

Untangling the Twisted Tale of Oriental Bittersweet

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It's amazing that the details of the introduction of one of eastern North America's worst invasive plants, Oriental bittersweet (*Celastrus orbiculatus* Thunb.), are essentially unknown. According to Alfred Rehder in his seminal *Manual of Cultivated Trees and Shrubs* (1927) the vine was introduced into cultivation from Asia in 1860, but he offered no specific details about who the responsible party was. Since then, most authors have simply taken Rehder at his word and repeated the 1860 date without question (or attribution). More recently, some botanists have cited 1879 as the date of introduction of Oriental bittersweet into North America based on an 1890 article by Charles S. Sargent, but again with only minimal details. The purpose of this article is to fill in this void in the early history of the plant, especially now that it has become such a ubiquitous—and highly destructive—member of our flora.

A Brief History of Oriental Bittersweet

The first species of *Celastrus* to be described was the American or climbing bittersweet (also called waxwork or stafftree), native to eastern North America, and named *C. scandens* by Linnaeus in 1753. The second was Oriental bittersweet, *C. orbiculatus*, native to Japan, Korea, and China and originally published in 1784 by Linnaeus's student, Carl Peter

Thunberg, in his ground-breaking *Flora Japonica* under the name *Celastrus articulatus*. Some ninety-seven years later, the Russian botanist Carl Maximowicz pointed out that this name was actually a misprint of *Celastrus orbicula-*



Oriental bittersweet, in yellow fall foliage, scrambles to the top of a tall eastern cottonwood (*Populus deltoides*) in Bussey Brook Meadow at the Arnold Arboretum.

tus, Thunberg's intended name, which he used in the index of *Flora Japonica* as well as in the original manuscript pages of the book. It took years of back and forth debate among botanists to straighten out the confusion caused by this simple typographical error, but *C. orbiculatus* is now universally accepted as the correct scientific name for Oriental bittersweet.

In *Flora Japonica* Thunberg also described a second Japanese species of bittersweet, *C. punctatus*, with smaller, more ovate leaves than *C. orbiculatus*, a different pedicel (flower stalk) structure, and rough white lenticels on its stems. Shortly after this plant entered cultivation in the mid- to late 1800s, it too became engulfed in a taxonomic debate, specifically as to whether it was a "good" species or just a variety of *orbiculatus*. Alfred Rehder, writing in L. H. Bailey's massive *Cyclopedia of American Horticulture* (1900), officially reduced *C. punctatus* to a variety of *C. orbiculatus*, with shorter petioles and smaller, thicker, elliptic leaves. This reduction in status was widely accepted in botanical publications for many years, most notably in the English version of Jisaburo Ohwi's *Flora of Japan* (1965), which described variety *punctatus* as "a southern phase, abundant usually near seashores, although transitional with the typical phase [*orbiculatus*]."

The traditional view of Oriental bittersweet taxonomy underwent a change in 1955 when Ding Hou, a freshly minted Ph.D. from Washington University in St. Louis, published his revision of the genus *Celastrus* in the *Annals of the Missouri Botanical Garden*. Hou reviewed the tortured history of Thunberg's two bittersweets and concluded they were both valid species. He also reviewed the taxonomy of the two *Celastrus* species described and illustrated in 1860 by Eduard von Regel, the Director of the St. Petersburg Botanical Garden: one was a "new" species that he christened *C. crispulus*, the other was Thunberg's species, *C. punctatus*. Writing in *Plantae Wilsonianae* in 1915, Alfred Rehder had expressed the opinion that both of Regel's plants belonged to the species *C. orbiculatus*—*crispulus* was a synonym and *punctatus* a variety—a determination that formed the basis for his citing 1860 as the date of Oriental bittersweet's introduction into cultiva-

tion. Ding Hou looked at the same article and reached a very different conclusion—Regel's *crispulus* was synonymous with Thunberg's *punctatus* and his *punctatus* was really Thunberg's *orbiculatus*. According to Hou's interpretation, Rehder was right about 1860 as the date for the introduction of *Celastrus orbiculatus*, but wrong about which of Regel's two species was the true Oriental bittersweet.

In the years following its publication, Ding Hou's revision of the genus *Celastrus* has stood the test of time. The current online *Flora of Japan Database Project*, for example, treats *C. punctatus* as a semi-evergreen species native to the warm-temperate or subtropical parts of the country, while the deciduous species *C. orbiculatus* is found in more northerly cool- and warm-temperate zones. Similarly, the English version of the *Flora of China*, which describes twenty-five species of *Celastrus*, includes both *C. orbiculatus* and *C. punctatus*. The former is widely distributed in the eastern and northeastern parts of the country, mainly north of the Yangtze River, while the latter is restricted to southeast China and Taiwan.

Introduction Into Europe

Eduard von Regel's 1860 *Gartenflora* article is significant for three reasons: 1) it is the first report of the cultivation of Oriental bittersweet outside of Asia; 2) it contains the first scientific illustrations of both *Celastrus orbiculatus* and *C. punctatus*; and 3) it unequivocally states that *C. punctatus* (= *C. orbiculatus* according to Hou) had "only recently been imported" into European gardens by the famous naturalist Philipp von Siebold.

Siebold is an important and colorful figure in the early history of European involvement in Japan. His spectacularly illustrated *Flora Japonica*—co-authored with Joseph Zuccarini and published in thirty volumes between 1835 and 1870—is a botanical landmark. Siebold was a Bavarian physician who spent six years (1823 through 1829) in Japan working for the Dutch government, teaching and practicing medicine, and making a significant collection of Japanese flora and fauna. His sojourn ended when he was imprisoned for political reasons (the unauthorized possession of a strategically important



Fig. 1-5. *Celastrus crispulus* Rgl.
6. *punctatus* Thbrg.

Illustration of *Celastrus orbiculatus* and *C. punctatus* from Eduard von Regel's 1860 article.

map of Japan) and forced to return to Holland in 1830. He did, however, manage to leave with a boatload of herbarium specimens and living plants, which he cultivated in his garden in Leiden. Siebold managed to return to Japan in August 1859 but was forced to leave in 1862. Again, he returned to Leiden with a collection of Japanese plants that he added to the "Jardin D'Acclimatation," which he had established in the 1830s (Spongberg 1990). He published a nursery catalogue for the garden in 1863 that listed an astounding 838 species and varieties of plants for sale, mainly from Japan and China. Included among the entries was "*Celastrus punctatus* Thbg." at the price of 1 or 2 francs, presumably depending on the plant's size. Based on this catalogue listing and on Regel's article from 1860, we can now say that Siebold probably collected seeds of *C. orbiculatus* (which he called *C. punctatus*) in the fall of 1859—at the start of his second visit to Japan—and sent them to colleagues in Europe for cultivation. Siebold's 1863 nursery catalogue listing appears to be the first recorded public offering of *C. orbiculatus* outside of Asia.

Introduction Into North America

On the other side of the Atlantic, Oriental bittersweet made its horticultural debut in the Kissena Nurseries catalogue first published in 1886 or 1887. The Kissena Nurseries were established by Samuel B. Parsons in 1871 as the successor to the earlier nursery he had established with his brother Robert in 1840 in Flushing, New York. The nursery specialized in ornamental trees and shrubs and was the first nursery in the United States to introduce Japanese maples into commerce and to propagate and distribute hardy evergreen rhododendrons (Meehan 1887). The Arnold Arboretum library has two virtually identical copies of the Kissena Nurseries "Descriptive Catalogue of Hardy Ornamental Trees, Flowering Shrubs and Vines." One of them has "1887?" penciled on it while the other is marked "Probably issued Spring, 1889." Both of the catalogues are 94 pages long and both include the identical entry for Oriental bittersweet on page 53: "*Celastrus punctatus*, Japan. Leaves marked with points of white. 75 cts.". (This reference to "points of white" is probably a misinterpretation of



Portrait of Samuel B. Parsons from Meehan, 1887.

the word *punctatus*, which Thunberg used in reference to the prominent white lenticels on the stems.) In the *Rhododendron* section of the catalogue, on page 78, there is a reference to "a recent published paper from C. M. Hovey, whose experience in this plant is well known, he states that he bought in 1884 [should read 1844], in England, a number of *Rhododendrons* supposed to be hardy." A search of the literature from this period turned up Hovey's article in the December 1885 issue of *The American Garden*, which makes spring 1886 the earliest possible date for the publication of the Kissena Nurseries catalogue.

***Celastrus paniculatus*.** Japan. A large-leaved, climbing vine. 50 cts.
 — ***punctatus*.** Japan. Leaves marked with points of white. 75 cts.
 — ***scandens* (Bitter Sweet).** America. Fine leaves, turning a bright yellow color in early fall, clusters of orange capsuled fruit. Very strong grower, well suited to cover rocks and trunks. 35 cts.

The listings for *Celastrus* from Parsons's 1887 Kissena Nursery Catalogue.



A remnant row of katsura trees (*Cercidiphyllum japonicum*) in Kissena Park, Flushing, New York, the former site of S. B. Parsons's Kissena Nurseries, photographed in November 2013.

The first horticultural description of Oriental bittersweet in America did not come until a few years later, in a *Garden and Forest* article by John G. Jack (1889). Under the heading "Notes from the Arnold Arboretum," Jack described *Celastrus articulata* (noting that the name should be *C. orbiculata*) and stated that it "has inhabited the Arboretum for several years, having been sent here from the Parsons' Nursery at Flushing [New York]." Jack was enthusiastic about its ornamental attributes: "The fruit is smaller than that of our American species, but it is very brilliantly colored, and, as it is produced here in the greatest profusion

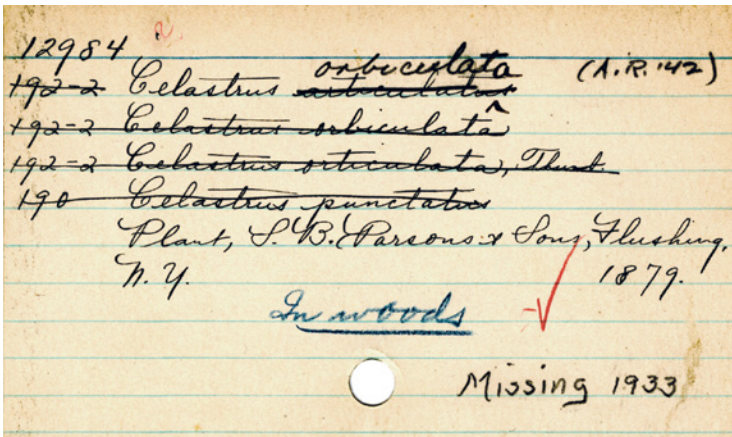
along the whole length of the spur-like lateral branches, it makes a great show after the leaves have fallen, remaining fresh and bright until nearly the end of winter. *C. articulata* is a hardy and vigorous plant, growing rampantly when once established in rich soil, and then sometimes producing stems twelve or fifteen feet long during a single season, and immense masses of foliage."

Remarkably, no more than three weeks later, in a letter to the editor of *Garden and Forest*, a writer who signed his name only as "S." described the elegant estate of Charles A. Dana on the tiny island of Dosoris in the town of Glen Cove on the north shore of Long Island, New York. The description goes into great detail about the fabulous garden plantings—especially the conifers—but one sentence stands out, "A seawall is built all around the island, and it is draped and festooned with Matrimony vine [*Lycium barbatum*], our native Bitter-sweet, a Japanese species of the same genus (*Celastrus articulatus*) and *Periploca Graeca*, which are planted on the top." While nothing can be said for sure about when the Oriental bittersweet on Dosoris was planted, the fact that it received such a prominent mention suggests that Mr. Dana's plants were well established and that he probably got them from Samuel Parsons, whose Kissena Nurseries were only twenty miles away in Flushing.

A little more than a year after these two articles appeared, in the November 12, 1890, issue of *Garden and Forest*, Charles S. Sargent wrote an article featuring *Celastrus articulata* under the heading of "New or Little Known Plants." The article described the morphology of the plant in detail and was accompanied by an illustration of the plant drawn by the Arboretum's botanical illustrator, Charles Faxon. Sargent praised its ornamental fruit "which, as long as they remain on the plants, nearly hide it from view" and reported that the Arboretum's first plant was received from Samuel Parsons in 1879.



Illustration of *Celastrus orbiculatus* by Charles Faxon from Sargent's 1890 article in *Garden and Forest*.



Arnold Arboretum accession card for *Celastrus orbiculatus* accession 190 from Samuel Parsons.

A check of the Arboretum's old card file system revealed that accession 190 had indeed been sent to the Arboretum by Samuel Parsons in 1879 under the name *C. punctatus*. In their articles, both Jack and Sargent changed the specific epithet to *articulata* instead of *punctatus*. Whether they did this because they thought the two species were synonymous or because they thought the plant was misidentified is unclear, but the latter explanation is more likely. Remarkably, the card file also revealed that seeds of "*Celas-*



Herbarium specimen from Arnold Arboretum accession 190-1, a plant raised from a cutting from the original plant from Parsons.

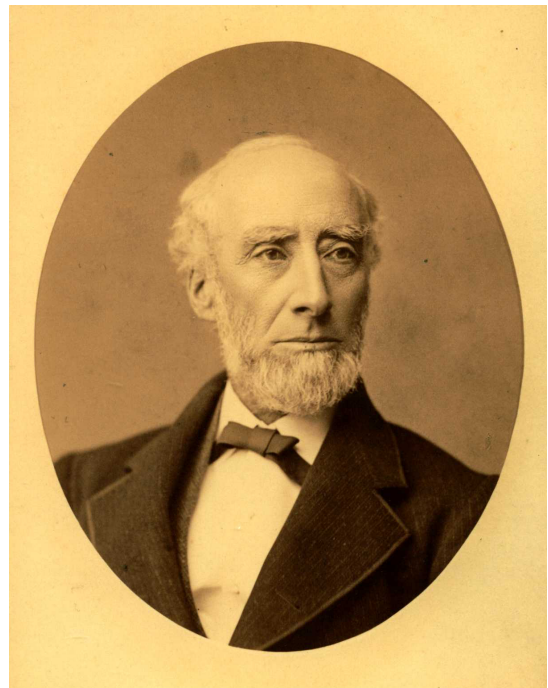
trus articulatus" (accession 192) were received by the Arboretum on March 2, 1880, from the Agricultural College in Sapporo, Japan, less than a year after Parsons sent the Arboretum a plant of "*C. punctatus*." Fortunately the Arboretum possesses herbarium specimens of both of these accessions, one from accession 190-1, which originated from a cutting collected on October 20, 1887, from Parsons's original plant, and the other from one of the original Sapporo plants collected on October 26, 1888. Both herbarium specimens are labeled "*articulata*" and both are in fruit, but only the Parsons specimen has leaves on it. As far as I have been able to determine, they are both *Celastrus orbiculatus*.

Who Sent the Seeds?

The unanswered question about the introduction of Oriental bittersweet into North America boils down to this: Where did Samuel Parsons get his plants? One possibility is that they came from Dr. George Rogers Hall, an American physician who lived in Japan from 1855 through 1861 and introduced many Japanese plants (including many collected by Siebold) into North America (Spongberg 1990). In March of 1862, upon his return to the United States, Hall hand-delivered a large shipment of Japanese plants and seeds to Parsons, who breathlessly described unpacking them in *The Horticulturist*. While there is no mention of *Celastrus* in the article, the door of possibility is left slightly ajar with the statement that the shipment contained "a large number of other tree and shrub seeds." But this seems an unlikely source for bittersweet given that it would have necessitated a seventeen year time lag before its distribution to the Arnold Arboretum. In addition, a comprehensive article titled "Ornamental Vines" by Josiah Hoopes in *The Horticulturist* (July 1874) describes American bittersweet (*Celastrus scandens*) and one of Hall's notorious introductions, Japanese honeysuckle (*Lonicera japonica*), but makes no mention of Oriental bittersweet.

The available evidence—what little there is—suggests that Thomas Hogg, Jr. was the source of Parsons's Oriental bittersweet seeds. Hogg served as the United States marshal assigned to the Japanese Consulate from 1862 to 1869

and later as an advisor to the Japanese Customs Service from 1873 through 1875. Hogg's father, Thomas, Sr., had immigrated to New York City from London in 1821 and established one of the first nurseries in the area. When Thomas, Sr. died in 1854, his two sons, James and Thomas, Jr., took over the business. During his diplomatic appointment in Japan, Hogg used the opportunity to send a number of Japanese plants—most notably variegated hostas and Japanese irises—to the family nursery in New York as well as to other horticulturally minded individuals in the northeast (Sargent 1888, 1894; Whitehead 2011). Hogg interacted with various Japanese nurseries as well as the European botanists who were working in Japan at the time, most notably Carl Maximowicz who lived in Japan from 1860 through 1864 and collected numerous plants—including Oriental bittersweet—for the St. Petersburg Botanical Garden (Bretschneider 1898). In a letter to his brother James (published in *The Horticulturist* in 1863), Hogg described their relationship: "There is a Russian Botanist (Mr. Macimovitch) now here making a collection of living

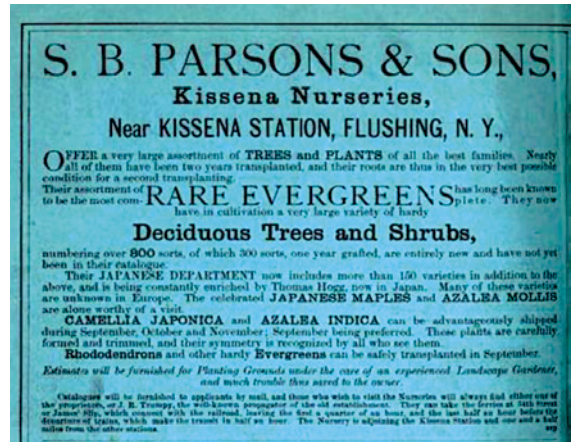


Portrait of Thomas Hogg, Jr.

and dried plants for a Society in St. Petersburg. He has been in the country three years, and is now about returning home by the way of Nagasaki. He has been very industrious, and has procured many valuable things. I frequently call upon him, and find him very communicative, and have obtained much valuable information from him."

During his second sojourn in Japan, Hogg worked as an advisor for the Japanese Customs Service, a position that allowed him more freedom to travel around the country and collect plants than he had had during his first trip (Sargent 1893). He again sent plants and seeds to numerous horticulturists, including Samuel B. Parsons, a fact that was documented in September 1875 in an article about Kissena Nurseries written by Josiah Hoopes: "Adjoining this block of fine specimens is a suite of cold-frames well filled with the largest collections of Japanese plants to be found,—not only in the United States, but in Europe as well. They were sent home by that indefatigable collector Thos. Hogg, now a resident of Japan." Parsons himself acknowledged Hogg's contributions in an advertisement on the back cover of the February 1876 issue of *Gardener's Monthly and Horticulturist*, which announced that "Their Japanese Department [of Kissena Nurseries] is being constantly enriched by Thomas Hogg, now in Japan." In the absence of any direct reference to the importation of Oriental bitter-sweet, these statements by Hoopes and Parsons are critically important because they provide a likely explanation for how and when *Celastrus orbiculatus* arrived in North America: collection in Japan by Thomas Hogg, Jr. in the fall of 1874; propagation by Samuel B. Parsons in 1875; distribution to the Arnold Arboretum in 1879; nursery sales in the early 1880s followed by the first North American catalogue listing in 1886 or 1887.

The rapidity of Oriental bittersweet's distribution was such that by 1893—less than twenty years after its collection in Japan—J. G. Jack reported that it "is now found in a good many gardens." And C. S. Sargent, in his book *Forest Flora of Japan* (1894) referred to Oriental bittersweet as "now well-known." In this same book, he makes the interesting observation that



Kissena Nursery advertisement on the back cover of the February 1876 issue of *Gardener's Monthly and Horticulturist* referring to Thomas Hogg sending plants from Japan.

"its leafless branches, covered with fruit, are sold in the autumn in great quantities in all Japanese towns, where they are used in house decorations"—a tradition similar to their current use on Thanksgiving tables and Christmas wreaths in the eastern United States.

By 1901 (and probably earlier), plants of "*Celastrus articulata*" were available directly from Japan via the Yokohama Nursery Company for 20 cents (gold) each or ten for \$1.80, and by 1907 the Biltmore Nursery in Asheville, North Carolina was offering 1½- to 2-foot-tall plants of *Celastrus orbiculatus* for 15 cents each, \$1.50 per dozen, or \$10 per hundred—an 80% drop in price from its initial public offering (75¢) in the Kissena catalogue some twenty years earlier.

The Era of Distribution and Promotion

In 1898, Sir Joseph Dalton Hooker, Director of Kew Gardens (and a good friend of Charles Darwin), reported in *Curtis's Botanical Magazine* that the Arnold Arboretum sent seeds of Oriental bittersweet to Kew in 1891. According to Hooker, the seedlings grew vigorously and flowered for the first time six years later, in June 1897, and fruited in November. Remarkably, this plant returned to North America when, according to George Nash writing in *Addisonia* in 1916, the New York Botanical Garden raised Oriental bittersweet plants "from seed

Thomas Hogg, Jr.'s Plant Introductions

Thomas Hogg, Jr. introduced many Japanese plants—both wild species and horticultural selections—to North America. Among his most famous are the old-fashioned variegated hostas ‘Decorata’ and ‘Undulata Albomarginata’, numerous Japanese maple cultivars, and the golden thread-leaved cypress (*Chamaecyparis pisifera* ‘Filifera Aurea’). Writing in the *Transactions of the Massachusetts Horticultural Society for the Year 1880*, Samuel B. Parsons, Jr. wrote, “Mr. Hogg has given us possibly more new Japanese plants than any collector since the time of Robert Fortune’s famous horticultural explorations.”

While I’ve been unable to locate a comprehensive list of Hogg’s introductions, the horticultural literature of the late nineteenth century is rife with references to them. The most important sources are an article by Hogg himself in *Gardener’s Monthly and Horticulturist* in 1879 (GMH), the 1887 Kissena Nurseries catalogue (KN), and Charles Sprague Sargent’s writings in *Garden and Forest* (GF) from 1888 to 1897 and *The Forest Flora of Japan* (FFJ) in 1894. From these four references, I’ve compiled the following list of Hogg’s woody plant introductions from Japan. No doubt persistent digging will add more species to this list in the future. Introduction years are from Rehder’s *Manual of Cultivated Trees and Shrubs*.

PLANT	YEAR OF INTRODUCTION	REFERENCE
Veitch fir, <i>Abies veitchii</i>	1874	Sargent FFJ, p. 83
Katsura tree, <i>Cercidiphyllum japonicum</i>	1864 or 1865	Hogg GMH 21: 53
Sweet autumn clematis, <i>Clematis terniflora</i>	1864?	Sargent GF 3: 621
Kousa dogwood, <i>Cornus kousa</i>	1874	Sargent FFJ, p. 47
Yeddo euonymus, <i>Euonymus hamiltonianus</i> var. <i>sieboldianus</i>	1865	Sargent FFJ, p. 26
Japanese winterberry, <i>Ilex serrata</i>	1866	Sargent FFJ, p. 25
Kobus magnolia, <i>Magnolia kobus</i>	1865	Sargent FFJ, p. 10; GF 6: 65
Japanese umbrella magnolia, <i>Magnolia obovata</i>	1865	Sargent FFJ, p. 9; GF 1: 305
Oyama magnolia, <i>Magnolia sieboldii</i>	circa 1865	Parsons KN, p. 24
Japanese photinia, <i>Photinia villosa</i>	1865	Sargent GF 1: 67
Kudzu, <i>Pueraria lobata</i>	—	Sargent GF 6: 504
Japanese hydrangea vine, <i>Schizophragma hydrangeoides</i>	—	Hogg GMH 21: 53
Stachyurus, <i>Stachyurus praecox</i>	1865	Sargent FFJ, p. 18
Japaneses stewartia, <i>Stewartia pseudocamellia</i>	1868	Sargent GF 9: 34
Sapphireberry, <i>Symplocos paniculata</i>	1865	Sargent GF 5: 89
Siebold viburnum, <i>Viburnum sieboldii</i>	—	Sargent GF 2: 556; Parsons KN, p. 50



Sapphireberry



Japaneses stewartia



Kousa dogwood



Color illustration of *Celastrus orbiculatus* from *Curtis's Botanical Magazine*, 1898, vol. 124 [ser. 3, vol. 54]: tab. 7599.

secured in 1897 from the Royal Gardens, Kew, England." Nash also noted that the painting that accompanied the article "was prepared from a vine growing on some small trees in the rear of the Museum building of the New York Botanical Garden. It was of accidental occurrence there, and perhaps originated from seed carried by the birds from the large specimen in the viticetum [a place where vines, especially grapevines, are cultivated] but a short distance to the east"—the very plant that had come from Kew Gardens in 1897. So the cycle is complete: bittersweet seeds went from the wilds of Japan to Flushing to Boston to England and then back to New York where they began to naturalize!

Oriental bittersweet was a relatively rare cultivated plant towards the end of the nineteenth century, mainly confined to the properties of wealthy horticultural enthusiasts. With its dramatic fruit display and rampant growth, however, the plant was destined for popularity, and the staff of the Arnold Arboretum, as it had done earlier, was leading the charge. E. H. Wilson, writing in his 1925 book about the Arnold Arboretum, *America's Greatest Garden*, described the plant in glowing terms, "On the left ascending the Bussey Hill road, is another arresting feature. It is merely a dense tangle of Japanese Bittersweet (*Celastrus articulata*) but how beautiful!—a mass of clear yellow foliage and a wild profusion of fruits with deep yellow husks cracked open, disclosing the clustered seeds clad in jackets of cinnabar-red." Later on he notes that some of the Arboretum's boulders of

granite and conglomerate were covered with Oriental bittersweet "whose stems are coiled and twisted into an intricate clump of growth, picturesque at all season of the year." No doubt he was referring to plants that E. J. Palmer later reported finding on the south side of Hemlock Hill in his 1935 publication, *Supplement to the Spontaneous Flora of the Arnold Arboretum*.

While Wilson was an admirer of Oriental bittersweet, the Arboretum's longtime horticulturist, Donald Wyman, was its true champion. He wrote about the plant in various Arnold Arboretum publications in 1939, 1944, and 1950 as well as in a number of other horticultural publications, and described it in his best-selling *Shrubs and Vines for American Gardens*, published in 1949. Wyman's 1944 article was a survey of the use of rapidly growing vines in the United States, which concluded



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A tangle of fruiting Oriental bittersweet on a stone wall in Cornwall, Connecticut.

that Oriental bittersweet grows well in most regions of the country, other than the coastal southeast and the arid west, and that a panel of eminent horticulturists considered it to be among the most ornamental of the ninety-one vines under observation.

Wyman's 1950 paper is particularly interesting because he looks specifically at the fruiting habit of three bittersweet species in relation to their complex flower structure. Based on a series of bagging experiments, he postulated that pollen of either American (*C. scandens*) or Oriental (*C. orbiculatus*) bittersweet could pollinate the other. He also reported the existence of a "polygamo-dioecious" clone of Oriental bittersweet at the Arnold Arboretum with self-fertile, perfect flowers. Wyman concluded his paper by admonishing nurserymen to stop growing *Celastrus* "indiscriminately" from seed and start "growing only pistillate [female] plants from cuttings and budding on each plant one or two buds of the staminate plant."

Wyman's report of the hybridization between American and Oriental bittersweet was not the first. Three years earlier, Orland White and Wray Bowden of the University of Virginia had reported the successful creation of hybrids between American and Oriental bittersweet, but only when *C. scandens* was used as the seed (female) parent. White and Bowden's 1947 paper is also noteworthy because it offered an early warning about the invasive tendencies of Oriental bittersweet, noting that it "has escaped from cultivation in Virginia and the New York Botanical Garden, where it has become almost a pest, as it readily germinated from seed and is widely distributed by birds eating the berries and voiding the seeds."

The Era of Invasiveness

Donald Wyman reiterated his enthusiasm for the ornamental value of Oriental bittersweet in his article in the October 1, 1964, issue of *American Nurseryman*, but tempered it with the caveat that "bittersweet vines are vigorous twiners and can become vicious pests." This warning, alas, was too little, too late.

In 1973, David Patterson published a short article on the "Distribution of Oriental Bittersweet in the United States," which was

abstracted from his recently completed Ph.D. thesis at Duke University. The article was blunt about the serious threat posed by Oriental bittersweet and the fact that, following its initial introduction, the plant was "popularized as an ornamental by the Arnold Arboretum." Sparring no one, he also noted its distribution by the National Arboretum in Washington, D.C., in 1966 and 1967 to nurseries and public gardens in 30 states as well as its recommended use for highway bank plantings in New Jersey, Rhode Island, and Massachusetts. He concluded his article with the prescient note that "There are no indications that Oriental bittersweet has reached the limits of its potential range in the United States. In the future, unless planting and distribution are discouraged, it may become as serious a pest as Japanese honeysuckle."

While most of Patterson's work on the physiological ecology of *Celastrus orbiculatus* has been superseded by modern research, his history of the plant's spread as a naturalized species is a classic example of the exponential growth of an invasive species, beginning with the earliest collection of a spontaneous plant in Cherry Grove, Maryland in 1912. By 1940, naturalized Oriental bittersweet had been collected at 16 sites in six states, and by 1970 it was reported from 84 sites in 19 states. Today it is reported from thousands of sites in at least 25 states.

Following Patterson's ground-breaking work, dozens of articles have been published on all aspects of the plant's biology, many of them focusing on its competitive displacement of American bittersweet in areas where the two species overlap. While there is considerable debate about the mechanisms driving this displacement, there can be little doubt that Oriental bittersweet is the more adaptable of the two species in terms of its growth potential, its tolerance of soil disturbance and low light, and its greater production of both pollen and seed. One study, published in 1999 by Jean Fike and Bill Niering of Connecticut College, documented how a lone plant of *Celastrus orbiculatus*—over a forty-year period—completely altered the trajectory of the typical old-field succession process in New London, Connecticut. In another study based on data from greater New



“A botanical boa constrictor”—Oriental bitter-sweet strangling a black locust tree.



Oriental bitter-sweet root suckers.

Oriental Bittersweet Life History

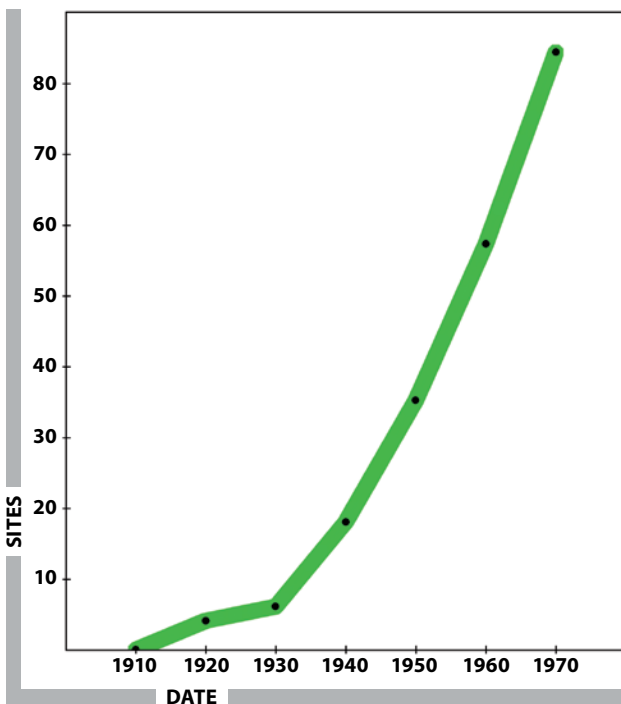
Celastrus orbiculatus is a high-climbing vine with stems that can grow up to 15 feet long in a single season and 60 feet long at maturity. It lacks tendrils and climbs by means of twining shoots that can eventually strangle the trunk of its host tree—not unlike a botanical boa constrictor (Lutz 1943). Oriental bitter-sweet produces simple, alternately arranged leaves that are highly variable in shape—from round or egg-shaped to oblong or elliptical; they are smooth with wavy, slightly toothed margins and tips that taper to a long or short point. Bittersweet roots are shallow growing and bright orange (a good field identification characteristic) and are used as an anti-inflammatory in traditional Chinese medicine. Any piece of root that is left behind after pulling or cutting the stems will give rise, Medusa-like, to numerous sucker shoots. This root-suckering capacity makes it extremely difficult to control Oriental bitter-sweet in landscapes where it has become established (Dwyer 1994).

Oriental bitter-sweet produces small, greenish flowers that typically become unisexual by the developmental failure of either the male or the female organs, thus making the plant functionally dioecious (Brizicky 1964). Occasionally a plant will develop both unisexual and perfect flowers (polygamodioecious), leading to individual specimens that are functionally monoecious (Wyman 1950; Hou 1955). The inconspicuous flowers are insect pollinated (mainly by bees) and produced on lateral branches in May and June. Following pollination, female plants produce round green fruits (capsules) that become highly conspicuous in the fall when they turn yellow and then split open to reveal seeds covered with a scarlet aril. A wide variety of birds (both native and exotic) feed on the brightly colored fruits and disperse the seeds across the landscape. Seedlings are common under the trees and shrubs where birds roost at night and seeds can remain viable in the soil for several years (Dwyer 1994).

Oriental bitter-sweet is highly adaptable and grows under a variety of light and soil conditions. Compared with the native *C. scandens*, the seedlings and young root sprouts of *C. orbiculatus* are extremely shade tolerant and can persist in the forest understory for a long time waiting for a light gap to develop (Leicht and Silander 2006). The plant is notorious for its ability to strangle and overwhelm nearby trees and shrubs and can cause serious damage in forests (Fike and Niering 1999). Oriental bitter-sweet was widely planted for ornamental, erosion control, and wildlife habitat purposes in the United States in the 1950s through 1970s and is now considered an invasive species throughout much of eastern North America. A recent publication from New Zealand (Williams and Timmins 2003) documented the spread of Oriental bitter-sweet in northern portions of that country, beginning in 1975.

York City, researchers at the Brooklyn Botanical Garden documented the concurrent decline of *Celastrus scandens* and increase of *Celastrus orbiculatus* over the past hundred and twenty years (Steward et al. 2003).

In a very recent Ph.D. thesis, David Zaya (2013) of the University of Illinois, Chicago, determined that when the two bittersweet species grow side by side in the wild, 1) the Oriental species hybridizes *asymmetrically* with its American cousin such that 51% of the seedlings produced by *C. scandens* were hybrids while only 1.6% of those of *C. orbiculatus* were; and 2) the rate of hybridization of *C. scandens* varies directly with its proximity to *C. orbiculatus*. In controlled crosses between the two species, Zaya found that pistillate plants of *C. scandens* were twenty times more likely to produce hybrids when pollinated with *C. orbiculatus* pollen than vice versa, confirming earlier reports that hybridization between the two species is mainly unidirectional. Remarkably, he also calculated that Oriental bittersweet produces up to 200 times more pollen per individual plant than *C. scandens*. In short,



From David Patterson's 1973 Ph.D. thesis, this figure shows the cumulative number of naturalized sites from which Oriental bittersweet was collected between 1910 and 1970.

American bittersweet, through a mechanism that Zaya refers to as "pollen swamping," is slowly being hybridized into oblivion by Oriental bittersweet.

Conclusion

The rise of Oriental bittersweet and the concurrent demise of its American cousin is a story that goes to the dark heart of the human relationship with nature—things "go oft awry" not from bad intentions but from ignorance. Without thinking much about it, we have globalized our environment in much the same way we have globalized our economy. Certainly the Arnold Arboretum has learned from its past mistakes and is now much more careful about promoting plants that have the potential to become invasive species. But the fact is that climate change—acting in concert with urbanization and globalization—has made the world much more complicated and less predictable than it was back in the days of Sargent, Jack, and Wilson. Across the planet, cosmopolitan ecosystems are displacing native vegetation at an alarming rate but at the same time many of these non-native species are growing vigorously on highly disturbed or badly contaminated land. It's a bittersweet conundrum that the plants that grow best under such conditions are seldom the ones we want.

Acknowledgements

The author would especially like to thank Anner Whitehead for her assistance in tracking down the connection between Thomas Hogg and Samuel Parsons, Lisa Pearson of the Arnold Arboretum Library and Archives for tracking down several obscure references, and the librarians at the New York Botanical Garden and the L. H. Bailey Hortorium at Cornell University for providing access to their Kissena Nurseries catalogues. This article is dedicated to the memory of Dr. Leslie Mehrhoff of the University of Connecticut, Storrs, who was deeply interested in all plants, regardless of their invasive tendencies.

References

- Bailey, L. H. 1893. *Annals of Horticulture in North America for the Year 1892*. New York: The Rural Publishing Company.
- Biltmore Nursery Catalogue. 1907. Asheville, North Carolina.
- Bretschneider, E. 1898. *History of European Botanical Discoveries in China*. London, England: Sampson Low Marston and Company.



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A curtain of Oriental bittersweet foliage.

- Brizicky, G. E. 1964. The genera of Celastrales in the southeastern United States. *Journal of the Arnold Arboretum* 45: 206–234.
- Dwyer, G. L. 1994. Element Stewardship Abstract for *Celastrus orbiculatus*. Nature Conservancy, Arlington, Virginia.
- Fike, J. and W. A. Niering. 1999. Four decades of old field vegetation development and the role of *Celastrus orbiculatus* in the northeastern United States. *Journal of Vegetation Science* 10: 483–492.
- Flora of Japan Database Project (<http://foj.c.u-tokyo.ac.jp/gbif/>). Japanese Society for Plant Systematics, accessed 25 August 2013.
- Hogg, T. 1863. Correspondence. *The Horticulturist* 18: 66–68.
- Hogg, T. 1879. History of *Sciadopitys* and other Japan trees. *Gardener's Monthly and Horticulturist* 21: 53–54.
- Hooker, J. D. 1898. *Celastrus articulatus*. *Curtis's Botanical Magazine* vol. 124 [ser. 3, vol. 54]: tab. 7599.
- Hoopes, J. 1874. Ornamental vines. *The Horticulturist and Journal of Rural Art and Rural Taste* 29(337): 193–195.
- Hoopes, J. 1875. A visit to Parsons' Nursery. *The Horticulturist and Journal of Rural Art and Rural Taste* 30(351): 257–259.
- Hou, D. 1955. A revision of the genus *Celastrus*. *Annals of the Missouri Botanical Garden* 42: 215–302.
- Hovey, C. M. 1885. Hardy Rhododendrons in New England. *The American Garden* 6: 300 .
- Jack, J. G. 1889. Notes from the Arnold Arboretum. *Garden and Forest* 2: 308–309.
- Jack, J. G. 1893. Late ornamental fruits. *Garden and Forest* 6: 507–508.
- Leicht, S. A. and J. A. Silander. 2006. Differential responses of invasive *Celastrus orbiculatus* (Celastraceae) and native *C. scandens* to changes in light quality. *American Journal of Botany* 93: 972–977.
- Lutz, H. 1943. Injury to trees caused by *Celastrus* and *Vitis*. *Bulletin of the Torrey Botanical Club* 70:436–439.

- Maximowicz, C. 1881. *Celastrus* L. Bulletin de l'Académie Impériale des Sciences de Saint-Petersbourg, ser. 3, vol. XXVII: 454–456.
- Meehan, T. 1887. S. B. Parsons. *The Gardener's Monthly and Horticulturist* 29: 378–379.
- Nash, G. V. 1916. *Celastrus articulatus*, Japanese shrubby bitter-sweet. *Addisonia* 4: 9–10, plate 125.
- Ohwi, J. 1965. *Flora of Japan* (in English). Smithsonian Institution, Washington, D.C.
- Palmer, E. J. 1935. Supplement to the spontaneous flora of the Arnold Arboretum. *Journal of the Arnold Arboretum* 16: 81–97.
- Parsons, S. B. 1862. Japanese Trees. *The Horticulturist* 17:186–187.
- Parsons and Company. 1887. *Descriptive Catalogue of Hardy Ornamental Trees, Flowering Shrubs and Vines*. Kissena Nurseries, Flushing, New York.
- Patterson, D. T. 1973. Distribution of Oriental bittersweet in the United States. *Journal of the Elisha Mitchell Scientific Society* 89: 245–246.
- Patterson, D. T. 1973. The ecology of Oriental bittersweet, *Celastrus orbiculatus*, a weedy introduced ornamental vine. Ph.D. thesis, Duke University, Durham, North Carolina.
- Regel, E. von. 1860. *Celastrus crispulus*, *Celastrus punctatus*. *Gartenflora* 9: 407–408.
- Rehder, A. 1900. *Celastrus*. In: L. H. Bailey (ed.), *Cyclopedia of American Horticulture*. New York: The Macmillan Co.
- Rehder, A. 1915. *Celastrus articulata*. In: C. S. Sargent (ed.) *Plantae Wilsonianae*, vol. 2, page 356. Cambridge, Massachusetts: The University Press.
- Rehder, A. 1927. *Manual of Cultivated Trees and Shrubs*. New York: Macmillan Publ. Co.
- "S." 1889. *Dosoris*. *Garden and Forest* 2: 346–347.
- Sargent, C. S. 1888. Public works. *Garden and Forest* 1: 144.
- Sargent, C. S. 1890. New or little known plants. *Celastrus articulata*. *Garden and Forest* 3: 550–551.
- Sargent, C. S. 1893. Notes. *Garden and Forest* 6: 24.
- Sargent, C. S. 1894. *Notes on the Forest Flora of Japan*. Boston: Houghton, Mifflin and Co.
- Siebold, P. F. von. 1863. Catalogue raisonné et prix-courant des plantes et grains du Japon et de la Chine, cultivées dans le Jardin d'Acclimatation de Ph. F. von Siebold à Leide. Privately printed.
- Spongberg, S. A. 1990. *A Reunion of Trees*. Cambridge, Massachusetts: Harvard University Press.
- Thunberg, C. P. 1784. *Flora Japonica* (1975 Reprint). New York: Oriole Editions.
- Steward, A. M., S. E. Clemants, and G. Moore. 2003. The concurrent decline of the native *Celastrus scandens* and spread of the non-native *Celastrus orbiculatus* in the New York City metropolitan area. *Journal of the Torrey Botanical Society* 130: 143–146.
- Whitehead, A. M. 2011. Thomas Hogg, Jr.: his times and his irises. *Review of the Society for Japanese Irises* 48(2): 23–45.
- White, O. E. and W. M. Bowen. 1947. Oriental and American bittersweet hybrids. *Journal of Heredity* 38: 125–127.
- Williams, P. A. and S. M. Timmins. 2003. Climbing spindle berry (*Celastrus orbiculatus* Thunbg.) biology, ecology, and impacts in New Zealand. Science for Conservation 234. Department of Conservation, Wellington, New Zealand.
- Wilson, E. H. 1925. *America's Greatest Garden: The Arnold Arboretum*. Boston: The Stratford Co.
- Wyman, D. 1939. Some twining vines. *Arnold Arboretum Bulletin of Popular Information*, series 4, vol. 7, no. 7: 33–36.
- Wyman, D. 1944. Available rapid growing vines for the United States. *Arnoldia* 4: 45–64.
- Wyman, D. 1949. *Shrubs and Vines for American Gardens*. New York: Macmillan Publ. Co. Wyman, D. 1950. Fruiting habits of certain ornamental plants. *Arnoldia* 10: 81–85.
- Wyman, D. 1964. Outstanding vines for foliage and colorful fruit. *American Nurseryman* 120: 13, 66–72.
- Yokohama Nursery Company Catalogue. 1901. Yokohama, Japan.
- Zaya, D. N. 2013. Genetic characterization of invasion and hybridization: a bittersweet (*Celastrus* spp.) story. Ph.D. thesis, University of Illinois, Chicago.
- Zhang Z. and M. Funston. 2008. Celastraceae. *Flora of China* (www.eflora.org), vol. 11.

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