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Front cover: Sarracenia leucophylla growing in the bog garden at the Atlanta Botanical Garden. The species name was published by Rafinesque in 1817. Photo by Daniel Mosquin.

Inside front cover: Diervilla sessilifolia is one of the Center for Plant Conservation species assigned to the Arnold Arboretum. Photo by Michael Dosmann.

Inside back cover: Flowers and developing fruits of Dipelta floribunda. Photo by Nancy Rose.

Back cover: Trunk of the type tree of Metasequoia glyptostroboides in Modaoqi, western Hubei, China. Photo by Zsolt Debreczy and István Rácz.

Constantine Rafinesque, A Flawed Genius

Daniel Mosquin

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Stenanthium was first proposed as a subgenus of *Veratrum* L. by Asa Gray in 1837. Rafinesque had already suggested this group be recognized as its own genus, named by him as *Anepsa*, in 1832. When it was generally agreed upon that this group of species should indeed be considered its own genus, Rafinesque's earlier contribution was disregarded, and Gray's *Stenanthium* was conserved instead. Pictured here is *Stenanthium occidentale* A. Gray.

Viburnum rafinesqueanum—to a teenaged boy in Manitoba beginning to learn the scientific names of plants, this moniker stood out. *Poa pratensis*? Meadow grass or Kentucky bluegrass (*pratensis* = “of a meadow”). *Caltha palustris*? Marsh marigold (*palustris* = “of a marsh”). *Aquilegia canadensis*? Canada columbine or red columbine. *Viburnum rafinesqueanum*? Here was a mess of near-impenetrable letters, a poetic delight to my ears when recited, which I soon learned honored a man named Rafinesque. A few years later in a floristics lecture, the good-natured eye-rolling reaction of the professor to my question about Rafinesque started a broader curiosity about the man.

Constantine Samuel Rafinesque was among the great American naturalists of the nineteenth century. He was also among the most controversial and eccentric natural history personalities of his time. In the course of four decades, he offended nearly every establishment botanist in the United States, leading to a disdain that persisted among these botanists and succeeding generations of their students. As one result, his contributions to botany and other natural history sciences were downplayed or ignored for many decades beyond his death in 1840. His reputation has been mended somewhat since the mid-nineteenth century, as those he interacted directly with passed away and several twentieth-century historians critically examined his life and work. What emerges is that the man was a flawed genius, whose inability to work within the bounds of scientific convention necessarily led to lower recognition than he would otherwise have deserved.

To immediately give an idea of Rafinesque and aspects of his personality, it is perhaps best to learn of his many roles in his own words:

“Versatility of talents and of professions, is not uncommon in America; but those which I have exhibited in these few pages, may appear to exceed belief; it is a positive fact that in knowledge, I have been a Botanist, Naturalist, Geologist, Geographer, Historian, Poet, Philosopher, Philologist, Economist, Philanthropist ... By profession, a Traveller, Merchant, Manufacturer, Collector, Improver, Professor, Teacher, Surveyor, Draftsman, Architect, Engineer, Pulmist [one who treats pulmonary diseases], Author, Editor, Bookseller, Library, Secretary ... and I hardly know myself what I may not become as yet: since whenever I apply myself to any thing, which I like, I never fail to succeed if depending on me alone, unless impeded and prevented by lack of means, or the hostility of the foes of mankind.”

RAFINESQUE'S LIFE

Rafinesque was Turkish-born to a French father and a mother of German descent on October 22, 1783. He was reared in Marseilles, France, by his mother and his father's family; his father was a merchant trader who spent much time abroad. In 1792, his family fled to Italy to escape the French Revolution. A year later, his father died during a yellow fever epidemic in Philadelphia. Rafinesque returned to France in 1797, where he remained until 1802.

At the age of 19, he landed in Philadelphia for three years, where his passion for botanizing the United States started immediately. He asserted that the brassicaceous *Draba verna* L. he picked up after stepping off the ship was a new species, as he generally believed that American counterparts of well-known European species could not be the same species. It is also in Philadelphia where he began to write books and papers. In 1805, he returned to Italy where he resided for a decade (occasionally living under the name Constantine Samuel Rafinesque Schmaltz, in order to avoid anti-French sentiment). Here, he married in 1809, had a daughter born in 1811 and an infant son who perished in 1814. A return to the United States was made in 1815, though the boat he was traveling on was ship-



LIBRARY OF THE ARNOLD ARBORETUM

Image of Constantine Rafinesque on the frontispiece of his 1815 publication *Analyse de la nature*.

wrecked off Long Island and he lost much of his collections and notes. Rafinesque lived in New York for three years, and helped to found the Lyceum of Natural History of New York. In 1818, a brief residence of under two years was made in Philadelphia, before undertaking a posting as Professor of Natural History at Transylvania University in Lexington, Kentucky, from 1819 to 1826. Post-professorship, he returned to Philadelphia for the remainder of his life. On September 18, 1840, he died of stomach cancer.

TAXONOMIC CONTROVERSIES

Botanist, taxonomic scholar, and former director of the Arnold Arboretum Elmer Drew Merrill completed the voluminous *Index Rafinesquianus* in 1949 wherein he attempted the Herculean task of compiling the botanical work



Anemion hallii (A. Gray) J. R. Drummond & Hutchinson is a member of the Ranunculaceae (buttercup family). The name *Anemion* was published in 1820 by Rafinesque. The *Flora of North America* account for the genus states: "North American taxonomists tend to retain the North American species in *Isopyrum* L. whereas taxonomists elsewhere recognize *Anemion*."



Rafinesque proposed the genus *Olsynium* in 1836. While occasionally used by other taxonomists (especially in the early twentieth century), the name did not receive widespread use until the late twentieth century. Instead, this species was typically placed in *Sisyrinchium*. *Olsynium douglasii* (A. Dietrich) E. P. Bicknell (seen here) was published in 1900.

of Rafinesque. Merrill seems to be ultimately sympathetic to Rafinesque, declaring:

"It is doubted if in the entire history of descriptive biology there is any other author who has suffered more from the weight of authority than Rafinesque. The leading biologists of his time, both in Europe and in America, ignored his numerous nomenclatural proposals to an extraordinary degree, whether he was correct in his conclusions or not."

However, from the perspective of a taxonomist, Merrill also states:

"After years of effort devoted in part to a consideration of the unending series of problems in botany alone, raised by Rafinesque's work, my frank conclusion is that in taxonomy and nomenclature we would have been infinitely better off today had Rafinesque never written or published anything appertaining to the subject."

How did Rafinesque engender such a conclusion? The answer begins with the nomenclatural system developed by Carl Linnaeus, the father of modern taxonomy. Prior to Linnaeus, the names of species were descriptive Latin polynomials (i.e., multiple words were used as a name). Linnaeus simplified this system to the consistent use of binomials, with the first word representing the genus or group (e.g., *Acer*, the maples) and the second representing the specific epithet (e.g., *rubrum*, or red). Combined with the author who first (validly) published the name, a species name is created, for example, *Acer rubrum* L. (L. is an abbreviation for Linnaeus). Linnaeus's system quickly became adopted by other scientists and remains in widespread use today.

A later addition to the Linnaean system was the concept of type specimens. The underlying idea of type specimens is that a name (an abstract notion) must be connected to a physical object, which provides an example of the taxon. Most often this type specimen is a dried herbarium specimen, but it can also be an illustration. Type specimens provide taxonomists with a way to re-examine the specimens that led to the establishment of a new species or presently define a species (in instances where a species was named prior to the concept of typification or where the type specimen was lost



The genus *Lomatium* was proposed in 1819. It did not see much use for the next century, as critics declared it too close to the name *Lomatia* R. Br. (Proteaceae). Coulter and Rose briefly adopted it in a 1900 monograph of the Umbelliferae, but it didn't see widespread use until 1920 when Macbride pointed out that, according to the rules of botanical nomenclature, it was a valid generic name despite the similarity to *Lomatia*. Seen here, *Lomatium brandegeei* (Coulter & Rose) J.F. Macbr. is native to British Columbia and Washington.

due to fire or other disasters), a nod to the principle of reproducibility in the scientific method.

An additional, and critical, concept to understanding the controversy surrounding Rafinesque is that the Linnaean system makes no attempt to define the boundaries of taxa. Though a hierarchical framework is provided, the questions of "What is a species?" or "What constitutes a genus?" are left to the determination of taxonomists. This leeway gives the taxonomist much latitude in determining what might constitute a taxon. If the taxonomist errs on making too broad of a definition (i.e., "lumps" too much variability within a taxon), it increases the likelihood that her or his work will be revised by the next taxonomist to examine the taxon. Similarly, if the taxonomist errs on making too narrow of a definition (i.e., "splits" a group into separate taxa based on too little variability), the likelihood of revi-



Parnassia glauca was one of a number of species published posthumously in 1840, in Rafinesque's *Autikon Botanikon*.



Though its center of diversity is in California, the genus *Ceanothus* has several central to eastern North American species including *Ceanothus herbaceus* (seen here), which was described and named by Rafinesque in 1808.

sion is again increased. An accurate, stable, and useful representation of taxa is the goal, though “lumpers” and “splitters” disagree on how best to reach that ideal.

Finally, it is also necessary to know the nomenclatural concept of “priority.” Priority is the principle that the first valid publication of a name for a taxon establishes the name when that taxonomic entity is recognized. At its most basic application, this idea resolves which name should take precedence when multiple names for a taxon have been published. In the modern age with peer review, ready access to a significant amount of published literature, and digitized herbarium specimens, it is an infrequent occurrence for a taxonomist to rename an already-named taxon. In the early nineteenth century in the United States, however, communication about newly described species (of which there were many) was difficult and only readily accessed in major centers. Different

authors contemporaneously giving separate names to the same taxon was a frequent occurrence, which later taxonomists resolved using the principle of priority.

The controversy surrounding the botanical work of Rafinesque was in large part a matter of his flooding the published literature with names, sometimes accompanied by poor descriptions. Often, it was claimed (and sometimes rightly so) that he did not need to see a specimen to ascribe it a new name. He was a splitter without equal:

“Altho’ this attempt may astonish or perplex some timid Botanists, my labors will be duly appreciated ere long, and my increasing efforts to improve the science meet with a kind reception from the new improving school. The axiom that a multiplication of names enlarges our ideas, holds true in all cases and sciences, since they are based on facts or mental entities. Some Linneists have vainly tried to discredit on generic

reform, and called us Genera-mongers. We may in return call them Genera-shufflers, who want to squeeze plants into improper genera, and delay improvements by opposing the corrections of botanical blunders. It is to them that we owe the superfluity of synonyms: they often shuffle plants into 3 or 4 Genera, as Linnaeus did for *Heliopsis*, until it must at last form a Genus of itself. It is a fact that almost all plants of doubtful Genera, are types of peculiar ones; the chances of it increase, as they are shifted."

With the establishment of the Linnaean system and the publication of *Species Plantarum* as the nomenclatural benchmark, Linnaeus is credited with the valid publication of a large number of genera and species. Linnaeus described about 1,440 genera, and most of these names are still in use today. By contrast, the splitter Rafinesque described approximately 2,700 genera—of these, no more than 50 or 60 are applied to recognized genera today (yet, had priority been applied, he would be credited with at least 160). Linnaeus also generated almost 9,000 binomials (species names), and again, the large majority of these are in use today. Rafinesque did not quite match Linnaeus in this category. Of the 6,700 or so species names published by Rafinesque, fewer than 300 are generally accepted.

Rafinesque's proclivity to deem the most minor variations as new species (and sometimes new genera) created work—much more work—for anyone who later attempted to publish a new species, write a monograph, or clarify names in a taxon. To give an example, *Clintonia* is a genus named by Rafinesque (and still recognized today). Before Rafinesque erected a new genus for this group in 1832, its species were variously recognized as being in *Dracaena* (the first published name was in 1789), *Convallaria*, and *Smilacina*. According to *The Plant List* (drawing on information from the World Checklist of Selected Plant Families), 41 names have been published within *Clintonia* (the actual number is likely higher). Working with a dataset of 35 names of "High Confidence Level" ("applied to the status of name records derived from taxonomic datasets which treat the whole of the taxonomic group in question on a global basis and have been peer reviewed"), 30 are at

the species rank (5 below the species level). Five of the species names are confidently recognized as "Accepted" species, and a single name for a recently described (1993) Asian species remains unresolved. The remaining 24 names are listed as synonyms, i.e., names that are considered to be already represented within the concept of a different name. Of these 24 synonyms, 19 were published by Rafinesque. Examples of species recognized by Rafinesque but generally regarded as minor variations within *Clintonia uniflora* (Sol.) Raf. include *Clintonia angustifolia* Raf. (a narrow-leaved entity), *Clintonia biflora* Raf. (a two-flowered entity), and *Clintonia ciliata* Raf. (presumably with fine hairs along the margins of an organ like a leaf or petal).

If a taxonomist were to discover what she/he believes to be a new species of *Clintonia*, the taxonomic work involved would require at a minimum comparing it against the type specimens of other members of the genus and reviewing the taxonomic literature to ensure a previously published name and description (including all synonyms) does not conform to the purported new species. In practice, the taxonomist would further compare it against additional specimens of each species in order to properly account for variation within each species. In order to name a new species in *Clintonia*, the work required would involve reviewing all of Rafinesque's names and descriptions to determine if he had named the entity first. For a relatively simple group of species like *Clintonia* (5 accepted species), the task would be difficult in modern times, and very difficult at the time of Rafinesque. For more taxonomically complicated genera, like *Trillium*, Rafinesque made the difficult near-impossible. There are about 38 recognized species of *Trillium* in North America, with more than two-thirds of these from eastern North America. Rafinesque is presently responsible for 3 of these accepted names, though he described an additional 31 species and 67 varieties.

This onslaught of published names of additional genera and species in many eastern North American plant groups, sometimes poorly described, was not well received. Amos Eaton, a botanist and author of the 1817 *Manual of Botany for the Northern States*, was generally



Four of the five recognized species of *Clintonia*, clockwise from above: *Clintonia borealis* (Sol.) Raf., the type species of the genus erected by Rafinesque in 1832; *Clintonia umbellulata* (Michx.) Morong, first named by Michaux as *Convallaria umbellulata* in 1803, then eventually transferred by Morong into *Clintonia* in 1894 after residing in a number of other genera; *Clintonia uniflora* (Menzies ex Schult. & Schult. f.) Kunth, transferred into *Clintonia* by Kunth in 1850; and *Clintonia andrewsiana* Torr., first described and published in 1857 after Rafinesque's proposal of *Clintonia* became generally accepted.



sympathetic to Rafinesque and considered him a friend. However, in 1817, he wrote to his student John Torrey:

“I am glad Mr. Rafinesque has not set you all wild. Why can not he give up that foolish European foolery, which leads him to treat Americans like half-taught school boys? He may be assured, he will never succeed in this way. His new names with which he is overwhelming the science will meet with universal contempt.”

Eaton accurately predicted the ultimate approach by much of the botanical establishment—ignore much of Rafinesque’s work, to the extent that the principle of priority was overridden in many cases to exclude Rafinesque’s contributions.

Asa Gray, the pre-eminent American botanist of the nineteenth century, contributed to the practice of discounting Rafinesque. Though he was charitable towards Rafinesque’s earlier work, Gray’s influence cemented the rejection of Rafinesque’s ideas about new genera and species when he wrote the following about Rafinesque after his death:

“Many of Rafinesque’s names should have been adopted; some as a matter of courtesy, and others in accordance with the strict rule.... One who, like Rafinesque, followed the easy rule of founding new genera upon all these species, could not fail to make now and then an excellent hit; but as he very seldom knew the plants themselves, he was unable to characterize his proposed genera, or to advance our knowledge respecting them in the slightest degree. In his later publications, this practice is carried to so absurd an extent as entirely to defeat its object ... A gradual deterioration will be observed in Rafinesque’s botanical writings from 1819 to about 1830, when the passion for establishing new genera and species, appears to have become a complete monomania”.

ON EVOLUTION

Another area where Rafinesque generated controversy was in his ideas about how species and genera were formed. One of the reasons Rafinesque named so many species and genera was because (in his own words, from 1832), “The truth is that Species and perhaps Genera also, are forming in organized beings by gradual deviations of shapes, forms and organs, taking place



Originally published as *Saxifraga ranunculifolia* by Hooker in 1832, Rafinesque clearly disagreed. He erected the genus *Hemieva* in 1836 to segregate this species, but was ignored. In 1879, Asa Gray named a new genus and species *Suksdorfia violacea*. In 1891, H. Engler assigned *Saxifraga ranunculifolia* to *Suksdorfia*. Recent phylogenetic studies suggest *Suksdorfia ranunculifolia* is within a distinct genus, so *Hemieva ranunculifolia* (Hook.) Raf. was resurrected in the second edition of *The Jepson Manual* (2012), a major taxonomic reference.

in the lapse of time,” and that “every variety is a deviation which becomes a species as soon as it is permanent by reproduction.”

Rafinesque’s ideas were informed by Adanson from 1763, to whom he gives credit:

“Adanson ... was like Linnaeus, Necker and myself (in fact like all acute observers) a strenuous supporter of the doctrine that Species were unlimited, and increasing by the natural process of semination, deviation, variation, hybridization and such. Whence he concluded that we could hardly ascertain the primitive types of species, that many known to ancient Botanists were lost or no longer found, while new ones were evolved in mountains, groves, fields, and gardens.”

To give context, the dogma of the time was that species were fixed entities, unchanging. Nearly all of Rafinesque's contemporaries used Rafinesque's descriptions of evolutionary trees and the formation of new genera and species as proof that his ideas in all areas (including taxonomy) were to be shunned. Gray also made note of this in his obituary of Rafinesque, reminding others of how Rafinesque strayed from the dogma of the time:

"According to his principles, this business of establishing new genera and species will be endless; for he insists, in his later works particularly, that both new species and new genera are continually produced by the deviation of existing forms, which at length give rise to new species."

In 1859, Darwin published *On the Origin of Species*, with his theory of evolution by natural selection. Gray became an evolutionist.

RAFINESQUE'S LEGACY

Upon Rafinesque's death, his belongings were junked or sold, including his plant collections and some of the over one thousand papers and books he authored. He died a pauper, with the money generated from the sale of his belongings not even covering the cost of his burial.

Proof of Rafinesque's genius resides in the 160 or so genera he would have established had the principles of priority been followed. That he would have surpassed ten percent of Linnaeus's total named genera, in a country that had already been relatively well explored, is testament to his keen observational skills and botanical acumen. Had he more credibility with his peers, his ideas on the formation of new genera and species may have invited additional exploration from other brilliant biological minds of the time, perhaps advancing the science of evolutionary biology by decades. Historians continue to mend his reputation,



Austrian botanist Josef August Schultes honored Rafinesque in 1830 with the publication of *Viburnum rafinesquianum*, known commonly as downy arrowwood.

such that one of Rafinesque's statements seems prophetic: "Time renders justice to all at last."

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A Quarter-Century Perspective on the Center for Plant Conservation Collections at the Arnold Arboretum

Abby Hird

Given the array of current threats to biodiversity (including habitat destruction, pollution, climate change, and invasive species), it is no surprise that roughly one out of every three plant species in the world is threatened with extinction. As native habitats are changing and disappearing, ex situ conservation (preservation of species outside their natural habitat as living plants, seeds, or other viable tissue) efforts are even more vital to the successful conservation of plants.

Public gardens, numbering more than 700 in the United States alone (BGCI 2012), offer valuable resources, facilities, and horticultural expertise that support conservation efforts. These ex situ refuges also allow visitors a unique chance to learn about and observe threatened species firsthand. While these important plant collections serve as insurance policies against extinction for many species, the recent North American Collections Assessment found that only 39% of North America's threatened species are currently cultivated in public gardens; clearly, there is much opportunity to increase rare plant conservation collections (Kramer et al. 2011). In addition to increasing the number of threatened species in ex situ collections, broadening genetic diversity within those collections will support meaningful conservation applications.

During my Putnam Fellowship from 2008 to 2010 I worked with Arboretum Curator of Living Collections Michael Dosmann to assess the conservation potential of the



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NANCY ROSE

Flowers and fall foliage of *Amelanchier nantucketensis*.



Coppery new foliage and yellow flowers of *Diervilla sessilifolia*.

living collections in the Arnold Arboretum. We started with the formal conservation collections maintained as a partnership with the Center for Plant Conservation (CPC) (Hird and Dosmann 2010). We knew the CPC collections were well-constructed collections of threatened species, but we didn't know how they had fared since their establishment nor what priorities we should keep in mind for future collections development. The following is a summary of our findings and the lessons we learned along the way.

Collecting, maintaining, and preserving plant biodiversity was a founding principle of the Arnold Arboretum in 1872 and remains at the core of the Arboretum's activities today. Charles S. Sargent, the Arboretum's first director, initiated the creation of one of the most extensive temperate woody species collections in the world. This long-standing commitment to collections development remains a core value of the Arboretum. Today, the Arboretum's rich and dynamic botanical collections serve active research and education programs, and represent an invaluable repository of preserved genetic resources.

The CPC was founded in 1984 through a collaboration among 18 botanical gardens and arboreta as a network aimed at the "establishment of a permanent, well-documented, and accessible collection of rare and endangered native plant taxa of the United States" (CPC 1984). The Arnold Arboretum played a key leadership role in jump-starting the effort by housing the first CPC office and building the first CPC collections. Now headquartered at the Missouri Botanical Garden in St. Louis, the CPC has grown to a nation-

wide network of 38 botanical institutions. This network works to preserve 772 critically endangered North American species that compose the CPC National Collection of Endangered Plants. Each participating institution is assigned species relevant to their institution and region, monitors remaining wild populations, and collects and maintains genetically sound, long-term ex situ collections to support research, education, and, ultimately, species survival.

As a CPC participating institution, the Arnold Arboretum is obligated to follow a set of eight management guidelines (facing page) described in the CPC Handbook (CPC 2007). The Arboretum meets and exceeds most CPC guidelines, especially in the areas of collections data management and research. These guidelines are associated with detailed information including original wild collection data, germination and propagation protocols, health conditions of each specimen through time, and cultural requirements for each species. However, a variety of challenges have prevented the Arboretum from fulfilling certain guidelines, such as meaningful seed storage and reintroduction of species.

CPC COLLECTIONS MANAGEMENT GUIDELINES (CPC 2007)

1. Taxa should be proposed and accepted by the CPC Science Advisory Council for inclusion into the National Collection.
2. Propagative materials should be collected from the wild in accordance with CPC guidelines and should be maintained in protective storage.
3. A usable seed storage and germination protocol should be developed for the taxon and initial seed viability should be determined if possible.
4. Horticultural techniques for ex situ cultivation should be established and documented, and the taxon should be successfully raised to reproductive maturity.
5. Adequate propagules and data should be stored in at least two separate secure sites
6. An initial baseline germination test should be conducted on stored seed accessions of the taxon, and viability should be retested at appropriate intervals, using enough seed if possible to detect statistically valid declines in viability.
7. Collaborative research agreements to be established for taxa as necessary and appropriate.
8. Legitimate reintroduction programs or experimental reintroductions are encouraged.

In total, the Arboretum has assisted in the conservation efforts of 24 threatened CPC species by collecting wild germplasm and maintaining those plants in the living collections



MICHAEL DOSMANN

Fothergilla major bears fragrant, bottlebrush-like flowers in spring.

Table 1. Historic and Contemporary CPC Collections at the Arnold Arboretum (current in bold)

SPECIES	FAMILY	NatureServe G-Rank1	Year of Transfer	Living (as of 06/15/12) Lineages/ Accessions/ Plants
<i>Abies fraseri</i>	PINACEAE	G2	Pending	5/7/9
<i>Amelanchier nantucketensis</i>	ROSACEAE	G3Q	–	14/14/47
<i>Buckleya distichophylla</i>	SANTALACEAE	G3	2005	1/1/1
<i>Clematis viticaulis</i>	RANUNCULACEAE	G2	2005	0/0/0
<i>Conradina verticillata</i>	LAMIACEAE	G3	1993	0/0/0
<i>Corema conradii</i>	EMPETRACEAE	G4	2005	1/1/1
<i>Diervilla rivularis</i>	CAPRIFOLIACEAE	G3	–	8/26/26
<i>Diervilla sessilifolia</i>	CAPRIFOLIACEAE	G4	–	14/26/33
<i>Fothergilla major</i>	HAMAMELIDACEAE	G3	–	15/16/27
<i>Gaylussacia brachycera</i>	ERICACEAE	G3	Pending	2/3/3
<i>Hudsonia montana</i>	CISTACEAE	G1	*	0/0/0
<i>Ilex collina</i>	AQUIFOLIACEAE	G3	–	14/14/25
<i>Kalmia (Leiophyllum) buxifolia</i>	ERICACEAE	G4	2005	1/1/2
<i>Magnolia pyramidata</i>	MAGNOLIACEAE	G4	Pending	0/0/0
<i>Paxistima canbyi</i>	CELASTRACEAE	G2	2005	0/0/0
<i>Prunus alleghaniensis</i>	ROSACEAE	G4	2005	3/3/3
<i>Prunus alleghaniensis</i> var. <i>davisii</i>	ROSACEAE	G4Q	*	1/1/1
<i>Rhododendron austrinum</i>	ERICACEAE	G3	1995	2/2/2
<i>Rhododendron prunifolium</i>	ERICACEAE	G3	–	9/10/28
<i>Rhododendron vaseyi</i>	ERICACEAE	G3	–	21/21/40
<i>Spiraea virginiana</i>	ROSACEAE	G2	–	42/44/44
<i>Torreya taxifolia</i>	TAXACEAE	G1	2010	10/10/14
<i>Viburnum bracteatum</i>	ADOXACEAE	G1G2	–	3/6/10

NatureServe 2012; see textbox on facing page for explanation of ranks.

* Species not assigned to the Arnold Arboretum, but is part of the CPC National Collection and living in the Arboretum.

About NatureServe G-ranks and Threat Levels

NATURESERVE'S Global Conservation Status Ranks (G-ranks) are the most comprehensive source of conservation information on species native to the United States or Canada (NatureServe 2012). G-ranks can be used to gauge the "level of need" for each species, which is useful when prioritizing collections curation and development activities such as repropagations, voucher collection, or backup germplasm distribution at an institution. Thus, *Torreya taxifolia* with a G-rank of G1 (Critically Imperiled) has the greatest conservation need (the most threatened in the wild, with the fewest remaining wild populations) among current CPC species and first priority in collections management decisions; while *Diervilla sessilifolia* with a G-rank of G4 (Apparently Secure) has a relatively lower conservation need.

Global Rank Categories

GX: Presumed Extinct, **GH:** Possibly Extinct, **G1:** Critically Imperiled (5 or fewer populations remain), **G2:** Imperiled (very few remaining populations), **G3:** Vulnerable (relatively few remaining populations), **G4:** Apparently Secure (common; widespread and abundant), **Q:** Questionable Taxonomy, **GNR:** Unranked, **GNA:** Not Applicable

(see Table 1). A majority of the Arboretum's CPC collections began via collecting expeditions to the southeast and northeast regions of the United States in the late 1980s and early 1990s by Rob Nicholson, then plant propagator for the Arnold Arboretum (Nicholson 1996). At the time of this assessment there were 13 species assigned to the Arnold Arboretum. Many of the current and historic CPC species collected by the Arboretum originate from the southeastern United States, and some have experienced cold hardiness issues in the Northeast. In the past 15 years, due to significant decline in health and numbers of living accessions, about half of the original CPC species have been transferred to more appropriate institutions closer to their native range and with more compatible climates.

PLANTS IN THE ARNOLD ARBORETUM'S CPC COLLECTIONS

***Abies fraseri*:** The Fraser fir is well-known in the Christmas tree industry due to its spirelike crown and fragrant foliage. Reaching heights of up to 25 meters (82 feet), this species is native to the Smoky Mountain Range and is unique because it grows at high elevations. It is severely threatened in the wild by the invasive

balsam wooly adelgid (*Adelges piceae*) introduced from Europe. In 1876, Asa Gray first collected a wild plant for the Arboretum (accession 1522), which did not survive. Since then, several specimens were unsuccessfully introduced to the the Arboretum. A collecting trip in 1985 supported the establishment of the CPC collection of this species, which have suffered excessive losses due to incompatible climate and spider mite infestations. The Arboretum maintains 6 specimens from 3 states (Virginia, North Carolina, and Tennessee).

***Amelanchier nantucketensis*:** The Nantucket shadbush is a stoloniferous shrub which forms dense colonies in its restricted native habitat along the northeastern Atlantic coast. Flowers usually open in May but are small and hard to notice. Threats to this species include overcrowding by other plant species, harmful management practices such as fire suppression, and uncontrolled land development of coastal habitat. The Arboretum maintains specimens collected in the 1980s from New York, Massachusetts, and Maine. A large group was successfully transplanted during the Bradley Rosaceous Collection renovations in 2009 and now thrives near Dawson Pond.

***Diervilla rivularis*:** The mountain bush honeysuckle is an arching shrub 1 to 2 meters (3.3 to 6.6 feet) tall and wide, very similar in appearance to *D. sessilifolia*, and forms colonies by rooting where the tips of its branches touch the ground. Small yellow flowers appear in July and attract insect pollinators. Its native range extends from the Blue Ridge to the Appalachian Plateau of the southeastern United States. This species is threatened in the wild by habitat destruction from logging and crowding by invasive species. The Arboretum maintains vigorous specimens from one location in Georgia, which are cut back every 2 to 3 years to maintain them as individual plants.

***Diervilla sessilifolia*:** The southern bush honeysuckle is a sprawling shrub, 1 to 2 meters (3.3 to 6.6 feet) tall and wide, very similar in appearance to *D. rivularis*, except that the leaves are sessile (stalkless) on its arching branches. Native from Georgia to the Blue Ridge in Virginia, this species is threatened by construction, development, and crowding by invasive species. The Arboretum currently maintains healthy specimens from Georgia, North Carolina, and Tennessee in the Leventritt Shrub and Vine Garden, and near the top of Bussey Hill.

***Fothergilla major*:** The mountain witchalder, or large fothergilla, is a dense, colonizing shrub known to reach up to 6 meters (19.7 feet) tall in the wild. Fragrant, creamy white bottlebrush-like flowers emerge in May and make this a popular landscape plant. It is native to six states in the southeastern United States, and is threatened by land development. The Arboretum has successfully cultivated this species since 1876. Specimens from North Carolina and Georgia currently thrive here.

***Gaylussacia brachycera*:** The box huckleberry is a slow-growing evergreen shrub native to the Mid-Atlantic United States; it grows in dense, self-incompatible clonal colonies. The oldest plant in North America is a colony of this species growing in Pennsylvania, thought to be about 5,000 years old. Small white tubular flowers resemble other species in the heath family. This species is threatened by irresponsible land development and management practices, and invasive species. Charles Sargent first brought this species to the Arboretum from Pennsylvania in 1905. Since then, several specimens have grown in the collections. The Arboretum currently maintains two specimens including one collected from Tennessee; both are growing well in the Leventritt Shrub and Vine Garden.

***Ilex collina*:** The longstalk holly is a multi-stemmed shrub to 3 meters (9.8 feet) tall that produces large, red to yellow berries on female plants. This species is native to North Carolina, Virginia, West Virginia, and possibly Tennessee, and is threatened by land development. There is taxonomic doubt as to whether this is a synonym of *I. longipes* or not. The Arboretum maintains specimens from all states except Tennessee, and this species thrives in cultivation.



Showy fall foliage color of *Fothergilla major*.

***Magnolia pyramidata*:** The pyramid magnolia grows 3 to 7 meters (9.8 to 23.0 feet) tall, and produces creamy white flowers that give it potential as an ornamental landscape plant. It is native to a limited range along the coastal plain of the southern and southeastern United States, and is threatened by land development. The Arboretum does not currently have specimens in the living collections, but had grown two lineages from Texas that were removed in 2001 when it was determined that the specimens were not *M. pyramidata*.

***Rhododendron prunifolium*:** The plumleaf azalea is one of the showiest native azaleas, and may reach up to 6 meters (19.7 feet) tall in the wild. It has glabrous leaves and bears clusters of red-orange flowers in July and August. It is native to Alabama and Georgia and is threatened by logging and low seedling numbers in the wild. The Arboretum currently has specimens from two locations in Georgia, and is responsible for introducing this species into cultivation in the early 1900s via plant collector T. G. Harbison.

***Rhododendron vaseyi*:** The pinkshell azalea is an upright shrub known to grow up to 5 meters (16.4 feet) tall in the wild. Scentless (and frost resistant) pink flowers emerge in April prior to leaf bud break, providing striking ornamental value. This species is native to North Carolina, and is threatened by land development and illegal collecting in the wild. The Arboretum introduced it to cultivation in 1880, and maintains several specimens from North Carolina which thrive in the Boston climate.

***Spiraea virginiana*:** The Virginia meadowsweet is a 1- to 2-meter-tall (3.3 to 6.6 feet) shrub that forms dense clumps of upright, arching stems with cream colored inflorescences in May. This species is endemic to the central and southern Appalachians, where its sporadic populations are threatened by competition with fast growing herbs and vines, habitat destruction including dam construction, and lack of sexual reproduction. Plants were first collected by the Arnold Arboretum in 1919 by T. G. Harbison in



A Fraser fir cone.

North Carolina (accession 10160), grown at the Case Estates, and then repropagated via cuttings and brought to the main Arboretum grounds in 1988, where the lineage still exists today. When this CPC collection was established in the mid-1980s and 1990s, the Arboretum amassed one of the most extensive ex situ collections of this species in the world, composed of plants from all states where it is currently known to grow. Two groups were recently transplanted to beds near the South Street and Mendum Street gates.

***Torreya taxifolia*:** Once a towering tree of 15 meters (49.2 feet) or more, the stinking cedar (named for its pungent, sharp needles) is native to Georgia and Florida, and is now one of the most threatened conifers in the world because of a fungal disease. The few remaining wild individuals have been reduced to root suckers. Until 2010, the Arboretum maintained 33 specimens from known remaining populations.



USDA FOREST SERVICE REGION 8 SOUTHERN ARCHIVE, USDA FOREST SERVICE, RUGWOOD.ORG

A stand of Fraser fir killed by balsam wooly adelgid.

This collection suffered severe attrition because the species is poorly adapted to the Boston climate. In 2010 the collection was successfully transferred to the Atlanta Botanical Garden (see textbox on page 22).

***Viburnum bracteatum*:** A shrub to 3 meters (9.8 feet) tall with spreading branches and sharply-toothed leaves, this viburnum species is well adapted to the Boston climate. There is some taxonomic question whether this species should be included as part of *V. dentatum*. It is native to Alabama, Georgia, and Tennessee, and has long been noted as naturally rare in the wild. It is currently threatened by limestone quarrying. The Arboretum first introduced it to cultivation in 1904 and maintains specimens from Tennessee and Georgia.

CPC COLLECTIONS REVIEW

Prior to this collections review, we had only anecdotal information about the CPC collections at the Arnold Arboretum. Staff members had made annual field checks of the CPC specimens, so there was a lot of information stored in BG-BASE (the curation database). We knew basic information such as which species grew well in certain areas of the Arboretum and which were problematic for maintenance, but we did not know certain things such as which CPC species were truly thriving (versus barely surviving) in the Arboretum's cultivated environment, and which CPC species were adequately represented as a collection to support conservation activities. We also wanted to develop directions for the care and maintenance of the CPC collections, an important step in determining curatorial and horticultural priorities for future development. Curatorial reviews



NANCY ROSE

Colorful fruit on a female plant of *Ilex collina* at the Arnold Arboretum.



***Magnolia pyramidata* has a limited native range in the United States.**



NANCY ROSE

Rhododendron vaseyi puts on a spectacular spring floral show in shades of pink.

of each CPC species were done by compiling all relevant plant records, conservation, and historical information in order to accurately assess the current value and future conservation potential of each collection. This process brought to light several ways to guide the management and development of the Arnold Arboretum's CPC collections (Hird and Dosmann 2010). Described in more detail below, we looked at the major collections factors: lineages, accessions, plants, and supporting documentation.

Lineages

The number of unique genetic lineages (i.e., plant material collected from one or a few individuals in one location; clonal reproduction can extend a lineage through time) of a species in an

ex situ collection reflects the potential genetic diversity available for research and conservation efforts (including reintroduction of plants to the wild). Genetic diversity allows for evolutionary adaptation of a species, and healthy plant populations typically have high levels of genetic diversity, allowing them to survive a variety of environmental pressures. Conservation collections should be managed with the aim of preserving as much genetic diversity as possible, as an insurance policy in case the gene pool of natural populations diminishes or disappears. Sampling standards have been developed to ensure the greatest genetic diversity is captured in ex situ collections of rare species (see Table 2; Falk and Holsinger 1991). For rare species with three or fewer populations remaining in the wild, 100% of these populations should be sampled and preserved in ex situ collections. For rare species with four or more populations remaining in the wild, approximately 80% of the populations should be preserved in ex situ collections. The Arnold Arboretum's CPC species mostly fall into the latter category, so an appropriate sample size for a majority of these collections is at least four or five unique populations. This can guide lineage development both within and among populations.

A few species such as *Spiraea virginiana* have a fairly wide genetic base at the Arboretum, but a few of the more-threatened species such as *Abies fraseri*, *Gaylussacia brachycera*, and *Viburnum bracteatum* are not adequately represented to support effective conservation. Notably, lower lineage numbers for some CPC species like *Abies fraseri* are a result of high attrition from lack of adaptability to the Arboretum's climate.

Accessions

The number of living accessions (i.e., plants from a single lineage, acquired by one means of propagation at one time) for each species further demonstrates the depth of each collection and sheds light on lineage redundancy within the living collections. With limited resources and space, the Arboretum sets a collections goal to have 2 to 3 accessions per unique lineage for most types of plants (species, etc.) in the living collection (Living Collections Commit-

Table 2. Recommended Number of Populations in a Rare Plant Sampling Program for Capturing Genetic Diversity at the Population Level (Falk and Holsinger 1991)

Number of Extant Populations	Number of Populations Sampled
1	1
2	2
3	3
4	3-4
5	3-5
>5	4-5

tee 2007). When comparing the total number of living accessions to the total number of living lineages, each CPC species is represented by 1 to 2 accessions per lineage. This assessment showed that both of the *Diervilla* species had a higher number of accessions per lineage, demonstrating redundant clones within the same lineages. To maintain appropriate accession-to-lineage ratios for the CPC collections, we identified lineages and accessions that could be bulked up via clonal propagation and others that could be “thinned” by sending back-up material to other institutions.

Plants

Health conditions through time and total numbers of living plant specimens give an indication of how well a species grows in the Arboretum and can provide guidance for collections management. At the time of this assessment in 2009, most CPC specimens were healthy. However, management needs were further considered for species with significant proportions of specimens in fair or poor condition, such as *Torreya taxifolia*, *Amelanchier nantucketensis*, and *Abies fraseri*. Also, *Magnolia pyramidata*, with no living plants represented in the collection, was prioritized for a collection transfer or germplasm acquisition.

By using the Arboretum collections standard of maintaining an average of 2 plants per unique accession (Living Collections Committee 2007), we identified collections redundancy or deficiency for each CPC species. As we analyzed accession-to-lineage ratios, we also compared the total number of living accessions with the total number of living plants

COURTESY OF MT. CURA CENTER



Rhododendron prunifolium bears red-orange flowers with prominent red stamens.

Finding a Home for *Torreya taxifolia*

TORREYA TAXIFOLIA, once a towering giant in the forests of Georgia and Florida, has been diminished to twig-like sprouts by an obscure fungal disease over the past century. It is now one of the most threatened conifers in the world. Several ongoing conservation efforts strive to understand the pathology of the disease and find effective management and reintroduction strategies. Several ex situ collections of the species have been aimed at conserving the narrowing genetic diversity of extant wild populations as well as producing seeds and cuttings for research.

A large-scale ex situ effort began in 1985, funded by the CPC and the Arnold Arboretum (Nicholson 1996). Rob Nicholson and Mark Schwartz collected cuttings from 163 wild lineages of *T. taxifolia* and then distributed resulting plants to 10 institutions in North America and Europe in the early 1990s. Using a 1996 Arboretum inventory of 156 of the original lineages as a foundation, we conducted an international inventory of this species in 2009 and tracked down all possible specimens that originated from the original CPC material.

Fortunately most of the lineages had been preserved among the institutions surveyed (a benefit of backing up collections). But about 20% were represented by only one or a few remaining plants per lineage, and about 40% of lineages existed only at one or two institutions. Lessons learned from this long-term ex situ effort include ensuring a collection holder has appropriate horticultural know-how, climatic compatibility, and staff commitment for successfully maintaining a collection. For example, a loss of 70% of unique lineages at the Arnold Arboretum was observed from 1989 to 2009. This loss is attributed to incompatible climate, poor adaptability to container nursery conditions, and human error (staff changeover, labeling errors, etc.). Further, 5 of the 8 institutions still maintaining the original *T. taxifolia* germplasm required accession data cleanup and several specimen identifications were determined lost or unknown due to accidental dissociation with accession numbers, labels, or records.

This long-term ex situ conservation effort demonstrates how living collections can contribute to the collective conservation power of public gardens. As a result of the 2009 ex situ inventory for *T. taxifolia*, redistribution of germplasm has occurred among collection holders to preserve and back up ex situ maternal lines at multiple institutions. Further, this inventory led to a successful transfer of this important CPC collection from the Arnold Arboretum to the Atlanta Botanical Garden in 2010.



Foliage of *Torreya taxifolia*.

per species, also taking into account specimen health. This allowed us to identify specific plants in need of repropagation, removal, or relocation. One particularly successful example of making management decisions to improve plant health is the *Amelanchier nantucketensis* specimens in the Bradley Rosaceous Collection (BRC). Poor health had been recorded for these plants for several years, and during bed renovations in the BRC they were transplanted to new beds near Dawson Pond. This location's higher soil moisture has resulted in improved health for the plants. A common issue identified for *Amelanchier nantucketensis*, both *Diervilla* species, and *Spiraea virginiana* was maintaining individuals of these mass-forming species. As a result, these specimens were put on a pruning schedule to prevent uncontrolled spreading and suckering.

Since the Arboretum's primary goal with the CPC collections is preservation of living germplasm, long term survival of the CPC plants is a top priority. Collections management at the Arboretum includes the preservation of unique lineages through clonal repropagation if needed. Sometimes plants brought to the Arboretum are not well-suited to survive in the collections for reasons such as lack of compatibility to cultivation or the local climate. Species whose records show high levels of lineage or plant loss, such as *Torreya taxifolia*, likely represent poor compatibility with Arboretum conditions, making them potential candidates for transfers to institutions better able to cultivate them.

Supporting Documentation

The geographic, temporal, and environmental details about the source of an accessioned living plant are referred to as the passport data, which are curated in the Arboretum's plant records. Passport data can make collections more valuable for conservation, education, horticulture, and research by associating valuable habitat or biological information with each specimen. For wild-collected plant material the value of a collection increases with the amount of passport data. This can range from coarse geographic information such as country and state to highly local information such as soil type or altitude of an original collection location.

Additional supporting documentation may include observations, voucher herbarium specimens, images, verifications, and recorded instances of collections use (for tours, publications, and educational projects involving a species). Herbarium specimens and images offer long-term genetic and biological information that can enhance understanding and aid in conservation of a threatened species. The Arnold Arboretum Cultivated Herbarium sets a goal to document the living collections with vegetative, flowering, and fruiting material per unique lineage (Curatorial Department 2009).

This CPC assessment identified gaps in passport data and supporting documentation for each species. In addition to augmenting geographic passport data for many CPC accessions, we also established herbarium specimen and image collecting targets, as well as past verifications that could be entered into the plant records database.

COLLECTIONS ENHANCEMENT PRIORITIES

The Arboretum has taken a number of positive steps following this assessment to improve and more effectively manage the CPC collections, making them more valuable and accessible for research, education, and conservation. Individual species reviews allowed us to create a prioritized master list of recommended curatorial and horticultural actions based on collections goals and needs.

Accomplishments include enhancements in plant records information through the addition of county names, latitude and longitude, or other location information when possible. Voucher and image collection has also been a priority for the curatorial department, and over 350 herbarium specimens have been collected to further document the CPC collections. Recommended repropagations, removals, and relocations have been completed, including repropagation of two *Abies fraseri* specimens which are failing in the collection; addition of new lineages (*Rhododendron vaseyi*); removal of non-wild-origin plants and acquisition of new wild-origin lineages (*Rhododendron prunifolium*); planting out of nursery stock (*Torreya taxifolia*); and removal of redundant specimens



Rhododendron vaseyi flowers.

to send as back-up material to other institutions (*Amelanchier nantucketensis*, *Spiraea virginiana*). Successful relocations of *Spiraea virginiana* and *Amelanchier nantucketensis* to other locations in the landscape have improved plant conditions and horticultural management of these collections. Horticultural practices identified and implemented during this assessment include applying horticultural oil to *Abies fraseri* to control spider mite outbreaks, cutting back of both *Diervilla* species and *Spiraea virginiana* to maintain specimens as individuals, and pruning of suckering roots to maintain individual specimens of *Amelanchier nantucketensis*. There were also several wild-origin lineages that were historically not included in the Arboretum's CPC collections, so these valuable specimens were formally reported to CPC and added to the annual inventory process for close monitoring and care in the future. After failed viability tests, we discarded a short-term seed collection of several CPC species (*Amelanchier nantucketensis*, *Diervilla sessilifolia*, *Ilex collina*, *Rhododendron vaseyi*, *Spiraea virginiana*) and storing garden-origin seed was discontinued. We streamlined the annual CPC collections inventory and data reporting processes by setting up automatic reports in BG-BASE. We also identified future acquisition targets for under-represented populations of several of

the CPC species. To encourage broader awareness of the Arboretum's CPC collections we created a web page of CPC species highlights and have given several public tours focused on CPC species. Perhaps our biggest success was the official transfer of the *Torreya taxifolia* CPC collection to a more appropriate location and garden.

FUTURE OPPORTUNITIES

Going forward, there are a lot of exciting opportunities for the Arboretum to maintain and enhance genetic diversity of the CPC collections and further meet the CPC collection management guidelines. This may

include wild-collecting additional plants or seeds for long-term seed storage and continuing to identify institutions that could receive backup germplasm of the Arboretum's CPC collections. Within the Arboretum, archival research for additional wild-collection information and digitization of species verification records may enhance plant records data. Incorporation of specific horticultural needs into the *Landscape Management Plan* (Horticulture Department 2012) would encourage close monitoring of CPC collections by staff horticulturists. Opportunities to further share information about CPC collections through classes, tours, and web applications present exciting possibilities.

Of top priority are additional collection transfers for *Abies fraseri*, *Gaylussacia brachycera*, and *Magnolia pyramidata*. These collections have not thrived at the Arboretum so transfer to a more appropriate institution or region of the United States would ultimately support the long-term survival of these species. Appealing to the CPC and identifying potential receiving institutions, are the first steps. Once remaining collections are stabilized and appropriate species are transferred, new acquisitions of Northeastern threatened woody species can be considered as potential CPC collections in the future. This regional focus for CPC

Spiraea virginiana sources revealed through molecular study

IN THE SUMMER of 2008, leaf tissue samples of all living specimens were sent to Jessica Brzyski, then PhD candidate at the University of Cincinnati, who was researching reproduction of *S. virginiana*. In the summer of 2009, Jessica visited the Arboretum as a Deland Award recipient and conducted controlled pollinations to determine the level of self-compatibility and out-crossing ability for *S. virginiana*. She was able to provide a summary of her molecular studies using the leaf tissue, which provided clarification on some of the questionable paternities of a few living specimens at the Arboretum, some of which had grown into large masses in recent years. The controlled pollinations were inconclusive, as 2009 was an extremely rainy summer and most of the pollinations were completed in the rain. However, the molecular information helped us re-identify specimens that came from the same populations as other specimens with known identities.

USDA-NRCS PLANTS DATABASE



Spiraea virginiana from Britton and Brown's *An illustrated flora of the northern United States, Canada, and the British Possessions*, 1913.

species would bring conservation work closer to home and likely result in increased success for threatened species grown, maintained, and utilized at the Arnold Arboretum.

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Book Review: *Conifers Around the World*

Peter Del Tredici

Conifers Around the World

Zsolt Debreczy and István Rácz,

edited by Kathy Musial

Budapest: DendroPress Ltd., 2011.

Two volumes—1,089 pages, 474 range maps, 1,300 line drawings, and more than 3,700 color photographs.

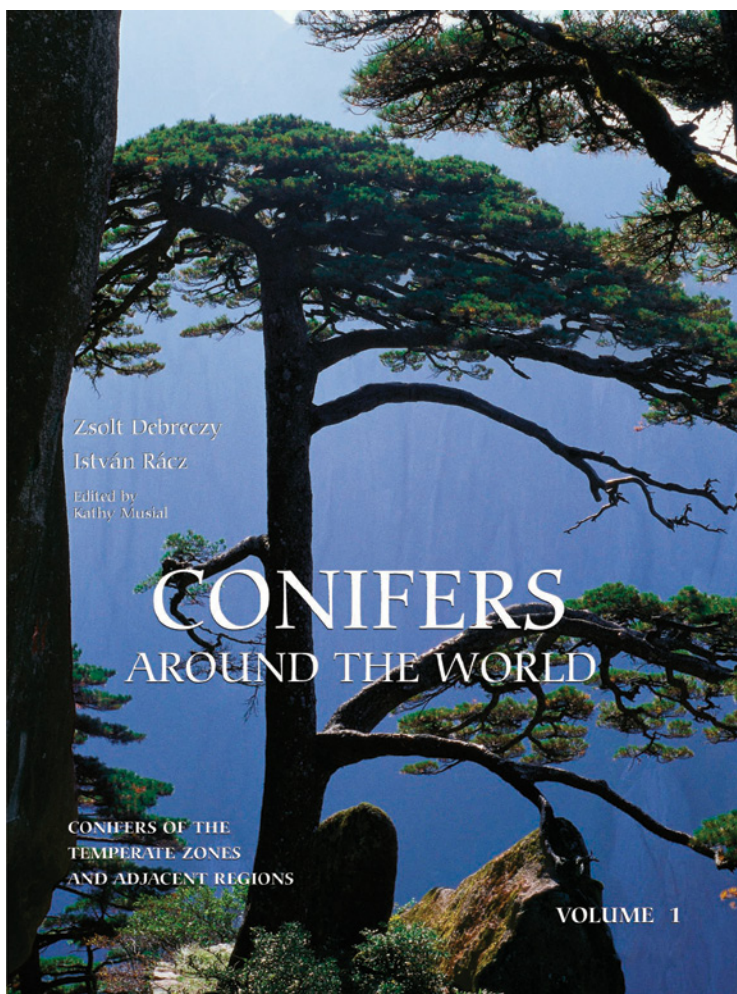
ISBN 978-963-219-061-7

W eighing in at fourteen pounds, the two volumes of *Conifers Around the World* are a botanical tour de force that harkens back to the days when plant books were lavishly illustrated with colorful plates that were as beautiful as the objects they were describing. In the context of the modern digital age, when print publications are generally described as dead, this gorgeous, full-color, large-format book (12.5 x 9.5 inches) is definitely an anachronism.

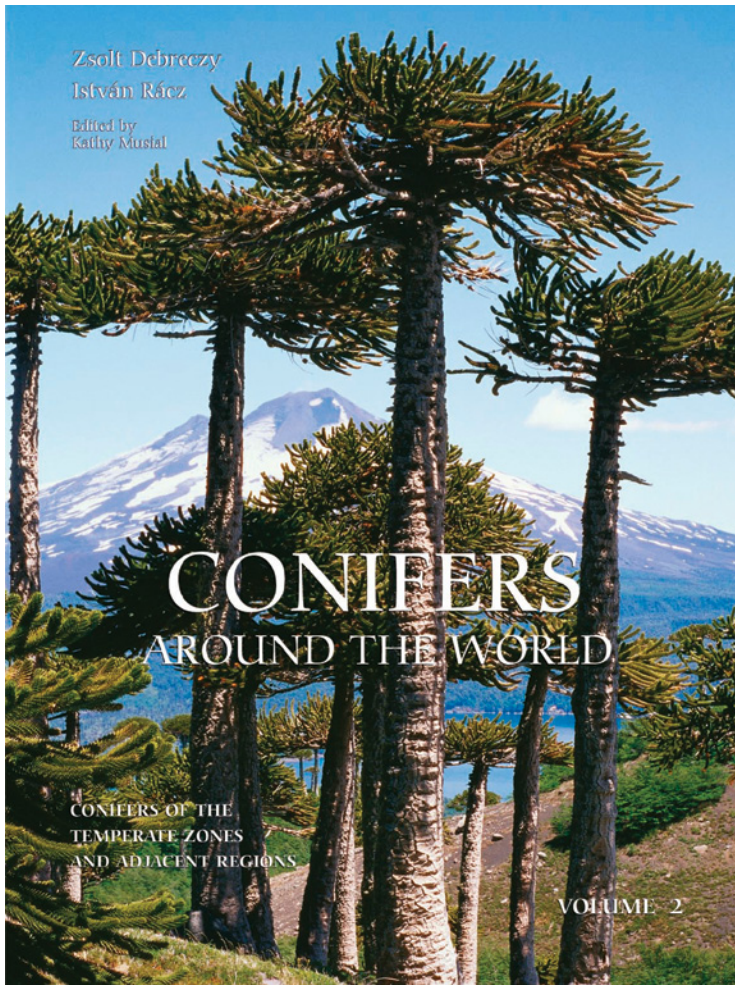
The production of this amazing 1,089-page work has been a long-term labor of love by its Hungarian authors, Zsolt Debreczy and István Rácz, who were in residence at the Arnold Arboretum as Mercer Fellows from 1988 through 1991 when they were just embarking on their project. The book describes over 500 conifer species and subspecies (in 56 genera) native to temperate or warm-temperate regions of the world.

The focus is on plants as they exist in nature, with only an occasional mention of cultivars. The full-color photos of conifers growing in their native habitats form the core of the book and, given the time and effort required to make them, are its most remarkable feature. This is especially true of rare conifers from China and Mexico, known from only a location or two in remote mountain ranges.

The basic format of the book is straightforward, with one full page devoted to each species. The top quarter of each page consists of



a concise technical description of the plant, which includes information about distribution, habitat, associated species, human uses, and conservation status. The lower three-quarters of the page is taken up with four or five photos illustrating the needles, cones, branch structure, and overall growth habit of the species in its native environment. The high quality of these photos—which are worth thousands of words—allows the authors to keep the descriptive text to a bare minimum. In addition to the 500-plus species treatments, separate sec-



tions of the book cover species ranges (474 maps reproduced from other sources); lengthy descriptions and numerous photographs of typical conifer habitats, arranged by continent; and a highly unusual “bark gallery” consisting of 648 color photos that augment the photos in the species treatments. And finally, there is a 130-page introduction that describes the history, morphology, ecology, taxonomy, biogeography, and evolution of conifers along with a complete listing and description of conifer families (written by Robert Price). This introduction could easily be expanded into a stand-alone book about conifer morphology and natural history. An early version of *Conifers Around the World* was published in Hungarian in 2000 (*Fenyők a Föld Körül*), but it is a pale shadow of the present English version. No doubt the editor, Kathy Musial of the Huntington Botanical Garden, played a major role in expanding the scope of

the book as well as making the English text completely clear and readable.

The overall organization of the book takes some getting used to, with plants arranged by the continents they are native to (and within each continent, alphabetically by genus and species). Volume 1 covers four geographical areas: Europe and adjacent regions, continental Asia and Hainan, Japan and adjacent islands, and Taiwan. Volume 2 includes six regions: western North America, eastern North America, Mexico and Central America, West Indies and Bermuda, Chile and Argentina, and Australia and Tasmania. This eclectic geographical arrangement reflects the authors’ wider purpose of presenting the modern distribution of conifers in a geological context—specifically on the Arcto-Tertiary Geoflora (ATG) concept. This idea was introduced in the late 1800s to help explain the disjunct distribution patterns found in many closely related plants, most famously of those found growing in eastern Asia and eastern North America, by postulating a unified flora that covered the temperate zones in the northern hemispheres during the late Cretaceous and early Cenozoic. The ATG concept

was developed at a time before geological time scales were accurately known and well before the advent of modern molecular systematics which allows for direct calculation of the age of species divergence. In short, the ATG concept works at a general level of explaining the distribution of various forest “types” (e.g., temperate broadleaf deciduous forest, mixed conifer broadleaf forest, etc.), but doesn’t work all that well at explaining the distribution patterns of the individual species that compose these forests. By using a geographical rather than a taxonomic arrangement of plants, the authors bring climate, geology, and geological history to the foreground as determinants of modern conifer distribution patterns. This arrangement also enhances the sense of place for each region, and gives one a sense of actually visiting the areas where the trees are growing. On the negative side, this arrangement results in the

ALL PHOTOS BY THE BOOK AUTHORS UNLESS OTHERWISE INDICATED



Bark gallery images, clockwise from upper left: *Abies pindrow*, *Larix decidua* var. *decidua*, *Podocarpus nivalis*, *Juniperus deppeana* var. *deppeana*.

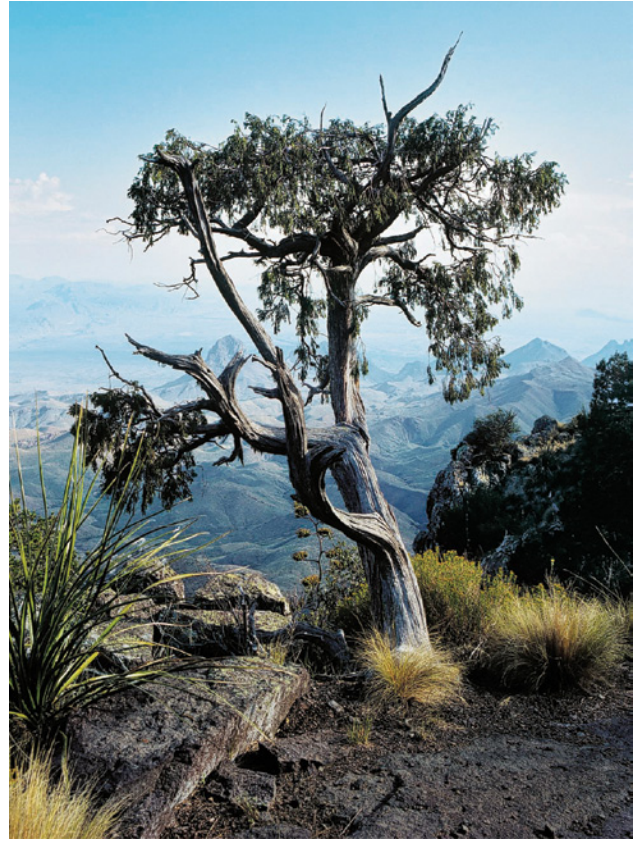


This specimen of *Cupressus arizonica* var. *arizonica* displays two types of bark: scaly, persistent ribs on the main trunk, and detaching leathery plates on the lateral branches.

spatial separation of closely related species (e.g., those within *Taxodium*) that are growing in separate regions.

The taxonomy used in the book, for the most part, follows the accepted botanical classification used by most conifer authorities, but Debreczy and Rácz do not shy away from expressing their own opinions when they disagree with standard texts. The near total absence of any references to modern molecular taxonomic research or of cladograms that show the genetic (i.e., evolutionary) relationships among related taxa are indicative of the book's firm rooting in traditional, herbarium-based taxonomy. While it is clearly the authors' prerogative to take this approach, it leaves one with the impression that the book is stuck in something of a time warp. There is one curious anomaly in the book: a twelve-page appendix devoted to the convoluted taxonomic history of *Pinus apulcensis*, the so-called Apulco ravine pine from southern Mexico. Why this species, with its tiny range, should occupy ten times much more space than any other species in the book is unexplained by the authors and left this reviewer thinking that a little molecular analysis might have been helpful in clarifying the confused taxonomic situation.

That being said, however, the book is a truly remarkable resource that all serious conifer



A *Juniperus flaccida* photographed in Big Bend National Park, Texas.

aficionados will want to own—not only for its exquisitely beautiful illustrations, but also for the vast amount of information about conifer biology, ecology, and taxonomy that it brings together under a single roof. What I particularly like about the book is how the authors' intimate personal experience with the trees shines through on every page—they have actually seen all (or virtually all) of the plants they describe and are generously sharing their experiences with the reader. While the book does a remarkable job at capturing the grandeur of the conifer kingdom, one hopes that it does not inadvertently become its epitaph in a world that is suffering mightily from the ever-expanding impacts of resource extraction, land transformation, and climate change.

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**FOLLOWING ARE TWO SPECIES EXCERPTS (reproduced at a reduced size) FROM
CONIFERS AROUND THE WORLD**



Tsuga dumosa (D. Don) Eichler, 1887; bas. *Pinus dumosa* D. Don, 1824; *Tsuga brunoniana* (Wall.) Carrière, 1855; *Tsuga yunnanensis* (Franch.) E. Pritz, 1900; *Tsuga calcarea* Downie, 1923

Himalayan Hemlock, Yunnan Tieshan, Ba Shing, Tengre Salla

Tsuga dumosa is the westernmost of the Asian hemlocks, ranging through the Himalayas from northwestern India to Yunnan and Sichuan, only marginally occurring in Tibet/Xizang (2300–3500 m). The Yunnan stands, once distinguished as *T. yunnanensis*, have needles less white below. *T. dumosa* can easily be distinguished from most other hemlocks by its often whiplike partly pendulous terminal shoots, and needles longest (<3.5 cm) in the genus and strikingly pruinose-white below. One of the most typical components of the Himalayan mid- and upper-elevation coniferous forests, it appears in mixed deciduous/evergreen broad-leaved forest dominated by Himalayan Live Oak and Tree Rhododendron. Its main zone is farther up, in its central and eastern range associating with *Abies densa*, *A. spectabilis*, *Larix griffithii*, and *L. himalaica*, in the west with *A. gamblei*, *A. pindrow*, *Cedrus deodara*, and *Picea smithiana*, with *Taxus contorta* or *T. wallichiana* var. *wallichiana* in the lower canopy layers.

TREE (<40+ m × <2.7 m) with typically long free trunk and wide-spreading branches forming a rounded or spreading crown. **BARK** first breaking to scaly ribs, in old trees evenly covered by scaly plates, detaching in thick plates and small scales; freshly exposed bark changing from dark reddish-brown to gray. **BRANCHLETS** maturing from yellowish-green to light brownish- or yellowish-white, hairy, later light grayish-brown, glabrescent. **NEEDLES** (1–3.5 cm) often distantly set, pectinately outspreading, falcate only on long-shoots, evenly tapering to finely emarginate apices, often finely serrulate, first pruinose-green above (adaxially), later shiny green; with 2 bright white stomatal bands below (abaxially). **CONES** (1.5–3 cm) ovoid to oblong-ovoid; scale apices (apomerises) slightly striate, slightly recurved at margins, otherwise thin; maturing from pruinose-green or -bluish to shiny brown.



*Pinus lambertiana* Douglas, 1827

Sugar Pine

The cyclitol-containing sweet resin of *Pinus lambertiana*, declared by John Muir to be "the best of sweets, better than maple-sugar", was once gathered by Indians, who also consumed its large tasty seeds. The tallest and most massive pine species in the world, *P. lambertiana* rules the coniferous landscape with its huge horizontally wide-spreading branches, their tips weighed down by the heavy cone clusters. Up to 63 cm, the long-stalked pendent cones are the longest in the genus; only *P. ayacahuite* (<40 cm), *P. strobiformis* (<48–60 cm), and *P. veitchii* (<50 cm) of Mexico are comparable. Distributed from northern Oregon along the Cascade Range, the adjacent Klamath Mountains southward through the Coast Ranges, and in the Sierra Nevada south to the Sierra San Pedro Mártir in Baja California (330–3200 m), *P. lambertiana* associates with almost all conifers of the west, most typically *Abies lowiana*, *A. magnifica*, *A. procera*, *P. jeffreyi*, *Pseudotsuga menziesii* var. *menziesii*, and *Sequoiadendron giganteum*, in mountain chaparral with lower canopy and shrub layers dominated by oaks, manzanitas, and madrones.

Haploxyton White pine with 5 needles. TREE (40–60<81 m × 1–3.5 m) with conical to flat-topped crown and horizontally wide-spreading main branches. **BARK** smooth, gray, with conspicuous lenticels, later breaking to narrow ridges, finally to long scaly plates, changing from cinnamon-brown to gray or dark gray. **BRANCHLETS** thick, pubescent, changing from green to tan, eventually gray. **NEEDLES** (5–10 cm) rather short, thick (thickest of the white pines, <2 mm), flexible, gray on inner surface (adaxially). **CONES** (15–55<63 cm) long-stalked, oblong-cylindrical, tapering at both ends, maturing yellowish-brown, persistent for months before falling; seeds large (1–2 cm), winged.



J. Babin (all photos on this page)

***Dipelta floribunda*: A Shrub of Subtle Beauty**

Michael Dosmann

In the horticultural world, it is not uncommon to hear plant lovers laud a particular plant's endless weeks of flowering, months of dazzling autumn leaf color, and flamboyant, persistent fruits the size of golf balls. I can appreciate plants like that, and yet sometimes I want something subtler. English novelist George Meredith wrote that "Speech is the small change of silence," and as I apply that maxim to the garden I find that I am drawn toward plants that possess quiet interest. One such plant is *Dipelta floribunda*, the rosy dipelta, a shrub native to central and western China.

The Arboretum has cultivated rosy dipelta for over a century, the first seeds coming to the Arboretum in February 1911 from E. H. Wilson's collection from Fang Hsien, western Hubei, the previous October. He made the collection from plants growing in "sunny places" at altitudes of 1,200 to 1,800 meters (3,937 to 5,905 feet). Seventy years later, the Arboretum received its latest accessions of this species, collected in Hubei during the 1980 Sino-American Botanical Expedition. Plants from two separate accessions from the 1980 SABE grow in the Arboretum, as does one large plant (accession 14514-B) from the Wilson accession. The Explorers Garden atop Bussey Hill serves as perhaps the best place to see these plants, though there is also another fine mass planting of rosy dipelta along Peters Hill Road.

Dipelta floribunda bears fragrant, pinkish-white flowers, typically blooming in early May. Each tubular corolla comprises five fused petals, with the two upper lobes forming a top lip, while the basal three lobes form a lower lip. Yellow pigment splashes along the lips and throat of the flower, no doubt serving as nectary guides for the bees that pollinate the flowers. At the base of the corolla are greenish bracts

that increase in size as the growing season advances, surrounding the fruits (two-seeded achenes) as they mature. The round, 1-inch-wide, papery bracts provide a bit of late summer interest—particularly as they blush a tawny pink—and also aid in the wind dispersal of the seeds. A casual examination of *Dipelta* reveals similarities with *Kolkwitzia amabilis*, beauty bush, also introduced by Wilson. The two genera are closely related to each other within Caprifoliaceae, the honeysuckle family; their flowers look similar, though *Kolkwitzia* fruits have but a single seed and lack *Dipelta*'s papery bracts.

Rosy dipelta is a large, vase-shaped shrub that typically attains a height of 12 to 15 feet (3.7 to 4.6 meters) and a width of 6 to 8 feet (1.8 to 2.4 meters). The leaves are lanceolate and rather coarse, and tend to abscise in the autumn with little effective color change. But when they do drop from the plant they reveal another bit of quiet interest. With a few years of age, the bark of the stems begins to shed in long, vertical, tawny-white strips. In the garden, some may think this somewhat messy (plantsman Michael Dirr muses that "the entire matrix ... assumes the presence of a pile of sticks"). However, I like this trait for both its tactile quality and its visual appeal in the winter. An undulating row of several of these fine shrubs at the back of a mixed perennial border provides an excellent backdrop, particularly when they are pruned to remove lower branches. Mix in several beauty bushes to extend the flowering season a few weeks, add a *Heptacodium miconioides* (seven-son flower) to provide late summer blooms, and enjoy all three of them for their habit and bark interest.

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