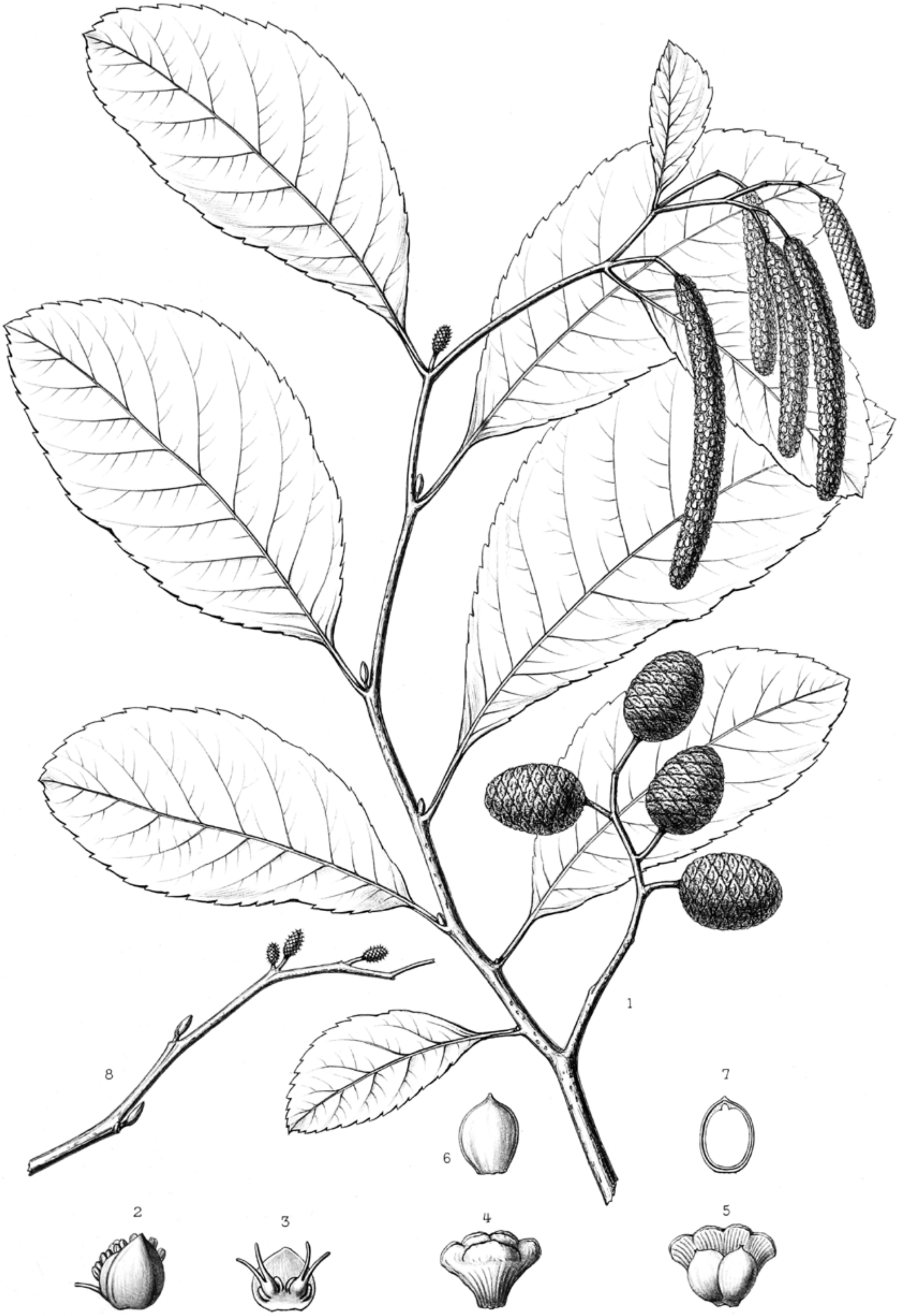
Introducing Seaside Alder: The Alder That Does Not Grow by the Seaside

Seaside alder is among the most disjunctly distributed tree species in North America, with major populations so widely separated that they are recognized as distinct subspecies. *Alnus maritima* subsp. *maritima* occurs on the Delmarva Peninsula, specifically along tributaries and streams of the Naticoke, Pocomoke, and Wicomico Rivers of Maryland's Eastern Shore, as well as along rivers, ponds, and dammed creeks in Delaware. *Alnus maritima* subsp. *oklahomensis* is restricted to four populations on the Blue River and two of its tributaries in south central Oklahoma, while *A. maritima* subsp. *georgiensis* occurs along opposite sides of a single pond in Bartow County, Georgia. What historical, ecological, and physiological factors caused this disjunct distribution? How genetically diverse are each of the regional subspecies and how might this affect their long-term viability?

Alnus maritima is a large shrub or small tree that tends to grow in spreading, multi-stemmed clumps in wet soils along banks of ponds, streams, and even fast moving rivers. Seaside alder's roots can tolerate partial submergence in water and, similar to legumes, have a symbiotic relationship with bacteria that assimilate atmospheric nitrogen. Despite its name, *A. maritima* doesn't occur on the seaside and is intolerant of saline soils. Individual trunks are usually 10 to 13 centimeters (4 to 5 inches) in diameter, 5 to 7 meters (16 to 23 feet) tall, and covered in smooth, light gray bark. The simple, alternate leaves are narrowly elliptical to obovate in shape, with a lustrous surface, leathery texture, and singly serrated margins.

Alnus maritima and other members of the birch family (Betulaceae, 230 species worldwide) are recognized by their distinctive floral catkins and conelike infructescences. Staminate (male) inflorescences are elongate catkins that hang loosely at the tips of branches, typical of trees that disperse pollen by wind. The tiny, apetalous, pistillate (female) flowers sit above woody, scalelike leaves (bracts), arranged as a spike in the leaf axils. At maturity, the woody bracts on the "cones" spread apart to release the water-dispersed seeds. Unlike birches, which have deciduous three-lobed bracts, alders' five-lobed woody bracts persist well into the following season, yielding an attractive display of inch-long spent "cones" in winter.

Eight species of alder occur in North America. Flower-to-seed development of most of these species requires a full year. Floral buds initiate in summer, go dormant over winter, open for pollination the following spring, and disperse their seeds in late summer and autumn. *Alnus maritima*, however, initiates floral development in spring, opens for pollination in late summer to early autumn, and releases seeds in late autumn or early winter of the same year. This phenological sequence (supported by more recent genetic data) delineates the alder subgenus *Clethropsis*, a clade that *A. maritima*



C. E. Faxon del. Rapine sc.

ALNUS MARITIMA, Nutt.

A. Riocreux direx.t Imp. J. Taneur, Paris.

shares with the Himalayan alder (*A. nitida*) and the Formosan alder (*A. formosana*). This means that seaside alder's nearest extant relatives are in southern Asia (Chen and Li 2004).

Investigating the Causes and Consequences of the Disjunction

Schrader and Graves (2002) classified the three regional populations of seaside alder as three subspecies. Subspecies are a taxonomic ranking used to distinguish geographically isolated populations of species that often have unique morphological features and specialized adaptations to local environments. *Alnus maritima* subsp. *oklahomensis* is the most distinctive of the three subspecies, with narrower leaves and larger trunks and canopies compared to the Delmarva (*A. maritima* subsp. *maritima*) and Georgia (*A. maritima* subsp. *georgiensis*) subspecies. *A. maritima* subsp. *oklahomensis* also occurs in more phosphorus deficient and alkaline soils than the other subspecies.

Alnus maritima subsp. *maritima* was the first population recognized in the early nineteenth century. Seaside alder's strange distribution was first noted when Elihu Hall discovered populations along the Blue River in the Indian Territory during his exploration of the region in 1872. Was this the result of a dispersal event or the remnant of a formerly broader range? John Furlow (1979), in his comprehensive monograph of American alder species, proposed that the Oklahoma population was a relict of range retraction, noting the fossil evidence of related species further west. Virginia Stibolt's (1981) study of seaside alder distributions suggested the Oklahoma population might be the result of dispersal by Native Americans, as the Delaware Indians were forcibly relocated to the Indian Territory several decades before Hall's discovery. However, Stibolt herself expressed skepticism about this hypothesis, and there is no ethnobotanical or historical reasoning for Native Americans to have intentionally or inadvertently dispersed seaside alder seeds. The discovery of the Georgia population in 1997 further undermined the dispersal hypothesis.

J. PHIL GIBSON

Alnus maritima subsp. oklahomensis has narrower leaves and larger trunk and canopy size than the other two subspecies of seaside alder.

Population Genetics as a Research Tool

Population genetics, the study of genetic diversity within and among populations of organisms, has further clarified the nature of seaside alder's present disjunct distribution. Additionally, using population genetics techniques can help conservation biologists assess the genetic health of the population. Namely, how diverse and genetically distinct are the existing populations, are those populations highly inbred, and how much do populations contribute to overall species diversity?

To measure population diversity and health, population geneticists compare frequencies of alleles (variants of genes) and frequencies of heterozygosity (possessing two alleles of a gene

Facing page. Charles Edward Faxon's illustration of *Alnus maritima* in Charles Sprague Sargent's *Flora of North America*, 1890. In the entry for this species Sargent wrote, "Its brilliant foliage and its bright golden staminate aments [catkins], hanging in September from the ends of the slender leafy branches, make it at that season of the year an attractive ornament for parks and gardens."

in a single individual) relative to homozygosity (having the same alleles of a gene in a single individual) to estimate degree of inbreeding in a population. Historically, rather than analyze the DNA of alleles of genes, geneticists compared the ultimate product of genes: proteins and enzymes, and their variants called allozymes. This form of analysis is simpler to perform and more cost effective compared to contemporary DNA amplification technologies. James Hamrick, Mary Jo Godt, and others developed and compiled large data sets of allozyme population genetic data for many plant species of diverse growth forms, pollination and seed dispersal methods, geographic ranges, rarity, habitats, and taxonomic status. These data allowed other researchers to compare the population diversity and structure of their species of interest to the "average" for a particular life history trait, e.g., wind-pollinated woody perennials, and have been a great benefit for developing appropriate conservation strategies.

Gibson et al. (2008) conducted the first comprehensive allozyme-based study of seaside alder population genetics. The study compared the structure and diversity of seaside alder populations with that of hazel alder (*Alnus serrulata*), a common and widespread species with a range covering the eastern third of North America. Hazel alder shares similar habitats with seaside alder, and even co-occurs with seaside alder in Georgia and the Delmarva Peninsula. Hazel alder is restricted to the eastern third of Oklahoma, east of the *A. maritima* subsp. *oklahomensis* populations. Aside from the differences in phenology, hazel alder persists in both shady and sunny areas, whereas seaside alder only occurs in full sun. Comparing these otherwise similar species with dramatically different ranges allowed Gibson et al. (2008) to determine how geographic isolation and rarity affected the genetic diversity of seaside alder. Additionally, the genetic data could clarify whether seaside alder's distribution was the result of anthropogenic dispersal or range retraction. If the former, the Oklahoma and Georgia populations would show very low genetic diversity relative to the Delmarva populations as the result of the genetic bottleneck from limited sampling from the putative source population. Further, Georgia and Oklahoma populations would share many alleles with the Delmarva populations. However, if seaside alder's present distribution is the result of range retraction, then populations in Delmarva, Georgia, and Oklahoma would show similar levels of diversity and possess unique alleles.

COURTESY OF ALAN CRESSLER

Leaves and immature infructescence of *Alnus maritima* subsp. *georgiensis* in Bartow County, Georgia.

COURTESY OF ALAN CRESSLER

Collecting specimens from the *Alnus maritima* subsp. *georgiensis* population required some swamp wading.

As expected, the isolated and narrowly distributed seaside alder regional populations exhibited lower levels of diversity and higher levels of inbreeding than the common and widespread hazel alder. Both species showed similar levels of genetic differentiation (genetic divergence) among Delmarva, Georgia, and Oklahoma populations, but overall genetic diversity values were higher than observed in other rare and widespread species, respectively. Gibson et al. (2008) suggested the alders' perennial, multi-stemmed, clonal growth habit and ability to sprout new shoots after disturbance and damage promote greater gene flow (movement of pollen or dispersal of seeds) and maintenance of genetic variation within each region. Additionally, genetic variation within regions might be maintained by extensive gene flow among populations *within* regions. In other words, although the vast distances among seaside alder in Delmarva, Georgia, and Oklahoma severely limit the exchange of pollen or seed, more localized gene flow seems to occur among networks of populations within regions. However, allozymes lack sufficient variation (or resolution) to detect differences among populations within regions, or among subpopulations within those populations. To test this hypothesis, more variable genetic markers are required.

Simple Sequence Repeat Microsatellites: High Definition Population Genetics

Microsatellites (also known as Simple Sequence Repeats, or SSRs) are regions of repeated sequences of DNA (e.g., GAGAGA) that do not code for proteins or enzymes. Such genes may serve some regulatory functions, but are often colloquially considered to be "junk" DNA. Their repeated sequence motifs lend them to a type of regular, neutral mutation that makes microsatellites particularly useful molecular marker for population genetic studies. Although more expensive and time consuming to develop and analyze, microsatellites offer much greater variability than allozymes and allow for finer-scale genetic analyses.

My own thesis work (Jones and Gibson 2011, 2012) used microsatellite markers to corroborate population genetic characteristics observed in

J. PHIL GIBSON

A colony of *Alnus maritima* subsp. *oklahomensis* grows along the Blue River in Oklahoma.

the earlier allozyme-based study, as well as to examine population dynamics within each subspecies to explain past and present gene flow. As hypothesized by Gibson et al. (2008), where subdivisions of regional populations occur (Oklahoma and Delmarva), significant genetic divergence (genetic differentiation) among subdivisions persists, indicating past gene flow occurred primarily among local population networks that preserved the high genetic diversity within regions.

COURTESY OF STANLEY A. RICE

The puzzlingly rare occurrence of *Alnus maritima* subsp. *oklahomensis* seedlings like these in the wild is the subject of ongoing research.

This research required new field sampling of seeds and leaf tissue for DNA extraction. Sampling *Alnus maritima* subsp. *georgiensis* was particularly memorable, as it required accessing private property (with official permission) in rural northwest Georgia where the lone population occurs. With echoes of hunting rifles in the distance, my graduate advisor Phil Gibson and I waded through waist-deep Drummond Swamp with caution. After collecting most of what we needed, and thinking we had made it without problems, a local in a pick-up truck stopped along the side of the road and approached us suspiciously. Without missing a beat, Phil stated that we were collecting samples from a species with potential medicinal value, a simple, if not quite accurate, explanation for our presence that seemed to satisfy the man, who then went on his way.

Who's Your (Pollen) Daddy?

Because the leaf tissue analyses compare the alleles among established individuals, they only suggest *past* gene flow. How, and to what extent, is gene flow occurring at present? This can be determined by comparing microsatellite alleles of existing individuals in a population with the alleles of their offspring. Alleles of offspring can be determined by extracting the DNA from the embryonic tissue in the seeds before they are dispersed from the mother plant. A plant species' mating system considers flower structure and pollination syndrome to account for the proportion of offspring that arise from mating (pollination and fertilization) with other individuals (outcrossing) relative to the proportion of pollination and fertilization by the same individual (selfing). Alders produce separate male and female flowers on the same individual (monoecy). Further, alders' highly reduced, non-showy flowers indicate pollination by wind. Wind pollinated plants tend to have long distance and highly dispersed potential pollen movement. Considering these factors, one would expect most offspring to have arisen from mating of two individuals. Indeed, we found over 94% of offspring from trees in both Georgia and Oklahoma (Delmarva populations were not sampled) had microsatellite alleles different than their maternal parents and were, therefore, highly outcrossed.

Additional analyses enabled us to assign potential pollen parents and determine the proportion of offspring sired by the same pollen parent on a given tree, the so-called correlation of paternity. We found higher correlations of paternity (more offspring sired by fewer pollen parents) in the more geographically separated Oklahoma populations than in Georgia overall, and, in Georgia, slightly higher correlations of paternity from trees on the west side of the pond, where trees occurred in notably denser stands. We concluded that vegetation and other geographic barriers between the sampled trees reduced the uniform dispersal of pollen clouds, a common phenomenon affecting the mating systems of wind-pollinated species. However, while these barriers tended to favor siring by fewer local pollen parents, we were able to identify potential individual pollen parents located some distance from the mother tree. In Oklahoma, some offspring collected from the main Blue River population were potentially sired by pollen parent trees located 5 to 7 kilometers (3 to 4 miles) away in nearby creeks. In Georgia, identified pollen parents were located on both sides of the pond. This means that gene flow via movement of pollen is possible among populations within each subspecies.

But How Did It Get There?

Both the allozyme and microsatellite genetic data strongly suggested the three regional seaside alder subspecies are the result of range retraction, not dispersal. Each population showed comparable levels of genetic diversity and each contained alleles unique to the region. What then, made seaside alder's range retract so much, and why was it so previously widespread? Why is a species like *Alnus serrulata* widespread, but *Alnus maritima* rare?

Alnus maritima and *Alnus serrulata* share many ecological features well suited for colonizing disturbed riparian sites, including tolerance of wet soils, the ability to fix nitrogen, and a robust multi-stemmed growth habit. However, *A. maritima* has been observed to only inhabit areas with full sun, whereas *A. serrulata* can inhabit both sunny and shady niches. Schrader et al. (2006) investigated the photosynthetic and growth characteristics of both alder species and found seaside alder to have lower chlorophyll concentrations, greater seedling growth rates in full sun, and lower seedling survivability in shade compared to *Alnus serrulata*. Therefore, while seaside alder would be more successful on relatively open, early-succession habitats, as the ecosystem matures, later succession species establish and develop canopies that shade seaside alder and reduce its competitiveness. It would eventually succumb to other shade tolerant species, including hazel alder. Schrader et al. (2006) proposed that the late Pleistocene, a time of significant climatic instability characterized by cycles of glacial advancement and retreat and changes in the locations of drainage basins, would have provided many opportunities for seaside alder to colonize and establish a broad range across the continent. Once the climate stabilized, however, those disturbance events stopped, and with it seaside alder's chance to thrive and spread. Stability brought on ecological succession, and seaside alder was gradually outcompeted by other species, except in its present range.

JOSEPH O'BRIEN, USDA FOREST SERVICE, BUGWOOD.ORG

Alders bear persistent, conelike infructescences. Those of the widely adaptable hazel alder (*Alnus serrulata*) are seen here.

Conservation Implications

The distinct genetic identity of each subspecies and the gene flow among populations within each region means that it is important to protect all populations to conserve the genetic diversity and long-term viability of the species. The Georgia and Oklahoma subspecies are now both classified as "critically imperiled," the most threatened conservation status according to state conservation agencies. Recent

COURTESY OF STANLEY A. RICE

These specimens of *Alnus maritima* subsp. *oklahomensis* along the Blue River are resprouting from the base following a fire.

floods have nearly wiped out one of the Oklahoma populations sampled in the microsatellite study. Should reestablishment of populations by conservation agencies become a viable conservation strategy, seeds should be sourced from local populations to preserve potential local adaptability and overall genetic diversity.

Despite showing levels of inbreeding lower than species of comparable rarity and distribution, and despite evidence of current pollen-mediated gene flow among populations within subspecies, seaside alder in the wild is failing to establish new individuals from seed. While seedlings readily develop under greenhouse conditions, seedlings in the wild consistently die early in development, rendering the relatively diverse seed pool irrelevant in creating new individuals and maintaining the long-term viability of the species. Seaside alder appears entirely dependent upon producing new clonal shoots to spread and maintain their genes, Should a larger scale flood or other widespread disturbance occur, few new individuals from seed banks or dispersal could reestablish a population. Researchers at the University of Oklahoma are currently investigating the possible environmental causes of seedling establishment failure, focusing on the role of fire regimes and soil conditions.

Though seaside alder's native range is restricted to USDA Hardiness Zone 7 (average annual minimum temperature 10 to 0°F [-12.2 to -17.8°C]), field trials conducted at Iowa State University suggest the species could survive winters as cold as Zone 3 (average annual minimum temperature -30 to -40°F [-34.4 to -40°C]). Seaside alder might also show horticultural potential in nitrogen-poor and water saturated soils, though it can also thrive in well-drained sites. The same Iowa State University lab has also registered a cultivar derived from an *A. maritima* subsp. *oklahomensis* called 'September Sun' for possible future horticultural use.

Much of seaside alder's current limited distribution seems to have been caused by natural competition in maturing riparian habitats. It nonetheless serves as an interesting study species for the potential genetic consequences of high isolation and fragmentation within a tree species, a phenomenon that might be increasingly common in the future because of global climate change.

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A five-year-old hedge of *Alnus maritima* 'September Sun' shows off glossy foliage and golden fall-blooming staminate catkins.

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J. Matthew Jones recently completed an Isabella Welles Hunnewell internship at the Arnold Arboretum and is currently a Research Associate with the University of California Division of Agriculture and Natural Resources.

Alfred Rehder: His German Roots

Dr. Arnd Rüdiger Grimmer

The plants pull up namely the sap through the roots.
Carl Linnaeus (1773)

Plants depend on their roots, of course, but it can also be said that people depend, in the figurative sense, on their roots. This year, 2013, is the 150th anniversary of the birth of renowned botanist Alfred Rehder, and it provides a welcome opportunity to remember his family roots, youth, and education: in a word, his origin in Germany.

Childhood and Youth in Waldenburg

Alfred Rehder was born on September 4, 1863, in Waldenburg, Saxony (Kobuski 1950, Reed 1951, Rehder 1972). This small town on the banks of the Mulde river was the capital and seat of power of the principality Schoenburg-Waldenburg, a miniature state with limited sovereignty but a high level of culture. His father, Paul Julius Rehder (1833–1917), was employed there beginning in 1859 as Prince Otto Friedrich's (1819–1893) director of parks and gardens. As a high court official, he lived in a wing of the castle and it was here that his eldest son Georg Alfred was born. (Note: While Rehder himself used only the first name Alfred, the parish register at St. Bartholomäus church in Waldenburg shows Georg Alfred as the name on his baptismal certificate.)

Julius Rehder was responsible for maintaining and developing the famous old park Greenfield, as well as the castle's park and pleasure garden. On behalf of the Prince he developed grand plans to transform the picturesque surroundings of town and river into a magnificent park comparable to the famous parks in Woerlitz and Muskau. These plans were never realized for reasons of cost.

Julius Rehder was one of the notables of the town. Besides his work for the prince, he was an authority on all things horticultural. A very sociable man, he had a large circle of friends. He was temporarily chairman of the club "Harmony," an association of the citizens for the cultivation of social life, in competition to the court society. My grandfather, Richard Rüdiger (1864–1934), and his family were close friends of Rehder, and in 1892 Rehder designed the Rüdiger's garden.

Alfred Rehder's mother, Thekla (1839–1897), was the daughter of the physician and author Dr. Julius Schmidt (1796–1872) (Ruckdeschel 1872) in Hohenleuben, a small rural commune in the principality Reuss-Schleiz. A bit of mystery surrounds Julius Schmidt's origins, but there is strong evidence that he was an illegiti-

ARCHIVES OF THE ARNOLD ARBORETUM

Julius Rehder, father of Alfred Rehder, in an undated photograph.

A.WINKLER, WWW.LUFTBILDER-WINKLER.DE

Waldenburg castle, where Alfred Rehder was born, as it appears today.

mate son of Heinrich, Duke of Anhalt-Köthen (1778–1847) (Fischer 1940). Alfred Rehder's ancestors thus include the ducal family of Anhalt, one of the oldest families in the German nobility. Interestingly, the founder of the world-renowned parks and gardens of Woerlitz was also a member of this family.

In 1825, Schmidt was a co-founder and president of the *Voigtländischen Alterthums-forschenden Gesellschaft,* a historical society that still exists today. The scientific interests of Rehder's maternal grandfather went far beyond his profession. He was a proficient botanist; in his "*Topographie der Pflege Reichenfels*" (Schmidt 1827) he described more than 300 native plant species.

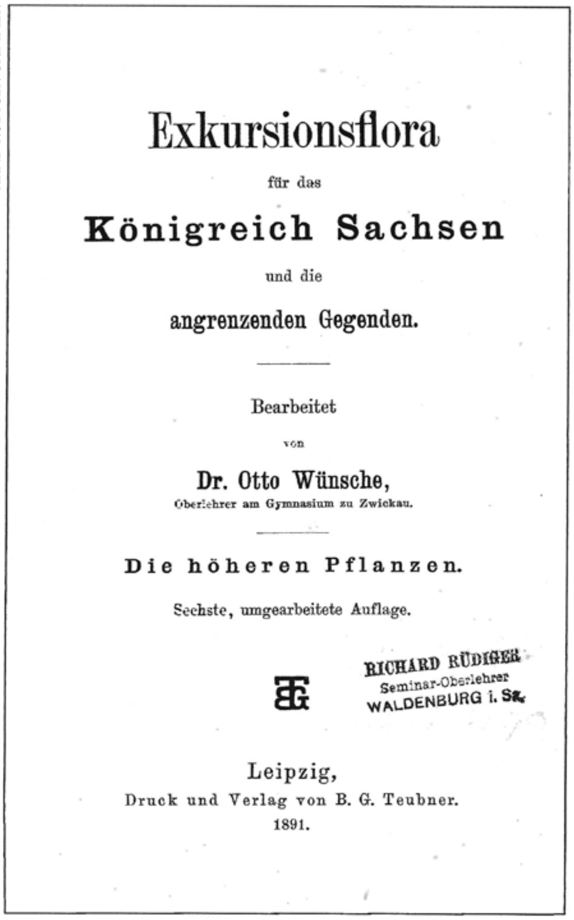
He also dealt with the influence of climate on horticulture. Schmidt suggested, first, that for each plant in the botanical literature the annual mean temperatures should be specified, in which "it thrives well, moderately, or not at all." Second, if the annual mean temperature would be explored for each area, these data "would save a lot of unnecessary tests to introduce new plant species" (Schmidt 1827). Exactly 100 years later, Alfred Rehder published his systematic investigation of plant hardiness zones and maps of these zones (Rehder 1927)—an ingenious further development of the ideas of his maternal grandfather and godfather.

After attending elementary school in Waldenburg, Alfred Rehder lived for two years in Berga/

ARND RÜDIGER GRIMMER

An 1840 coin featuring the profile of Heinrich Herzog von Anhalt-Köthen, Alfred Rehder's maternal great-grandfather.

ARND RÜDIGER GRIMMER



Exkursionsflora

für das

Königreich Sachsen

und die

angrenzenden Gegenden.

Bearbeitet

von

Dr. Otto Wünsche,

Oberlehrer am Gymnasium zu Zwickau.

Die höheren Pflanzen.

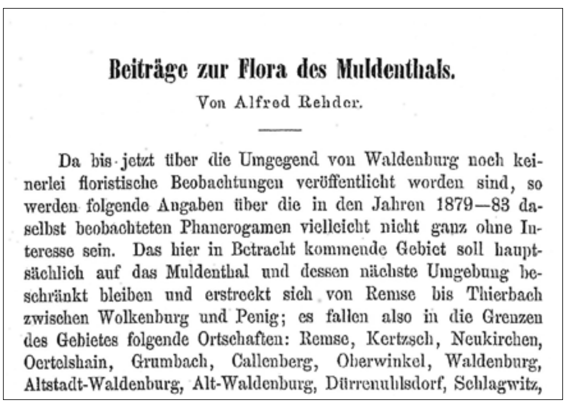
Sechste, umgearbeitete Auflage.

RICHARD RÜDIGER
Seminar-Oberlehrer
WALDENBURG i. Sa.

Leipzig,
Druck und Verlag von B. G. Teubner.
1891.

Frontispiece of the flora of Saxony written by botanist Otto Wünsche, who taught Alfred Rehder during his school days in Zwickau.

ARND RÜDIGER GRIMMER



Beiträge zur Flora des Muldenthals.

Von Alfred Rehder.

Da bis jetzt über die Umgegend von Waldenburg noch keinerlei floristische Beobachtungen veröffentlicht worden sind, so werden folgende Angaben über die in den Jahren 1879—83 daselbst beobachteten Phanerogamen vielleicht nicht ganz ohne Interesse sein. Das hier in Betracht kommende Gebiet soll hauptsächlich auf das Muldenthal und dessen nächste Umgebung beschränkt bleiben und erstreckt sich von Remse bis Thierbach zwischen Wolkenburg und Penig; es fallen also in die Grenzen des Gebietes folgende Ortschaften: Remse, Kertzsch, Neukirchen, Oertelshain, Grumbach, Callenberg, Oberwinkel, Waldenburg, Altstadt-Waldenburg, Alt-Waldenburg, Dürrenuhlsdorf, Schlagwitz,

By the age of 23 Alfred Rehder had written a flora for his home region in Saxony.

Elster with his uncle, the Reverend August Schillbach, who prepared him to attend high school. Here Rehder gained his thorough knowledge of Latin and Greek, which he would later use in shaping a variety of new plant names. Throughout his life he dealt with the question of historically and linguistically correct notation, including in his papers entitled "*Botanikerlatein*" (Botanist's Latin) (Rehder 1885) and "Origin of the name *Camellia*" (Rehder 1938). During this time his character development was molded by the modest but intellectual atmosphere of a Protestant parsonage. Alfred Rehder had a broad general education, and he was interested in matters far removed from horticultural and arboricultural fields. Kobuski (1950) reported that it was a joy to hear him tell of his younger days in Germany and the cultural life in which he participated.

Starting at Easter in 1876, he attended high school (*Gymnasium zu Zwickau*) in Zwickau. Here he met the teacher who would determine his future, Otto Wünsche (1839–1903), who was the most famous botanist in Saxony at the time. His plant identification book *Exkursionsflora für das Königreich Sachsen* (Flora of the Kingdom of Saxony) (Wünsche 1869) was, with its clear key and excellent analytical method, the model for all subsequent school floras. He gave lessons in botany and natural history, and "many a disciple was won by him for botany" (Schorler 1905), including Rehder.

In 1881, Alfred Rehder left the school without a high school diploma (Erler 1882) and went back to Waldenburg. He began a three-year apprenticeship as a gardener with his father. Being a gardener was not only his father's profession, it was the family tradition. His grandfather Jacob Heinrich Rehder (1790–1852) (Thietje 2003) had, as long-standing court gardener for Prince Pueckler, an essential part in the creation of Muskau Parks, and his great-grandfather, Friedrich August Schmidt, was court gardener of Count Carl von Brühl (1772–1837) in Pförten/Brody in Lower Lusatia.

In addition to his tireless practical work in gardening, Rehder also expanded his theoretical knowledge. Even during the apprenticeship, he published his first scientific paper "*Einiges Über Pilze*" ("About Mushrooms") (Rehder 1883). As a result of many walking tours through his Saxony countryside, his paper entitled "*Flora des Muldenthals*" (Rehder 1886) was written.

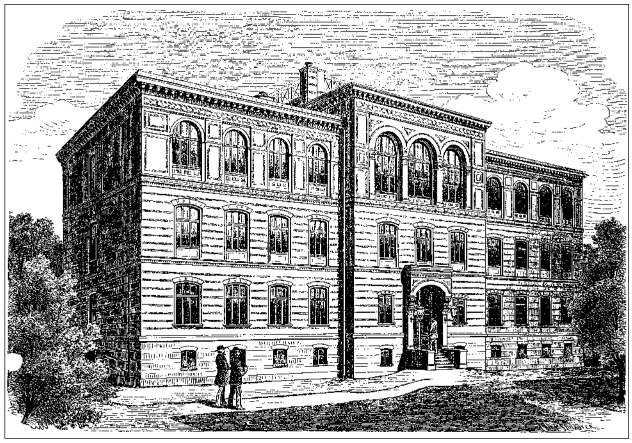
Rehder's Years of Travel

In March 1884, the apprenticeship was finished. Fourteen years of traveling then began for the young gardener, and during this period Rehder made himself familiar with all aspects of gardening work. First, he went to Berlin at the Botanical Garden of the Friedrich-Wilhelm-University and used the opportunity to gain new knowledge about taxonomy and field research. As first proof of his growing taxonomic skills, he gave a lecture at the 1886 meeting of the Association of Natural History in Zwickau. The 23-year-old spoke about beardmosses, and showed convincingly that the esteemed explorer Henry M. Stanley had made errors in the determination of this plant species (Anonymous 1886).

After an interlude in 1886 working with a flower grower in Frankfurt, he went to Muskau and worked for a year with Gustav Schrefeld (1831–1891), a disciple and successor of his grandfather (Jacob Heinrich Rehder was no longer alive.) In Muskau, Alfred Rehder lived with his grandmother Auguste. It is very likely that here he got to know his future wife, Anneliese (1875–1967), the daughter of Gustav Schrefeld. During this period he was especially interested in the well-known garden and tree nursery, Arboretum Muscaviense.

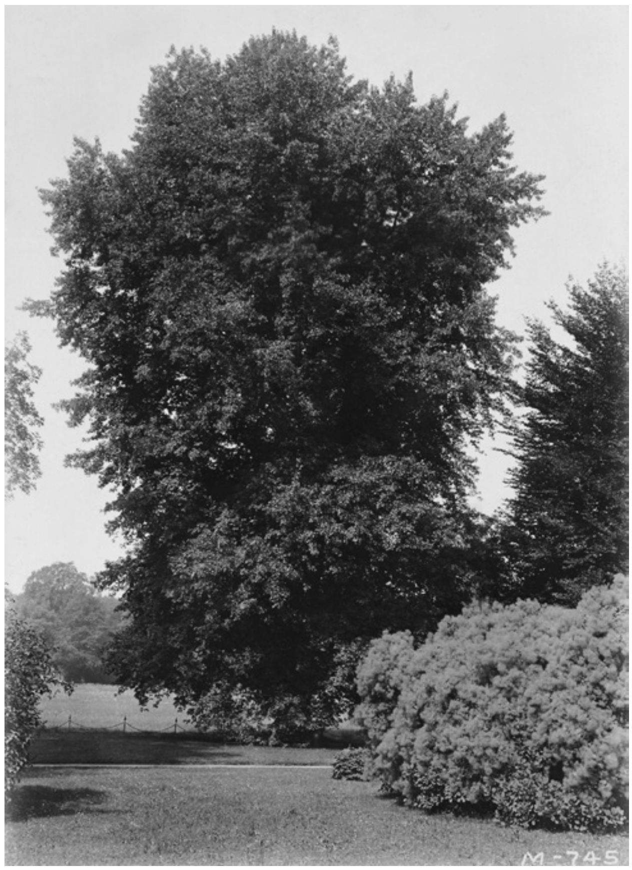
In 1888 he worked—now as head gardener—for a year at the Grand Ducal Botanical Garden of Hesse-Darmstadt. During the next six years he worked at the Botanical Garden of the University of Göttingen. Rehder was fully responsible for the entire garden and, with enthusiasm and vigor, immediately began a profound reorganization of the venerable institution. This earned him acclaim and also extended his research work, as he made contact with leading botanists and wrote more than 20 publications.

In 1890, Prince Otto of Stolberg-Wernigerode offered the University of Göttingen an area for a garden for the study of alpine plants on the Brocken, the tallest of the Harz Mountains. This *Brockengarten* was designed and created by Rehder. His later pioneering work on the hardiness of woody plants and developing hardiness zone maps was founded in his work at this garden.



ARND RÜDIGER GRIMMER

An 1888 illustration of the botanical museum in Berlin.



ARCHIVES OF THE ARNOLD ARBORETUM

A large silver maple (*Acer saccharinum*) and a cluster of smokebush (*Cotinus coggygria*) growing in Muskau Park, photographed by Alfred Rehder on July 24, 1901, during a return trip to Germany for research.

Brockengarten

Alfred Rehder was instrumental in the creation of the *Brockengarten,* a botanical garden designed for the study of alpine plants. After years of neglect in the 1970s and 1980s, the garden was reestablished in the 1990s. Today, alpine plants from many regions can be seen in the garden, with a weather station and telecommunications tower arising at the mountain's peak. Seen here, sky blue *Gentiana ternifolia* from China and *Calceolaria uniflora* from the Patagonia region in South America.

PHOTOS COURTESY OF DR. GUNTER KARSTE, NATIONAL PARK HARZ

However, the collaboration with his supervisor, Albert Peter (1853–1937), director of the Göttingen garden, soon proved to be very difficult. The professor saw in the only 10-years-younger colleague merely a practical working gardener, without academic training, and prohibited any independent decision-making. The situation was untenable, all attempts at mediation failed, and Rehder soon announced his resignation. As before, he used this time to change, to open up to a new field of work, and in 1895 he became editor of the leading German horticultural journal, *Möller's Deutsche Gärtner Zeitung.*

Rehder threw himself into journalism. In the three years from 1896 through 1898 he published a total of 120 articles on a wide range of horticultural and dendrological topics. His extraordinary ability to represent scientific results in a clear and persuasive form of writing emerged from this journalistic work.

13. Jahrgang. 1898.

Möller's

Deutsche Gärtner-Zeitung.

Herausgege... von
Ludwig Möller-Erfurt.

Verlag
von
Ludwig Möller in Erfurt.

ARCHIVES OF THE ARNOLD ARBORETUM

Rehder spent several years editing and writing for *Möller's Deutsche Gärtner Zeitung,* the leading German horticultural journal of the day.

A New Beginning in America

In the 1880s, grape phylloxera (an aphid-like insect that can damage or kill grapevine roots) spread in Germany and threatened to destroy the wine producing industry. American grape (*Vitis*) species were found to be resistant to phylloxera, so knowledge of these plants was indispensable for the survival of European wine production. In 1898 Rehder received from the German government a mandate to examine the *Vitis* species on the East Coast, while at the same time reporting about American horticulture for his journal. As a destination, he chose the Arnold Arboretum in Boston, which was part of Harvard University and, despite being in existence for only 26 years, was regarded as the center of American dendrology.

His initial reception in Boston was far from friendly, as the over-cautious port authorities had him summarily detained. Through the mediation of the founder and director of the Arnold Arboretum, Charles S. Sargent (1841–1927), he was set free. Rehder's launch into the United States was also difficult for him in economic terms, and for a while he improved his meager income by weeding in the Arboretum. Sargent quickly recognized the exceptional botanical skills of the young German and offered him a permanent position.

The next article in this issue describes the further development of the "*unübertrefflichen* [unsurpassable]" (Höfker 1927; Günther 1979) Alfred Rehder. His enormous talent and tireless energy enabled him to combine his family tradition with the resources of the Arnold Arboretum to become the most important dendrologist of the twentieth century.

Acknowledgement:

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ARCHIVES OF THE ARNOLD ARBORETUM

Alfred Rehder reading in the library of the Arnold Arboretum, 1898.

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Dr. Arnd Rüdiger Grimmer grew up in Waldenburg. He studied chemistry and worked for many years at the Academy of Sciences of the GDR and the Humboldt University–Berlin. Concurrent with his retirement he studies the regional history of the Principality of Schoenburg-Waldenburg and recently coordinated a 150th anniversary celebration of Alfred Rehder in Waldenburg.

Remembering Alfred Rehder

Lisa Pearson

Alfred Rehder sailed for America on the Cunard steamship *Cephalonia* in the spring of 1898. He had a small stipend from the gardening journal he worked for, *Möllers Deutsche Gärtner-Zeitung,* to gather material for articles. To supplement his income, Rehder applied to Charles Sprague Sargent, director of the Arnold Arboretum, for summer employment as a "working student" on the grounds. He was put to work weeding the newly planted shrub collection "by the vigorous use of the hoe," as he later recalled, his labors earning him the princely sum of $1.00 per day. Rehder had planned to return to Germany in the fall but Sargent, recognizing his potential value to the institution, convinced him to stay in Boston as an assistant in the Arboretum's herbarium.

Rehder's first major assignment came by way of Charles E. Faxon, curator of the herbarium and illustrator of Sargent's *Silva of North America.* Faxon had been approached by Liberty Hyde Bailey of Cornell University to prepare drawings for his *Cyclopedia of American Horticulture.* Faxon, who was busy with other projects, delegated this request to Alfred Rehder, who sent Bailey some illustrations as well as an article on *Aesculus* with a note explaining that his talents were better suited to writing than to drawing. Bailey was impressed by Rehder's work and had him write all the material on woody plants for the *Cyclopedia,* an assignment which took him over a year to complete. Rehder traveled to Europe for three months in the summer of 1901 to complete research for his monograph, *Synopsis of the Genus* Lonicera. There he studied specimens of honeysuckles—living plants and dried herbarium specimens—and began work on his next project, the *Bradley Bibliography.*

In 1900, Charles Sargent selected Rehder to compile the *Bradley Bibliography.* This five volume, 3,789-page work is "a guide to the literature of woody plants, including books and articles in the proceedings of learned societies and in scientific and popular journals, published in all languages to the end of the nineteenth century." Partial funding for its creation came from a gift by Abby A. Bradley in memory of her father William Lambert Bradley of Hingham, Massachusetts, who died in 1894. Bradley, who made his fortune in the chemical fertilizer industry, was devoted to the study of trees, and his daughter's gift was to promote the scientific activities of the Arboretum. Sargent decided that the donation would be best used to create a comprehensive and up-to-date bibliography of woody plants, which would in turn facilitate research activities by the staff. The assignment before Rehder was monumental, and to complete it he consulted every botanical library collection in the eastern United States, as well as making two trips to Europe to visit libraries in ten countries. He also employed consultants who sent additions to the *Bradley Bibliography* for material in languages in which he was not adept, such as Hungarian and Serbian. In the bibliography, the entries for publications that Rehder did not examine himself are marked with a small symbol, but those total fewer than five percent of the more than 100,000 entries. The first volume was published in 1911 with a further four volumes being issued through 1918. His work did not go unnoticed: Harvard University awarded Rehder an honorary Master of Arts degree in 1913 for his work on the *Bradley Bibliography.*

Rehder and Wilson

Rehder continued his compilation of the *Bradley Bibliography* through the publication of the first volume in 1911 and beyond for those remaining, but as herbarium assistant he also worked to identify the huge number of specimens brought back from China by Ernest H. Wilson on his 1907–1909 and 1910–1911 collecting trips. The 1907–1909 expedition alone produced over 50,000 herbarium sheets, and


ARCHIVES OF THE ARNOLD ARBORETUM

Alfred Rehder next to a rather sprawling specimen of *Magnolia stellata* in front of the Arboretum's Hunnewell Building. Photograph by R.W. Curtis, June 8, 1922.

seeds, cuttings, bulbs, and roots of over 1,000 species, some of them completely new, and all of which needed identification and classification. The documentation of this labor by Rehder and Wilson, as well as their colleagues George Russell Shaw and Camillo Schneider, was the three-volume *Plantae Wilsonianae: An Enumeration of the Woody Plants Collected in Western China for the Arnold Arboretum of Harvard University During the Years 1907, 1908, and 1910 by E. H. Wilson.* Rehder and Wilson would also collaborate on *A Monograph on Azaleas,* published in 1921, as well as a number of articles in the *Journal of the Arnold Arboretum.* In addition to their professional collaboration, they and their families were also genuine friends. In his letters to Rehder from Japan, Wilson often sends greetings from his wife Ellen to Rehder's wife Anneleise, and in a letter to Wilson from Breslau in 1930, Rehder familiarly tells about his having some "good Rhine wine."

Wilson's collecting trips to Japan in 1914, and Japan, Korea, and Formosa (Taiwan) in 1917–1919, as well as those of Joseph F. Rock from 1922 to 1927, swelled the herbarium holdings exponentially and provided a seemingly endless stream of plant material for analysis. In a 1926 letter to Elmer D. Merrill (then the Dean of the College of Agriculture at the University of California, Berkeley, and later Director of the Arnold Arboretum) Rehder laments, "Like you I am getting 'snowed under' with material coming in all the time." With the death of Charles Faxon in 1918, Rehder was appointed curator of the herbarium and during his 22-year tenure he increased the holdings by over 300,000 mounted specimens. Many of those sheets were


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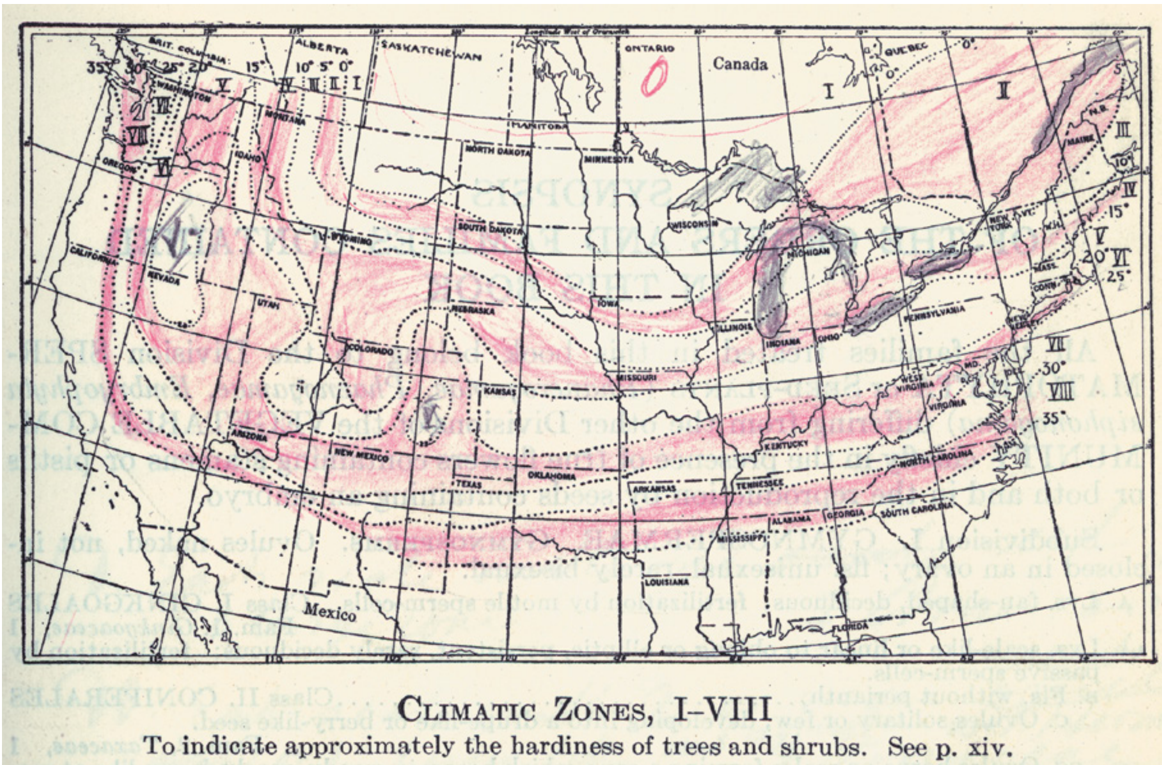
(Left to right) John George Jack, Alfred Rehder, Ernest Jesse Palmer, Clarence Kobuski, and Louis Victor Schmidt at a 70th birthday celebration for Rehder at the Arboretum, September 1, 1933.

Plant Hardiness Zone Maps

TODAY, plant hardiness zone information is found on everything from catalogs to plant labels in nursery pots, but less than 100 years ago there was no national map of hardiness zones for the United States. It was not until the publication of Alfred Rehder's *Manual of Cultivated Trees and Shrubs Hardy in North America* in 1927 that one became available, its publication predating the first USDA hardiness map by more than 30 years. This early map was divided into eight zones and did not include Florida, the southern portions of Texas and Louisiana, and it only took in the parts of Canada contiguous with the northern border of the United States. For the second edition of his *Manual,* Rehder used a modified version of a zone map published in 1936 by Donald Wyman that included more of Canada.

ARCHIVES OF THE ARNOLD ARBORETUM



The plant hardiness zone map, with colored pencil added by Rehder, in his personal copy of his 1927 *Manual of Cultivated Trees and Shrubs Hardy in North America.*

the product of Arboretum-sponsored expeditions such as those by Wilson and Rock, but through his network of colleagues at other institutions, Rehder also actively collected duplicate sets of their sheets to fill gaps in the Arboretum herbarium holdings of the flora of important regions.

Rehder as Writer and Editor

In 1919, Rehder took over the behind-the-scenes management of a new institutional periodical, the *Journal of the Arnold Arboretum.* He had lobbied for its creation to fill the gap left by the demise of *Garden and Forest* in 1897 and to provide a quarterly forum for articles more technical and lengthy than could be accommodated by the *Bulletin of Popular Information.* In his preface to volume one, issue one, Sargent summed up its purpose, "In its pages will appear notes on trees and shrubs with descriptions of new species and their relationships, letters from correspondents, and notes on the vegetation of countries visited by officers and agents of the Arboretum." While it was Sargent's name which appeared as editor at that time, the bulk of the production work, preliminary editing, and the authorship of many articles for the *Journal* fell on Rehder's shoulders. In 1926, Rehder

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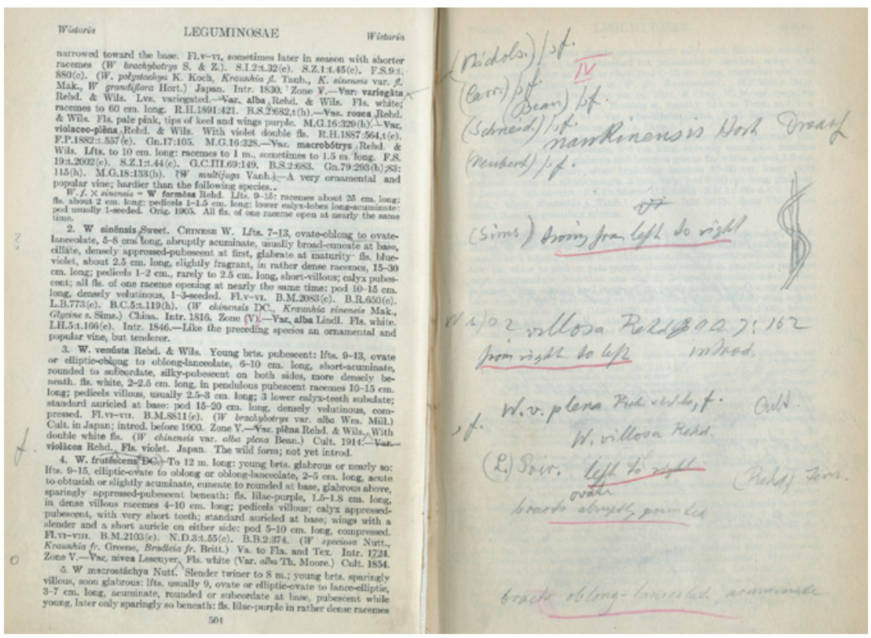
More than 60 plant taxa have been named in honor of Alfred Rehder. Seen here is *Clematis rehderiana*, a handsome clematis native to China and Nepal.

became joint editor to assist an increasingly frail Charles Sargent. With volume eight the next year, Rehder and Wilson assumed joint editorial control. Wilson's untimely death in an automobile accident in October 1930 caused more reorganization and Rehder assumed the role of senior editor with Joseph Horace Faull and Karl Sax as associate editors. In the following year Clarence Kobuski, Rehder's assistant in the herbarium, took over for Sax as joint editor and continued in this role until Rehder's retirement in 1940. At that time, A. C. Smith became editor as well as curator of the herbarium, and a ten-member editorial board was formed that included Alfred Rehder, who continued in this capacity until 1948, just a year before his death.

Charles Sprague Sargent, who had guided the Arnold Arboretum since its founding in 1872, died in March 1927 after several years of declining health. The institution was on shaky fiscal ground, forcing acting director Ernest Wilson to cut costs wherever he could. He trimmed the staff in Jamaica Plain and abroad, even curtailing Joseph Rock's plant collecting in western China. But in the midst of the turmoil, publication of Rehder's *Manual of Cultivated Trees and Shrubs Hardy in North America* provided a bright spot for the institution in that momentous year. The *Manual* presented "a systematic and descriptive enumeration of the cultivated trees and shrubs hardy in North America," and facilitated "their identification by means of analytical keys." It immediately became the go-to book for botanists and horticulturists alike. The book proved so useful and popular that it went to a second printing. In 1940, a completely revised second edition was issued, which took in new species and applied changes to rules and nomenclature adopted in the 1930 and 1935 International Botanical Congresses. Multiple reprintings of this second edition of the *Manual* have been made over the years, including a paperback version as recently as 2001. In the foreword to a commemorative 1986 reprinting of the *Manual,* botanist Theodore Dudley noted that Rehder "possessed an insatiable curiosity and outstanding originality, demanded of himself the very highest standards, and was dedicated to the systematics and biology of all woody plants."



Wistaria LEGUMINOSAE *Wistaria*

narrowed toward the base. Fl.v–vi, sometimes later in season with shorter racemes (*W brachybotrys* S. & Z.). S.I.2:t.32(c). S.Z.1:t.45(c). F.S.9:t. 880(c). (*W. polystachya* K. Koch, *Kraunhia f.* Taub., *K. sinensis* var. *f.* Mak., *W grandiflora* Hort.) Japan. Intr. 1830. Zone V.—Var. **variegata** Rehd. & Wils. Lvs. variegated.—Var. **alba** Rehd. & Wils. Fls. white; racemes to 60 cm. long. R.H.1891:421. B.S.2:682,t(h).—Var. **rosea** Rehd. & Wils. Fls. pale pink, tips of keel and wings purple. M.G.16:329(h).—Var. **violaceo-plèna** Rehd. & Wils. With violet double fls. R.H.1887:564,t(c). F.P.1882:t.557(c). Gn.17:105. M.G.16:328.—Var. **macrobótrys** Rehd. & Wils. Lfts. to 10 cm. long: racemes to 1 m., sometimes to 1.5 m. long. F.S. 19:t.2002(c). S.Z.1:t.44(c). G.C.III.69:149. B.S.2:683. Gn.79:293(h);83: 115(h). M.G.18:133(h). (*W multijuga* Vanh.)—A very ornamental and popular vine; hardier than the following species.

W. f. × *sinensis* = **W formòsa** Rehd. Lfts. 9–15: racemes about 25 cm. long: fls. about 2 cm. long: pedicels 1–1.5 cm. long: lower calyx-lobes long-acuminate: pod usually 1-seeded. Orig. 1905. All fls. of one raceme open at nearly the same time.

2. **W sinénsis** Sweet. Chinese W. Lfts. 7–13, ovate-oblong to ovate-lanceolate, 5–8 cm. long, abruptly acuminate, usually broad-cuneate at base, ciliate, densely appressed-pubescent at first, glabrate at maturity: fls. blue-violet, about 2.5 cm. long, slightly fragrant, in rather dense racemes, 15–30 cm. long; pedicels 1–2 cm., rarely to 2.5 cm. long, short-villous; calyx pubescent; all fls. of one raceme opening at nearly the same time: pod 10–15 cm. long, densely velutinous, 1–3-seeded. Fl.v–vi. B.M.2083(c). B.R.650(c). L.B.773(c). B.C.5:t.119(h). (*W chinensis* DC., *Kraunhia sinensis* Mak., *Glycine s.* Sims.) China. Intr. 1816. Zone (V).—Var. **alba** Lindl. Fls. white. I.H.5:t.166(c). Intr. 1846.—Like the preceding species an ornamental and popular vine, but tenderer.

3. **W. venústa** Rehd. & Wils. Young brts. pubescent: lfts. 9–13, ovate or elliptic-oblong to oblong-lanceolate, 6–10 cm. long, short-acuminate, rounded to subcordate, silky-pubescent on both sides, more densely beneath. fls. white, 2–2.5 cm. long, in pendulous pubescent racemes 10–15 cm. long; pedicels villous, usually 2.5–3 cm. long; 3 lower calyx-teeth subulate; standard auricled at base: pod 15–20 cm. long, densely velutinous, compressed. Fl.vi–vii. B.M.8811(c). (*W brachybotrys* var. *alba* Wm. Mill.) Cult. in Japan; introd. before 1900. Zone V.—Var. **plèna** Rehd. & Wils. With double white fls. (*W chinensis* var. *alba plena* Bean.) Cult. 1914.—Var. **violácea** Rehd. Fls. violet. Japan. The wild form; not yet introd.

4. **W. frutéscens** DC.—To 12 m. long: young brts. glabrous or nearly so: lfts. 9–15, elliptic-ovate to oblong or oblong-lanceolate, 2–5 cm. long, acute to obtusish or slightly acuminate, cuneate to rounded at base, glabrous above, sparingly appressed-pubescent beneath: fls. lilac-purple, 1.5–1.8 cm. long, in dense villous racemes 4–10 cm. long; pedicels villous; calyx appressed-pubescent, with very short teeth; standard auricled at base; wings with a slender and a short auricle on either side: pod 5–10 cm. long, compressed. Fl.vi–viii. B.M.2103(c). N.D.3:t.55(c). B.B.2:374. (*W speciosa* Nutt., *Kraunhia fr.* Greene, *Bradleia fr.* Britt.) Va. to Fla. and Tex. Intr. 1724. Zone V.—Var. **nivea** Lescuyer. Fls. white (Var. *alba* Th. Moore.) Cult. 1854.

5. **W macrostáchya** Nutt. Slender twiner to 8 m.; young brts. sparingly villous, soon glabrous: lfts. usually 9, ovate or elliptic-ovate to lance-elliptic, 3–7 cm. long, acuminate, rounded or subcordate at base, pubescent while young, later only sparingly so beneath: fls. lilac-purple in rather dense racemes

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ARCHIVES OF THE ARNOLD ARBORETUM

Rehder had blank pages bound into his personal copy of the *Manual of Cultivated Trees and Shrubs Hardy in North America* so that he could write notes and corrections.

ARCHIVES OF THE ARNOLD ARBORETUM

Rehder made many images of plants at the Arboretum and elsewhere, including this 1898 photo of an American elm (*Ulmus americana*) at the corner of Green Street and Rockview Street in Jamaica Plain (near the Arboretum). A note from 1936 indicates that it was the second largest tree in Boston at the time, though now, sadly, it no longer exists.

Rehder (right) posed with his wife Annaliese (left) and others at the base of the famed "drive-through" giant sequoia (*Sequoiadendron giganteum*) known as Wawona in the Mariposa Grove in Yosemite National Park on July 14, 1939.

Rehder's Legacy

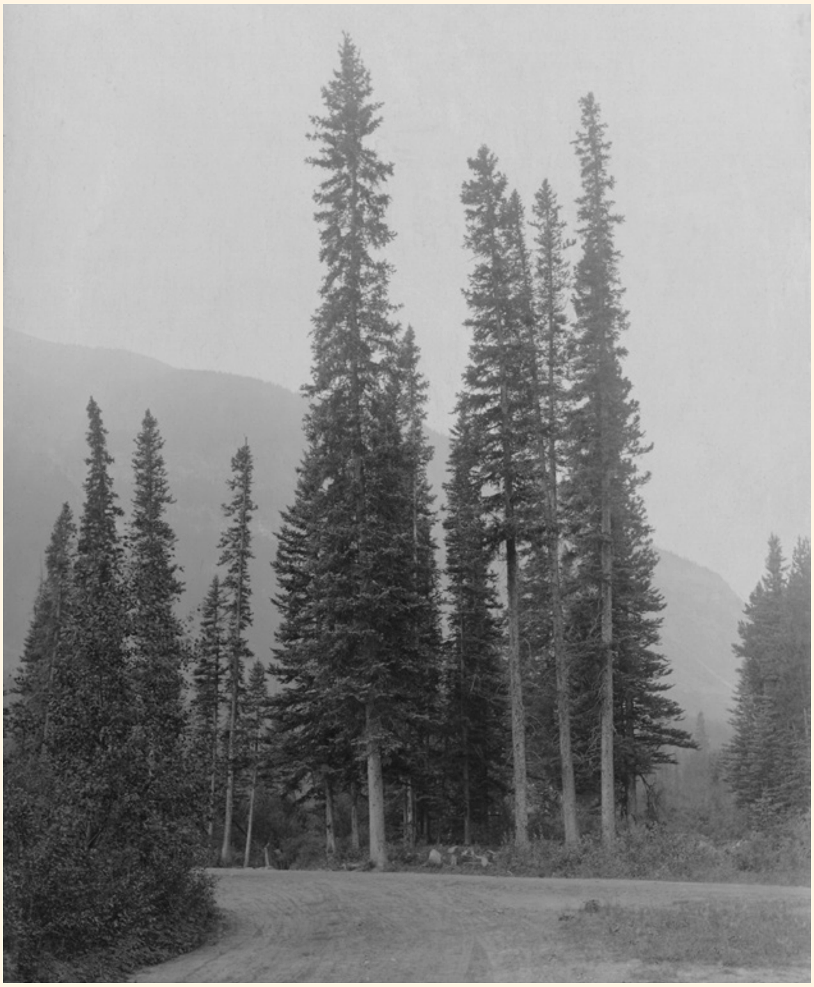
Alfred Rehder was well respected by his colleagues at the Arboretum and elsewhere, and by all accounts was also extremely well liked by everyone who knew him. He was a mentor to many of the younger Arboretum staff; his assistant in the herbarium, Clarence Kobuski, considered it a privilege to have worked with him and remembered him as even-tempered and fatherly. Outside of work, Rehder was a cultured man who had especially enjoyed attending the opera when he lived in Germany, but who also delighted in tending his garden and caring for the wild birds which came to his feeders and birdbath.

The year 1940 marked Rehder's seventy-seventh birthday and the maximum age he could continue to work for Harvard University. He reluctantly retired from the Arboretum but retained an office for his use in the Hunnewell Building where he filled his time with a final great project, the *Bibliography of Cultivated Trees and Shrubs, Hardy in the Cooler Temperate Regions of the Northern Hemisphere.* It "assembled the accepted names, with synonyms, of all the entities treated in his Manual," and then provided citations in the botanical literature for those names. It was a project long in the making; Rehder had been assembling a card catalog since 1915 of references for use in the *Bibliography.* By the time he got around to writing it there were nearly 150,000 cards of citations. Rehder completed and saw the book to press in June 1949. In July 1949 he died quietly at his home on Orchard Street, in

Finding the Dwarf Alberta Spruce

IN 1904, Alfred Rehder and John George Jack, Professor of Dendrology at the Arnold Arboretum, went on a plant collecting expedition to the Canadian Rockies. While waiting for a train near Lake Laggan, Alberta, they decided to take a walk. On their stroll they came upon a remarkable dwarf form of the local variety of white spruce (*Picea glauca* var. *albertiana*). Seedlings were sent back and the one surviving plant grew into a fine specimen. With its dense, almost perfectly conical growth, extreme cold hardiness, and ease of propagation, dwarf Alberta spruce (*P. glauca* var. *albertiana* f. *conica*) was soon adopted by the nursery trade and is now ubiquitous in gardens and container plantings. Two accessions (11586 and 182-2005) of this popular garden plant may be found in the Arboretum's Conifer Collection and the Leventritt Shrub and Vine Garden.

NANCY ROSE

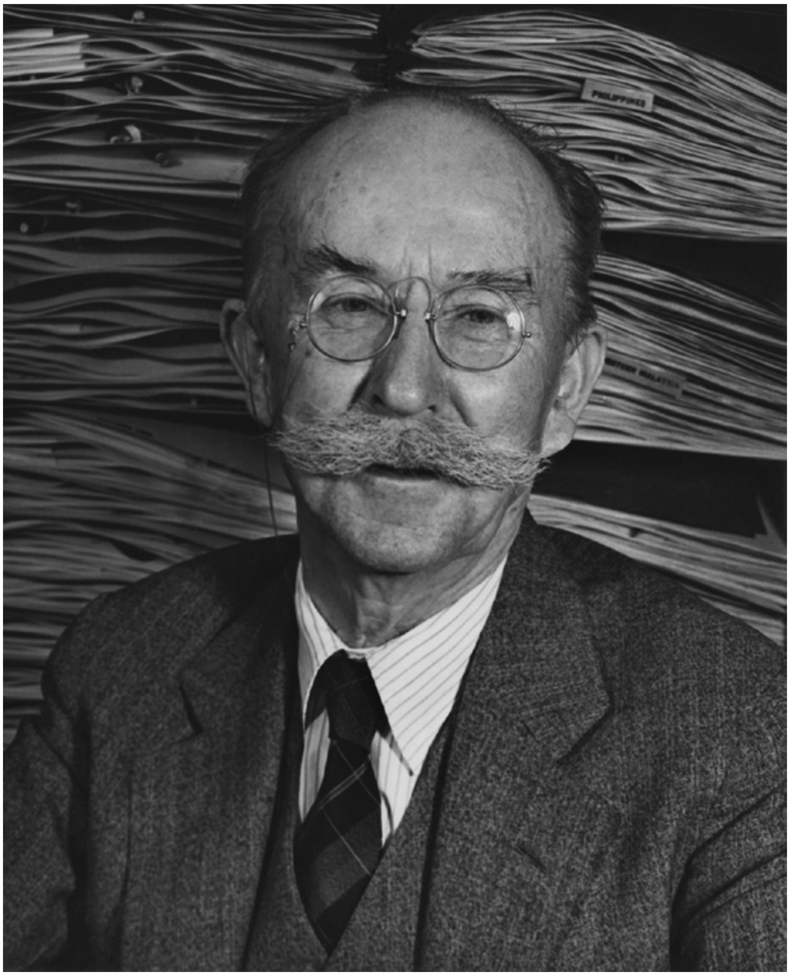


ARCHIVES OF THE ARNOLD ARBORETUM

A stand of *Picea glauca* var. *albertiana* photographed by Alfred Rehder in August 1904 near Banff, Alberta, and a potted specimen of the now widely-grown dwarf Alberta spruce.

Jamaica Plain, just steps from the Arnold Arboretum where he had spent more than half a century. He left an extensive botanical library which, with the help of Elmer D. Merrill, his family sold to the National Museum in Manila whose library and collections had been destroyed in the Second World War.

Alfred Rehder's career was no doubt aided by his immigration to the United States, where, with hard work and intelligence, he could make a name for himself professionally despite the lack of a university degree. Rehder also happened to be in the right place at the right time; his arrival coincided with an increasing institutional interest in Asian plant exploration. His depth of knowledge and attention to detail were recognized and would prove invaluable for the growth of the Arnold Arboretum through the first half of the twentieth century.



ARCHIVES OF THE ARNOLD ARBORETUM

A 1939 portrait of Alfred Rehder with herbarium specimens behind him.

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Lisa Pearson is Head of Library and Archives at the Arnold Arboretum.

Dispersal

Anna Laurent

Editor's Note: Presented here is a sampling of photographs from *Dispersal,* a project by writer and photographer Anna Laurent. *Dispersal* will be on display in the Arnold Arboretum's Hunnewell Visitor Center from October 26, 2013, to January 26, 2014.

Seed pods are incredible little vessels tasked with protecting seeds as they mature, and assisting with their dispersal. *Dispersal* explores how species have evolved different forms to fulfill these common functions. Individually, each photograph is a fine art portrait of a unique botanic specimen; as a series, the collection becomes a visual and scientific inquiry into the diversity of botanic design. Each specimen profile includes text exploring the seed pod's relationship to its parent plant and natural environment, and a bit about its ethnobotanical history. The project explores questions of structure and behavior: Why are the magnolia's seeds red? Why do lotus seeds remain dormant for so long? Why do some trees hold onto their fruits until the seeds have dispersed, while others release the entire vessel?

The project began in Southern California, where I began collecting seed pods—dangling from tree canopies and lodged between sidewalk cracks—in my urban Hollywood neighborhood. I have since collected specimens in the rain forests of Hawaii, the deserts of northern Iraq, and ecologies throughout the United States, including the Arnold Arboretum.

Seed structures were collected from sites as lush as Lotusland in California (seen here, *Nelumbo nucifera*) and as sere as the foothills of Kurdistan. All photos by the author.

Hawaiian wood rose (*Merremia tuberosa*)

Collected: February 2012 in Hilo, Hawaii

Merremia tuberosa **is an exquisite specimen, this dowager of the woods: a morning glory in youth, a rose in death—its tubular, yellow blossoms are lovely, but hardly memorable. Then, in its senescence, the callow flowers are replaced by the vestments of old age—a dried calyx, a delicate globe that envelops its seeds. I was introduced to the species on a collecting trip in Hawaii last winter. Its native range is Central America, but *Merremia tuberosa* has traveled the high seas to appear in dried flower arrangements in India, the Cook Islands, and French Polynesia. On the leeward side of the island, they blossom liberally along roadsides. Each pod nurtures four black seeds, nested together like a tiny teacake. Ballooning high on a vine, the papery vessels are perfectly positioned to tumble towards new soil, catch a breeze, or drift along in the tide. Hawaii is a good climate for all these dispersal mechanisms, perhaps most of all by water. The seeds occasionally appear along beaches, and more often are carried locally via streams and storm runoff. Hawaiians have names for many of their plants, and the wood rose is no exception. They call it Pilikai, which means "close to the ocean."**

Oriental poppy (*Papaver orientale*)

Collected: September 2010 in Portland, Oregon

European plant collectors gathered seeds from mountains adjacent to the Euphrates River in the early eighteenth century, and the species has since dispersed in temperate regions throughout the world, including the Pacific Northwest and gardens in Portland, Oregon. With its tomato-red petals and eggplant-colored anthers, the *Papaver orientale* blossom has long been a darling of botanical illustrators. It is beautiful. The seed pod, however, better reveals the unusual morphology common to species in the Papaveraceae family: there is no style, instead a collection of sessile stigmas radiates atop the ovary, now swelling above a tangle of dehiscent anthers. When mature, seeds are released through small apertures that open below the stigmatic disc. The puckered pod shivers in the breeze, tossing small black bits like a pepper-pot.

Lotus (*Nelumbo nucifera*)

Collected: September 2011 at Lotusland Garden in Montecito, California

Lotus seeds are botanically renowned for their patience—or, more accurately, "persistent seed dormancy." When they tumble into the water from a bowed stem and ripened pod, *Nelumbo nucifera* seeds will not germinate right away—sometimes, not for many centuries. Instead, they collect together in what becomes an underwater seed bank. It's a survival strategy, one with two-fold functionality in the genus *Nelumbo*. First, seed dormancy prevents new plants from competing with their parents. A single lotus plant can spread quickly, cultivating an entire fresh water pond in a couple years. Any young plant would have little chance of survival in such a densely populated environment. Instead, the seed remains safely buried underground. When catastrophe strikes, viable *Nelumbo* seeds will regenerate a stricken population (this natural-disaster-contingency is a common explanation for plants that exhibit seed dormancy). The second reason is more particular to the lotus. With their nutritious rhizomes, a pond of *Nelumbo* is a food bank for aquatic herbivores. A family of muskrats or beavers will establish residence and remain for several generations, leaving only when they've eaten the entire root system. If new seeds were to germinate, they'd be consumed as well. It's a good idea, then, to wait until the hungry muskrats depart the pond in search of new tubers. Then, the seeds have a safe—and open—space to grow.

Fleshy-flowered Spindletree (*Euonymus carnosus*)

Collected: October 2012 at the Arnold Arboretum in Boston, Massachusetts

In the fall, the Arnold Arboretum's grove of *Euonymus* trees is a pink haze of plump ornaments. Trees in the genus are characterized by their inconspicuous green or yellow flowers, while the fruits are brightly-colored capsules that split open to reveal seeds covered in an equally bright arillus. Like many other species in the genus, *Euonymus carnosus* appeals to its primary seed dispersal agent—birds—with small flashes of red fleshy skin, from which the black seeds seem to coalesce like droplets. Birds, attracted to red wavelengths, pluck the seeds and consume the wattle-like skin. The seeds are carried for the length of the courier's digestive tract, then dispersed. The specific epithet, *carnosus,* translates to "fleshy," which refers to the thick flower petals and fruits. *Euonymus* means "aptly-named," an etymology with origins in Greek mythology. The genus of fiery-leaved trees was believed to descend from Euonyme, the mother of the Furies, as the fruits of the tree are beautiful but can be poisonous. *Euonymus carnosus* is native to forests and woodlands in parts of China and Japan; multiple accessions of this species have grown well at the Arnold Arboretum.

Empress Tree (*Paulownia tomentosa*)

Collected: October 2012 at Lotusland Garden in Montecito, California

Like scales of a fish or feathers on a bird, *Paulownia tomentosa* seeds nest in tight formation—as many as 2,000 to a pod, packed in four interior compartments. Woody, beaked capsules hinge open from a high canopy (often 10 to 25 meters [33 to 82 feet] above ground), offering seeds a long trajectory to seek new ground. Autumn gusts conjure clouds of silvery wings that billow to earth by the millions. *P. tomentosa* flowers are no less marvelous: tubular purple blossoms believed to endow eternal youth in its native China, where it was first recorded in the third century BCE. Today, its prized wood is carved into bridal chests and coffins in Japan and elsewhere. The tree reached American shores in two ways: as an introduced ornamental tree, and, apparently, as a sort of stowaway. There are accounts of its entry as packing material for nineteenth-century Chinese porcelain exports. Traveling major cities by rail or ship, the crates left seeds in their wake—a legacy of empress trees.

Astragalus

Collected: June 2011 near Jarmo, Kurdistan, northern Iraq

It's not always easy—or possible—to identify a seed pod collected in the wild. I found these in the Iraqi steppe near Jarmo, a neolithic farming site in Kurdistan's foothills, one of the first settlements to cultivate grains. I was working on a documentary about the future of agriculture in the Fertile Crescent, and, as we were finishing an interview with an antiquities curator, I set down my camera to collect these capsules. They would prove difficult to identity. One can often refer to a flora (a manual listing all plants in a country), but Iraq lacks this document. Begun years ago, it was delayed due to wars and sanctions. Botanists from Iraq and the Royal Botanic Garden Edinburgh have recently resumed the project, but it will take a while. Having yet to collect this species in Iraq's vast desert wilderness, none of the botanists were able to identify the pods. Meanwhile, I've tentatively named it an *Astragalus* and have sought confirmation from an *Astragalus* expert in neighboring Iran. When he replies to my query, I'll have a line to contribute to Iraq's flora.

Anna Laurent is a flora-focused writer, producer, and photographer.

Standing Tall: The Upright Swede (*Tilia cordata* 'Swedish Upright')

Michael S. Dosmann

Some fifty years ago, the Arnold Arboretum introduced a cultivar of littleleaf linden (*Tilia cordata*) to the world. In the same issue where the Arboretum witchhazel introduction *Hamamelis* × *intermedia* 'Arnold Promise' was officially published, Donald Wyman (1963) lauds the merits of an unusual linden with a narrow habit, bestowing upon it the name 'Swedish Upright'. At the time of its registration, the original tree (accession 12112-A) growing atop Peters Hill was 35 feet (10.7 meters) in height and had a width of just 15 feet (4.6 meters). (In the *Arnoldia* article, the numeral 1 was accidentally left off the 15, suggesting an even more narrow spread—perhaps a 'Swedish Pencil' instead!) Well before the official registration and publication of the cultivar name, the tree was being watched. Its slenderness was noted as early as 1950, and a photo of it graced the cover of the July 15, 1960, issue of *American Nurseryman,* with an accompanying article by Wyman promoting the then yet-to-be-named cultivar's habit. He described how "the upper branches are slightly upright; just above the middle they are horizontal, and below that they are markedly drooping to pendulous." The form, he notes, is akin to that of pin oak (*Quercus palustris*).

And where did this tree originate? Over 100 years ago, the Arboretum acquired propagation material from taxonomist Alfred Rehder, whose legacy appears throughout this issue. Little is known about the original source beyond the fact that scions arrived from Sweden in 1906. It is not known if Rehder brought the material with him, or sent it to Boston while he was in Europe conducting research in preparation for the *Bradley Bibliography.* Although there is no mention as to why Rehder was interested in the scions in the first place, it is likely that he recognized an unusual habit on a particular tree in Sweden and thought it worth procuring for the Arboretum's collection.

The original tree currently stands 42.5 feet (13 meters) tall, with a maximum spread of 19.5 feet (5.9 meters), although functionally the width is less. Its trunk diameter at breast height is 18.75 inches (47.5 centimeters). This centenarian is in good health and will, we hope, continue on for many more years. Two younger accessions (one from 1961 and another from 1991), clones of the original tree, also grow in the Arboretum collections and share the lean attributes of the original.

Tilia cordata is appreciated for its ability to grow in a wide array of environments—sites that range from parks and landscapes to street edges with poorer soils. Too often, I see littleleaf lindens (usually one of the many available cultivars such as 'Greenspire') shoehorned between the street and the side of a building, where they struggle to survive with limited space and often succumb within a few years. I often wonder how 'Swedish Upright' would do instead. Assuming it possesses the stress tolerance of the species (and there is no reason to think otherwise), I like to think it would do very well. Like the rest of the littleleaf lindens, 'Swedish Upright' produces deep green, slightly glossy leaves that may develop shades of yellow in the autumn. Small, fragrant, yellowish flowers are produced in early to mid summer, and are followed by the fruits—small, globose nutlets with accompanying strap-like bracts that mature from pale green to tan.

In the 1963 *Arnoldia* article about 'Swedish Upright' Donald Wyman credited Rehder for originally selecting the plant, but he missed the opportunity to mention that in the very month the cultivar was registered (September 1963), Alfred Rehder would have turned 100. Today, we can celebrate both Rehder's 150th birthday and the 50th anniversary of this handsome tree's introduction.

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