

Taxonomic revision of the genus *Catalpa* (Bignoniaceae)

RICHARD T. OLSEN AND JOSEPH H. KIRKBRIDE, JR.

U.S. National Arboretum, 3501 New York Avenue NE, Washington, DC 20002-1958, USA;
e-mail: richard.olsen@ars.usda.gov

Abstract. A taxonomic revision of *Catalpa* (Bignoniaceae), a genus of perennial trees frequently used in horticulture as garden and street trees, is provided. Eight natural species and two hybrid species are recognized, four in sect. *Catalpa*, four in sect. *Macrocatappa*, and two hybrid species in sect. *Catalpa*. Although *C. punctata* has been used for one of the tropical species, *C. macrocarpa* is the correct scientific name. *Catalpa tibetica* is synonymous with *C. bignonioides*, *C. fargesii* with *C. bungei*, and *C. obovata* with *C. macrocarpa*. Lectotypes are designated for: *Bignonia cassinoides*, *Bignonia longisiliqua*, *Bignonia longissima*, *Catalpa* Walter, *Catalpa* subsect. *Corymbosae*, *Catalpa bignonioides* var. *kaempferi*, *Catalpa bungei*, *Catalpa bungei* var. *heterophylla*, *Catalpa bungei* var. *intermedia*, *Catalpa domingensis*, *Catalpa fargesii*, *Catalpa henryi*, *Catalpa* × *hybrida*, *Catalpa ovata* var. *flavescens*, *Catalpa punctata* var. *lepidota*, *Catalpa purpurea*, *Catalpa syringifolia* var. *pulverulenta*, *Catalpa sutchuensis*, *Catalpa* × *teasii*, and *Cumbulu*. Second-step lectotypes are designated for: *Catalpa duclouxii*, *Catalpa ekmaniana*, *Catalpa oblongata*, *Catalpa obovata*, and *Catalpa ovata*. Neotypes are designated for: *Bignonia triloba*, *Catalpa aureovittata*, *Catalpa bignonioides* var. *variegata*, *Catalpa* × *erubescens*, *Catalpa* × *erubescens* f. *purpurea*, *Catalpa* × *galleana*, *Catalpa* × *hybrida* var. *atropurpurea*, *Catalpa japonica*, *Catalpa syringifolia* var. *aurea*, *Catalpa syringifolia* var. *koehnei*, *Catalpa syringifolia* var. *nana*, *Catalpa* × *teasiana*, and *Catalpa umbraculifera*.

Keywords: Bignoniaceae, Catalpeae, *Catalpa bignonioides*, *Catalpa brevipes*, *Catalpa bungei*, *Catalpa speciosa*.

The genus *Catalpa* Scop. (Bignoniaceae Juss., tribe Catalpeae DC. ex Meisn.) has eight natural species evenly distributed between two distinct, monophyletic sections, *C.* sect. *Catalpa* and *C.* sect. *Macrocatappa* Griseb. Section *Catalpa* is composed of four species of temperate, deciduous trees with a disjunct distribution between temperate China, two species, and eastern United States, two species (Li, 1952, Wen, 1999, Yih, 2012). All the temperate species are cultivated, with greater or lesser frequency, throughout the temperate regions of the globe, and are escaped and naturalized in many areas. Section *Macrocatappa* is composed of four species of tropical, evergreen trees found only in the Greater Antilles, from Jamaica across Cuba and Hispaniola to the Bahamas. Of the four tropical species only *C. longissima* (Jacq.) Dum. Cours. is found in cultivation around the world, especially in tropical botanic gardens (Gentry, 1992).

The temperate catalpas are often described as the most beautiful of the hardy flowering trees, with thyrses of white or yellow flowers or racemes or corymbs of pink flowers (Meyer, 1907, Clarke, 1988, Dirr, 2009, Grimshaw & Olsen, 2011). Frequently *Catalpa* plants received from both commercial and noncommercial sources have been misidentified. A current taxonomic treatment of *Catalpa* is needed based on the wealth of new collections and for the future application of new analytic techniques that have become available since Paclt's (1952a) taxonomic revision of the genus. Therefore, descriptions of the genus *Catalpa*, its species, and three hybrids, and a key for their identification are presented here. All synonyms of each taxon are given, and each botanical name is typified according to the *International Code of Nomenclature for algae, fungi, and plants* (ICNafp; McNeill et al., 2012). This information is necessary for the correct

identification of *Catalpa* accessions, and their utilization in research and breeding programs to develop new, novel cultivars for the urban landscape (Olsen et al., 2006a, 2006b).

Taxonomic history

Bignonia L. was a broadly circumscribed genus when first published into which Linnaeus (1753, 1763) placed many disparate members of the family Bignoniaceae and classified in his *Didynamia Angiospermia*. In 1753, he included Catesby's (Catesby, 1730) species from the Carolinas (= *Catalpa bignonioides* Walter) and Kämpfer's (Kämpfer, 1712) species from Japan (= *C. ovata* G. Don) in *Bignonia catalpa* L. In 1763, he expanded its circumscription further to include elements equivalent to *B. longissima* Jacq. (Jacquin, 1760) [= *C. longissima* (Jacq.) Dum. Cours.]. At that point, the circumscription of *B. catalpa* encompassed the entire genus *Catalpa*, as accepted here. *Bignonia catalpa* had two fertile stamens, and the rest of the species in Linnaeus's *Bignonia* had either four or five fertile stamens. This was a serious contradiction because the number of fertile stamens was one of the most important characters in Linnaeus's system of classification, and was supposed to be constant in each genus.

Scopoli (1777) and Walter (1788) were early adopters of Linnaeus's binomial nomenclature and used his artificial system of classification based on the number of stamens and styles in the flower. Both Scopoli and Walter realized that *B. catalpa* had two fertile stamens, and the other *Bignonia* species four or five fertile stamens. Each man (Scopoli, 1777: 170; Walter, 1788: 64) resolved the conflict by establishing the genus *Catalpa* with just two fertile stamens, and both used Linnaeus's specific epithet as their generic epithet. Scopoli published his *Catalpa* with *B. catalpa*, and Walter published his *Catalpa* with *C. bignonioides*. In his preface, Walter stated that he had only Linnaeus's *Systema naturae* (Linnaeus, 1735), *Genera plantarum* (Linnaeus, 1737), and *Species plantarum* (Linnaeus, 1753) to work from (Walter, 1788, Rembert, 1980). Thus, *Catalpa* Walter was validly published independently of *Catalpa* Scop.

Bignonia catalpa is the type of *Catalpa* Scop., according to Arts. 10.2 and 10.3 of the *ICNafp* (McNeill et al., 2012), but what is the type of

Catalpa Walter? Walter's description of *Catalpa*, his adoption of Linnaeus' specific epithet, and its placement in *Diandria*, *Monogynia* clearly indicated that he was publishing a genus for Linnaeus's *Bignonia* species with two fertile stamens, but he used the specific epithet *bignonioides* to show that his species was similar to *B. catalpa*, but not the same. Walter established an indirect connection between *B. catalpa* and his genus *Catalpa*. So, *Catalpa* Walter included two species when it was published, *B. catalpa* and *C. bignonioides*, and was not automatically typified when published because it included two species, according to Arts. 10.2 and 10.3 of the *ICNafp* (McNeill et al., 2012). *Bignonia catalpa* is **here designated** as lectotype of *Catalpa* Walter. Therefore, *Catalpa* Walter becomes an isonym of *Catalpa* Scop, has no nomenclatural standing, and is to be disregarded, according Art. 6.3 Note 2 of the *ICNafp* (McNeill et al., 2012).

de Candolle (1838) published a generic summary of the Bignoniaceae in which he presented subtribe *Catalpeae* DC., a nomen nudum, with 17 genera, including *Catalpa* and *Tecoma* Juss. Seven years later in the *Prodromus*, de Candolle (1845) validated subtribe *Catalpeae*. Endlicher (1839) published tribe *Tecomeae*, with six genera, also including *Catalpa* and *Tecoma*. Meisner (1840) published tribe *Catalpeae*, with 21 genera, but included the genus *Tecoma* making the name superfluous following Art. 52.1 of the *ICNafp* (McNeill et al., 2012). Since tribe *Catalpeae* is based on the generic name *Catalpa*, it can, according to Art. 52.3, be used when corrected to include only the genera *Catalpa*, *Chilopsis* D. Don, and \times *Chitalpa* T. S. Elias & Wisura.

In the nineteenth Century, there were three general trends in *Catalpa* systematics, which culminated in Bureau's (Bureau, 1894) unifying revision of the genus. The first trend was the publication in Europe and the United States (Don, 1837, von Meyer, 1837, Teas, 1875) of the botanical names for the remaining temperate species: *C. ovata*, *C. bungei* C. A. Mey., and *C. speciosa* Teas. The second trend in mid-nineteenth Century was initiated by Charles Wright's exploration of Cuba in the Greater Antilles (Howard, 1988). The numbering and distribution of his collections were organized by Asa Gray at the Harvard University herbarium. August Grisebach (1866; 1870, 1873) received Wright's *Catalpa* specimens, and revised the genus for Cuba, naming two new species and a new variety from Cuba and

recognizing the tropical species as a distinct section of *Catalpa*. The third trend was the publication of more than 15 scientific names based on cultivated plants by European horticulturists. Most of these names are synonyms of our accepted botanical species. These names should be treated as cultivars under the *International Code of Nomenclature for Cultivated Plants* (ICNCP; Brickell et al., 2009). At the end of the nineteenth Century, Bureau (1894) published the first *Catalpa* monograph. This treatment synthesized the known data and resembles ours, except for the acceptance of *C. fargesii* Bureau as a good species.

At the beginning of the twentieth Century in the United States, Nathaniel Lord Britton was interested in the Caribbean flora, and conducted numerous collecting trips throughout the region. Britton (1918) reviewed the tropical species of *Catalpa*, and separated them from *Catalpa* as the genus *Macrocatappa* (Griseb.) Britton. In Europe, Ignatz Urban focused on the vegetation and flora of the Antilles, which led to a large number of publications, including his *Symbolae antillanae* (Urban, 1898–1928, Carroll et al., 1965). In collaboration with the Swedish botanist Erik Ekman, he described four new species of tropical *Catalpa*. At mid-Century, Paclt (1947, 1948a, 1948b, 1950, 1951a, 1951b, 1952a, 1952b, 1953, 1954, 1962) carried out a series of studies on the anatomy, biochemistry, cultivars, cytology, entomological pests, morphology, physiology, phytopathology, and taxonomy of *Catalpa*. He recognized 13 species and 18 infraspecific taxa in the genus (Paclt, 1952a). At the end of the last Century, Alwyn Gentry (1992) revised the tropical species in the Greater Antilles. In his revision, he accepted four species.

Since the mid-nineteenth Century, fossils have been recognized as members of the genus *Catalpa*: *C. tenuiloba* (Saporta) Paclt (Saporta, 1862: 273, Paclt, 1952a: 244), *C. crassifolia* Newb. (Newberry, 1870: 56, Berry, 1935, Hickey, 1977), *C. microsperma* Saporta (Saporta, 1889: 62), *C. palaeosperma* Saporta (Saporta, 1889: 62), *C. spiegelii* Engelm. (Engelhardt, 1922: 70), *C. rugosa* E. Reid and M. Chandler (Reid & Chandler, 1926: 128), *C. sibirica* M. G. Gorbunov (Gorbunov, 1962: 359), *C. coloradensis* (Axelrod) J. A. Wolfe & H. E. Schorn (Axelrod, 1987: 108, Wolfe & Schorn, 1990: 33), *C. kryshstovichi* Stephyrtza (Stephyrtza & Negru, 1987: 66), and *C. hispaniolae* Poinar (Poinar, 2016). Six are from leaf impressions, *C. coloradensis*, *C. crassifolia*, *C. kryshstovichi*, *C. sibirica*, *C. spiegelii*, and

C. tenuiloba, one is from flowers in amber, *C. hispaniolae*, and the other three are from seed impressions. Further study utilizing modern techniques is needed to certify the classification of the fossil species in the genus *Catalpa*.

Phylogeny

Molecular studies have demonstrated that the family Bignoniaceae is monophyletic (Spangler & Olmstead, 1999, Olmstead et al., 2000, 2009, Olmstead, 2013, Stevens, 2001, Refulio-Rodriguez & Olmstead, 2014). While Gentry (1980, 1992) recognized *Catalpa* and monospecific *Chilopsis* as members of a large tribe Tecomeae Endl., recent phylogenetic studies (Li et al., 2006, Li, 2008, Olmstead et al., 2009) have shown that they form a well-supported clade, tribe Catalpeae, separate from a much reduced tribe Tecomeae (Fig. 1).

Within tribe Catalpeae, *Chilopsis linearis* (Cav.) Sweet is sister to a strongly supported *Catalpa* clade. The *Catalpa* clade has two strongly supported sister lineages, *Catalpa* sect. *Catalpa* with four temperate, deciduous species in China and eastern North America, and *Catalpa* sect. *Macrocatappa* with four tropical, evergreen species in the Greater Antilles. In *Catalpa* sect. *Catalpa*, *C. bungei* is sister to a strongly supported clade consisting of *C. ovata*, *C. bignonioides*, and *C. speciosa*, with *C. ovata* sister to a strongly supported clade consisting of *C. bignonioides* and *C. speciosa* (Fig. 1).

The close relationship of *Catalpa* and *Chilopsis* has been demonstrated by their capacity to hybridize (Rusanov, 1964, 1971, 1981, Elias & Wisura, 1991, Li et al., 2006), and while the latter might be subsumed within *Catalpa*, we prefer to maintain both genera, since *Chilopsis* is sister to a monophyletic *Catalpa*. *Chilopsis* differs from *Catalpa* by its alternate leaves (vs. ternate or opposite leaves in *Catalpa*), isolateral, linear to linear-lanceolate leaf blades with narrowly long acute base and apex, without areas of sessile, glandular, patelliform trichomes (vs. dorsiventral, elliptic, ovate, oblong, or elliptic-lanceolate leaf blades with cordate, obtuse, truncate, or cuneate base and acuminate, long acuminate, broadly acute, obtuse, or retuse apex, and with dark, triangular areas of dense, sessile, glandular, patelliform trichomes in the abaxial axes of the secondary veins and sometimes the tertiary veins), and four fertile stamens and one staminode (vs. two fertile stamens and three staminodes).

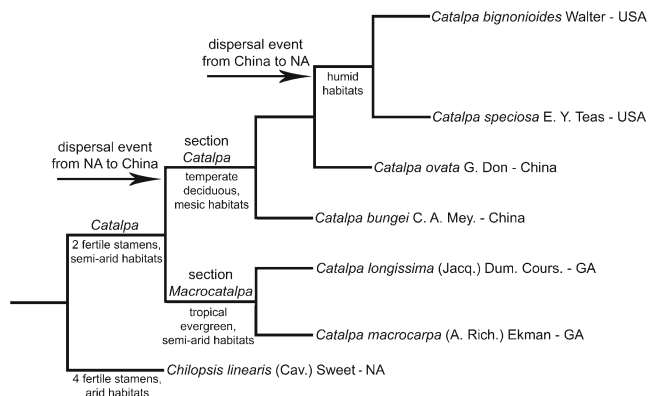


FIG. 1. Phylogeny of Bignoniaceae tribe Catalpeae, modified from Spangler and Olmstead (1999), Li (2008), Olmstead et al. (2009), and Olmstead (2013). *Catalpa brevipes* Urb. and *C. purpurea* Griseb. are not included because no fresh material was available. Multiple samples of the same species have been merged together to simplify the phylogeny. GA = Greater Antilles; NA = North America; USA = United States of America.

Molecular analyses (Olmstead, 2013) suggest that Bignoniaceae originated in South America, and then spread northwards throughout the New World. Tribe Catalpeae is the only clade of the family that is restricted to the northern hemisphere. A major adaptive change for the tribe, relative to the rest of the family, was development of tolerance to cold temperatures. Catalpeae probably originated in North America with *Chilopsis* in arid regions of the southwestern United States of America and Mexico, and *Catalpa* sect. *Macrocatappa* in drier zones of the Greater Antilles. Finally, *Catalpa* sect. *Catalpa* evolved in the temperate forests of China and eastern United States. Two dispersal events are suggested by the phylogeny and current distribution (Fig. 1). A dispersal to China involving an ancestor from the North America sect. *Macrocatappa* gave rise to the clade of section *Catalpa*. *Catalpa bungei* and *C. ovata* subsequently evolved in China, and a second dispersal event from China to North America gave rise to the clade of *C. bignonioides* and *C. speciosa* (Fig. 1).

Horticultural history

The Royal Society of London, a collection of wealthy patrons, sponsored the English naturalist Mark Catesby's exploration of the colony of Carolina in North America from 1722 to 1725. Catesby (1730–1732) published his observations alongside the illustrated plates of his discoveries from the new world in *The Natural History of Carolina, Florida and the Bahama Islands*. The “catalpah tree” is illustrated on plate 49 of volume

one published in 1730. In the description of the plate, the “catalpa-tree” (here without the “h”), he stated “This tree was unknown to the inhabited parts of Carolina, till I brought seeds from the remoter[sic] parts of the country.” Catesby used the local Indian names for the plants and animals he collected and observed on his travels, with catalpa a derivation of the Chickasaw (Creek) name “katalpa” or “kutuhlpa” used for the plant, and the ultimate source of the generic name.

Catesby introduced catalpa (*Catalpa bignonioides*) into England in 1726 (Aiton, 1789, Sweet, 1826). It was an overnight success, with plants listed for sale as early as 1730 in London nurseries with increased production by the 1750s (Catesby, 1763, Laird, 1998) after the first introductions began to flower with abandon and their ornamental merits proven. Catalpa was also quickly adopted by the colonies, with notable plantings in southern and mid-Atlantic plantations and gardens by the 1750s (Catesby, 1730, Davis, 1978). By the end of the eighteenth Century, catalpa became widespread throughout landscapes of America thanks to increased availability in the fledgling nursery industry (Leighton, 1976). By the early nineteenth Century, catalpa was cultivated throughout Europe, as demand for this beautiful flowering and undemanding exotic from America increased (Duhamel du Monceau, 1755, Cavanilles, 1801, Loudon, 1838). Interest in the species waned in the twentieth Century, as evidenced by the fact that no new cultivars have been described since the last monograph (Paclt, 1952a).

The Chinese catalpa, *Ts'i* or *zi* (*Catalpa ovata*), has been cultivated for nearly two thousand years,

valued for its wood qualities, including traditional timber uses and specifically for musical instruments, print blocks, and coffins (Li, 2007, Grimshaw & Olsen, 2011). *Catalpa ovata* was introduced by Chinese Buddhist monks into Korea and Japan, where it became widely cultivated and absorbed into Shinto practices. The Chinese philosophy of designing gardens along the cardinal directions to appease the “four gods”, or *Shijin-Setsu*, was adopted in Japanese gardens, with *C. ovata* representing the white tiger of the West (Makowska, 2014). In his Japanese travelogue, *Amoenitatum exoticarum*, Kämpfer (1712) described and illustrated this “Japanese” species for westerners, including Linnaeus who included it in his *Bignonia catalpa*. However, it was not cultivated outside eastern Asia, until two nearly simultaneous European introductions a century and a half later. In 1848, seeds of *C. ovata* (as *C. kaempferi*) were received at the Muséum National d’Histoire Naturelle in Paris from China and the resultant plants were distributed to French nurseries (Pépin, 1856). The following year, seeds of *C. ovata* from Japan were sent to Franz Philipp von Siebold’s Belgian nursery, and were soon offered for sale (Grimshaw & Olsen, 2011). Unfortunately, the French introduction was confused with the simultaneous introduction of “*C. bungei*” seed from China, which proved to be additional *C. ovata*, an error that was unnecessarily compounded by later botanists and horticulturists, but was unraveled and highlighted by Grimshaw and Olsen (2011). *Catalpa ovata* was distributed widely in the latter half of the nineteenth Century—often incorrectly as *C. bungei*—and was noted for its small, creamy-yellow flowers, which were in contrast to the larger, white flowers of *C. bignonioides*, and its greater hardiness. Seed of *C. ovata* were imported into the United States as early as 1864 (Sargent, 1889), but on the whole, the species has never garnered much interest from horticulturists in the United States. Two cultivars are known, but are extremely rare in cultivation. Its greatest contribution has been spontaneous or controlled hybridizations with its close relatives in sect. *Catalpa*, the North American *C. bignonioides* and *C. speciosa*. All three species will hybridize when grown in proximity to one another (Scott, 1912), as there is overlap in flowering times, and the genus, on the whole, is regarded as outcrossing (Stephenson & Thomas, 1977; Olsen, unpubl. Data).

Catalpa speciosa, the northern or hardy catalpa, has supplanted *C. bignonioides*, the southern or common catalpa, as the most-widely grown catalpa in North America. Although noted by explorers in French Louisiana, and specifically the Ohio region, in the eighteenth Century (Duhamel du Monceau, 1755, Michaux, 1803), it was treated as the northern and western extension of *C. bignonioides* throughout much of the nineteenth Century (Michaux, 1803, 1812, Sims, 1808, Nuttall, 1818, 1836, Loddiges, 1828, Short, 1845, Lesquereux, 1860, Patterson, 1876, Schneck, 1876, Gray, 1878). Side by side observations of the true, introduced southern catalpa (*C. bignonioides*), which was widely planted across North America (Warder, 1881), with the local, hardier and earlier flowering Ohio Valley populations provided conclusive evidence that two species existed in North America (Warder & Steele, 1853, Teas, 1866, Meehan 1875a, 1875b, Schneck, 1876, Barney, 1878a, 1878b, 1879, Engelmann, 1880, Barnes, 1881, Warder, 1879a, 1879b, 1881, Warder et al., 1882). Kirkbride and Olsen (2011a) related this history in detail as they solidified the type and nomenclature for *C. speciosa*. Whether seeds of *C. speciosa* were introduced and plants cultivated in Europe in the eighteenth Century is a matter of speculation, for if an early French introduction did occur, material was either subsequently lost (Elwes & Henry, 1912) or integrated into the common catalpa (*C. bignonioides*) gene pool.

After recognition of *Catalpa speciosa* by American horticulturists and botanists, the species was widely disseminated by enterprising nurserymen in the U.S. and abroad (Barney, 1878a, Engelmann, 1880, Warder, 1881). Its popularity was greatly enhanced due to exaggerated claims of profits to be made as a multi-purpose forest crop, one that with few inputs and little maintenance could provide durable fence and telegraph posts, railroad ties, boxcar material, and fuel for the westward expanding railroad companies (Barney, 1878a, 1879). Railway men like E. E. Barney of Dayton, Ohio, collaborated with Midwestern nurseries to create a lucrative seed business supplying the growing demand for *C. speciosa* plantations, resulting in wide spread distribution of *C. speciosa* (Del Tredici, 1986), but also *C. bignonioides* and *C. ovata* by unscrupulous collectors ignorant of the species differences (Stone, 1908a, 1908b). This “catalpa craze” (Del Tredici, 1986) continued into the twentieth

Century, on the singular efforts of J. P. Brown, who expounded on the virtues of *C. speciosa* (Brown, 1900, 1901, 1903) even as evidence was accruing that refuted the value of the species as a profitable forestry or timber crop, beyond the production of fence posts (Sargent, 1886, Hall, 1902, Oman, 1911, Scott, 1912). Brown, as editor of *Arboriculture: a journal of the forests*, sent seed of true *C. speciosa* to subscribers and correspondents around the world, including Europe, East Asia, India, South Africa, and the Americas. Brown was attempting to ameliorate the rampant fraud in the catalpa seed business in which much of the seed sold by collectors in North America was adulterated with *C. bignonioides*, *C. ovata*, and their hybrid *C. ×erubescens* (Brown, 1908, Stone, 1908a, 1908b). Despite strong advocacy, catalpa plantations were a passing fad, and *C. speciosa* became relegated to ornamental and street-tree plantings and waste places, like *C. bignonioides* before it. In this regard, *C. speciosa* is now preferred by the nursery industry owing to its straighter trunk, more disease-tolerant foliage, and greater hardiness.

Although *Catalpa bungei* has, like *C. ovata*, been cultivated since Chinese antiquity (Keng, 1974), it has not been widely cultivated beyond its native range. Early western plant explorers noted that *C. bungei* was commonly cultivated in temples and palaces in northern China (Grimshaw & Olsen, 2011), and it was from the vicinity of Beijing that the species was discovered by A. A. Bunge (Bunge, 1833). Differentiating between *C. bungei* (*qui* or *quishu*) and *C. ovata* (*Ts'i* or *zi*) in historic Chinese literature is difficult, although Li (2007) points out that *qui* (autumn) referred to *C. bungei*, which was asexually propagated, whereas *zi* (son or offspring) referred to *C. ovata*, which was propagated by seed. A tradition that continues today in modern China (Olsen & Kirkbride, pers. observ.). *Catalpa bungei* has been used in autumn festivals since the Tang Dynasty (618–907AD) (Valder, 1999). Despite being relatively frequently encountered and collected by plant explorers, the species failed to become widely established in cultivation. As indicated under *C. ovata*, the first introduction of *C. bungei* was mired in confusion with the morphologically distinct *C. ovata* in Paris in 1848. The true species was finally introduced at the start of the twentieth Century under different names and different sources (Grimshaw & Olsen, 2011). *Catalpa bungei*, *sensu strictu*, is a rather gaunt,

upright tree, with large white, heavily pink spotted flowers, and rich, dark green foliage. The species still holds a place of prominence in Chinese culture, with extensive research and selection occurring on this valued forestry species in China. Outside of China, it is rarer than it should be and relegated to a handful of botanical collections (Grimshaw & Olsen, 2011).

The four tropical species of *Catalpa* sect. *Macrocatalpa* (*Catalpa brevipes*, *C. longissima*, *C. macrocarpa*, and *C. purpurea*) are essentially absent from cultivation. The exception is Haitian yokewood or oak (*C. longissima*), which is an agroforestry species in the Caribbean (Timyan et al., 1997) and can be found in tropical botanical collections in North America (Francis, 1990). We have grown seedlings of both *C. longissima* and *C. macrocarpa* (received from Fairchild Tropical Botanical Garden, Coral Gables, Florida) at the U.S. National Arboretum, Washington, DC, where they over-winter in heated greenhouses and are used in controlled hybridizations. In tropical environs, young plants flower regularly (Francis, 1990), although in container-production flowering is sporadic (Olsen, pers. observ.). These species can be hybridized with *Chilopsis*, however, our attempts to hybridize them with species of *Catalpa* sect. *Catalpa* have been unsuccessful (Olsen, unpubl. data).

Materials and methods

This study is based on examination of herbarium specimens using a dissecting microscope and online, herbarium-specimen images at various institutions, observation of cultivated specimens, and consultation of specialized literature. Herbarium specimens of *Catalpa* and its closest relatives, *Chilopsis*, and *×Chitalpa*, were studied at the following herbaria: A, BH, BM, BONN, BRIT, E, GH, K, KUN, MARY, MO, NA, NAS, NY, OS, P, PE, PH, S, UPS, US, and XAL. Between 2006 and 2015, more than 80 accessions of *Catalpa*, *Chilopsis*, and *×Chitalpa*, were cultivated and grown to flowering and fruiting at the USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville, Maryland. The plants were observed and studied at all stages of their development. The terminology employed follows Lawrence (1955), Radford (1986), Gentry and Tomb (1979), Gentry (1980, 1992), Harris and Harris (1994), and Kiger and Porter (2001).

Systematic treatment

Catalpa Scop., Intr. Hist. Nat. 170. 1777; *Catalpium* Raf., Princ. Fond. Somiol. 27. 1814, orth. Var. Type: *Bignonia catalpa* L. (= *Catalpa bignonioides* Walter).

Catalpa Walter, Fl. Carol. 64. 1788, isonym (per typ. Des., see discussion).

Macrocatalpa (Griseb.) Britton, J. New York Bot. Gard. 19: 8. 1918; *Catalpa* Scop. sect. *Macrocatalpa* Griseb., Cat. Pl. Cub. 191. 1866. Type [Paclt, 1952a: 270]: *Catalpa punctata* Griseb., nom. Illeg. superfl. [= *Catalpa macrocarpa* (A. Rich.) Ekman].

Trees or rarely *shrubs*, 1–32 m tall, tropical evergreen or temperate deciduous, with spherical, glandular trichomes sessile on many structures, young stems terete, with scattered lenticels elliptic or rarely circular. *Leaves* simple in whorls of 3 or opposite, petiolate, petioles terete, blade entire or bi- or trilobate, ovate, elliptic to elliptic lanceolate, or oblong, abaxially with dark, triangular areas in axes of secondary veins and sometimes also tertiary veins, with dense glandular, patelliform trichomes sessile. *Inflorescences* terminal, indeterminate, thyrses or racemose or corymbose in one species (*C. bungei*), with whorls of 3 branches evenly spaced along rachis, branched or sometimes without branches (*C. bungei*), pedunculate, peduncles terete, with 1 small bract at each branch base and 2 small bracts at each dichasium base or only with small bracts at base or middle of pedicels. *Flowers* hermaphroditic, pedicellate, pedicels terete; calyx calyptriform, globose to broadly globose, turbinate to broadly turbinate, or obpyriformis to broadly obpyriformis, mucronate at apex, splitting from apex to base into 2 or sometimes 3 lobes, with sparse to dense glandular, patelliform trichomes sessile and sometimes

also hispidulous, sparsely villous, or stellate pubescent, green to purple, corolla sympetalous, campanulate, aestivation imbricate, glabrous, bilabiate, lower 3 lobes longer than upper 2, white, various shades of purple, or yellow, with 2 abaxial ridges running from between base of 3 lower lobes to base of corolla tube, yellow for full length, turning wine red; androecium included or just the anthers exerted, fertile stamens 2, with divaricate anthers, staminodes 3, much shorter than stamens, stamens and staminodes separating from corolla tube near base; pollen areolate organized in tetrads; gynoecium superior, ovary oblong, 2-carpellate, placentation axile, ovules numerous, style terete, stigma 2-lobed, elliptic to oblong, glabrous, without floral disk. *Capsules* bilocular, with septum, many seeded, linear, terete, cuneate at base, narrowly acute at apex, longitudinally striate, dark brown, dehiscent perpendicular to septum from apex to base. *Seeds* flat, thin, winged, wings formed by basal connation of long, ciliate hairs, body transversely, narrowly elliptic or oblong, ciliate on lateral edges with very long hairs. $2n = 40$.

Distribution.—Eight species, two in China, two in the eastern United States, and four in the Greater Antilles.

Catalpa leaves and branches have been described as lepidote (Bureau, 1894, Paclt, 1952a, Gentry, 1992), i.e. covered with small, scurfy scales (Harris & Harris, 1994). Examination of fresh leaves and branches showed that they are covered by small, sessile, spherical, glandular trichomes, 0.04–0.1 mm in diameter (Elias & Newcombe, 1979, Nogueira et al., 2013). When older or dried out in herbarium specimens, the spherical, glandular trichomes collapse and appear to be scale-like.

Key to the *Catalpa* taxa

1. Trees or shrubs, tropical evergreen with only a few leaves lost at a time; petioles 0.3–4(–6) cm long, not constricted at base; leaf blades 1–14 × 0.7–5(–6) cm, 1.6–4.5(–6) times as long as wide; Greater Antilles. sect. *Macrocatalpa*
2. Leaves abaxially with the midrib and secondary and tertiary veins prominent and reticulate without magnification; inflorescences with 3–8 flowers, with the rachis 1–2 cm long; Cuba and Hispaniola.
3. Leaves adaxially with the veins impressed, abaxially with dark brown, triangular, glandular areas in axes of basal secondary veins 0.3–0.9 mm long; calyx lobes 5–7 mm long; corolla white. 1. *C. brevipes*
3. Leaves adaxially with the veins prominulous, abaxially with dark brown, triangular, glandular areas in axes of basal secondary veins 1.5–2 mm long; calyx lobes 6–10 mm long; corolla purple. 2. *C. purpurea*
2. Leaves abaxially with the secondary and tertiary veins appearing plane, smooth, and not reticulate without magnification; inflorescences with (3–)25–100 flowers, with the rachis (0.3–)4–15 cm long.
4. Leaf blades acute or long acuminate to obtuse at apex, sometimes weakly apiculate; inflorescences with 40–100 flowers, with 5–7 whorls of 3 branches evenly spaced along rachis; corolla white or light purple; Jamaica, Hispaniola, and Martinique. 3. *C. longissima*
4. Leaf blades obtuse to broadly acute at apex; inflorescences with (3–)25–35(–55) flowers, with (0–)3 or 4(–6) whorls of 3 branches evenly spaced along rachis; corolla light yellow; Cuba, Hispaniola, and Bahamas. 4. *C. macrocarpa*

1. Trees, temperate deciduous with all leaves lost during winter; petioles 2–22 cm long, constricted at base 0.5–1 mm in diam. For 2–8 mm of length; leaf blades 9–40 × 6–36 cm, 0.9–1.6(–1.7) times as long as wide; eastern North America and China, also horticultural hybrids. sect. *Catalpa*
5. Petioles 1–1.3 mm in diam.; inflorescences racemose or corymbose, without branches, with the flowering portion 8–13 × 7–12 cm, with 6–15 flowers; flower pedicels 20–40 mm long; seed hairs 13–25 mm long; China. 5. *C. bungei*
5. Petioles (1.5–)2.1–4.5 mm in diam.; inflorescences thyrsoid, with basal branches of compound dichasia and apical branches of simple dichasia, with the flowering portion 11–48 × 14–26(–35) cm, with 28–500 flowers; flower pedicels 2–20 mm long; seed hairs 3–20 mm long; China and eastern North America, horticultural hybrids.
6. Leaf blade trilobate or sometimes entire in hybrids, abaxially with dark, triangular, glandular areas in axes of some tertiary veins; inflorescences with 1 small bract at each branch base and 2 small bracts at each dichasium base; pedicels without small bracts; calyx before splitting 5.5–8(–10.5) × 4–8 mm, after splitting with the lobes 7–10 × 4–8 mm; corolla yellow or white (in hybrids), with the tube 1.1–1.9 cm long, 5–10 mm wide at throat, with the 2 upper lobes 0.7–1.1 × 0.5–1.4 cm; stamens 10–17 mm long; style 7–9 or 11–16 (in hybrids) mm long; capsules 4–35 per infructescence, 4–8 mm in diam., with the septum 2–4.5 mm wide; seeds with the body 2.4–4.5 × 5.5–6 or 14–24 (in hybrids) mm; China, horticultural hybrids.
7. Calyx lobes 7–8 × 4–5 mm; corollas yellow, with the tube 1.1–1.2 cm long, with 3 lower lobes 0.8–1.2 × 1–1.2 cm, 2 upper lobes 0.7–0.9 × 0.5–0.8 mm long; stamens 10–11 mm long; style 7–9 mm long; capsules 20–35 per infructescence; seeds with the body 2.4–2.6 × 5.5–6 mm; China. 6. *C. ovata*
7. Calyx lobes 8–10 × 5–8 mm; corollas white, with the tube 1.5–1.9 cm long, with 3 lower lobes (1–)1.2–1.7 × 1.2–1.8 cm, 2 upper lobes 0.8–1.4 × 0.9–1.6 cm; stamens 13–17 mm long; style 11–16 mm long; capsules 4–25 per infructescence; seeds with the body 3–4.5 × 14–24 mm; horticultural hybrids.
8. Young stems, leaf blades and inflorescence rachis and branches glabrous to glabrate or villous and stellate pubescent; leaves purple turning green when older; capsules 4 or 5 per infructescence, 4–5 mm in diam., with the septum 2–3.5 mm wide. *C. ×erubescens* f. *purpurea*
8. Young stems, leaf blades and inflorescence rachis and branches glabrous to glabrate, villous or hirsute; leaves green; capsules 7–25 per infructescence, 5–8 mm in diam., with the septum 3–4.5 mm wide.
9. Young stems and leaf blades glabrous to glabrate or villous; inflorescences with (200–)300–500 flowers; seeds with the body 3.5–4.8 × 14–15 mm. *C. ×erubescens*
9. Young stems and leaf blades hirsute, hispidulous or villous; inflorescences with 50–180 flowers; seeds with the body 3.5–4.5 × 17–24 mm. *C. ×galleana*
6. Leaf blade entire or rarely bi- or trilobate, abaxially without glandular areas in axes of tertiary veins; inflorescences without bracts; pedicels with a whorl of 3 small bracts near base or at middle; calyx before splitting 8–13 × 6–11.5 mm, after splitting with the lobes 8–19 × 7–11 mm; corolla white, with the tube 1.5–4 cm long, 8–19 mm wide at throat, with the 2 upper lobes 1–2 × 0.8–2.7 cm; stamens 16–26 mm long; style 12–28 mm long; capsules 1–3(–5) per infructescence, 9–17 mm in diam., with the septum 4–8 mm wide; seeds with the body 4.5–7.5 × 26–42 mm; eastern North America.
10. Old trunks with bark plated; inflorescences with 60–80 flowers, with the rachis 12–26(–28) cm long; corolla with the tube 1.5–2.5 cm long, 8–12 mm wide at throat, with lower 3 lobes 1–1.7 × 0.8–2 cm, upper 2 lobes 1–1.3 × 0.8–1.6 cm; stamens 16–22 mm long; style 12–20 mm long; capsules 9–12 mm in diam., with the septum 4–5 mm wide; seeds with the body 4.5–5.5 × 30–42 mm, with the sides drawn out to an acute point; usually flowering after *C. speciosa*; southeastern North America. 7. *C. bignonioides*
10. Old trunks with bark vertically furrowed; inflorescences with 28–40(–75) flowers, with the rachis 7–12.5(–18) cm long; corolla with the tube (2.3–)2.5–4 cm long, 13–19 mm wide at throat, with lower 3 lobes 2–2.6 × 2–3 cm, upper 2 lobes 1.5–2 × 1.5–2.7 cm; stamens 22–26 mm long; style 20–28 mm long; capsules 10–17 mm in diam., with the septum 5–8 mm wide; seeds with the body 5.5–7.5 × 26–31 mm, with the sides drawn out to an obtuse point; usually flowering before *C. bignonioides*; middle Mississippi River and lower Ohio River valleys. 8. *C. speciosa*

Catalpa Scop. sect. *Macrocatappa* Griseb., Cat. Pl. Cub. 191: 1866; *Macrocatappa* (Griseb.) Britton, J. New York Bot. Gard. 19: 8. 1918. Type [Paclt, 1952a: 270]: *Catalpa punctata* Griseb., nom. illeg. [= *Catalpa macrocarpa* (A. Rich.) Ekman].

1. *Catalpa brevipes* Urb., Repert. Spec. Nov. Regni Veg. 24: 12. 1927. Type: Cuba. Prov. Oriente: Peninsula of Cabo Crux, south of Niguero, on Limestone Terraces Facing the Sea, 16 Jan 1923, *E. L. Ekman* 16,166 (Holotype: B†; Lectotype, Designated by Paclt 1952a: 274: S Herb. No. 15–22,670; Isolectotypes: MO2719409 [Fragments], NY00111547).

Catalpa ekmaniana Urb., Ark. Bot. 22A(10): 61. 1929; *Catalpa brevipes* Urb. var. *ekmaniana* (Urb.) Paclt, Candollea 13: 275. Paclt 1952a, 1952b; *Catalpa brevipes* Urb. subsp. *ekmaniana* (Urb.) Borhidi, Bot. Közlem. 58: 177. 1971. Type: Haiti. Massif de la Hotte, Morne Rochelois,

Miragoane, on limestone hills east of town, *E. L. Ekman* H6476 (holotype: B†; lectotype, first-step designated by Paclt 1952a: 275, second-step, **here designated**: S herb. no. 04–3509; isolectotype: S herb. no. 04–3508).

Catalpa oblongata Urb. & Ekman, Ark. Bot. 22A(10): 61. 1929; *Catalpa brevipes* Urb. var. *oblongata* (Urb. & Ekman) Paclt, Candollea 13: 274. Paclt 1952a, 1952b; *Catalpa brevipes* Urb. subsp. *oblongata* (Urb. & Ekman) Borhidi, Bot. Közlem. 58: 177. 1971. Type: Haiti. Dep. Nord-Ouest, Môle St-Nicolas, Cap Les Anglais, 7 Jul 1925, *E. L. Ekman* H4495 (holotype: B†; lectotype, first-step designated by Paclt 1952a: 275, second-step, **here designated**: S herb. no. 04–3510; isolectotype: S herb. no. 09–21,496).

Shrubs or small *trees* more than 1 m tall, tropical evergreen, young stems puberulous or

hispidulous, with lenticels elliptic, $0.5\text{--}0.7 \times$ ca. 0.2 mm, tan, with scattered to rare glands, sessile, globose, $0.04\text{--}0.08$ mm in diam., tan. *Leaves* opposite or in whorls of 3, sometimes unequal in size in each whorl, the petioles $0.3\text{--}1.8$ cm long, $0.5\text{--}0.8$ mm in diam., not constricted at base, puberulous or hispidulous, with glands globose, sessile, $0.04\text{--}0.08$ mm in diam., blade entire, elliptic or ovate to elliptic-oblong, $1.5\text{--}6.5 \times 1\text{--}3.5$ cm, $1.6\text{--}1.8$ times as long as wide, cuneate or obtuse at base, obtuse or weakly retuse at apex, coriaceous, midrib with $5\text{--}7$ arcuate secondary veins on each side and 1 at base, anastomosing near margin, adaxially glabrous to glabrate, with glands globose, sessile, $0.04\text{--}0.08$ mm in diam., midrib and secondary veins impressed, glabrate to hispidulous, abaxially hispidulous or puberulous, with glands globose, sessile, $0.04\text{--}0.08$ mm in diam., with midrib and secondary and tertiary veins prominent without magnification and reticulate, hispidulous or puberulous, margins entire or sometimes weakly erose, with glands globose, sessile, $0.04\text{--}0.08$ mm in diam., with dark brown, triangular areas in the axils of the basal secondary veins $0.3\text{--}0.9$ mm long, with dense, sessile, glandular, patelliform trichomes ca. 0.08 mm in diam. *Inflorescences* conical thyrses, with $3\text{--}5$ flowers, puberulous, with glands globose, sessile, $0.04\text{--}0.08$ mm in diam., with a few scattered lenticels like those on stems, the rachis terete, $1\text{--}2$ cm long, small bracts linear, $1\text{--}2$ mm long. *Flowers* with the pedicels puberulous, with the trichomes, glandular, spherical, sessile, ca. 0.04 mm in diam, calyx broadly obpyriformis, splitting into two lobes, lobes broadly elliptic, $5\text{--}7$ mm long, obtuse and mucronate at apex, glabrous, with glands spherical sessile, $0.04\text{--}0.06$ mm in diam., corolla with the tube ca. 1.5 cm long, with the three lower lobes circular to transversely broadly elliptic, obtuse at apex, the two upper lobes transversely broadly elliptic, obtuse at apex, connate at base, corolla white, stamens glabrous, ovary glabrous, with glands globose, sessile $0.04\text{--}0.08$ mm in diam., style basally shortly puberulous and apically glabrous. *Capsules* $8\text{--}32 \times 0.2\text{--}0.5$ cm, puberulous, with glands globose, sessile, $0.04\text{--}0.08$ mm in diam. *Seeds* with the body transversely narrowly oblong, $0.5\text{--}0.8 \times 6\text{--}10$ mm, truncate at base and apex, sides drawn out to an acute point, sericeous and ciliate on sides, with hairs $4\text{--}8$ mm long, tan.

Distribution and habitat.—Native to Cuba (Granma Province), Haiti, and southwestern

Dominican Republic. Found on coastal limestone formations.

Selected specimens examined. CUBA. ORIENTE: Cape Cruz (type locality), 1 Aug 1935, *Brother León 16,326* (US).

HAITI. Pussi-à-Roches, 13 Mar 1925, *E. L. Ekman H3502* (MO, S, US); Massif de la Hoffe, group Morne Rochelois, Miragoane, in limestone cliffs towards Anse-à-Veau, 23 Nov 1926, *E. L. Ekman H7290* (S); Gonave Island, 11 Aug 1927, *W. J. Eyerdam 221* (US).

We agree with Gentry (1992) and consider this species to be closely related to *Catalpa purpurea* Griseb. and differing from it by “smaller white flowers and generally smaller leaves”. *Catalpa brevipes* and *C. purpurea* are the least collected and most poorly understood of the *Catalpa* species. Field studies and DNA material of each species are needed to clarify their relationships.

For *Catalpa brevipes* subsp. *ekmaniana*, Paclt (1952a: 275) cited “Type: *Ekman H 6476* ... in hb. S!” At S, there are two duplicates of *Ekman H6476*, so Paclt’s lectotypification referred to a gathering, not a single specimen, and is a first-step lectotypification. One specimen of *Ekman H6476* at S, herb. No. 04–3509, is here designated as the second-step lectotype.

For *Catalpa brevipes* var. *oblongata*, Paclt (1952a: 275) cited “Type: *Ekman H 4495* ... in hb. S!” At S, there are two duplicates of *Ekman H4495*, so Paclt’s lectotypification referred to a gathering, not a single specimen, and is a first-step lectotypification. One specimen of *Ekman H4495* at S, herb. No. 04–3510, is here designated as the second-step lectotype.

2. *Catalpa purpurea* Griseb., Cat. Pl. Cub. 192. 1866; *Macrocatalpa purpurea* (Griseb.) Britton, J. New York Bot. Gard. 19: 9. 1918. Type: Cuba. Cuba Orientali, *C. Wright 3037* (Lectotype, here designated: GOET000330; Isolectotypes: BM000992388, G00025586, GH00091936, GOET000329, MO1998511, MO3437391 [Fragments], NY00114851 [1 Leaf], P00608171).

Catalpa denticulata Urb., Repert. Spec. Nov. Regni Veg. 24: 12. 1927; *C. purpurea* Griseb. *f. denticulata* (Urb.) Paclt, Candollea 13: 277. 1952a, 1952b. Types: Cuba: Prov. Oriente, Palmarito de Cauto, top of mountain, ca. 350 m elev., 27 Jun 1924, *E. L. Ekman 19,091* (holotype: B†; lectotype, designated by Paclt, 1952a: 277; S herb. no. S04–3506; isolectotype: NY00111548).

Trees tropical evergreen, young stems puberulous to glabrate, with lenticels elliptic, $0.2\text{--}0.3 \times 0.16\text{--}0.2$ mm, tan, with scattered to rare glands, sessile, globose, $0.06\text{--}0.1$ mm in diam.,

tan. *Leaves* opposite or in whorls of 3, slightly unequal in size in each whorl, the petioles 0.4–3.5 cm long, 0.9–1 mm in diam., not constricted at base, puberulous, with trichomes sessile, spherical, glandular 0.05–0.1 mm in diam., adaxially glabrate, blade entire or sometimes denticulate, elliptic to elliptic-oblong, 1.2–12 × 1–5 cm, 1.8–2.5 times as long as wide, obtuse at base, obtuse or retuse at apex, chartaceous to coriaceous, midrib with 5 arcuate secondary veins on each side and 1 at base, anastomosing near margins, adaxially glabrate to puberulous, with the veins prominulous, glabrate to puberulous, with glandular trichomes sessile, spherical, like those on petioles, abaxially hispidulous, with the midrib and secondary and tertiary veins prominent without magnification and reticulate, hispidulous, with dark brown, triangular areas in the axils of the basal secondary veins 1.5–2 mm long, with dense glandular, patelliform trichomes, sessile, 0.1–0.2 mm in diam. *Inflorescences* conical thyrses, with ca. 8 flowers, hispidulous, with 3 whorls of 3 branches evenly spaced along the rachis and an apical flower, peduncles 0.3–2.8 cm long, the rachis terete, 1–1.5 cm long, with the flowering portion ca. 5 × ca. 4 cm, with 1 small bract at each branch base and 2 small bracts at each dichasium base, the small bracts narrowly elliptic, 3–4 × 0.6–0.7 mm, narrowly acute at apex, abscising at base early, leaving ridges at bases of branches and dichasia, hispidulous, with glandular trichomes sessile, spherical, like those on rachis and branches, the basal branches of compound dichasia, the apical branches of simple dichasia. *Flowers* with the pedicels 12–21 mm long, with glandular trichomes sessile, spherical, ca. 0.04 mm in diam. Like those on calyx, with 2 opposite small bracts on apical half of pedicel of lateral flowers of each dichasium, with the small bracts subulate, 0.8–1.7 × 0.2–0.4 mm, narrowly acute at apex, hispidulous, calyx globose, 6–10 × 9–10 mm, with spherical, glandular trichomes sessile, 0.04–0.06 mm in diam., splitting into 2 lobes, the lobes broadly elliptic, 6–10 × 6–7 mm, obtuse and mucronate at apex, corolla with the tube 1.5–2 cm long, 10–15 mm wide at throat, with the 3 lower lobes circular to transversely broadly elliptic, 1–1.5 cm long, obtuse at apex, with the 2 upper lobes transversely broadly elliptic, obtuse at apex, the corolla purple, stamens ca. 13 mm long, glabrous, staminodes glabrous, stamens and staminodes inserted in corolla tube ca. 1 mm from base, ovary 3–3.5 mm long, glabrous, with spherical, glandular trichomes sessile, style 8–12 mm long, basal half puberulous and apical half glabrous,

stigma 1–2 mm long. *Capsules* unknown. *Seeds* unknown.

Distribution and habitat.—Native to Cuba (Granma and Santiago de Cuba Provinces) and Haiti, including the Île de la Gonâve. Found on limestone outcrops from 200 to 400 m elevation.

Illustrations.—Bisse (1981: Fig. 6c).

Selected specimens examined. CUBA. ORIENTE: Mogote prope Palmarito de Cauto, ca. 300 m elev., 10 Apr 1918, *E. L. Ekman 9171* (MO, S); El Mogote, near Palmarito de Cauto, 15 Apr 1956, *M. López Figueiras 2677* (US).

HAITI. Ile la Gronave, les Abricols, towards les Etroits, ca. 200 m elev., 1 Aug 1927, *E. L. Ekman H8763* (S).

The specimens with denticulate leaves are distinctive, and were recognized by Urban (1927) as a distinct species. Paclt (1952a) and Gentry (1992) reduced *Catalpa denticulata* to a synonym of *C. purpurea* because the type collection of *C. denticulata* has both entire and denticulate leaves. We agree with Paclt and Gentry, and have continued to treat it as a synonym of *C. purpurea*.

Charles Wright collected in Cuba between 1856 and 1867 (Howard, 1988). His collections were sorted, labelled and distributed by Asa Gray at Harvard University. Gray sent a single set of specimens for determination to A. Grisebach at Göttingen, “Geheimer Regierungsrath”. Grisebach’s herbarium is now at the University of Goettingen (GOET), Germany. Most of the types for his new taxa were in his personal herbarium. There are two specimens of *Wright 3037*, GOET000329 and GOET000330, at GOET, and we are designating GOET000330 as lectotype because it is the more complete specimen.

3. *Catalpa longissima* (Jacq.) Dum. Cours., Bot. Cult., Ed. 1, 2: 190. 1802; *Bignonia longissima* Jacq., Enum. Syst. Pl. 25. 1760; *Bignonia longisiliqua* Jacq., Selectarum Stirp. Amer. Hist., Ed. 2, 90. 1780, Nom. Illeg. Superfl.; *Bignonia quercus* Lam., Encycl. Méth., Bot. 1: 417. 1785; *Macrocatalpa longissima* (Jacq.) Britton, J. New York Bot. Gard. 19: 8. 1918. Type: Lectotype, **here designated**: C. Plumier, Pl. Amer. t. 57. 1756.

Bignonia tenuisiliqua Vahl, Eclóg. Amer. 2: 43. 1798. Type: *J. P. B. von Rohr s.n.* (holotype: C10008602).

Bignonia pseudoquercus Tussac, Fl. Antill. 4: 118, t. 37. 1828. Type: F. R. de Tussac, Fl. Antill. 4: t. 37 (lectotype, designated by Gentry, 1992: 19).

Trees (3–)4–30 m tall, tropical evergreen, young trunks with bark smooth, old trunks with bark vertically furrowed, young stems glabrous or

rarely minutely puberulous, with lenticels circular, $0.3\text{--}0.5 \times \text{ca. } 0.15$ mm, tan, with sessile, globose glands $0.04\text{--}0.08$ mm in diam., tan. *Leaves* opposite or in whorls of 3, slightly unequal in size in each whorl, the petioles with an adaxial furrow, $0.5\text{--}4$ (–6) cm long, $0.6\text{--}0.9$ mm in diam., not constricted at base, glabrous or puberulous, with spherical, glandular trichomes dense, sessile, $0.06\text{--}0.08$ mm in diam., blade entire, elliptic to elliptic-lanceolate to narrowly ovate, $2.5\text{--}14 \times 1\text{--}4.5$ (–6) cm, $2.9\text{--}3$ (–4.5) times as long as wide, obtuse at base, acute or long acuminate to obtuse at apex, sometimes weakly apiculate, chartaceous, midrib with 6–10 arcuate secondary veins on each side and 1 at base, anastomosing near margin, adaxially glabrous, with spherical, glandular trichomes sessile, $0.04\text{--}0.08$ mm in diam., with veins prominulous, abaxially with secondary and tertiary veins appearing plane, smooth, and not reticulate without magnification, glabrous, with a few, spherical, glandular trichomes sessile, $0.04\text{--}0.1$ mm in diam., with dark brown, triangular areas in axils of the basal secondary veins, $0.8\text{--}2$ mm long, with glandular, patelliform trichomes dense, sessile, $0.08\text{--}0.12$ mm in diam. *Inflorescences* conical thyrses, with 40–100 flowers, with 5–7 whorls of 3 branches evenly spaced along the rachis and an apical flower, with 1–3 apical branches of simple dichasia, 1–2 cm long, glabrous, with spherical, glandular trichomes sessile, $0.04\text{--}0.08$ mm in diam., peduncles $0.4\text{--}1.4$ cm long, glabrous or puberulous, with a few scattered lenticels like those on stems, with glandular trichomes sessile, spherical, $0.04\text{--}0.08$ mm in diam., with flowering portion $7\text{--}17 \times 6\text{--}14$ cm, with 1 small bract at each branch base and 2 small bracts at each dichasium base, small bracts linear or rarely, narrowly elliptic, $1\text{--}1.5 \times 0.1\text{--}0.2$ (–0.5) mm, narrowly acute at apex, glabrous, with glandular trichomes dense, sessile, spherical, like those on stems, abscising at base very early, leaving scars at base of branches and dichasia, with rachis terete, $5\text{--}15$ cm long, glabrous, with a few scattered lenticels like those on stems, with spherical, glandular trichomes sessile, $0.04\text{--}0.08$ mm in diam., with 2–5 basal branches of compound dichasia, $3\text{--}6$ cm long, glabrous, with spherical, glandular trichomes sessile, $0.04\text{--}0.08$ mm in diam. *Flowers* with pedicels $3.5\text{--}7$ mm long, glabrous, with glandular trichomes like those on

calyx, calyx globose, $4\text{--}5 \times 4\text{--}5$ mm, glabrous, with spherical, glandular trichomes sessile, $0.04\text{--}0.08$ mm in diam., splitting into 2 lobes, lobes circular, $4\text{--}7 \times 4\text{--}6.5$ mm, obtuse and mucronate at apex, with spherical, glandular trichomes sessile, $0.06\text{--}0.1$ mm in diam., corolla with tube $1\text{--}2$ cm long, ca. 0.2 mm wide at base, $5\text{--}10$ mm wide at throat, with 3 lower lobes circular to transversely broadly elliptic, $0.8\text{--}1.5 \times \text{ca. } 0.9$ cm, obtuse at apex, with 2 upper lobes transversely broadly elliptic, ca. $1 \times 0.7\text{--}0.8$ cm, obtuse at apex, corolla white or light purple, lower lobes with rows of yellow dots along veins and inside tube, stamens ca. 10 mm long, glabrous, with short, subsessile, glandular trichomes on filament bases, staminodes $0.7\text{--}2$ mm long, glabrous, stamens and staminodes inserted in corolla tube $0.5\text{--}1$ mm from base, ovary $2\text{--}2.2$ mm long, glabrous, with spherical, glandular trichomes dense, sessile, $0.04\text{--}0.08$ mm in diam., style $8\text{--}10$ mm long, basal half puberulous and apical half glabrous, stigma $1.5\text{--}2$ mm long. *Capsules* 1–3 per infructescence, $25\text{--}64 \times 0.2\text{--}0.4$ cm, glabrous, with spherical, glandular trichomes sessile, $0.04\text{--}0.08$ mm in diam., the septum $1.5\text{--}2.8$ mm wide. *Seeds* with body transversely narrowly elliptic, $0.8\text{--}1.1 \times 7\text{--}13$ mm, broadly acute or truncate at base, truncate at apex, sides drawn out to an acute point, glabrous and ciliate on sides, with hairs $5\text{--}20$ mm long, tan.

Distribution and habitat.—Native to Jamaica, Haiti, and Dominican Republic. Cultivated sporadically throughout the New and Old World tropics, including Dominica, Guadeloupe, and Martinique in the Lesser Antilles. Found from sea level to 500 m elevation.

Illustrations.—Descourtilz (1822): Fig. 18), as “Bignone a feuilles ondées”; Gentry (1992: Fig. 5); Plumier (1755: Fig. 57), as “Bignonia arborea, folis ex uno centro ternis”; Tussac (1828): Fig. 37), as “Bignonia pseudoquercus”.

Selected specimens examined. DOMINICA. Botanic Gardens, Roseau, 16 Jul 1938, *W. H. Hodge* C (US).

DOMINICAN REPUBLIC. AZUA: 6.4 km SW of Los Negros on road to Barrero, $18^{\circ}19.5'N$, $70^{\circ}53.2'W$, 100 m elev., 30 Apr 1980, *M. Mejía* & *T. zanoní* 6151 (MO). B-ARAHONA: Paraíso, $18^{\circ}0'N$, $71^{\circ}9'W$, near sea level, 12 Apr 1985, *A. Gentry* & *M. Mejía* 50,729 (MO). I-NDEPENDENCIA: Balneario La Zursa, 30 km SE of Jimaní on road to Duverge, 1.5 km E of Baitoa, $18^{\circ}24'N$, $71^{\circ}34'W$, 0 m elev., 3 Jul 1980, *M. Mejía* & *T. zanoní* 7136 (MO). LA VEGA: “Guaigui” Río Camu, 3 km N of T junction near Guaigui, W of

La Vega, 19°10'N, 70°33'W, 300 m elev., 9 Apr 1985, A. Gentry & T. zanoni 50,648 (MO); near Guama de Jumunucu, km 27 from San Francisco de Macoris on road to Bonae, 19°0'N, 70°25'W, 40 m elev., 23 Jan 1981, M. Mejía et al. 10,398 (MO). **LLANURA ORIENTAL:** Prov. San Pedro de Macoris, lado S de la carretera hacia La Romana, el Peñón, 18°27'N, 69°14'W, 20 m elev., 7 May 1993, R. García et al. 4583 (MO). **MONTE CRISTI:** Guayubín, 100 m elev., 13–21 Feb 1921, W. L. Abbott 993 (US). **PEDERNALES:** 17–28 km N of Cabo Rojo, 18°4'N, 71°39'W, 330–350 m elev., S. A. Thompson et al. 7629 (MO). **PERAVIA:** Galeón de Baní, 18°18'N, 70°25'W, 70 m elev., A. Gentry & T. zanoni 50,506 (MO, US); El limón, ca. 7 km al SE de San José de Ocoa, 640 m elev., 18°29'N, 70°29'W, 2 Oct 1994, F. Jiménez & A. Veloz 1775 (S). **SANTIAGO:** Tamboril, 16 May 1887, H. F. A. Eggers 1938 (P, US). **SANTO DOMINGO:** Llano Costero, Santo Domingo City, 18 May 1929, E. L. Ekman 12,543 (S, US); Peninsula de Samaná, prov. De Samaná, Santa Bárbara de Samaná, at Punto Corozas, 3 Aug 1930, E. L. Ekman H15827 (S). **VALLE DE CIBAO:** Prov. Salcedo, 2.8 km SO de Villa Tapia, próximo a La Barranca, 19°17'N, 70°27'W, 80 m elev., M. Mejía & J. Pimentel 23,712 (MO). **VALVERDE:** at stream crossing Autopista Duarte in center of town of Laguna Salsada, 19°34'N, 71°6'W, 60 m elev., 23 May 1980, M. Mejía & T. zanoni 6514 (MO).

GUADELOUPE. Jardin botanique, 1886, A. Duss 1915a (US).

HAITI. Bayeux at mouth of Rivière de Port Margot, N coast, between Cap Haitien and Le Borgue (La Plaine de Port Margot), 6 m elev., 19–24 Jun 1941, H. H. Bartlett 17,450 (US); Dép. du Sud, prope Camp Perrin, 12 Jun 1917, E. L. Ekman H243 (S); Dép. du Sud, Roche-à-Bateau, 24 Jun 1917, E. L. Ekman H295 (S); Massif de la Hoffé, group Mome Rochelais, Miragoane, limestone hills near the town, 25 Mar 1927, E. L. Ekman H7892 (S, US); Porto au Prince, Apr 1827, J. Hennecart 1834 (P); W bank of La Vallée valley, Tortue Island, 3–10 May 1929, E. C. Leonard & G. M. Leonard 15,354 (MO, US).

JAMAICA. CLARENDON: Canoe Valley, near river, 30 Jan 2002, E. Kay & U. Whyte 240 (MO). **Kingston:** Constant Spring, 10 Dec 1890, A. S. Hitchcock s.n. (MO). **MANCHESTER PARISH:** near northwest base of Round Hill, 10 m elev., 4 Feb 1980, A. Gentry & V. Kapos 28,378 (MO, US); Alligator Pond, near coast, 3 Apr 1956, W. T. Stern 639 (BH). **SAINT ANDREWS:** near U.C.W.I. campus, Mona, 168 m elev., 15 Oct 1957, T. G. Yuncker 17,080 (S). **SAINT CATHERINE:** Little Goat Island, 3–15 m elev., 2 Apr 1968, G. R. Proctor 28,592 (MO, US). **SAINT THOMAS:** Four-mile Wood, ca. 0.8 miles due NE of Grants Pen, 26 Jan 1979, G. R. Proctor 37,990 (NA).

MARIANAS. Guam, Andersen Field, 7 Jan 1954, F. R. Fosberg 35,391 (US); Tinian, Peipeinimaru, 20 m elev., 30 Apr 1982, D. Herbst & M. V. C. Falanruw 6808 (US); Saipan, High Commissioner's residence, 4 Jun 1973, M.-H. Sachet 1814 (US).

MARTINIQUE. 1861, C. P. Bélanger 960 (P); environs de Fort de France, May 1865, L. Hahn 838 (P); without locality, L. Hahn s.n. (US).

PANAMA. Santana Park, Panama City, Jul 1914, H. Pittier 6716 (US).

PHILIPPINES. Luzon, Bataan Peninsula, Lamao Forest Reserve, Jun 1907, H. M. Curran 7354 (US).

USA. HAWAII: Oahu, Manoa Campus, University of Hawaii, 15 Sep 1967, D. Herbst 597 (US); Kauai, Lihue Ditric, Lihue, park in front of Water Department office, adjacent to Nawiliwili Road (across from Kukui Grove Shopping Center), 50–100 m elev., 6 May 1988, D. H. Lorence & M. N. Lorence 6352 (MO).

VENEZUELA. DISTRITO CAPITAL: Grounds of the Univeside Central de Venezuela, Caracas, 1975, P. Berry s.n. (MO).

Paclt (1952a: 271) typified *Catalpa longissima* on a Jacquin specimen in the Linnaean herbarium, London (LINN), and Gentry (1992: 19) identified that specimen as number 776.1. There is no *Catalpa* specimen at LINN identified as having been collected by Jacquin. LINN 776.1 has no collector or provenance indicated, so LINN 776.1 is not original material of *B. longissima* and cannot be chosen as type. Jacquin (1760: 25) cited “*Plum. ic. 57*” (Plumier, 1755–1760) when he published *Bignonia longissima*. Therefore Plumier's plate number 57 (Plumier, 1755–1760) is original material, and is here designated as the lectotype of *B. longissima*.

Jacquin (1763: pages 182–183) published an expanded treatment of his *Bignonia longissima* in the first edition of his *Selectarum stirpium Americanum historia*. In the second edition of the same work, he published *B. longisiliqua* (Jacquin, 1780: page 25). The two editions have two different species names, but the same synonymy, description, and distribution, and common name discussion, this expanded in the second edition to include an English common name. Therefore, the publication of *B. longisiliqua* in the second edition must be interpreted as an indirect reference to *B. longissima*, making the former name superfluous.

4. *Catalpa macrocarpa* (a. Rich.) Ekman in Urban, Symb. Antill. 9: 254. 1924; *Echites macrocarpus* a. Rich. In R. De La Sagra, Hist. Phys. Cuba Pl. Vasc., Bot. 11: 94. 1850. Non *Echites macrocarpus* Wallich, Numer. List N. 1662, 1829, Nom. Nud.; *Catalpa punctata* Griseb., Cat. Pl. Cub. 192. 1866, Nom. Illeg. Superfl.; *Robbia macrocarpa* (a. Rich.) Miers, Apocyn. S. Amer. 108. 1878; *Macrocatappa punctata* Britton, J. New York Bot. Gard. 19: 8. 1918, Nom. Illeg. Superfl. Type: Cuba. *R. de la Sagra s.n.* (lectotype, here designated [or perhaps holotype]: P00608167).

Catalpa punctata Griseb. var. *pubescens* Griseb., Cat. Pl. Cub. 192. 1866; *C. pubescens* (Griseb.) Bisse, Ciencias (Havana), ser. 10, 2: 21. 1975. Type: Cuba. Cuba oriente, Bayamo, Wright 3036 (holotype: GOET000328; isotypes: GH00091935, K000449866, MO1998507, P00608168).

Catalpa punctata Griseb. var. *lepidota* Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6: 206. 1894. Type: Cuba. Cuba oriente, Wright 3035 (lectotype, here designated: P00608169; isolectotypes: GH00091934, GOET000327, K000449865, MO1998509, MO3437393 [fragments], P00608170, S [2 sheets], US47325 barcode 00125867).

Catalpa domingensis Urb. & Ekman, Ark. Bot. 22A(10): 63. 1929; *C. punctata* Griseb. var. *domingensis* (Urb. & Ekman) Paclt, Candollea 13: 273. 1952a, 1952b; *C. punctata* Griseb. subsp. *domingensis* (Urb. & Ekman) Borhidi, Bot. Közlem. 58: 177. 1971. Types: Dominican Republic: Barahona, Cabo Falso, 7 Jul 1925, E. L. Ekman H7011

(holotype: B†; **lectotype, here designated:** S herb. no. S04-3507; isocototypes: K000449863, NY00111549, S herb. no. S09-21497).

Catalpa obovata Urb., Ark. Bot. 22A(10): 62. 1929. Type: Haiti. Massif de la Hotte, group Morne Rochelois, Miragoane, 25 Aug 1927, *E. L. Ekman H7897* (holotype: B†; lectotype, first-step designated by Paclt, 1952a: 275, second-step, **here designated:** S herb. no. S04-3511; isocototypes: A00091932, GH00091933, K000449864, MO1611358, NY00111550, S herb. no. S09-21495, US1304087).

Catalpa punctata Griseb. f. *urbanii* Paclt, Candollea 13: 274. 1952a, 1952b. Type: Haiti. Massif de la Selle, group Morne des Commissaires, near Anses-à-Pitre, 15 Sep 1926, *E. L. Ekman H6966* (holotype: S herb. no. S16-35100; isotypes: B†, MO2770788, LL00208102, US01066402).

Trees 5–20 m tall, tropical evergreen, young trunks with bark nearly smooth, young stems hispidulous or puberulous, with scattered to rare glands, sessile, globose, 0.04–0.06 mm in diam., tan. *Leaves* in whorls of 3 or rarely opposite, unequal in size in each whorl, the petioles 0.5–2.5(–3) cm long, 0.5–1.2 mm in diam., not constricted at base, hispidulous or rarely puberulous or glabrous, the blade entire, elliptic to narrowly elliptic, 1–7 × 0.7–4 cm, 1.8–3 times as long as wide, obtuse at base, obtuse to broadly acute at apex, chartaceous to coriaceous, midrib with 3–7 arcuate secondary veins on each side and 1 at base, anastomosing near the margin, adaxially glabrous to glabrate, with spherical, glandular trichomes sessile, 0.05–0.1 mm in diam., with the veins prominulous, hispidulous to glabrate, abaxially densely hispidulous to glabrous or puberulous, with the secondary and tertiary veins appearing plane, smooth, and not reticulate without magnification, densely hispidulous to glabrous, with dark brown, triangular areas in axils of basal secondary veins, 0.5–2 mm long, with dense, glandular, patelliform trichomes sessile, 0.05–0.2 mm in diam. *Inflorescences* conical thyrses or rarely reduced to a dichasium (*Ekman* 7897), with (3–)25–35(–55) flowers, with (0–)3 or 4(–6) whorls of 3 branches evenly spaced along the rachis and an apical flower, basal branches of compound dichasia 0.8–2 cm long, hispidulous to glabrous, apical branches of simple dichasia 0.5–1.5 cm long, hispidulous to glabrous, rachis terete, (0.3–)4–6(–10) cm long, hispidulous to glabrous, with spherical, glandular trichomes sessile, 0.06–0.1 mm in diam., with a few scattered lenticels like those on stems, peduncles 0.2–1.4 cm long, hispidulous to glabrous, with a few scattered lenticels like those on the stems, the flowering portion 3–10 × 3.5–8 cm,

with (3–)25–35(–55) flowers, with 1 small bract at each branch base and 2 small bracts at each dichasium base, the small bracts subulate, 1.5–3.5 × 0.2–0.4 mm, narrowly acute at apex, abscising at base very early, leaving ridges at the bases of the branches and dichasia, glabrous to hispidulous, with spherical, glandular trichomes sessile, like the rachis and branches. *Flowers* with pedicels 4.5–17 mm long, hispidulous to glabrous or puberulous, with spherical, glandular trichomes sessile, 0.06–0.1 mm in diam., like those on the calyx, with 2 opposite small bracts on the apical half of the pedicel of the lateral flowers of each dichasium, the small bracts subulate, 0.5–1.2 × ca. 0.1 mm, narrowly acute at apex, glabrous to hispidulous, with spherical, glandular trichomes sessile, ca. 0.05 mm in diam., calyx broadly globose, 3–4.5(–7) × 2.7–4.2(–6) mm, hispidulous to glabrous, with glandular trichomes sessile, spherical, 0.05–0.1 mm in diam., splitting into 2 or 3 lobes, lobes broadly elliptic to circular or elliptic, 4–7 × 2.5–6 mm, obtuse and mucronate at apex, corolla with the tube 0.5–1.4 cm long, 1–2 mm wide at base, 5–10 mm wide at throat, with the 3 lower lobes circular to transversely broadly elliptic, 0.5–1 × 0.7–0.9 cm, obtuse at apex, with the 2 upper lobes transversely broadly elliptic, 0.7–0.9 × 0.5–0.85 cm, obtuse at apex, the corolla light yellow with red and magenta or orange and brown markings in the throat, stamens 9–13 mm long, glabrous, staminodes 1.5–2 mm long, glabrous, stamens and staminodes inserted in corolla tube ca. 0.5 mm from base, ovary 2–3 mm long, glabrous, style 8–10 mm long, basal half puberulous and apical half glabrous, stigma 1–1.5 mm long. *Capsules* 1 per infructescence, 11–65(–90) × 0.2–0.4(–0.5) cm, glabrous or hispidulous, with the septum 1.2–2 mm wide. *Seeds* with the body transversely narrowly elliptic, 0.7–2 × 8–15(–17) mm, truncate at base and apex, sides drawn out to an acute point, pilose and ciliate on sides, with hairs (5–)15–20 mm long, tan.

Distribution and habitat.—Native to the Bahama Islands (Andros), Cuba, Haiti, and Dominican Republic. Frequently found on limestone from sea level to 300 m elevation.

Illustrations.—Bisse (1981: Fig. 6a, b), as “*Macrocatalpa punctata*” and “*M. tomentosa*”.

Selected specimens examined. BAHAMA ISLANDS. SOUTH ANDROS: in thinly coppiced rocky area less than 1 mile S of The Bluff, E side of road, 1 May 1979, *D. S. Correll & H. B. Correll* 50,608 (MO, US); FG-66-346, 22 Mar 1971, *W. T. Gillis* 10,398 (S).

CUBA. HABANA: Río Santa Ana (W of Mariano), 22 Mar 1922, *E. L. Ekman* 13,649 (S). **LAS VILLAS:** Camino de la Costa, E of Castillo, 1–20 Jul 1950, *R. Howard* et al. 233 (BH). **ORIENTE:** Vicinity of Daiquiri, 14–16 Mar 1912, *N. L. Britton* & *J. F. Cowell* 12,690 (MO, US); Mir prope cavernas ad Mijial, 6 Mar 1915, *E. L. Ekman* 1912 (MO), 4912 (S); Daiquiri in dumetis solo calcareo, 16 Nov 1916, *E. L. Ekman* 8367 (MO, S); Santiago de Cuba, 14 Jul 1916, *E. L. Ekman* 8490 (S), 21 Nov 1917, *E. L. Ekman* 8956 (S); Papayo (prope Sevilla), 25 Jul 1918, *E. L. Ekman* 9436 (S). **PINAR DE RÍO.** Lábalo, in the thickets S of Lábalo, 22 Jun 1920, *E. L. Ekman* 11,449 (MO, S); Bahía Honda, in coastal thickets at Punta Gobernadora, 28 Dec 1920, *E. L. Ekman* 12,687 (S); Sandino, Península de Guanahacabibes, Sep 1999, *A. Urquiola* et al. 447 (S). **SANTA CLARA:** below Soledad, Caunao River to Cienfuegos Bay, 5 Apr 1929, *J. G. Jack* 7177 (P, US); Caunao River to Cienfuegos Bay, 23 Jul 1929, *J. G. Jack* 7533 (S, US).

DOMINICAN REPUBLIC. BARAHONA: Península de Barahona, near Mare-à-Chat, 11 Sep 1926, *E. L. Ekman* H6953 (syntypes of *Catalpa domingensis*: S, LL, MO, US); 22 km SO de Oviedo, 17°51'N, 71°31'W, 30 Sep 1995, *R. García* et al. 5902 (MO). **PEDERNALES.** 20 km NW of Oviedo, 17°51'N, 71°30'W, 210 m elev., 12 Apr 1985, *A. Gentry* & *M. Mejía* 50,748 (MO); Cabo Rojo, 10 Feb 1969, *A. H. Liogier* 13,742 (NY, P, US).

HAITI. Massif de la Selle, group Morne des Commissaires near Anses-à-Pitre, 15 Sep 1926, *E. L. Ekman* H6966 (syntypes of *Catalpa domingensis*: S, LL00208102).

Traditionally, this species has been called *Catalpa punctata*. Ekman (1924) was the first to recognize that Grisebach (1866: 192) had included an earlier specific epithet, *Echites macrocarpus*, which Grisebach should have used instead of *C. punctata*. Paclt (1952a: 272) failed to grasp this situation, and continued to use *C. punctata*. Gentry (1992: 21) did understand, and accepted *C. macrocarpa* as the correct name for the species with *C. punctata* as a synonym, as we have also done.

For *Echites macrocarpa*, Richard (1850) cited only the locality, “Crescit in insula Cuba.” According to Art. 40.3 Note 2 the citation of a locality does not constitute mention of a single specimen or gathering, so Richard did not cite a type. In P there is a specimen with a label bearing the following, “Herbarium Richard, *Echites macrocarpa* nob., Sp. nova, Cuba, Legit Ramon de la Sagra.” It is uncertain whether the specimen is a holotype, i.e. the one specimen used by the author, or original material and a syntype. McNeill (2014) recommended that uncertain specimens like this one be annotated “Lectotype, designated here (or perhaps holotype),” and McNeill’s recommendation has been followed.

For *Catalpa punctata* var. *lepidota*, Bureau (1894) cited a syntype gathering, *Wright 3035*, and the herbarium in which it is deposited, P.

There are two specimens of *Wright 3035* at P, and the more complete specimen, P00608169, is here designated as lectotype.

For *Catalpa domingensis*, Urban and Ekman (Urban 1929: 63) cited “n. H 7011 (typus)”. The holotype at B was destroyed during the Second World War. At S there are two duplicates of *E. L. Ekman H7011*, herbarium numbers S04–3507 and S09–21497. Number S04–3507 is a fruiting specimen consisting of three branches, and number S09–21497 consists of detached parts. Number S04–3507 is here designated as lectotype because it consists of complete specimens.

For *Catalpa obovata*, Urban (1929: 63) cited a single gathering, “n. H 7897”. The holotype at B was destroyed during the Second World War. Paclt (1952a: 275) attempted to lectotypify the name on a specimen at S. There are two duplicates of *E. L. Ekman H7011* at S, herbarium numbers S04–3511 and S09–21495, so Paclt’s lectotypification was not effective. Number S04–3511 is here designated as lectotype.

Catalpa Scop. sect. *Catalpa*; *Catalpa* Scop. sect. *Extratropicae* Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6: 175. 1894; *Catalpa* Scop. subsect. *Thysoideae* Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6: 175. 1894; *Catalpa* Scop. sect. *Eucatalpa* Paclt, Candollea 13: 251. 1952 nom. Inval. (see Art. 21.3 of ICNafp [McNeill et al., 2012]). Type: *Bignonia catalpa* L. (= *Catalpa bignonioides* Walter).

Catalpa Scop. subsect. *Corymbosae* Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6: 195. 1894; *Catalpa* Scop. sect. *Sinocatalpa* Q. W. Yao & P. C. Huang, J. Nanjing Technol. Coll. Forest Prod. 1980: 123. 1980. Type: *Catalpa bungei* C. A. Mey. (lectotype, here designated).

5. *Catalpa bungei* C. A. Mey Bull. Sci. Acad. Imp. Sci. Saint-Petersbourg 2: 51. 1837. Type: China. China Borealis, 1831, A. A. von Bunge s.n. (Lectotype, here designated: P00608163; Isolectotypes: GH, P00608165).

Catalpa bungei C. A. Mey. var. *heterophylla* C. A. Mey., Bull. Sci. Acad. Imp. Sci. Saint-Petersbourg 2: 51. 1837; *C. heterophylla* (C. A. Mey.) Dode, Bull. Soc. Dendrol. France 1907: 203. 1907. Type: China. China borealis, 1831, A. A. von Bunge s.n. (lectotype, here designated: P00608164).

Catalpa fargesii Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6: 195. 1894. Type: China. Su-Tehuan oriental, district de Tchen-Kéou-Tin, 1400 m elev., Jun, *R. P. Farges* 495 (lectotype, here designated: P00753649; isolectotypes: A00091972, MPU015961, NY00328754, P00753650, P00753651, P00753652, P00753653).

Catalpa vestita Diels, Bot. Jahrb. Syst. 29: 577. 1901. Type: China. Zwischen Yang yu und Gnie yu, May–Jun, *Hügel* 1384 (holotype: B†).

Catalpa duclouxii Dode, Bull. Soc. Dendrol. France 1907: 201. 1907.; *C. fargesii* Bureau f. *duclouxii* (Dode) Gilmour, Bot. Mag. 159: t. 9458. 1936. Type:

China: Yunnan, Mo-so-yn, Apr 1888, *P. J. M. Delavay* 3352 (lectotype, first-step designated by Paclt, 1952a: 257, second-step, **here designated**: P00753637; isolectotypes: P00753638, P00753639).

Catalpa sutchuenensis Dode, Bull. Soc. Dendrol. France 1907: 204. 1907. Type: China: Su-Tehuan proental, district de Tchen-Kéou-Tin, 1400 m elev., Jun, *R. P. Farges* 495 (lectotype, **here designated**: P00753647; isolectotype: P00753648).

Catalpa bungei C.A. Mey. var. *intermedia* Pamp., Nuovo Giorn. Bot. Ital. 17: 715. 1910. Type: China. Hu-pè [Hubei], Lung il fiume Jang-se-kiang, 700 m elev., 20–30 Jun 1907, *P. C. silvestri* 2221 (lectotype, **here designated**: F1012559; isolectotypes: A00091971 [fragment], F1012559a, P03576325).

Catalpa fargesii Bureau f. *alba* Q. Q. Liu & H. Y. Ye, Bull. Bot. Res., Harbin 13: 221. 1993. Type: China. Shanxi province: Ji Shan county, Tai Yang town, Xun Zhong village, *Liu Q.-Q. & Ye H.-Yu* 8903 (holotype: PE).

Trees (2–)3–32 m tall, (6–)35–77 cm DBH, temperate deciduous, young trunks with bark smooth, occasional deciduous plates, transitioning to vertically furrowed bark on older trunks, young stems glabrous to stellate, with lenticels elliptic, 0.5–0.7 × 0.15–0.2 mm, tan. *Leaves* in whorls of 3, distinctly unequal in size in each whorl, the petioles 2–12 cm long, 1–1.3 mm in diam., constricted at base ca. 0.5 mm in diam. For ca. 4 mm of length, glabrous to densely stellate, the blade entire, ovate to broadly ovate, 9–20 × 6–13 cm, 1.1–1.5(–1.7) times as long as wide, truncate or weakly cordate at base, long acuminate at apex, midrib with 4–6 arcuate secondary veins on each side and 1 at base, chartaceous, adaxially glabrous to hispidulous and stellate, with the veins prominulous, abaxially glabrous to hispidulous and stellate, with the veins prominent, with dark brown, triangular areas in the axils of the basal secondary veins, 2.5–4.5 mm long, with dense, patelliform trichomes sessile, glandular, 0.1–0.2 mm in diam. *Inflorescences* obconical racemose or corymbose, with 6–15 flowers, without branches, with peduncles 1.5–5 cm long, glabrous to densely stellate, with a few scattered lenticels like those on the stems, with flowering portion 8–13 × 7–12 cm, with bracts at base of each pedicel, bracts narrowly elliptic, 11–21 × 1.5–4 mm, narrowly acute at apex, glabrous to densely stellate, with the rachis terete, 3–7 cm long, glabrous to densely stellate, with a few scattered lenticels like those on stems. *Flowers* with the pedicels 20–40 mm long, glabrous to densely stellate, with spherical, glandular trichomes sessile, ca. 0.04 mm in diam. Like those on calyx, sometimes with a bracteole at the middle of the pedicel, the bracteole narrowly elliptic,

5–7(–12) × 0.5–0.8(–1.2) mm, narrowly acute at apex, glabrous to densely stellate, calyx broadly turbinate, 9–12 × ca. 7 mm, glabrous to stellate, with spherical, glandular trichomes sessile, 0.04–0.06 mm in diam., dark red to greenish red, splitting into 2 or 3 lobes, lobes broadly elliptic or circular, 8–12 × 7–10 mm, obtuse and mucronate at apex, corolla with tube (1.6–)2–2.6 cm long, ca. 2 mm wide at base, 15–18 mm wide at throat, with 3 lower lobes circular to transversely broadly elliptic, 1.5–2.3 × 1.6–2.2 cm, obtuse at apex, with 2 upper lobes transversely broadly elliptic, 1.3–2 × 1.3–2.1 cm, obtuse at apex, connate at the base for 2/3–3/4 of length, the corolla white with many red dots on the tube outside, the lower lobes with rows of red dots along the veins or scattered densely over the surface and inside the tube, with 2 keyhole-shaped bright yellow spots at the mouth of the tube on the inside between the lower lobes, turning dark red with age, stamens 15–25 mm long, white, glabrous, staminodes 1–5 mm long, white, glabrous, stamens and staminodes inserted in corolla tube ca. 2 mm from base, ovary 3–5 mm long, green, style 17–22 mm long, glabrous, white, stigma 1–3 mm long, glabrous, white. *Capsules* 1–3 per infructescence, 25–80 × 0.3–0.6 cm, glabrous, with the septum 3–4 mm wide. *Seeds* with the body transversely narrowly oblong, 1.3–2 × 10–17 mm, truncate at base and apex, sides drawn out to an acute point, glabrous and ciliate on sides, with hairs 13–25 mm long, tan. $2n = 40$.

Distribution and habitat.—Native to China. It has been cultivated there for millennia, and is now found in the following provinces: Anhui, Beijing, Chongqing, Gansu, Guangdong, Guangxi, Guizhou, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shaanxi, Shandong, Shanghai, Shanxi, Sichuan, Tianjin, Yunnan, and Zhejiang (Fang et al., 2009). Rarely cultivated in North America and Europe (Olsen & Kirkbride, 2010, Grimshaw & Olsen, 2011). Usually found in drier areas and cultivated by bare-root transplanting of young trees (Li, 2007).

Illustrations.—Bureau (1894: Fig. 3, as “*Catalpa fargesii*”, Fig. 4); Dode (1907: 198), as “*Catalpa duclouxii*” and “*Catalpa sutchuenensis*”; Gilmour (1936: Fig. 9458), as “*Catalpa fargesii* f. *duclouxii*”; Grimshaw and Olsen (2011: pages 27, 48, 49, 52, 53), as “*Catalpa fargesii*”; Kunming Institute of Botany (1979: 705, Figs. 4–6), as “*Catalpa fargesii*”; Olsen and Kirkbride (2010: 76,

inside back cover); Schneider (1911: Figs. 403g, h, 404e, f); Valder (1999: Fig. 19.1, 2002: Fig. 3.6); Wang et al. (1990: page 15, plate 5, parts 4–7), as “*Catalpa fargesii*”.

Selected specimens examined. CHINA. BEIJING: Peking, 11 May 1923, *W. Y. Hsia s.n.* (PE); Prince Park, Peking, 5 May 1930, *T. N. Liou 1944* (PE). CHIHLI: Western Hills, Peiping, 7 May 1929, *C. Y. Chiao 21,324* (BH, NA, NAS, US). GANSU: Dongchalinchang, Tian Shui, 1000 m elev., 28 Jun 1993, *Y. F. Wang et al. 93,291* (MO), 2 Jul 1993, *Y. X. Sun et al. 93,381* (MO). GUIZHOU: prope Liang Hso Pso, Oct 1916, *O. Schoch 394* (S, US); Yun-fou-shan, near Pinfa, Kweiting, 600 m elev., 3 Jul 1930, *Y. Tsiang 5554* (NAS). HEBEI: Tsingiyuan, près Peking, 4 Jun 1915, *R. P. Licent 1034* (P); Lingshouhsien Agricultural Experiment Station, 5 May 1932, *K. S. Hao 3100* (PE). HENAN: Kioshan and vicinity, 33°N, 20 Jun 1917, *L. H. Bailey s.n.* (BH); Neixiang Xian, Baotianman Nature Reserve, Dahualishu Gou, 33°24'N, 111°53'20"E, 950–1150 m elev., 31 May 1994, *D. E. Boufford et al. 26358* (MO, NY). HUBEI: Li-Chuan, Hsio-Pa, 1036 m elev., 4 Sep 1948, *W. C. Cheng & C. T. Hwa 855* (PE); near Guan Shan, 32°21'16"N, 110°52'5"E, 830 m elev., 12 Sep 1994, *NACPEC94-Wudang Shan WD-009* (NA); Hu-pè [Hupeh], Lung li fiume Jang-se-kiang, 700 m elev., 20–30 Jun 1907, *P. C. silvestri 2221a* (syntype of *Catalpa bungei* var. *intermedia*: FI012560, A [fragment]); Patung Hsien, 9 Jul 1934, *Ho-Ch'ang Chow 798* (E, PE); 8 May 1907, *Y. Yobe s.n.* (NAS). JIANGSU: Nanking city, 19 Sep 1933, *W. C. Cheng 1045* (PE); S. I-shing, 21 May 1926, *C. L. Tso 608* (NAS). SHAANXI: Mienhsien, Wuhouchen, 2 May 1942, *K. T. Fu 3614* (KUN), 9 May 1942, *3658* (NAS); Hu-Hsien, Lü-Kung-Chai, 7 Sep 1934, *Y. Y. Pai 1268* (PE); Chow-tze-hsien, Sze-fu-ying, 16 Sep 1934, *Y. Y. Pai 1378* (PE); cen Er, ao templum Chin-sü, ca. 800 m elev., 5 Nov 1924, *H. Smith 5539* (MO, UPS); Zhouzhi Xian, Zhouzhi, Houzhenzi, 33°48'N, 107°48'E, 1400 m elev., 23 Dec 1999, *G. H. Zhu et al. 2530* (MO). SHANXI: Taihangshan, Tsincheng, 800 m elev., 26 Jun 1937, *K. M. Liou 7487* (PE); Chao yü, 22 Jul 1914, *F. N. Meyer 1708* (NA, NY, P); Yüan-chüdiotr, Ye-cho-shan, ca. 800 m elev., 24 Jul 1924, *H. Smith 1926* (PE); Yüan-ch'ü district, Ye-cho-shan, ca. 800 m elev., 24 Jul 1924, *H. Smith 6590* (PE, UPS). SICHUAN: near Nanchi, Chengkou-hsien, 24 May 1932, *W. P. Fang 10,011* (PE); Tchen-kéou-tin, 1400 m elev., *R. P. Farges 28* (P); Mastzushan, Wushanpsiem, 900 m elev., 11 May 1939, *Wang Si-Tchen 10,535* (KUN); S Wushan, Jun 1900, *E. H. Wilson 976* (P, US). YUNNAN: Yunnan-sen District, Pin-fa, 1902, *J. Cavalerie 101* (E); Song-Ming, Lung-Tan-Chien, 2200 m elev., 10 Oct 1940, *Y. P. Chang 83* (PE); environs de Yunnan Sez, 4 Apr 1897, *F. Ducloux 187* (syntypes of *Catalpa duclouxii*: P00608160, P00608161, P00608162), 10 Apr 1904, *F. Ducloux 192* (E), 10 Apr 1904, *F. Ducloux 2320* (P); open situations around villages in the Lichiang valley, 27°N, 2500 m elev., May 1906, *G. Forrest 2121* (E, P); West Highway Station, Kunming, 1900 m elev., 12 Jul 1945, *T. N. Liou 13,887* (PE); Yunnan-sen, Kunming, near Tsjung-chu-sh temple, 2100–2400 m elev., 3 Apr 1981, *J. Murata 10,549* (E); headwaters of the Red River, or Menghuaho, from Maokai to Tatsang, 8–12 Apr 1922, *J. F. Rock 3097* (E, P, US); high plateau near Talifu and Likiang to the foot of the Likiang Snow Range, near Tien Wei, 6–11 May 1922, *J. F. Rock 3217* (US); Haut-Mekong, Tsékou, 1895, *J. A. Soulié 1422* (syntypes of *Catalpa duclouxii*: P00753640, P00753641, P00753642); 40 km SW of Kunming, near Anning Hot Spring,

24.55°N, 102.29°E, 20 Apr 1989, *Sun Hang et al. 14,101* (E, MO, P); Lung-ling Hsien, 1800 m elev., 5 Apr 1934, *H. T. Tsai 55,650* (KUN, PE); Lichiang, near city, 2500 m elev., 18 Apr 1937, *P. Yu 11,154* (KUN); Lichiang, Nguluka, 2800 m elev., *T. T. Yu 15,190* (KUN); Yu long-shan, Li-kiang, 2500 m elev., Oct–Nov 1935, *C. W. Wang 71,759* (NAS); Kunming, He-Lung-Tang, 1800 m elev., 1 Apr 1941, *F. T. Wang 1698* (KUN); Liaching, Nguluko, 2800 m elev., 17 Jun 1937, *T. T. Yu 15,190* (PE). WITHOUT LOCALITY: 900 m elev., May 1904, *E. H. Wilson 4289* (P).

FRANCE. Arboretum de Segrez, *M. de Vilmorin s.n.* (P).

GERMANY. NORTH RHINE-WESTPHALIA: Bonn, Horti Botanici Universitatis Bonnensis, 9 May 2015, *H. Römer xx-0-BONN-32784* (BONN).

NETHERLANDS. GELDERLAND: Botanical Garden “de Dreijen”, botanical garden accession number BG23734, 51°48'N, 5°40'E, 2 Jul 1993, *C. C. H. Jongkind 1051* (MO).

USA. DISTRICT OF COLUMBIA: US National Arboretum, Washington, Asian Collections – Flood Plain, NA64776-J, 38°54'38"N, 76°57'20"W, 11 m elev., 14 May 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6022* (NA), 27 Apr 2012, *6629* (NA), NA53522-J, *6630* (NA), NA64776-H, 18 May 2009, *6154* (NA), 27 Apr 2012, *6631* (NA); US National Arboretum, Washington, Asian Collection, Korean Hillside, bed 1, NA53522-P, 38°54'48"N, 76°57'24"W, 38 m elev., 14 May 2014, *J. H. Kirkbride, Jr. & R. T. Olsen 6665* (NA). MARYLAND: Prince Georges County, USDA-ARS Glenn Dale Plant Introduction Station, Glen Dale, NA64776-001, 38°57'53"N, 76°48'18"W, 45 m elev., 23 May 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6026* (NA), 22 May 2009, *6155* (NA). MASSACHUSETTS: Arnold Arboretum, Boston, 12,927-A, block 21-NW, 42°18'5"N, 71°07'17"W, 31 m elev., 14 Jun 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6044* (NA), 17,664-A, *6045* (NA). NEW YORK: New York Botanical Garden, Bronx, *Metasequoia* grove, 75783A, 40°51'29"N, 73°52'31"W, 17 m elev., 4 Sep 2008, *J. H. Kirkbride, Jr. et al. 6070* (NA), 15 Jul 2009, *6070* (NA).

von Bunge (1833: 45) misidentified his *Catalpa* collection from temperate China as *C. syringifolia* Sims (= *C. bignonioides* Walter). von Meyer (1837) realized that it was a new *Catalpa* species, stated that Bunge was the first to provide specimens of the species, and named it in his honor. von Meyer (1837) also named *C. bungei* var. *heterophylla*, which had entire and lobed leaves. Paclt (1952a: 255) lectotypified the species and variety on two Bunge specimens of the same collection at LE. The first set of Bunge's collections is at LE, but a large set, probably his personal herbarium, was acquired by E. S.-C. Cosson and is now incorporated into P (Stafleu & Cowan, 1976: 407). Dr. Irina Illarionova of the Komarov Botanical Institute, St. Petersburg (LE) informed us that there are no Bunge specimens of this species at LE. Presumably Paclt's lectotypes are lost, so one of the three specimens at P, P00608163, is here designated as the new lectotype of *C. bungei*, and another one, P00608164, is here

designated as the new lectotype of *C. bungei* var. *heterophylla*. The three specimens at P and the one at GH were all annotated “*Catalpa bungeana*”. This name has appeared in literature, but has never been validly published.

For *Catalpa fargesii*, Bureau (1894: 196) cited “Abbé Farges, n. 495” at P. There are seven duplicates of *Farges 495* of which six were annotated by Bureau as *C. fargesii*, so one of those, P00753649, is here designated as lectotype.

For *Catalpa sutchuenensis*, Dode (1907: 204) cited part of *R. P. Farges 495* in P. Of the seven duplicates of *Farges 495* at P, two of them, P00753647 and P00753648, have been annotated as *C. fargesii* and *C. sutchuenensis*. One of those, P00753647, is here designated as lectotype of *C. sutchuenensis*. There was no justification for Dode to segregate those two duplicates as a separate species. Both *C. fargesii* and *C. sutchuenensis* are synonymous with *C. bungei*.

For *Catalpa duclouxii*, Dode (1907: 201–203) did not cite collections. Paclt (1952a: 257) designated *Delavay 3352* at P as lectotype, but there are three duplicates of this collection at P, so one of those duplicates, P00753637, is here designated as second-step lectotype.

For *Catalpa bungei* var. *intermedia*, Pampanini (1910: 715) cited collections number 2221 and 2221a of P. C. Silvestri, which are syntype gatherings. The duplicate of *Silvestri 2221* at FI, FI012559, with a herbarium label that was annotated by Pampanini as var. *intermedia* is here designated as lectotype.

This species has been treated as three separate species, *Catalpa bungei*, *C. fargesii*, and *C. duclouxii*. *Catalpa bungei* was characterized as having simple pubescence, *C. fargesii* as having stellate pubescence, and *C. duclouxii* as being glabrous. Based on their overall appearance, *C. duclouxii* was synonymized with *C. fargesii* (Gilmour, 1936), and its status was changed to a form of *C. fargesii*. In 2013, based on examination of the collections of *Catalpa* at PE, KUN, and NAS, we discovered that the pubescence of this species forms a continuum from heavily pubescent to glabrous. At one end of the continuum, the most heavily pubescent specimens have all visible organs, except the corolla, densely stellate, so densely pubescent that the surfaces of the organs are completely concealed by the pubescence. Advancing along the continuum, the density of the pubescence gradually decreases in the specimens, and simple hairs are apparent mixed amongst the stellate hairs. Further along, the frequency of stellate

hairs declines until they are absent on the stems and leaves, but still present on the inflorescences and flowers, other than the corolla. Further still, the stellate hairs decline in frequency until only simple hairs exist on the inflorescences and stellate hairs on the flowers, the latter continuing to decline until there are only a few stellate hairs on the calyx, which are difficult to see without magnification. Finally, the decline of both stellate and simple hairs continues along the continuum until one arrives at the specimens at the other extreme, which are completely glabrous. Pan et al. (1980) recognized 11 varietal types along this continuum, three within *C. fargesii* and eight within *C. bungei*. Their varietal names were written in Chinese, and so were not valid botanical names. In our opinion, pubescence type and density cannot be used to separate the members of this species into specific or infraspecific taxa.

In 2013, we visited a prosperous farm in the village of Zhong He Cun, Yunnan beside highway S221, at 1975 m elevation, approximately 44.5 km north-northwest of Dali, at 25°58'36.20"N, 100°6'2.03"E. The farmer was cultivating *Catalpa bungei* for firewood and timber. Next to his residence was a triangular area of approximately 170 m², which was used to produce firewood, and immediately south of the farm buildings was a rectangular plot of approximately 660 m², which was used to produce timber. When he established his farm, he planted *C. bungei* branches, which were easy to establish and grew rapidly. As he removed individual trees for firewood many shoots sprouted from the cut stumps and nearby roots. The root sprouts were used for replanting new groves as needed. He had been harvesting firewood from the plot for many years without replanting. The trees were close together and harvested at a relatively small size. The trees in the rectangular plot were spaced further apart and were much larger. When harvested, the lumber from the timber trees will be sought after because of its light weight, fine grain, and resistance to fungal and insect damage. The wood will be used in furniture construction and boat building.

As discussed previously (see Horticultural history), cultivated specimens of *Catalpa ovata* have often been misidentified as *C. bungei*, and the misidentification has been perpetuated to this day. We have obtained material of *C. bungei* from commercial nurseries all over the United States and Europe, and always the material turned out to be *C. ovata* (Olsen & Kirkbride, 2010). In spite of

Meyer's (Meyer, 1907) assessment that "this tree is one of the finest flowering trees in the world", *C. bungei* is rarely cultivated in western gardens (Olsen & Kirkbride, 2010), while it is widely cultivated in Chinese gardens (Valder, 1999, 2002).

6. *Catalpa ovata* G. Don, Gen. Hist. 4: 230. 1837. Type: Japan. *C. P. Thunberg s.n.* (Lectotype, First-Step Designated by Paclt, 1952a: 252, Second-Step, **here designated**: UPS-THUNB 14230; Isolectotype: UPS-THUNB 14231).

Catalpa bignonioides Walter var. *kaempferi* DC., Prod. 9: 226. 1845; *C. kaempferi* (DC.) Siebold & Zucc., Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 4(2): 142. 1846; *C. bungei* C. A. Mey. var. *nana* Lavallée, Enum. Arbres 174. 1877. Type: E. Kämpfer, *Amoen. Exot. Fasc.*, un-numbered plate on p. 842, 1712 (lectotype, **here designated**).

Catalpa henryi Dode, Bull. Soc. Dendrol. France 1907: 199. 1907. Types: China: Kouy Tchéou province, environs de Kouy-Yang, 1 Jun 1898, E. Bodinier 2309 (lectotype, **here designated**: P03576298; isolectotypes: E, P03576277, P03576278, P03576288, P03576289).

Catalpa ovata G. Don var. *flavescens* Bean, Trees Shrubs Hardy Brit. Isles 1: 313. 1914. Type: United Kingdom. Arboretum, Royal Botanic Gardens, Kew, tree in Pagoda Vista, 19 Jul 1905, W. J. Bean *s.n.* (lectotype, **here designated**: K).

Trees (1–)3–20(–32) m tall, (2–)30–70(–100) cm DBH, temperate deciduous, young trunks with bark smooth, old trunks with bark vertically furrowed, young stems sparsely hirsute, with lenticels narrowly elliptic, 0.7–1.4 × ca. 0.2 mm, tan, with numerous punctate glands, 0.06–0.08 mm in diam., brown. *Leaves* in whorls of 3, slightly unequal in size in each whorl, petioles 6–22 cm long, 2.5–4.5 mm in diam., constricted at base 0.5–1 mm in diam. For ca. 4 mm of length, glabrate, adaxially sparsely hirsute, blade trilobate, ovate to broadly ovate, 19–33.5 × 20.5–31 cm, 0.9–1.3 times as long as wide, cordate at base, acuminate at apex and apices of lobes, midrib with 4–6 arcuate secondary veins on each side and 2 or 3 at base, chartaceous, adaxially sparsely hispidulous, with the veins prominulous, hispidulous, with dark brown, triangular areas in axils of 1 or 2 basal secondary veins, 1–2.5 mm long, with glandular, patelliform trichomes sessile, 0.08–0.2 mm in diam., abaxially sparsely hispidulous, with veins prominent, hispidulous, with dark brown, triangular areas in axils of 3–5 basal secondary veins and some tertiary veins, 1–3 mm long in axils of secondary veins, 0.5–2 mm long in axils of tertiary veins, with dense, glandular, patelliform trichomes sessile, 0.08–0.2 mm in diam. *Inflorescences* conical thyrses of basal compound and apical simple dichasia, with 6–9 whorls of 3 branches evenly spaced along the rachis and an

apical flower, with 1–2 basal whorls of branches of compound dichasia, ca. 11 cm long, glabrate, with 5–8 apical whorls of branches of simple dichasia, 1.5–2 cm long, glabrate, with 150–450 flowers, peduncles 2–6 cm long, glabrate, with a few scattered lenticels like those on stems, flowering portion 20–24(–29) × 18–24(–30) cm, with 1 small bract at each branch base and 2 small bracts at each dichasium base, small bracts narrowly elliptic, 2–11 × 0.5–2 mm, narrowly acute at apex, glabrate and short ciliate, abscising at base very early, leaving lunate ridges at bases of branches and dichasia, with the rachis terete, 17–25 cm long, glabrate, with a few scattered lenticels like those on stems. *Flowers* with the pedicels 2–6 mm long, glabrous to glabrate, with a few spherical, glandular trichomes sessile, ca. 0.04 mm in diam. Like those on calyx, without small bracts on pedicel, calyx turbinate, 5.5–8 × 4–6 mm, glabrous to glabrate at apex, with spherical, glandular trichomes sessile, ca. 0.04 mm in diam. And glandular, patelliform trichomes sessile at apex, 0.1–0.16 mm in diam., green, splitting into 2 lobes, lobes elliptic, 7–8 × 4–5 mm, obtuse and mucronate at apex, corolla with tube 1.1–1.2 cm long, 0.7–1 mm wide at base, 5–8 mm wide at throat, with 3 lower lobes transversely broadly elliptic to circular, 0.8–1.2 × 1–1.2 cm, obtuse at apex, with 2 upper lobes broadly elliptic, 0.7–0.9 × 0.5–0.8 cm, obtuse at apex, connate at base for 1/10–1/2 of length, corolla yellow, lower lobes with rows of purple dots along veins and inside tube, with 2 keyhole-shaped bright yellow spots at mouth of tube on inside between lower lobes, turning dark red with age, stamens 10–11 mm long, white, glabrous, staminodes ca. 2 mm long, white, glabrous, stamens and staminodes inserted in corolla tube ca. 1 mm from base, ovary ca. 2 mm long, glabrous, green, style 7–9 mm long, glabrous, white, stigma ca. 1 mm long, white. *Capsules* 20–35 per infructescence, 15–30 × 0.4–0.7 cm, glabrous, with septum 2–2.1 mm wide. *Seeds* with body transversely oblong, 2.4–2.6 × 5.5–6 mm, truncate at base and apex, sides drawn out to an obtuse point, glabrous and ciliate on sides, with hairs 4–10 mm long, tan. $2n = 40$.

Distribution and habitat.—Native to China. It has been cultivated there for millennia, and is now found in the following provinces: Anhui, Beijing, Chongqing, Fujian, Gansu, Guangdong, Guizhou, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong, Shanghai, Shanxi, Sichuan, Tianjin, Yunnan, and Zhejiang

(Fang et al., 2009). It is commonly cultivated in China, Japan, North America, Europe, and other temperate areas. Usually found in drier zones.

Illustrations.—Cox and Dunn (1973–1974: Figs. 1-1d, 1-2f, 2i); Grimshaw and Olsen (2011: pages 32, 33, 45); Hooker (1882: 6611); Kämpfer (1712: 842), as Kawara Fisági; Kunming Institute of Botany (1979): 705, Figs. 1–3; Lavallée (1880: Fig. 10), as “*Catalpa kaempferi*”; Schneider (1911: Figs. 403e, f, 404c, d); Wang et al. (1990: page 15, plate 5, parts 1–3).

Selected specimens examined. **CANADA. ONTARIO:** Dominion Arboretum, 3 Aug 1931, *M. N. Zinck & J. M. Gillett X-208-1* (BH).

CHINA. BEIJING: Prince Park, Peking, 23 Jun 1933, *K. S. Hao 5188* (PE), 2 Jul 1930, *T. N. Liou 1943* (PE); Pieping College of Agriculture, 30 May 1930, *T. N. Liou 7961* (PE). **GUIZHOU:** Jingnan zhen, 1300 m elev., 17 May 2005, *Liu J. G. 103* (PE); Lungli, Changtingpa, 4 Jul 1930, *Y. Tsiang 8426* (NAS). **HEBEI:** Paoking Hsien, Jun 1901, *E. H. Wilson 1631* (P). **HENAN:** Kaifeng Hsien, 20 Jun 1932, *K. S. Hao 3440* (PE). **HUBEI:** Chakar, Kalgan [Zhangjiakou], 21 Aug 1949, *Y. W. Tsui 410* (PE); Ichang, 1886, *A. Henry 1391* (syntypes of *Catalpa henryi*: K000779199, K000779200, P00753644, P00753645, P00753646), 1684 (syntypes of *Catalpa henryi*: E [2], P00753643); Wuhan, on grounds of Wuhan Botanical Institute, 5 Oct 1986, *G. Tao & T. Stuessy 5038* (OS). **HUBEI:** Luotiao, 15 Jun 1979, *He Q.-G. 49-2* (PE). **HUNAN:** Mount Shunhuangshan, Dongan County, 280 m elev., 26 Dec 2004, *Liu J.-K. 598* (PE). **JIANGSU:** Paohwashan, 31 May 1933, *M. Chen 275* (PE); first primary school, Cehngcheng, 15 Jul 1932, *Y. Tsiang 10,291* (NAS); garden of Pitt Agricultural School, Nanking, 8 Jun 1920, *L. F. Tsu 715* (MO). **JIANGXI:** Fenyizhen, Fenyi County, 200 m elev., 17 Dec 2005, *Ding X.-P. 30* (PE). **KOUY-TCHEOU:** Kouy-yang, 1 Jun 1898, *E. Bodinier 2309* (E). **LIAONING:** Fengting, Chienshan, 26 Jul 1930, *H. W. Kung 7511* (PE); Aug 1909, *Y. Yabe s.n.* (NAS). **SHAANXI:** T'ipaishan, Chiao-ling-sze, 6 Oct 1934, *Y. Y. Pai 1604* (PE). **SHANDONG:** Mengshan, Pingy County, 600 m elev., 1 Jun 2006, *Gao C.-Y. 20,062-201-1* (PE). **SICHUAN:** Tsai-tze-pa, Chengkouhsien, 4 Jun 1932, *W. P. Fang 10,130* (PE). **YUNNAN:** Honang-ts'au-fa, May 1918, *J. Cavalerie 4914* (P); Kunming, Helungtang, 1 Oct 1940, *Y. Lu 5869* (KUN), 1 Oct 1940, *F. T. Wang 257* (KUN); plaine de Téou-tang, 2900 m elev., Jul, *R. P. Maire s.n.* (P); vallée Ling fang, 2900 m elev., Jun, *R. P. Maire 2980* (NAS, S); vallée de Téou-tang, 2500 m elev., Jul, *R. P. Maire s.n.* (P); Lufeng Xian, Jiuzhang Zhen, Qianjia Cong, 25°3.914'N, 101°47.572'E, 1822 m elev., 20 Jul 2006, *J. Wen et al. 9147* (MO, US). **ZHEJIANG:** Tienmushan, 14 Aug 1927, *W. Y. Hsia 299* (PE); Wenchow, 16 Jul 1926, *Y. L. Keng 4* (PE).

FRANCE. Ecole de botanique, Muséum National d'Histoire Naturelle, Jul 1894, *L. E. Bureau s.n.* (P); Horto botanico Naumetensi, Jul–Aug 1860 (fl.), *L. E. Bureau s.n.* (P); Jardin des plantes de Nantes (Loire inférieure), 20 Jun 1865, *L. E. Bureau s.n.* (P); dans un jardin particulier, *J. Lépin s.n.* (P).

GERMANY. NORTH RHINE-WESTPHALIA: Bonn, Horti Botanici Universitatis Bonnensis, 12 Jun 2014, *H. Römer xx-0-BONN-12054* (BONN).

JAPAN. HONSHU: Aomori, Hakkoda, 7 Aug 1887, *U. J. Faurie 880* (P); montagnes de Aomori, (nord de Nippon), 11

Sep 1889, *U. J. Faurie 1170* (P); Yokohama, 1862, *K. I. Maximovicz s.n.* (P, S); Kyoto-fu, Oomoto Kameyama Botanical Garden, Ten'on-kyo, Kameoka-shi, 100 m elev., 28 May 1991, *T. Takahashi & M. Sawada 1795* (MO). **KANSAI:** Akashi village, 18 Jun 1937, *K. Ijano 18909* (BH); Nagasaki, Jun (fl.) & Oct (fr.) 1863, *K. I. Maximovicz s.n.* (MO, US).

TURKMENISTAN. Aschabad, May 1900, *P. E. E. Sintensis 193* (P, S).

UNITED KINGDOM. CAMBRIDGESHIRE: Hort. Bot. Cambridge, Aug. 1879, *G. Engelmann s.n.* (MO), Aug. 1882 (MO).

USA. CALIFORNIA: Los Angeles County, W Los Angeles, Vavra Estate, 725 Bel-Air Road, 16 Jun 1952, *M. S. Mathias 2316* (BH). **DISTRICT OF COLUMBIA:** US National Arboretum, Washington, experimental plot along the N side of Azalea Road 36 m E of Eagle Nest Road, 38°54'30"N, 76°58'10"W, 24 m elev., 16 Jun 2015, *J. H. Kirkbride, Jr. & R. T. Olsen 6720* (NA); vacant lot just across Southern Railroad tracks near outlet to the Tidal Basin, 9 Oct 1920, *O. M. Freeman s.n.* (US); 14 Oct 1897, *E. S. Steele s.n.* (GH); monument grounds, 11 Jul 1905, *C. D. Mell s.n.* (US). **ILLINOIS:** Morton Arboretum, #55–2000-2, 9 Sep 2008, *K. Ball & D. Walker 11309v08* (KUN). **LOUISIANA:** Ouachita Parish, Mill's Pond area off LA 144, 9 Oct 1970, *R. Bandi 696* (MO). **MARYLAND:** Prince Georges County, USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 39°0'29"N, 76°56'36"W, 37 m elev., 17 Jun 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6058* (NA), 6059 (NA), 6061 (NA), 6062 (US), 22 Sep 2008, 6063 (NA), 6082 (NA), 6084 (NA), 10 Jun 2009, 6171 (NA), 6173 (NA), 18 Jun 2009, 6178 (NA), 29 Sep 112009, 6199 (NA), 6200 (NA), 6201 (NA), 1 Jun 2012, 6640 (NA), 6641 (NA), 6642 (NA), 6644 (NA), 9 Jun 2014, 6676 (NA), 6677 (NA); Frederick County, near Thurston, near Sugarloaf Mountain, 18 Jun 1954, *C. F. Reed & J. Collars 33,355* (MO). **MASSACHUSETTS:** Arnold Arboretum, Boston, 98–61-A, block 21-SW, 42°18'5"N, 71°7'17"W, 31 m elev., 14 Jun 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6042* (NA), 237–2002-B, block 21-NW, 6043 (NA). **NEW YORK:** Tompkins County, Ithaca, along Stewart Avenue, car line, S side of Fall Creek Bridge, 22 Jul 1914, *C. C. Thomas 3140* (BH). **OHIO:** Erie County, Kelley's Island Township, Kelley's Island, along first road N of Lake Shore Road going W from Addison Street to Division Street, 11 Jul 1969, *T. Duncan 327* (OS). **PENNSYLVANIA:** Bradford County, wet bottom along Sugar Run, 2 miles E of Evergreen, 22 Jul 1956, *H. A. Wahl 17,556* (BH).

Don (1837: 230) recognized that *Bignonia catalpa* encompassed two species, *Catalpa bignonioides* from North America and an unnamed species from Japan and China, which he named as *C. ovata*. He included *B. catalpa* of Thunberg (1784), a misapplication, and Kämpfer's (Kämpfer 1712) *Kawara fisági* as synonyms. Until the end of the nineteenth Century, the correct name of this species was overlooked or placed in the synonymy of *Catalpa kaempferi*. The great majority of the nineteenth Century literature referred to *C. kaempferi*. Paclt (1952a: 252) lectotypified *C. ovata* on the Thunberg specimen in UPS-THUNB. There are two Thunberg specimens of *C. ovata* in UPS-

THUNB, so the Thunberg specimen number 14230 in UPS-THUNB is here designated the second-step lectotype.

In 1848, two packets of catalpa seeds arrived at the Muséum National d'Histoire Naturelle, Paris (Bossin, 1850, Decaisne, 1851, Jacques, 1855, Pépin, 1856, Grimshaw & Olsen, 2011). One came from China and was identified as *Catalpa bungei*, and the other came from Japan and was identified as *C. kaempferi* or "nain". At the same time a dwarf catalpa arrived at the Muséum, and was identified as *C. kaempferi*. At some point the dwarf catalpa was also identified as *C. bungei* in horticulture. The seeds were grown out at the Muséum and in other French gardens, and flowered for the first time in 1855. The dwarf catalpa did poorly, did not flower, and was propagated vegetatively. They were widely distributed in Europe, and entered into commerce as *C. bungei* and *C. kaempferi*, respectively. From the descriptions of its flowers (Decaisne, 1851, Pépin, 1856), the seeds were *C. ovata*, and the dwarf catalpa is now recognized to be *C. bignonioides* 'Nana'. As a result of their broad distribution by the Muséum, *C. ovata* and *C. bignonioides* 'Nana' became widely cultivated throughout Europe. Hooker (1882) and Henry (1912) pointed out that *C. ovata* was being distributed and sold under the erroneous name *C. bungei*, but even today, *C. ovata* is still being distributed in horticulture as *C. bungei* or *C. kaempferi*.

Traditionally, this species was propagated in China from seed (Li, 2007). It reaches flowering age quicker than *C. bungei* (Olsen, pers. observ.).

In the protologue of *Catalpa henryi*, Dode (1907) cited three syntype gatherings at P: *Bodinier 2309* with five duplicates, *Henry 1391* with three duplicates, and *Henry 1684* with a single duplicate. *Bodinier 2309* (P03576298) is here designated as lectotype of *C. henryi* because it has flowers and immature fruits.

Bean (1914) did not cite a type or specimens in the protologue of *Catalpa ovata* var. *flavescens*. At K there are two specimens collected by Bean, which we consider to be original material, *W. J. Bean s.n.* 19 Jul 1905 from the Arboretum, Royal Botanic Gardens, Kew, and 24 Aug 1910 from Coombe Wood. *Bean s.n.* 19 Jul 1905 from the Arboretum, Royal Botanic Gardens, Kew, is here designated

lectotype of *C. ovata* var. *flavescens* because it is a more complete specimen.

7. *Catalpa bignonioides* Walter, Fl. Carol. 64. 1788. Types: UNITED STATES. South Carolina. *Fraser 28-D* (Neotype as "Holotype", Designated by Reveal et al., 1990: 17: BM-SL, f. 28, Photo in Rembert, 1980: Fig. 7); Lexington County, just behind (N of) Truck Stop and "44 Restaurant", on E Side of SC Hwy 34 at I-20, about 9 mi SE of Leesville, 20 May 1997, *John B. Nelson 18,315* (Epitype as "Neotype", Designated by Ward, 2007b: 1098: GH; Isoepitype: USCH).

Bignonia catalpa L., Sp. pl. 622. 1753; *Catalpa cordifolia* Moench, Methodus 464. 1794, nom. Nov.; *Catalpa ternifolia* Cav., Descr. pl. 26. 1801, nom. Illeg. superfl.; *Catalpa communis* Dum. Cours., Bot. Cult. 2: 189. 1802, nom. Illeg. superfl.; *Catalpa syringifolia* Sims, Bot. Mag. 27: t. 1094. 1806, nom. Illeg. superfl.; *Catalpium amena* Raf., Fl. Ludov. 139. 1817, nom. Illeg. superfl.; *Catalpa catalpa* (L.) H. Karsten, Deut. Fl. 927. 1882, nom. Inval.; *Catalpa arguta* anon., Hand-List Trees Shrubs Grown Arbor. 2: 107. 1896, nom. Inval. Type: *Bignonia urucu foliis, flore cordiæ albo*, Catesby, Nat. Hist. Carolina 1: t. 49. 1730 (lectotype, designated by Reveal et al., 1990: 17).

Bignonia triloba T. Freeman & Custis, Account Red River 46. 1807. Type: USA. LOUISIANA: Tangipahoa Parrish, woods along Tangipahoa River just east of Independence, 16 May 1964, *J. W. Thieret & L. Williams 17,370* (neotype, here designated: US2526418).

Catalpa syringifolia Sims var. *nana* Ed. Otto & A. Dietr., Allg. Gartenzeitung 19(14): 112. 1851; *C. bignonioides* Walter var. *nana* (Ed. Otto & A. Dietr.) Bureau, Nouv. Arch. Mus. Hist. Nat., ser. 3, 6: 183. 1894; *C. bignonioides* Walter f. *nana* (Ed. Otto & A. Dietr.) Paclt, Candollea 13: 261. 1952a, 1952b. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, cultivated tree, 37 m elev., 39°0'29"N, 76°56'36"W, 10 Jun 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6172* (neotype, here designated: NA; isoneotypes: NY, P).

Catalpa syringifolia Sims var. *aurea* Mast., Gard. Chron. 41: 1322. 1871; *C. bignonioides* Walter var. *aurea* (Mast.) Lavallée ex Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6: 183. 1894; *C. bignonioides* Walter f. *aurea* (Mast.) Paclt, Candollea 13: 263. 1952a, 1952b. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, cultivated tree, 36 m elev., 39°0'31"N, 76°56'36"W, 11 Jun 2014, *J. H. Kirkbride, Jr. & R. T. Olsen 6684* (neotype, here designated: NA; isoneotypes: K, MO, NY, P).

Catalpa umbraculifera G. Ugolini, Bull. Reale Soc. Tosc. Ortic. 13: 330. 1888. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, cultivated tree, 37 m elev., 39°0'29"N, 76°56'36"W, 10 Jun 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6172* (neotype, here designated: NA; isoneotypes: NY, P).

Catalpa bignonioides Walter var. *variegata* Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6: 183. 1894; *C. speciosa* Teas var. *albovariegata* F. G. Schwer., Mitt. Deutsch. Dendrol. Ges. 19: 289. 1910; *C. speciosa* Teas f. *albovariegata* (F. G. Schwer.) Rehder, Bibl. Cult. Trees 659. 1949; *C. bignonioides* Walter f. *variegata* (Bureau) Paclt, Candollea 13: 263. 1952. Type:

USA. DISTRICT OF COLUMBIA: U.S. National Arboretum, clonal container plants in greenhouse, 28 May 2010, *J. H. Kirkbride, Jr. & R. T. Olsen 6409* (neotype, **here designated**: NA; isoneotypes: K, MO, NY, P).

Catalpa bignonioides Walter var. *koehnei* (Hesse) Dode, Bull. Soc. Dendrol. France 1907(6): 206. 1907; *C. bignonioides* Walter f. *koehnei* (Hesse) Paclt, Candollea 13: 262. 1952. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, cultivated tree, 37 m elev., 39°0'29"N, 76°56'36"W, 10 Jun 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6174* (neotype, **here designated**: NA; isoneotypes: K, MO, NY, P).

Catalpa syringifolia Sims var. *pulverulenta* Rob., Gard. Ill. 30: 289. 1908; *C. speciosa* Teas var. *pulverulenta* (Rob.) W. T., Gard. Mag. (London) 53: 30. 1910; *C. bignonioides* Walter var. *pulverulenta* (Rob.) Bean, Trees Shrubs Hardy Brit. Isles 1: 312. 1914; *C. speciosa* Teas f. *pulverulenta* (Rob.) Rehder, Bibl. Cult. Trees 659. 1949; *C. bignonioides* Walter f. *pulverulenta* (Rob.) Paclt, Candollea 13: 263. 1952. Type: Anonymous, Gard. Ill. 30: un-numbered photograph on page 289. 1908 (lectotype, **here designated**).

Catalpa tibetica Forrest, Notes Roy. Bot. Gard. Edinburgh 13: 155. 1921. Types: China: Yunnan: Jun 1919, *G. Forrest 18,950* (lectotype, designated by Kirkbride and Olsen (2011b: 628); E No. 00287957; isolectotypes: E No. 00287958, K, P).

Trees (1–)3–21.5(–30) m tall, (2–)35–66(–200) cm DBH, temperate deciduous, young trunks with bark smooth, old trunks with bark plated, plates variable in shape, 4–8(–10) cm long, young stems glabrous, with lenticels elliptic, 0.5–1.2 × 0.2–0.7 mm, tan, with scattered to rare glands, sessile, globose, 0.04–0.06 mm in diam., tan. *Leaves* in whorls of 3, distinctly unequal in size in each whorl, the petioles 10–18 cm long, 2.1–4 mm in diam., constricted at base 0.5–1 mm in diam. For 2–5 mm of length, glabrous or apical 1/3 villous and basal 2/3 glabrous when blade pubescence dense, adaxially glabrate, blade entire or rarely, weakly trilobate, ovate to broadly ovate, (10–)15–31 × (8–)12.5–22.5(–24.5) cm, 1.1–1.5 times as long as wide, cordate, truncate, obtuse, or rarely cuneate at base, long acuminate at apex, midrib with 6 or 7 arcuate secondary veins on each side and 2 or 3 at base, chartaceous, adaxially glabrous to glabrate, with the veins prominulous, glabrate to villous, abaxially glabrate to villous or densely villous, with the veins prominent, villous to densely villous, with dark brown, triangular areas in the axils of 4 or 5 basal secondary veins, 1.5–4 mm long, with dense glandular, patelliform trichomes sessile, 0.14–0.36 mm in diam. *Inflorescences* conical thyrses of basal compound and apical simple dichasia, glabrous to glabrate, with 4–6 whorls of 3 branches evenly spaced along the rachis and an

apical flower, with 2–4 basal branches of compound dichasia 3–13 cm long, with 1–3 apical branches of simple dichasia 0.7–2 cm long, glabrous to glabrate, without bracts, the peduncle 2–7.5(–11) cm long, with a few scattered lenticels like those on stems, the flowering portion 15–31 × 14–26 cm, with 60–80 flowers, with the rachis terete, 12–26(–28) cm long, with a few scattered lenticels like those on stems. *Flowers* with the pedicels 3–16 mm long, glabrous, with spherical, glandular trichomes sessile, ca. 0.04 mm in diam. Like those on calyx, with a whorl of 3 small bracts at middle of pedicel, small bracts subulate, narrowly oblong, or narrowly elliptic, 1.3–7 × 0.2–1 mm, narrowly acute at apex, glabrate, frequently damaged or lost on older flowers, calyx broadly obpyriformis, 8–12 × 6–9 mm, glabrous, with sessile, spherical, glandular trichomes 0.04–0.06 mm in diam., purple to greenish purple, splitting into 2 or rarely 3 lobes, the lobes broadly elliptic to elliptic or circular, 8–12 × 7–9 mm, obtuse and mucronate at apex, corolla with tube 1.5–2.5 cm long, 1–2 mm wide at base, 8–12 mm wide at throat, 3 lower lobes circular to transversely broadly elliptic, 1–1.7 × 0.8–2 cm, obtuse at apex, 2 upper lobes transversely broadly elliptic, 1–1.3 × 0.8–1.6 cm, obtuse at apex, connate at base for 1/3–1/2 of length, corolla white with a few purple dots near base of tube outside, lower lobes with rows of purple dots along veins and inside tube, with 2 keyhole-shaped bright yellow spots at mouth of tube on inside between lower lobes, turning dark red with age, stamens 16–22 mm long, white, glabrous, staminodes 3–6 mm long, stamens and staminodes inserted in corolla tube 2–3 mm from base, white, glabrous, ovary 2–3 mm long, glabrous, green, style 12–20 mm long, glabrous, white, stigma 1–2 mm long, white. *Capsules* 1–3(–5) per infructescence, 24–56 × 0.9–1.2 cm, glabrous, septum 4–5 mm wide. *Seeds* with body transversely, narrowly oblong, 4.5–5.5 × 30–42 mm, truncate and notched in center at base, truncate at apex, sides drawn out to an acute point, glabrous and ciliate on sides, with hairs 3–12 mm long, tan. $2n = 40$.

Distribution and habitat.—Native to northern Florida, southern Georgia, southern Alabama, southern Mississippi, southern Louisiana, eastern most edge of Texas (Weniger, 1996), and the southern edge of Arkansas. Now widely cultivated in all temperate areas of the world, especially eastern North America and Europe. Usually found in humid areas.

Illustrations.—Bean (1914: figure facing page 312); Castle (1888): 47); Catesby (1730): Figs. 49, 1763; Fig. 47); Cox and Dunn (1973–1974: Figs. 1-1b, 1-2e, i, 2a, f); Loddiges (1828: Fig. 1285), as “*Catalpa syringifolia*”; Michaux (1812: Fig. 6), as “*Bignonia catalpa*”; Robinson (1908), as “*Catalpa syringaefolia pulverulenta*”; Sargent (1894): Figs. 288, 289), as “*Catalpa catalpa*”; Schneider (1911: Figs. 403a–d, 404b); Schumann (1894)–1895: Fig. 91b–d); Sims (1808: Fig. 1094); T. (1910: 30), as “*Catalpa syringaefolia pulverulenta*”.

Selected specimens examined. CANADA. ONTARIO: Norfolk County, Port Dover, Prospect Street, Prospect Hill, Woodhouse Turnpike, 42°47'N, 80°12'W, 13 Jul 1951, *J. E. Cruise* 1291 (BH).

CHINA. CHIHUI: Tientsin, 5 Oct 1912, *M. Stron Clemens* 1957 (E). **YUNNAN:** Liking city, 15 Jun 1939, *R. C. Ching* 20,717 (PE); Aug 1919, *G. Forrest* 18,926 (syntypes of *C. tibetica*: E No. 00287955, E No. 00287956). **ZHEJIANG:** Yuchuan, Hangchow, 22 May 1935, *H. Migo* s.n. (NAS).

FRANCE. Ecole de botanique, Muséum National d'histoire Naturelle, Jul 1894, *L. E. Bureau* s.n. (P), Oct 1894, s.n.; Jardin des plantes de Nantes (Loire inférieure), 20 Jun 1865, *L. E. Bureau* s.n. (P); Jardin de la Girandière, (Loire inférieure), *L. E. Bureau* s.n. (P); Muséum National d'histoire Naturelle, 17 Jul 1894, *L. E. Bureau* s.n. (P).

GEORGIA. Batumi, Mctvane Konchi Botanical Garden, 41°42'6"N, 41°43'9"E, 120 m elev., 22 Jun 1999, *J. Stone* et al. 1824 (MO).

GERMANY. NORTH RHINE-WESTPHALIA: Bonn, Horti Botanici Universitatis Bonnensis, 30 Jun 2015, *H. Römer* xx-0-BONN-32752 (BONN).

KYRGYZSTAN. Chui, Chui Valley, District of Airport “Manas”, 41°56.29'N, 74°30.96'E, 638 m elev., 7 Jun 2006, *I. Sodobekov* & *N. Rogova* KPL00575 (MO).

MEXICO. TAMAULIPAS: En la ciudad de Nuevo Laredo en el Parque Juarez, 27°29'3"N, 99°31'3"W, 150 m elev., 24 Jul 1978, *J. I. Calzada* 4601 (MO, XAL).

PERU. LIMA: Lima Botanical Garden, 200 m elev., 7 Jan 1946, *R. J. Seibert* 2329 (MO).

USA. ALABAMA: Barbour County, ca. 8 miles W of junction 30 and US 431, 20 May 1968, *R. Kral* & *D. Demaree* 30,896 (BRIT); Russell County, sandy bank of creek, 15 miles N of Cottonton, 13 Aug 1927, *K. M. Wiegand* & *W. E. Manning* 2906 (BH). **CALIFORNIA:** Sonoma County, Mirabel Park, 1.5 miles N of Forestville, on the lot of Mr. Lotkoff, 22 Jul 1951, *P. Rubtsoff* 525 (BH). **DISTRICT OF COLUMBIA:** US National Arboretum, Washington, DC, on the W side of Azalea Road, 0.4 miles (0.7 km) from the Administration Building, NA68686-H, 38°54'36"N, 76°58'36"W, 42 m elev., 28 May 2009, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6159 (NA), 3 Jun 2009, 6166 (NA), 11 Jun 2014, 6683 (NA); US National Arboretum, Washington, DC, along the Bladensburg Road fence, NA78287-H, 38°54'32"N, 76°58'39"W, 62 m elev., 31 Jun 2009, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6165 (NA); US National Arboretum, Washington, DC, along the E side of the Flowering Tree Walk – SE Section, NA76511-H, 38°54'34"N, 76°58'2"W, 17 m elev., 12 Jun 2015, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6717 (NA), NA76511-J, 38°54'33"N, 76°58'4"W, 20 m

elev., 6718 (NA); grounds of the US Department of Agriculture [national mall], 1873, *G. Vasey* s.n. (US), 1886 (US). **FLORIDA:** Gainesville, 26 Sep 1942, *E. West* 8663 (US); Alachua County, Gainesville, N of Shand's Hospital on University of Florida campus, 1 May 1981, *K. E. Woeste* 33 (BH). **GEORGIA:** Baker County, along Ichawaynochaway Creek near field station, 16 Nov 1947, *R. F. Thorne* 7604 (BH). **ILLINOIS:** Jackson County, 9 Oct 1889, *G. H. French* s.n. (P); DuPage County, Glen Ellyn, 11 Jul 1898, *B. T. Gault* s.n. (BRIT); Menard County, Athens, Jun 1864, *E. Hall* s.n. (P), Jun 1866, s.n. (P). **IOWA:** Iowa City, 2 Jul 1909, *M. P. Somes* 3299 (US). **LOUISIANA:** Baton Rouge Parish, near Pluckett, 22 Apr 1928, *C. A. Brown* 1941 (BRIT); Natchitoches Parish, near Lime Kiln Bayou, Lime Kiln, W of Natchitoches, *C. A. Brown* 7174 (A). **MASSACHUSETTS:** Arnold Arboretum, AA accession no. 592–60-C, map location 21, grid SW, 3 Jul 2003, *S. H. Brown* 219–03 (A); Arnold Arboretum, AA accession no. 290–56, 6 Jul 1964, *S. Kreps* s.n. (A). **MARYLAND:** USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 39°0'29"N, 76°56'36"W, 37 m elev., 10 Jun 2009, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6169 (NA), 6170 (NA), 9 Jun 2014, 6680 (NA), 11 Jun 2014, 6681 (NA); Montgomery County, back yard of Clark Day, 26 Walker Avenue, Gaithersburg, 39°8'46"N, 77°11'57"W, 154 m elev., 19 Jun 2009, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6180 (NA); Talbot County, Ratcliff Manor, 350 m NE of the manor house at side of driveway from St. Michaels Road, state route 33, 38°45'53"N, 76°6'30"W, 4 m elev., 8 Jun 2011, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6609 (NA), 610 m NE of manor house, 6610 (NA); Prince Georges County, USDA-ARS George Washington Carver Center, 5601 Sunnyside Avenue, College Park, along railroad tracks, 39°1'13"N, 76°54'28"W, 29 m elev., 11 Jun 2014, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6682 (NA); Prince Georges County, Patuxent Wildlife Research Center, Duvall Residence, 39°2'14"N, 76°47'16"W, 42 m elev., 10 Jun 2009, *J. H. Kirkbride, Jr.* & *M. C. Perry* 6168 (NA); Montgomery County, dry ground by Connecticut Avenue, North Chevy Chase, 11 Jun 1949, *L. B. Smith* 4807 (US); Prince Georges County, Beltsville Agricultural Research Center, Central Farm, at N end of Entomology Road, 22 Aug 1997, *J. L. Reveal* et al. 8152 (MARY). **MISSISSIPPI:** Washington County, Leland, 7 May 1995, *C. T. Bryson* 14,820 (MO); Simpson County, along Strong River at Mendenhall, highway 49, 10 May 1967, *S. B. Jones* 12,270 (BRIT). **NEW JERSEY:** Somerset County, Watchung, 5 Jul 1931, *H. N. Moldenke* 1869 (BH). **NEW YORK:** Rockland County, Sparkill, 12 Jul 1885, *E. Miller* 56 (BH). **NORTH CAROLINA:** banks of the Swannanoa River, Biltmore, 8 Jun 1896, *Biltmore Herbarium* 385 (BH, MO, P, PH, US). **PENNSYLVANIA:** eastern Pennsylvania, *Hultgren* s.n. (UPS-THUNB 14232, UPS); Lehigh County, 1 mile N of Fogelsville, 8 Aug 1955, *R. L. Schaeffer, Jr.* 49,689 (US). **TENNESSEE:** Lake County, Reelfoot Lake State Park, field N of ranger's house, S of Air Park Inn, 18 January 1987, *M. Guthrie* 1623 (BRIT). **TEXAS:** Sabine County, along Colorow Creek, route #87, 11 miles N of Milam, 23 May 1959, *D. S. Correll* et al. 22,230 (BRIT); Lee County, 6 miles WSW of Giddings, farmstead of Oscar Schulz, 6 May 1949, *V. L. Cory* 55,766 (US). **VIRGINIA:** Reynolds Homestead, Virginia Tech, 463 Homestead Lane, Critz, 36°38'37"N, 80°8'56"W, 340 m elev., 8 Jul 2009, *J. H. Kirkbride, Jr.* & *R. T. Olsen* 6182 (NA). **WISCONSIN:** Crawford County, Gays Mills, village park along the Kickapoo River, upstream from the Highway 171 bridge, T10N R4W NW1/4 NE1/4 sect. 28, 213 m elev., 10 Jul 2012, *M. Nee* 59,317 (MO).

Paclt (1952a: 259) was the first to typify *Catalpa bignonioides* in his synopsis of the genus. He gave the type of *C. bignonioides* as, “*Linnaeus* [?] in hb. BM. (Herb. Hort. Clifford.), actually missing”. No specimen of *Catalpa* was found in an online search of the George Clifford Herbarium at the Natural History Museum, London, nor by Reveal et al. (1990). Reveal et al. (1990), concluding that *C. bignonioides* was being described as new by Walter, cited the specimen of *C. bignonioides* in the Walter Herbarium at the Natural History Museum, London (BM-SL 28-D; Rembert 1980: Fig. 7) as the holotype. They assumed that Walter had used the one specimen in his herbarium. Ward (2006, 2007a, 2007b) demonstrated that the Walter Herbarium actually is composed of John Fraser’s collections. The specimen of *C. bignonioides* in the Walter Herbarium bears the identification “*Catalpa bignonioides*” in Fraser’s hand (Ward, 2007b). Ward (2007b) rejected Fraser’s specimen as a potential type because it consisted of only a single, partial, broken leaf and lacked linkage to Walter, but did not cite nor mention its designation as type for *C. bignonioides* by Reveal et al. (1990). Since the specimen of *C. bignonioides* in the Walter Herbarium cannot be considered part of Walter’s original material and there is no other original material that can be associated with the name (Ward, 2007b), selection of a neotype was required. Reveal et al. (1990) identified the specimen of *C. bignonioides* in the Walter Herbarium (BM-SL 48-D) as a “holotype”, which according to Art. 9.9 of the ICNafp (McNeill et al., 2012) is a correctable error, and was a neotypification of *C. bignonioides* on Fraser (BM-SL 48-D). Ward (2007b) later designated *John B. Nelson 18,315* (GH) as “neotype” of *C. bignonioides* because he considered the Fraser specimen to be an inadequate specimen for a neotype. His reasons for selecting *Nelson 18,315* (GH) over Fraser (BM-SL 48-D) are also the reasons for selecting an epitype, so Art. 9.9 (McNeill et al., 2012) also applies to Ward’s type selection, which is an epitype.

The Red River Expedition, led by surveyor Thomas Freeman and accompanied by Dr. Peter Custis as naturalist, ascended the Red River in the spring and summer of 1806 (Morton, 1967). The expedition stopped close to River View, Texas, near the Texas-Oklahoma-Arkansas meeting point. Freeman and Custis described *Bignonia triloba* from

“a tree growing on the banks of the bayous between the Coashalla and Natchitoches” (Freeman & Custis, 1807). Custis’s collections were given to Benjamin Smith Barton, and his herbarium was incorporated into the herbarium of the Academy of Natural Sciences (PH), Philadelphia. Dr. Tatyana Livshultz, Curator of Botany, informed us that there are no Custis specimens of *Catalpa* in their herbarium. Freeman and Custis (1807) considered it to resemble *Catalpa bignonioides*, and its location is within the probable native distribution of *C. bignonioides*. A collection of *C. bignonioides* from Louisiana, *Thieret & Williams 17,370* (US2526418), is here designated as neotype of *B. triloba*.

Numerous minor variants of *Catalpa bignonioides* have been discovered in cultivation during the last two and a half centuries, and many of them have been given scientific names. In our opinion, they should be treated as cultivars under the ICNCP (Brickell et al., 2009), and not given formal scientific recognition. *Catalpa syringifolia* var. *nana*, *C. syringifolia* var. *aurea*, *C. umbraculifera*, *C. bignonioides* var. *variegata*, *C. syringifolia* var. *koehnei*, and *C. syringifolia* var. *pulverulenta* are cultivated plants described in Europe between 1851 and 1908 with minimal descriptions and without type or specimen citations. Probably they were all described from living garden plants, and we were unable to locate collections of these taxa in the principal European herbaria. All available *Catalpa* cultivars were grown out at the USDA-ARS U.S. National Arboretum, Woody Landscape Plant Germplasm Repository, Beltsville, Maryland, USA, and herbarium vouchers were prepared from them. Matching the protologue descriptions to our vouchers, we have designated neotypes for these names using our vouchers of cultivated plants that most closely resemble the descriptions in their protologues. For other taxa known only in horticulture, we have also treated them in the same way.

Schwerin (1910) described *Catalpa speciosa* Teas var. *albovariegata* F. G. Schwer. from a tree growing in the Botanischer Garten und Botanisches Museum Berlin-Dahlem. He described the variegated form of *C. bignonioides* with white variegations. There are not enough differences in the variegation color shades to separate *C. bignonioides* var. *variegata* from *C. speciosa* var. *albovariegata*, so the same

specimen is here designated as neotype for both varieties.

Usually *C. bignonioides* flowers after *C. speciosa* (Cox & Dunn, 1973–1974).

8. *Catalpa speciosa* Teas in Meehan, Gard. Monthly & Hort. Advertiser 17(6): 181. 1875; *C. bignonioides* Walter Var. *speciosa* (Teas) Meehan, Gard. Monthly & Hort. Advertiser 17(6): 181. 1875. Type: USA. ILLINOIS: Wabash [River] Bottom near Mt. Carmel, May 1879, *J. Schneck s.n.* (neotype, designated by Kirkbride & Olsen, 2011a: 1762; MO 1998510).

Trees (1–)6–24 m tall, (2–)8–60(–110) cm DBH, temperate deciduous, young trunks with bark smooth, old trunks with bark vertically furrowed, young stems glabrous, with common or rare scattered lenticels, elliptic, 0.6–0.7 × 0.2–0.4 mm, tan, with scattered to rare glands, sessile, globose, ca. 0.06 mm in diam., tan. *Leaves* in whorls of 3, distinctly unequal in size in each whorl, petioles 10–16 cm long, 2.5–3.5 mm in diam., constricted at base 0.5–1 mm in diam. For 2–3 mm of length, apical 1/3 villous and basal 2/3 villous to glabrate, blade entire or rarely, bi- or trilobate, ovate to broadly ovate, 15–40 × 12–25 cm, 1.2–1.6 times as long as wide, cordate, truncate, or obtuse at base, long acuminate or acuminate at apex, midrib with 5 or 6 arcuate secondary veins on each side and 1 or 2 at base, chartaceous, adaxially glabrous to glabrate, with the veins prominulous, villous, abaxially densely villous, with the veins prominent, densely villous, with dark brown, triangular areas in the axils of 2–4 basal secondary veins and none in the axils of the tertiary veins, 1–4.5 mm long, with dense glandular, patelliform trichomes sessile, 0.16–0.36 mm in diam. *Inflorescences* conical thyrses of basal compound and apical simple dichasia, with 3 or 4 whorls of 3 branches evenly spaced along the rachis and an apical flower, with 1 or 2 basal branches of compound or simple dichasia, 4–9.5 cm long, glabrous to glabrate, with 1–3 apical branches of simple dichasia, 1.5–3.5 cm long, glabrous to glabrate or villous, peduncles 1–7 cm long, glabrate to villous, with a few scattered lenticels like those on stems, rachis terete, 7–12.5(–18) cm long, glabrate to villous, with a few scattered lenticels like those on stems, without bracts, flowering portion 11–22 × 14–23 cm, with 28–40(–75) flowers. *Flowers* with the pedicels 5–20 mm long, glabrate, with spherical, glandular trichomes sessile, ca. 0.04 mm in diam. Like those on calyx, with a whorl of 3 small bracts near base or at middle of pedicel, small bracts subulate, 1.5–5 × 0.2–0.6 mm, narrowly acute at apex, glabrate, frequently damaged or lost on older

flowers, calyx broadly obpyriformis or turbinate, 8–13 × 8.5–11.5 mm, glabrate to sparsely villous, with spherical, glandular trichomes sessile or sessile and substipitate, ca. 0.04 mm in diam., with stalks 0.1–0.2 mm long, purple to greenish purple, splitting into 2 or rarely 3 lobes, lobes broadly elliptic to elliptic or circular, 11–19 × 8–11 mm, obtuse and mucronate at apex, corolla with tube (2.3–)2.5–4 cm long, 1–2 mm wide at base, 13–19 mm wide at throat, 3 lower lobes circular to transversely broadly elliptic, 2–2.6 × 2–3 cm, obtuse at apex, 2 upper lobes transversely broadly elliptic, 1.5–2 × 1.5–2.7 cm, obtuse at apex, connate at the base for 1/4–1/2 of length, corolla white with a few purple dots near base of tube outside, lower lobes with rows of purple dots along veins and inside tube, with 2 keyhole-shaped bright yellow spots at mouth of tube on inside between lower lobes, turning dark red with age, stamens 22–26 mm long, white, glabrous, staminodes 4–9 mm long, white, glabrous, stamens and staminodes inserted in corolla tube 2–5 mm from base, ovary ca. 3 mm long, glabrous, green, style 20–28 mm long, glabrous, white, stigma 1–2 mm long, white. *Capsules* 1–3 per infructescence, 20–55 × 1–1.7 cm, glabrous, septum 5–8 mm wide. *Seeds* with body transversely narrowly oblong, 5.5–7.5 × 26–31 mm, truncate and notched in center at base, truncate at apex, sides drawn out to an obtuse point, glabrous and ciliate on sides, with hairs 8–17 mm long, tan. $2n = 40$.

Distribution and habitat.—Native to central North America in the middle Mississippi River and lower Ohio River valleys in the states of Missouri, Arkansas, Illinois, Indiana, Kentucky, Tennessee, and northeastern Texas. Widely cultivated in the eastern United States, and frequently cultivated in other temperate areas of the world. Commonly found in humid areas, and frequently naturalized as an escape.

Ecology and phenology.—Usually *Catalpa speciosa* flowers before *C. bignonioides* (Cox & Dunn, 1975–1974), and is an obligate outcrosser (Stephenson & Thomas, 1977). During the day, it is pollinated by bumblebees and carpenter bees, and at night by moths (Stephenson & Thomas, 1977). Two pollination strategies are being followed. During the day, flowers produce less nectar with a lower sugar concentration, and at night flowers produce more nectar with a higher sugar concentration (Stephenson & Thomas, 1977). Low fruit set per inflorescence is controlled by the plants. “After approximately four flowers

are pollinated per inflorescence, further pollination is inhibited and flowers that open subsequently are functionally male” (Stephenson, 1979).

Illustrations.—Cox and Dunn (1973–1974: Figs. 1-1a, 1-2a, c, 2k); Del Tredici (1986: cover, pages 2, 7, 8); Rehder (1914: 684, Figs. 839, 685, 840); Sargent (1894: ts. 288, 289).

Selected specimens examined. FRANCE. Arboretum Segrezianum, 8 Jul 1895, *L. E. Bureau s.n.* (P).

USA. ARKANSAS: Baxter County, Cotter, 16 Jun 1914, *E. J. Palmer 6021* (MO); Boone County, Harrison, city park, 18 May 1995, *E. Sundell et al. 11,298* (BRIT). CALIFORNIA: E San Bernardino County, E Mojave Desert, Clark Mountain Range, Pachalka Spring, 1494 m elev., 26 May 1977, *R. F. Thorne et al. 49,055* (MO). DISTRICT OF COLUMBIA: US National Arboretum, Washington, SW corner of Valley Road & Meadow Road, along banks of Red Oak Run, NA77211-H, 38°54'47"N, 76°57'54"W, 13 m elev., 22 May 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6025* (NA), 24 Sep 2008, 6085 (NA); US National Arboretum, Washington, 63 m SE of the intersection of Azalea Road and Eagle Nest Road, National Grove of State Trees, Section 1, NA76633-H, 38°54'28"N, 76°58'13"W, 15 m elev., 28 May 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6029* (NA), 24 Sep 2008, 6086 (NA); US National Arboretum, Washington, on what was the outside of the old M Street gate across Eclipse Road (M Street Entrance), at E side of the gate, NA76632-H, 38°54'23"N, 76°58'5"W, 13 m elev., 28 May 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6030* (NA), 24 Sep 2008, 6087 (NA); US National Arboretum, Washington, near Heart Pond, NA77210-H, 38°54'49"N, 76°57'57"W, 13 m elev., 3 Jun 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6031* (NA), 24 Sep 2008, 6088 (NA); US National Arboretum, Washington, Boxwood Garden between beds H and I, near Bladensberg Road, NA75615-H, 38°54'42"N, 76°58'34"W, 31 m elev., 28 May 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6158* (NA); US National Arboretum, Washington, on the E side of Hickey Run at the N edge of Meadow Road, 38°54'45"N, 76°57'60"W, 1 Jun 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6162* (NA). ILLINOIS: Quincy County, bottoms of Burton Creek E of highway ILL 96 (Sec 27 T25 R8W), 17 Nov 1939, *R. A. Evers 90* (MO); Gallatin County, New Haven, 29 May 1919, *E. J. Palmer 15,320* (A, K); on the lower Wabash [River], 1 Jun 1880, *J. Schneck s.n.* (A, GH). INDIANA: Spencer County, Route 66, just W of Rockport, 25 Aug 1986, *C. F. Reed 125,663* (MO). KANSAS: Geary County, creek bottom in the N part of Jackson Township, 13 Oct 1935, *F. C. Gates 18,711* (MO); Clay County, Bloom farm, 2 Jun 1890, *A. Schaffner s.n.* (OS). KENTUCKY: Jefferson County, Louisville, W of Jefferson Road, 22 May 1941, *M. Black s.n.* (BH); 1854, *C. W. Short s.n.* (K); Wolfe County, Swift Camp Creek, 11 Oct 1941, *E. L. Braun 4328* (MO); McLean County, 2 miles NW of Calhoun, 22 Sep 1973, *R. S. Conrad 20* (MO). LOUISIANA: St. Martin Parish, St. Martinville, 9 Jan 1874, *A. B. Langlois s.n.* (MO); Lafayette Parish, edge of woods along Vermilion River, SW side of Lafayette, 20 Apr 1964, *J. W. Thieret & L. R. Williams 17,134* (BRIT). MARYLAND: Montgomery County, at N edge of MD Route 28, ca. 138 m E of MD Route 112, 39°6'11"N, 77°17'25"W, 134 m elev., 5 Jun 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6167* (NA); Prince Georges County, front yard of Petro Design/Build, Inc., 16,401 Old Central Avenue, Mitchellville, 38°53'47"N, 76°43'15"W, 40 m elev., 19 Jun 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6181* (NA), 19 May 2010, 6309 (NA), 6310 (NA); Prince Georges County,

residence of Mrs. Madeline V. Smith, 7821 Murkirk Road, Beltsville, 39°3'22"N, 76°52'12"W, 76 m elev., 21 May 2012, *J. H. Kirkbride, Jr. & R. T. Olsen 6638* (NA); USDA-ARS Woody Landscape Germplasm Plant Repository, Beltsville Agricultural Research Center Beltsville, 39°0'31", 36 m elev., 29 May 2014, *J. H. Kirkbride, Jr. & R. T. Olsen 6667* (NA), 6 Jun 2014, 6669 (NA). MASSACHUSETTS: Arnold Arboretum, Boston, 42°18'5"N, 71°0'17", 31 m elev., 14 Jun 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6046* (NA); Bristol County, Center Street, Raynham, 7 Jul 1961, *F. C. Seymour 19330* (MO). MICHIGAN: Lansing, 27 Sep 1885, *L. H. Bailey s.n.* (BH). MINNESOTA: Houston County, Islan 19, Mississippi River mile #694.6, T104N R3W Sec 31, 21 Jul 1975, *S. R. Ziegler & M. F. Leykom 1900* (MO). MISSOURI: St. Louis, cultivated, 31 May 1879, *G. Engelmann s.n.* (GH, K), 6 Jun 1879, *s.n.* (K); Johnson County, wooded area just W of junction of Washington and Hunt Streets in Warrensburg, 21 Jul 1972, *D. Getz 84* (BRIT); Oregon County, gravel bar along warm branch of Spring River, just N of Arkansas line, 2 miles south of Thayer, 10 Aug 1934, *J. A. Steyermark 14395* (MO). NEVADA: 9 miles N of Beatty and S of Springdale, Oasis Valley, Route 95, 1158 m elev., 16 Jul 1969, *J. Beatley 9342* (US). NEW YORK: Schuyler County, 83 m SE of the southeastern corner of the parking area for Aunt Sara's Falls on Route 14, 0.7 miles NW of the junction of Routes 14 and 224 in Montour Falls, 42°21'8"N, 76°51'16"W, 137 m elev., 28 Jul 2010, *J. H. Kirkbride, Jr. et al. 6415* (NA). NORTH CAROLINA: Durham County, 316 Morrene Road, 78°57'W, 36°1'N, 23 May 1984, *D. Smith 957* (MO). OKLAHOMA: Payne County, 2 miles W of Stillwater, 2 Nov 1947, *J. D. Reeves 59* (MO). OHIO: Montgomery County, Dayton, *C. C. Barney s.n.* (GH); Hardin County, Route 81, 2.9 miles W of Hardin County line, 24 Jul 1959, *E. M. Herrick 1748* (OS); Franklin County, Columbus, Ohio State University, E. Lane Avenue, just E of Tuttle Park Place, 14 Jun 1989, *R. M. Lowden 4169* (OS); Knox County, Clay Township, ca. 0.5 miles from Martinsburg, Routes 62 and 541, 0.5 miles from Runk's farm (3700 Grove Church Road, Gambier), ca. 630 feet from Grove Church Road, 30 Aug 2011, *M. Marlatt 17* (OS); Ottawa County, Bay Township, Winnous Point, ca. 4 miles SW of Port Clinton, W end of Sandusky Bay, 22 Jun 1966, *R. L. Stuckey 2941* (OS). PENNSYLVANIA: Scott Arboretum, Swarthmore College, Swarthmore (the college campus), 51 m E of Worth Health Center, next to Chester Road (PA 320), 39°54'16"N, 75°21'2", 43 m elev., 7 Oct 2009, *J. H. Kirkbride, Jr. & R. T. Olsen 6214* (NA); Union County, 2 miles W of Forest Hills, 18 Jul 1951, *D. Rickard s.n.* (MO). RHODE ISLAND: Providence County, Town of Johnston, Graniteville section, W bank of Woonasquatucket River ca. 200 m N of Route 44 bridge over river, 41°51.79'N, 71°29.38'W, 37 m elev., 26 Jun 2003, *J. E. Laferrière 3706* (BRIT). SOUTH CAROLINA: Pickens County, Lake Isaqueena, ca. 3 km W of Highway 133, 4 km N of Clemson, 24 May 1987, *S. R. Hill 18,025* (MO). TENNESSEE: Marshall County, wooded limestone slope by I-65, 12.3 miles N of US 64 exit, 2 Jun 1969, *R. Kral 34,755* (MO); Carroll County, Huntington, corner of Clark Street and Browning Avenue, 16 May 1959, *B. A. Taylor 10* (BRIT). TEXAS: Harris County, just W of San Jacinto River, east of Channelview, 12 Nov 1945, *V. L. Cory 50,753* (BRIT); Smith County, Wenona, 3 May 1944, *H. E. Moore, Jr. 760* (BH). UTAH: 117 East 3rd North, Provo, 1372 m elev., *D. H. Galway 10,649* (US). VERMONT: Cheshire County, town of Walpole, village of North Walpole, shore of the Connecticut River just below the Bellows Falls, 43°5'N, 72°26'W, 21 Sep 1985, *D. E. Boufford et al. 23,643* (MO).

VIRGINIA: Southampton County, Ivor, 20 Aug 1936, *M. L. Fernald* et al. 6696 (GH, US). WEST VIRGINIA: Mrs. Ray's yard in Davis, 991 m elev., 5 Jul 1952, *H. A. Allard* 20,663 (US). WISCONSIN: Houston County, Island 19, Mississippi River mile #694.6, T104N R3W Sec 31, 21 Jul 1975, *S. R. Ziegler & M. F. Leykom* 1900 (BRIT).

The *Catalpa* holdings of the following herbarium were examined for collections of or determinations by E. Y. Teas: A, BH, BRIT, BUT, CINC, DMNH, E, F, GH, K, MICH, MSC, MU, ND, NY, OS, P, PH, PUL, S, UPS, US, and YUO, and none were found. Paclt (1952a) cited "Type: *Schneck*[?] (U.S.A.: Illinois) in hb. MO! (Herb. Engelmann)". There are nine Schenck specimens of *C. speciosa* in eight gatherings at MO. Paclt did not present enough information to clearly identify a single specimen, so we (Kirkbride & Olsen, 2011a) lectotypified the species.

HYBRID TAXA

Catalpa ×erubescens Carrière, Rev. Hort. (Paris) 41: 460. 1869;

C. bignonioides Walter nothof. *erubescens* (Carrière) Beissn., Schelle & Zabel, Handb. Laubholzben. 433. 1903. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 36 m elev., 39°0'31" N, 76°56'36"W, 6 Jun 2014, *J. H. Kirkbride, Jr. & R. T. Olsen* 6671 (neotype, **here designated**: NA; isoneotypes: K, NY, MO, P).

Catalpa aureovittata Corbelli, Dizionario di Floricoltura 1: 298. 1873; *C. aureovittata* Carrière, Rev. Hort. (Paris) 46: 140. 1874; *C. syringifolia* Sims var. *aureovittata* (Corbelli) A. de Vos, Ann. Bot. Hort. 25: 95. 1875. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 36 m elev., 39°0'31"N, 76°56'36"W, 6 Jun 2014, *J. H. Kirkbride, Jr. & R. T. Olsen* 6672 (neotype, **here designated**: NA; isoneotypes: K, NY, MO, P).

Catalpa ×hybrida Späth, Gartenflora 47: 481, t. 1454. 1898. Type: F. L. Späth, Gartenflora 47: t. 1454. 1898. (lectotype, **here designated**).

Catalpa ×teasii Penh., as "*C. teasii*", Amer. Naturalist 39: 134. 1905. Type: D. P. Penhallow, Amer. Naturalist 39: Fig. 5, p. 122 (lectotype, **here designated**).

Catalpa japonica Dode, Bull. Soc. Dendrol. France 6: 200. 1907; *C. ×hybrida* Späth var. *japonica* (Dode) Rehder in L. H. Bailey, Stand. Cycl. Hort. 2: 685. 1914; *C. ovata* G. Don. var. *japonica* (Dode) Bean, Trees Shrubs Hardy Brit. Isles 1: 313. 1914; *C. ×erubescens* Carrière var. *japonica* (Dode) Paclt, Candollea 13: 266. 1952. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 36 m elev., 39°0'31"N, 76°56'36"W, 6 Jun 2014, *J. H. Kirkbride, Jr. & R. T. Olsen* 6671 (neotype, **here designated**: NA; isoneotypes: K, NY, MO, P).

Catalpa ×teasiana Dode, Bull. Soc. Dendrol. France 6: 205. 1907. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 36 m elev., 39°0'31"N, 76°56'

36"W, 6 Jun 2014, *J. H. Kirkbride, Jr. & R. T. Olsen* 6671 (neotype, **here designated**: NA; isoneotypes: K, NY, MO, P).

Catalpa ×erubescens Carrière f. *adina* Paclt, Candollea 13: 266. 1952. Type: CZECH REPUBLIC. Plzeň, *J. Paclt* 11 (holotype: PR n.v.).

Trees (1.5–)3–10(–15) m tall, (3–)4–28(–93) cm DBH, temperate deciduous, young trunks with bark smooth, older trunks with bark vertically furrowed, young stems glabrous, with lenticels elliptic, 0.6–1.5 × 0.2–0.5 mm, tan, with scattered to rare glands, sessile, globose, 0.04–0.06 mm in diam., tan. *Leaves* in whorls of 3, distinctly unequal in size in each whorl, petioles (4.5–)10–21 cm long, (1.5–)2.5–4 mm in diam., constricted at base 0.5–1 mm in diam. For 5–8 mm of length, glabrous, adaxially glabrate, blade strongly trilobate or entire, ovate to broadly ovate, (12.5–)16–33 × (9.5–)15–36 cm, 0.9–1.5 times as long as wide, cordate to truncate at base, long acuminate at apex and lobes, midrib with 5–7 arcuate secondary veins on each side and 2 at base, chartaceous, adaxially glabrous to glabrate or sparsely villous, veins prominulous, glabrate to villous, sometimes with dark brown, triangular areas in axis of 3 or 4 basal secondary veins, 2–3 mm long, with dense glandular, patelliform trichomes sessile, 0.1–0.2 mm in diam., abaxially villous to densely villous, veins prominent, glabrate to villous, with dark brown, triangular areas in axis of 4 or 5 basal secondary veins and sometimes tertiary veins, 1.5–6 mm long in axis of secondary veins, ca. 2 mm long in axis of tertiary veins, with dense, glandular, patelliform trichomes sessile, 0.12–0.3 mm in diam. *Inflorescences* conical thyrses of basal compound and apical simple dichasia, glabrous to glabrate, with 6 whorls of 3 branches evenly spaced along the rachis and an apical flower, with 2–4 basal branches of compound dichasia, 5–20 cm long, with 1–3 apical branches of simple dichasia, 1.5–5 cm long, peduncles 6–9 cm long, glabrous to glabrate, with a few scattered lenticels like those on stems, rachis terete, 15–34 cm long, with a few scattered lenticels like those on stems, flowering portion 20–48 × 17–35 cm, with (200–)300–500 flowers, with 1 small bract at each branch base and 2 small bracts at each dichasium base, small bracts narrowly elliptic, 3.5–13 × 0.4–2.5 mm, narrowly acute at apex, glabrate and short ciliate, abscising at base very early, leaving lunate ridges at bases of branches and dichasia. *Flowers* with pedicels 2–9 mm long, glabrous, with spherical, glandular trichomes sessile, 0.04–0.06 mm in diam., like those on the calyx, calyx turbinate, 7–9 × 5.5–7 mm, glabrous, with spherical, glandular trichomes sessile, 0.04–

0.06 mm in diam., sometimes with a few glandular, patelliform trichomes at apex, sessile, 0.14–0.18 mm in diam., purple to greenish purple, splitting into 2 lobes, lobes broadly elliptic to elliptic, 8–9 × 7–8 mm, obtuse and mucronate at apex, corolla with tube 1.7–1.9 cm long, ca. 1 mm wide at base, 7–10 mm wide at throat, 3 lower lobes circular to transversely broadly elliptic, 1.3–1.5 × 1.3–1.7 cm, obtuse at apex, 2 upper lobes transversely broadly elliptic, 1–1.2 × 1–1.6 cm, obtuse at apex, connate at base for ca. 1/2 of length, corolla white, lower lobes with rows of purple dots along veins and inside tube, with 2 keyhole-shaped bright yellow spots at mouth of tube on inside between lower lobes, turning dark red with age, stamens 15–17 mm long, white, glabrous, staminodes 3–7 mm long, white, glabrous, stamens and staminodes inserted in corolla tube ca. 2 mm from base, ovary 2–3 mm long, glabrous, green, style 12–15 mm long, glabrous, white, stigma ca. 1 mm long, white. *Capsules* 10–25 per infructescence, 26–44 × 0.5–0.7 cm, glabrous, septum 3.5–4 mm wide. *Seeds* with body transversely narrowly oblong, 3.5–4.5 × 14–15 mm, truncate at base and apex, sides drawn out to an obtuse point, glabrous and ciliate on sides, with hairs 5–20 mm long, tan. $2n = 40$.

Distribution.—Known only from horticulture.

Illustrations.—Grimshaw and Olsen (2011: 40); Späth (1898: Fig. 1454).

Selected specimens examined. ARGENTINA. BUENOS AIRES: La Plata, downtown, *A. Gentry & E. Zardini 49,141* (MO).

USA. DISTRICT OF COLUMBIA: US National Arboretum, Washington, experimental plot along the N side of Meadow Road 40 m W of Holly Spring Road, 38°54'52"N, 76°57'41"W, 17 m elev., 16 Jun 2015, *J. H. Kirkbride, Jr. & R. T. Olsen 6719* (NA); NE corner of the Astrophysical Observatory grounds, S of Smithsonian Building, 16 Jun 1947, *E. H. Walker 4153* (US).

MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 39°0'29"N, 76°56'36"W, 37 m elev., 6 Jun 2008, *J. H. Kirkbride, Jr. & R. T. Olsen 6035* (NA), 14 Jun 2008, *6049* (NA), 22 Sep 2008, *6081* (NA), 18 Jun 2009, *6177* (NA), 9 Jun 2014, *6679* (NA).

Élie-Abel Carrière (1818–1896) was a French horticulturalist of the nineteenth Century (Williams, 2004). For almost all of his professional career, he was located in Paris, and for more than 30 years he worked in the gardens of the Muséum d'Histoire Naturelle, rising to Chef de Culture. There is no evidence that he had a personal herbarium, suggesting that he utilized the collections of the Muséum

d'Histoire Naturelle for his taxonomic studies (Williams, 2004: 368). In 2009 we visited the Muséum National d'Histoire Naturelle and examined the living collections on the grounds of the Muséum and the herbarium (P). There were no specimens of *Catalpa ×erubescens* on the grounds of the Muséum or in the herbarium. So, a neotype is here designated using our collection grown out at the USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville, Maryland.

Corbelli (1873) described *Catalpa aureovittata* Corbelli in Italian. The next year, Carrière (1874) described *C. aureovittata* Carrière. Carrière stated that amongst his papers he had encountered notes on this species, which he had made in 1866, and commented that the epithet *aureovittata* should be used for this species, regardless of its source, and was more appropriate than the epithet, which he had applied, *erubescens*. Carrière's French description is almost word-for-word identical to that of Corbelli in Italian. The same neotype is here designated for these names so that they will be permanently linked together.

The parents of this taxon have always been accepted as *Catalpa bignonioides* and *C. ovata* (Carrière, 1869; Späth, 1898; Dode, 1907; Rehder, 1914; Paclt, 1952a).

Catalpa ×erubescens Carrière f. *purpurea* (Wawra & Abel) Paclt, Candollea 13: 264. 1952; *C. syringifolia* Sims var. *purpurea* Wawra & Abel, Wiener Ill. Gart.-Zeitung 11: 40. 1886; *C. bignonioides* Walter var. *purpurea* (Wawra & Abel) Beck & Abel, Wiener Ill. Gart.-Zeitung 15: 315. 1890; *C. ×erubescens* Carrière var. *purpurea* (Wawra & Abel) Dode, Bull. Soc. Dendrol. France 1907: 205. 1907; *C. ovata* G. Don var. *purpurea* (Wawra & Abel) Bean, Trees Shrubs Hardy Brit. Isles 1: 313. 1914; *C. ×hybrida* Späth var. *purpurea* (Wawra & Abel) Rehder in L. H. Bailey, Stand. Cycl. Hort. 2: 685. 1914. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, cultivated tree, 36 m elev., 39°0'31"N, 76°56'36"W, 9 Jun 2014, *J. H. Kirkbride, Jr. & R. T. Olsen 6678* (neotype, **here designated**: NA; isoneotypes: K, MO, NY, P).

Catalpa ×hybrida Späth var. *atropurpurea* Späth, Baumschulenweg 1906–1907 121: 88. 1906; *C. ovata* G. Don var. *atropurpurea* C. A. Schenck, Fremländische Wald- und Parkbäume 3: 182. 1939. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, cultivated tree, 36 m elev., 39°0'31"N, 76°56'36"W, 9 Jun 2014, *J. H. Kirkbride, Jr. & R. T. Olsen 6678* (neotype, **here designated**: NA; isoneotypes: K, MO, NY, P).

Trees 3–4 m tall, ca. 4 cm DBH, temperate deciduous, young trunks with bark smooth, older trunks with bark vertically furrowed, young stems sparsely villous and stellate pubescent when young, glabrous when older, with lenticels elliptic, 0.6–1.5 × 0.2–0.5

mm, tan, with scattered to rare glands, sessile, globose, 0.04–0.06 mm in diam., tan, purple turning green when older. *Leaves* in whorls of 3, distinctly unequal in size in each whorl, purple when young, turning green when older, petioles 17–21 cm long, 3–4 mm in diam., constricted at base 0.5–1 mm in diam. For 5–8 mm of length, glabrous, adaxially glabrate, blade trilobate or entire, ovate to broadly ovate, 15–23 × 13–23 cm, 0.9–1.3 times as long as wide, cordate to truncate at base, long acuminate at apex and lobes, midrib with 5 arcuate secondary veins on each side and 2 at base, chartaceous, adaxial surface including veins glabrous to glabrate or sparsely villous and sparsely stellate pubescent when young, glabrate when older, with the veins prominent, sometimes with dark brown, triangular areas in the axis of 2 or 3 basal secondary veins, 1.5–5 mm long, with dense glandular, patelliform trichomes sessile, 0.1–0.18 mm in diam., abaxially villous and sparsely stellate pubescent when young, villous when older, veins prominent, glabrate to villous and sparsely stellate pubescent when young, glabrate to villous when older, with dark brown, triangular areas in the axis of 4 or 5 basal secondary veins and sometimes the tertiary veins, 1.5–3 mm long in axes of secondary veins, 0.5–2 mm long in axes of tertiary veins, with dense glandular, patelliform trichomes sessile, 0.1–0.16 mm in diam. *Inflorescences* conical thyrses of basal compound and apical simple dichasia, glabrous to glabrate and sparsely stellate pubescent when young, glabrous to glabrate when older, with 5 whorls of 3 branches evenly spaced along the rachis and an apical flower, with 2–4 basal branches of compound dichasia, 5–12 cm long, with 1–3 apical branches of simple dichasia, 1.5–3 cm long, glabrous to glabrate and sparsely stellate pubescent when young, glabrous to glabrate when older, peduncles 5–7 cm long, with a few scattered lenticels like those on the stems, rachis terete, 14–15 cm long, with a few scattered lenticels like those on stems, flowering portion 16–18 × 13–22 cm, with 40–200 flowers, with 1 small bract at each branch base and 2 small bracts at each dichasium base, small bracts narrowly elliptic, 3–11 × 0.8–1.8 mm, narrowly acute at apex, glabrate or hispidulous and short ciliate, abscising at the base very early, leaving lunate ridges at bases of branches and dichasia. *Flowers* with pedicels 3–8 mm long, glabrous or sparsely stellate pubescent, with spherical, glandular trichomes sessile, 0.04–0.06 mm in diam. Like those on calyx, calyx turbinate, 8–10.5 × 6–8 mm,

glabrous, with spherical, glandular trichomes sessile, 0.04–0.06 mm in diam., sometimes with a few glandular, patelliform trichomes at apex, sessile, ca. 0.16 mm in diam., purple, splitting into 2 lobes, the lobes elliptic, 8–9 × 5–6 mm, obtuse and mucronate at apex, corolla with the tube 1.5–1.7 cm long, ca. 1 mm wide at base, ca. 7 mm wide at throat, 3 lower lobes circular to transversely broadly elliptic, 1.2–1.4 × 1.2–1.4 cm, obtuse at apex, 2 upper lobes transversely broadly elliptic, 0.9–1.1 × 1.1–1.3 cm, obtuse at apex, connate at base for ca. 1/3 of length, corolla white, lower lobes with rows of purple dots along veins and inside tube, with 2 keyhole-shaped bright yellow spots at mouth of tube on inside between lower lobes, turning dark red with age, stamens ca. 13 mm long, white, glabrous, staminodes 2–6 mm long, white, glabrous, stamens and staminodes inserted in corolla tube ca. 2 mm from base, ovary ca. 2 mm long, glabrous, green, style 13–14 mm long, glabrous, white, stigma ca. 1 mm long, white. *Capsules* 4 or 5 per infructescence, 21–33 × 0.4–0.5 cm, glabrous, septum 2–3.5 mm wide. *Seeds* with the body transversely narrowly oblong, 3–4 × 15–22 mm, truncate at base and apex, sides drawn out to an obtuse or acute point, glabrous and ciliate on sides, with hairs 10–17 mm long, tan.

Distribution.—Known only from horticulture.

Selected specimens examined. USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 39°0'29"N, 76°56'36"W, 37 m elev., 6 Jun 2008, J. H. Kirkbride, Jr. & R. T. Olsen 6036 (NA), 29 Sep 2009, 6202 (NA).

Neotypes are here designated for *Catalpa syringifolia* var. *purpurea* and *C. ×hybrida* var. *atropurpurea*, known only from cultivation, following the procedures previously discussed under *C. bignonioides* for horticultural names.

The earliest spring growth of all taxa was examined, and a startling discovery was made. There is sparse stellate pubescence mixed with simple hairs on the young stems, leaves, inflorescences, and flower buds of this taxon. As the summer progresses and these organs mature, the stellate pubescence is lost. It has been hypothesized that the parents of this taxon are *Catalpa bignonioides* and *C. ovata* (Wawra & Abel, 1886, Beck & Abel, 1890, Dode, 1907, Bean, 1914, Rehder, 1914), which is what Paclt (1952a) accepted. The only other *Catalpa* taxon with stellate pubescence is *C. bungei*, which suggests that it was involved in the parentage of this taxon. Molecular research is

needed to clarify the true parentage.

Catalpa × *galleana* Dode, Bull. Soc. Dendrol. France 6: 205. 1907. Type: USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, cultivated tree, 37 m elev., 39°0'29"N, 76°56'36"W, 6 Jun 2008, *J. H. Kirkbride, Jr.* & *R. T. Olsen 6034* (neotype, **here designated**: NA; isoneotypes: K, MO, NY, P).

Catalpa bignonioides Walter f. *rehderi* Paclt, Candollea 13: 259, t. 11 & 12. 1952. Type: CZECH REPUBLIC. Central Bohemia, Prague, ca. 290 m elev., *Paclt 3* (holotype: PR n.v.).

Trees (2–)3.5–16 m tall, (5–)8–10 cm DBH, temperate deciduous, young trunks with bark smooth, old trunks with bark vertically furrowed, young stems sparsely hirsute, with lenticels narrowly elliptic, 0.5–1.2 × 0.2–0.4 mm, tan, with numerous punctate glands, 0.06–0.08 mm in diam., brown. *Leaves* in whorls of 3, strongly unequal in size in each whorl, petioles 5.5–22 cm long, 1.8–4.5 mm in diam., constricted at base 0.5–1 mm in diam. For 3–6 mm of length, glabrate, adaxially sparsely hirsute, blade entire or weakly to strongly trilobate, ovate to broadly ovate, 18–33 × 14–29 cm, 1.1–1.3 times as long as wide, weakly cordate to cordate or truncate at base, acuminate at apex and apices of lobes, midrib with 5 or 6 arcuate secondary veins on each side and 2 at base, chartaceous, adaxially sparsely hispidulous, veins prominent, hispidulous, with dark brown, sometimes with triangular areas in axis of 1 or 2 basal secondary veins, 2–4 mm long, with glandular, patelliform trichomes sessile, 0.1–0.24 mm in diam., abaxially sparsely villous, veins prominent, villous, with dark brown, triangular areas in axes of 3–5 basal secondary veins and sometimes tertiary veins, 1.5–4 mm long in axes of secondary veins, 1–5 mm long in axes of tertiary veins, with dense glandular, patelliform trichomes sessile, 0.08–0.16 mm in diam. *Inflorescences* conical thyrses of basal compound and apical simple dichasia, glabrate, with 4–8 whorls of 3 branches evenly spaced along the rachis and an apical flower, with 1–3 basal whorls of branches of compound dichasia, 6–9(–19) cm long, with 4–8 apical whorls of branches of simple dichasia, 2–3(–6) cm long, peduncles 1–7.5 cm long, glabrate, with a few scattered lenticels like those on the stems, rachis terete, 13–27 cm long, with a few scattered lenticels like those on stems, flowering portion 13–30 × 14–30 cm, with 50–180 flowers, with 1 small bract at each branch base and 2 small bracts at each dichasium base, small bracts narrowly elliptic, 3–7 × 0.5–1.4 mm, narrowly acute at apex,

glabrate and short ciliate, abscising at the base very early, leaving lunate ridges at bases of branches and dichasia. *Flowers* with the pedicels 2.5–20 mm long, glabrous to glabrate, with a few spherical, glandular trichomes sessile, ca. 0.04 mm in diam., like those on calyx, without small bracts on pedicel, calyx turbinate, 5.5–10 × 5–8 mm, glabrous to glabrate at apex, with spherical, glandular trichomes sessile, ca. 0.04 mm in diam. And glandular, patelliform trichomes at apex, sessile, 0.1–0.16 mm in diam., green, splitting into 2 lobes, lobes elliptic, 9–10 × 5–8 mm, obtuse and mucronate at apex, corolla with tube ca. 1.7 cm long, 1–2 mm wide at base, 8–10 mm wide at throat, 3 lower lobes transversely broadly elliptic to circular, 1–1.7 × 1.2–1.8 cm, obtuse at apex, 2 upper lobes broadly elliptic, 0.8–1.4 × 0.9–1.4 cm, obtuse at apex, connate at the base for 1/3–1/2 of length, corolla white, lower lobes with rows of purple dots along veins and inside tube, with 2 keyhole-shaped bright yellow spots at mouth of tube on inside between lower lobes, turning dark red with age, stamens 13–16 mm long, white, glabrous, staminodes 3–4 mm long, white, glabrous, stamens and staminodes inserted in corolla tube ca. 1 mm from base, ovary ca. 2 mm long, glabrous, green, style 11–16 mm long, glabrous, white, stigma ca. 2 mm long, white. *Capsules* 7–14 per infructescence, 32–46 × 0.6–0.8 cm, glabrous, septum 3–4.5 mm wide. *Seeds* with body transversely oblong, 3.5–4.5 × 17–24 mm, truncate at base and apex, sides drawn out to an obtuse point, glabrous and ciliate on sides, with hairs 9–22 mm long, tan.

Distribution.—Known only from horticulture.

Illustrations.—Grimshaw and Olsen (2011: page 41).

Selected specimens examined. USA. MARYLAND: USDA-ARS Woody Landscape Plant Germplasm Repository, Beltsville Agricultural Research Center, Beltsville, 39°0'29" N, 76°56'36" W, 37 m elev., 22 Sep 2008, *J. H. Kirkbride, Jr.* & *R. T. Olsen 6079* (NA), 10 Jun 2009, *6175* (NA), 1 Jun 2012, *6643* (NA), *6645* (NA), 6 Jun 2014, *6670* (NA), *6673* (NA), *6674* (NA). MASSACHUSETTS: Arnold Arboretum, Boston, 925–42-B, block 21-NW, 42°18'5"N, 71°07'17"W, 31 m elev., 14 Jun 2008, *J. H. Kirkbride, Jr.* & *R. T. Olsen 6048* (NA).

Dode (1907: 205) described *Catalpa* × *galleana* as a garden hybrid, but was uncertain as to its parentage. He suggested that one of its parents was *C. ovata*, but did not know what the other parent was. It has become accepted that the parents of this hybrid were *C. ovata* and *C. speciosa* (Smith, 1941,

Paclt, 1952a). Molecular studies are needed to confirm this. A neotype is here designated for this name, known only from cultivation, following the procedures previously discussed under *C. bignonioides* for horticultural names.

ACCEPTED TAXA

1. *Catalpa brevipes* Urb.
2. *Catalpa purpurea* Griseb.
3. *Catalpa longissima* (Jacq.) Dum. Cours.
4. *Catalpa macrocarpa* (A. Rich.) Ekman
5. *Catalpa bungei* C. A. Mey.
6. *Catalpa ovata* G. Don
7. *Catalpa bignonioides* Walter
8. *Catalpa speciosa* Teas

Catalpa × *erubescens* Carrière (*C. ovata* × *C. bignonioides*).
Catalpa × *erubescens* Carrière f. *purpurea* (Wawra & Abel)
 Paclt (*C. ovata* × *C. bignonioides*).
Catalpa × *galleana* Dode (*C. ovata* × *C. speciosa*).

NOMINA NUDA

- Catalpa bignonioides* Walter var. *grandiflora* Beck & Abel, Wiener Ill. Gart.-Zeitung 15: 316. 1890, is *C. bignonioides*.
Catalpa bignonioides Walter var. *semiplena* Plouvier, Compt. Rend. Hebd. Séances Acad. Sci. 224: 672. 1947, is *C. bignonioides*.
Catalpa himalayaca Dippel, Handb. Laubholz. 1: 50. 1889, is *C. ovata*.
Catalpa himalayensis Dippel, Handb. Laubholz. 1: 50. 1889, is *C. ovata*.
Catalpa kaempferi (DC.) Siebold & Zucc. var. *crassifolia* Goetze, Mitt. Deutsch. Dendrol. Ges. 25: 174. 1916, is *C. ovata*.
Catalpa kaempferi (DC.) Siebold & Zucc. var. *vera* Dippel, Handb. Laubholz. 1: 51. 1889, is *C. ovata*.
Catalpa longisiliqua Sims ex Cham., Linnaea 7: 720. 1832, is *C. longissima*.
Catalpa nana Dippel, Handb. Laubholz. 1: 51. 1889, is *C. bignonioides*.
Catalpa pumila Beck & Abel, Wiener Ill. Gart.-Zeitung 15: 317. 1890, is *C. bignonioides*.
Catalpa thumbergii Beck & Abel, Wiener Ill. Gart.-Zeitung 15: 315. 1890, is *C. ovata*.
Catalpa vulgaris Carrière, Rev. Hort. (Paris) 41: 460. 1869, is *C. bignonioides*.
Catalpa wallichiana Beck & Abel, Wiener Ill. Gart.-Zeitunb 15: 318. 1890, is *C. ovata*.
Catalpa wallichii Beck & Abel, Wiener Ill. Gart.-Zeitunb 15: 317. 1890, is *C. ovata*.
Macrocatpalpa tomentosa Bisse, Arboles Cuba 73. 1981, is *C. macrocarpa* and probably based on *Catalpa punctata* Griseb. var. *pubescens* Griseb.

EXCLUDED TAXA

- Catalpa cassinoides* (Lam.) Spreng., Syst. Veg. 1: 70. 1824; *Bignonia cassinoides* Lam., Encycl. 1: 418; 1785; *Tabebuia cassinoides* (Lam.) DC., Prodr. 9: 213. 1845. Type: BRAZIL. Rio de Janeiro, *P. Commerson s.n.* (lectotype, **here designated** [or perhaps holotype]: P-Juss 4957 [P00675480 and P00675481, mounted as one specimen]). [= *Tabebuia cassinoides* (Lam.) DC. (Gentry, 1992)].
Catalpa crassifolia Newb., Ann. Lyceum Nat. Hist. New York 9: 56. 1870; *Aristolochia cordifolia* Newb., Later Extinct Fl. N. Amer. 90. 1898, nom. Illeg.; *Paranymphea crassifolia* (Newb.) E. W. Berry, Mem. Geog. Surv. Canada 182: 39. 1935. Type: USA. MONTANA: Banks of the Yellowstone River, 1855, *F. V. Hayden s.n.* (holotype: USNM P 566, n.v.). [= *Paranymphea crassifolia* (Newb.) E. W. Berry (Hickey, 1977)].
Catalpa hirsuta Spreng., Syst. Veg. 1: 70. 1824. Type: unknown. Sprengel cited the distribution of his species as Brazil, and there are no native *Catalpa* species in Brazil. His 12-word description is not adequate to determine what species was described.
Catalpa microphylla (Lam.) Spreng. Syst. Veg. 1: 70. 1824; *Bignonia microphylla* Lam., Encycl. 1: 418. 1785; *Tabebuia microphylla* (Lam.) Urb., Symb. Antill. 5: 496. 1908; *Tecoma microphylla* (Lam.) Urb., Symb. Antill. 7: 377. 1912. Type: C. Plumier, Pl. amer. t. 55, f. 2. 1756 (lectotype, designated by Gentry, 1992: 215). [= *Tabebuia microphylla* (Lam.) Urb. (Gentry, 1992)].
Catalpa pottsii Seem., Allg. Gartenzeitung 19: 321. 1851. Type: unknown. [= *Chilopsis linearis* (Cav.) Sweet (Seemann, 1856)].
Catalpa silvestrii (Pamp. & Bonati) S.-Y. Hu, Quart. J. Taiwan Mus. 12: 47. 1959; *Paulownia silvestrii* Pamp. & Bonati, Nuovo Giorn. Bot. Ital. 18: 177. 1911; *Shiuyinghua silvestrii* (Pamp. & Bonati) Paclt, J. Arnold Arbor. 43: 217. 1962. Type: CHINA. HUPEH: Praeter ripam fluminis Yang-tze Kiang et praecipue fluvii Han Kiang, 700 m elev., 20–30 Jun 1907, *J. C. silvestri 3286* (holotype: FI n.v.; isotype: A00056866 fragments). [= *Shiuyinghua silvestrii* (Pamp. & Bonati) Paclt (Paclt, 1962)].
Catalpa spiegelii Engelm., Abh. Hessischen Geol. Landesanst. Darmstadt 7: 70. 1922; *Bytneriopsis spiegelii* (Engelm.) Kvaček & V. Wilde, Bull. Geosci. 85: 170. 2010. Type: Specimen No. MDAR Me 3436 (Me027) (holotype: Hessisches Landesmuseum Darmstadt, Darmstadt, Germany). [= *Bytneriopsis spiegelii* (Engelm.) Kvaček & V. Wilde (Kvaček & Wilde, 2010)].
Cumbulu Adans., Fam. Pl. (Adanson) 2: 199. 1763. Type: H. van Rheede, Hort. Malab. 1: t. 41. 1678. (lectotype, **here designated**) (= *Gmelina* L.; Paclt, 1956; Nicolson et al., 1988: 261; de Kok, 2012). This has been cited as a synonym of *Catalpa* Scop. (Paclt, 1952a: 248).

Acknowledgments

We thank the curators and staffs of the following herbaria for their permission to visit and study their collections and libraries: A, BH, BM,

BONN, BRIT, E, GH, K, KUN, MARY, MO, NAS, NY, OS, P, PE, PH, S, UPS, US, and XAL and the curators and staffs of the following herbaria for supplying information about their *Catalpa* collections: BUT, CINC, DMNH, F, MICH, MSC, MU, ND, OS, PUL, and YUO. We extend special thanks to Dr. Arne Anderberg (S), Dr. Marc Appelhans (GOET), Dr. Joel T. Fry, Bartram's Garden, Philadelphia, Mr. Glyn Church, Church Gardens, Oakura, Dr. Laurent Gautier (G), Dr. Mats Hjertson (UPS), Dr. Irina Illarionova (LE), Dr. Charles E. Jarvis (BM), Dr. Tatyana Livshultz (PH), Dr. Chiara Nepi (FI), Dr. Otakar Šída (PR), Dr. Juraj Paclt, Bratislava, Dr. Adele Smith (E), Dr. James C. Solomon (MO), Dr. Jana Uhlířová (BRA), and Dr. Emily W. Wood (GH) for searching their collections for *Catalpa* specimens and supplying images of those specimens. We thank Susan E. Bentz for her support in numerous ways of our *Catalpa* research programs at the U.S. National Arboretum; John Bennett and Joli McCathson of the Maryland Big Tree Program, Michael Dosmann of the Arnold Arboretum, Melissa Islam and Cindy Newlander of the Denver Botanic Gardens, Michael Nee of the New York Botanical Garden (NY), John Petro, Petro Design/Build Group, Mitchville, Maryland, and Madeline V. Smith, Beltsville, Maryland for their support and assistance in the collection of *Catalpa* specimens; Robin A. Everly in the Botany Library of the National Museum of Natural History, Smithsonian Institution (US), Emma Antobam and Marie Long in the Mertz Library of the New York Botanical Garden (NY) and Leonie Paterson in the Library of the Royal Botanical Garden Edinburgh (E) for their bibliographic assistance; Drs. Kanchi N. Gandhi (GH), Werner Greuter (B), John McNeill (E), and John H. Wiersma (BARC) for nomenclatural advice; and Dr. Daniel B. Ward for informing us about the differences between *Catalpa* Scop. and *Catalpa* Walter. We extend special thanks Dr. Zhao Shiwei, Director and Dr. Kang Wang, Research Horticulturist of the Beijing Botanical Garden, Yong Yang, Associate Professor of the Institute of Botany, Chinese Academy of Sciences, Beijing, Dr. Wei-Bang Sun, Director of the Kunming Botanical Garden, and Dr. Zhuang Yule, Director and Dr. Li Mei, Deputy Director of the Nanjing Botanical Garden Memorial Sun Yat-sen for their support and assistance during our trip to China in 2013. Special thanks go to Dr. John H. Wiersma (BARC) for his review of the pre-submission

manuscript, and to Dr. Richard G. Olmstead and an anonymous reviewer for their comments on the submitted manuscript.

Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

Literature cited

- Aiton, W.** 1789. Hortus kewensis: or, a catalogue of the plants cultivated in the royal botanic garden at Kew, vol. 2. George Nicol, London.
- Axelrod, D. I.** 1987. The late Oligocene Creede flora, Colorado. University of California Publications in Geological Sciences 130: 1–235.
- Barnes, C. R.** 1881. Catalogue of the phaenogamous and vascular cryptogamous plants of Indiana, p. 22. Review Steam Book & Job Printers, Crawfordsville, Indiana.
- Barney, E. E.** 1878a. Facts and information in relation to the catalpa tree (*Catalpa bignonioides*), its value, and importance of its extensive cultivation in groves. J. W. Johnson Printer, Dayton, Ohio.
- _____. 1878b. The varieties of *Catalpa*. The Gardener's Monthly and Horticulturist 20: 312–313.
- _____. 1879. Additional facts and information in relation to the catalpa tree, *Catalpa bignonioides* and its variety? Speciosa. Dayton journal book and job printing establishment, Dayton, Ohio.
- Bean, W. J.** 1914. Trees and shrubs hardy in the British isles, vol. 1. John Murray, London.
- Beck von Mannagetta, G. R. & F. Abel.** 1890. Die gegenwärtig vorhandenen Formen des Trompetenbaumes. Wiener Illustrierte Garten-Zeitung 15: 314–318.
- Berry, E. W.** 1935. A preliminary contribution to the floras of the Whitemud and Ravenscrag formations. Canada Department of Mines, Geological Survey Memoirs 182: 1–103.
- Bisse, J.** 1981. Arboles de Cuba. Editorial Científico-Técnica, Havana.
- Bossin, M.** 1850. *Catalpa nain* (arbre nouveau). Journal d'Horticulture Pratique de la Belgique 8: 186–188.
- Brickell, C. D., C. Alexander, J. C. David, W. L. A. Hettterscheid, A. C. Leslie, V. Malecot, X. Jin & J. J. Cubey.** 2009. International Code of Nomenclature for Cultivated Plants (ICNCP or Cultivated Plant Code). Scripta Horticulturae ISHS 10 (Regnum Vegetabile 151): 1–184.
- Britton, N. L.** 1918. The relatives of catalpa trees in the West Indies. Journal of the New York Botanical Garden 19: 6–9.
- Brown, J. P.** 1900. The catalpa tree, and its importance in commerce. Courier Publishing Company, Connersville, Indiana.

- _____. 1901. The *Catalpa speciosa*. Bulletin of the International Society of Arboriculture 1: 1–24.
- _____. 1903. The hardy American forest tree: *Catalpa speciosa*. Arboriculture a Journal of the Forests 2: 95–140.
- _____. 1908. A Mormon apostle pays his respects to the catalpa. Arboriculture a Journal of the Forests 7: 154–155.
- Bunge, A. A. von.** 1833. Enumeratio plantarum, quas in China Borealicollegit. A. A. von Bunge, St. Petersburg.
- Bureau, L. E.** 1894. Révision du genre *Catalpa*. Nouvelles Archives du Muséum d'Histoire Naturelle, sér. 3, 6: 169–208.
- Candolle, A. P. de.** 1838. Revue sommaire de la famille des Bignoniacées. Bibliothèque Universelle de Genève, sér. 2, 17: 117–136.
- _____. 1845. Bignoniaceae. Prodrômus Systematis naturalis regni vegetabilis 9: 142–248. Fortin, Masson et Sociorum, Paris.
- Carrière, É.-A.** 1869. *Catalpa erubescens*. Revue Horticole Journal d'Horticulture Pratique 41: 460.
- _____. 1874. *Catalpa aureovittata*. Revue Horticole Journal d'Horticulture Pratique 46: 140.
- Carroll, E., S. Sutton & R. A. Howard.** 1965. A cumulative index to the nine volume of the Symbolae antillanae seu fundamenta floriae Indiae occidentalis, edited by Ignatius urban. Arnold Arboretum of Harvard University, Jamaica Plain, Massachusetts.
- Castle, L.** 1888. The catalpas. The Journal of Horticulture, Cottage Gardener and Home Farmer, ser. 3, 16: 46–48.
- Catesby, M.** 1730–1732. The natural history of Carolina, Florida and the Bahama Islands, vol. 1. The author, London.
- _____. 1763. Hortus Europae Americanus: or, a collection of 85 curious trees and shrubs, the produce of North America. W. Richardson and S. Clark, London.
- Cavanilles, J. A.** 1801. Descripción de las plantas que D. Antonio Josef Cavanilles demostró en las lecciones públicas del año 1801. Imprenta Real, Madrid.
- Clarke, D. L.** 1988. Bean's trees and shrubs hardy in the British Isles, ed. 8. John Murray, London.
- Corbelli, P.** 1873. Dizionario di Floricultura Ossia catalogo alfabetico, descrittivo, illustrato, vol. 1. Tipografia Bondavalli e Gasparini, Reggio Emilia.
- Cox, B. & D. B. Dunn.** 1973–1974. Catalpas occurring the vicinity of Columbia, Missouri. Transactions of the Missouri Academy of Science 7-8: 137–145.
- Davis, R. B.** 1978. Intellectual life in the colonial south 1585–1763, vol. 3. University of Tennessee Press, Nashville.
- Decaisne, J.** 1851. Arbrisseaux de la Chine récemment introduits au Muséum. Revue Horticole, sér. 3, 5: 405–407.
- Del Tredici, P.** 1986. The great catalpa craze. Arnoldia 46: 2–10.
- Descourtilz, M. E.** 1822. Flore médicale des Antilles, vol. 1. Pichard, Mme. Veuve Prichard, Gauthier, Paris.
- Dirr, M. A.** 2009. Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses, ed. 6. Stipes Publishing, Champaign, Illinois.
- Dode, L.-A.** 1907. Notes dendrologiques. Bulletin de la Société Dendrologique de France 6: 190–209.
- Don, G.** 1837. General history of the dichlamydeous plants, vol. 4. J. G. & F. Rivington, London.
- Duhamel du Monceau, H. L.** 1755. Trait des arbres et arbustes, vol. 1. H. L. Guérin & L. F. Delatour, Paris.
- Ekman, E. L.** 1924. *Catalpa macrocarpa*. In: I. Urban (ed.), Symbolae Antillanae 9: 254. Fratres Borntraeger, Leipzig.
- Elias, T. S. & L. F. Newcombe.** 1979. Foliar nectaries and glandular trichomes in *Catalpa* (Bignoniaceae). Acta Botanica Sinica 21: 215–224.
- _____. & **W. Wisura.** 1991. ×*Chitalpa tashkentensis* (Bignoniaceae), an intergeneric hybrid of ornamental value. Baileya 23: 139–144.
- Elwes, H. J. & A. Henry.** 1912. The trees of Great Britain & Ireland, vol. 6. Privately printed, Edinburgh.
- Endlicher, S. L.** 1839. Bignoniaceae. Pp. 708–715 In: Genera plantarum. Fr. Beck., Wien
- Engelhardt, H.** 1922. Die alltertiäre Flora von Messel bei Darmstadt. Abhandlungen der Hessischen Geologischen Landesamt Darmstadt 7: 17–128.
- Engelmann, G.** 1880. *Catalpa speciosa*, Wärdner. Botanical Gazette 5(1): 1–2.
- Fang, J., Z. Wang & Z. Tang.** 2009. Atlas of woody plants in China: distribution and climate, vol. 1. Higher Education Press, Beijing.
- Francis, J. K.** 1990. *Catalpa longissima* (Jacq.) Dum. Cours., yokewood. Silvics Manual. SO-ITF-SM-37, 4pp. USDA Forest Service, Southern Forest Experiment Station, New Orleans.
- Freeman, T. & P. Custis.** 1807. An account of the Red River in Louisiana. War Office of the United States, Washington, DC.
- Gentry, A. H.** 1980. Bignoniaceae—part I (Crescentieae and Tourrettieae). Flora Neotropica Monograph 25(1): 1–130.
- _____. 1992. Bignoniaceae—part II (tribe Tecomeae). Flora Neotropica Monograph 25(2): 1–370.
- _____. & **A. S. Tomb.** 1979. Taxonomic implications of Bignoniaceae palynology. Annuals of the Missouri Botanical Garden 66: 756–777.
- Gilmour, J. S. L.** 1936. *Catalpa fargesii* forma *duclouxii*. Curtis's Botanical Magazine 159: t. 9458, a 2-page color plate, a half-page, black-and-white, diagnostic figure, and 3 pages of un-numbered text.
- Gorbunov, M. G.** 1962. Description of Tertiary plants of western Siberia. Trudy Sibirskogo Nauchno-issledovatel'skogo Instituta Geologii 22: 359, t. 75.
- Gray, A.** 1878. Synoptic flora of North America, vol. 2, part 1, pp. 319–320. Ivison, Blakeman, Taylor, and Company, New York.
- Grimshaw, J. & R. T. Olsen.** 2011. Tree of the year: Chinese species of *Catalpa* Scop. International Dendrology Society. Yearbook 2011: 26–59.
- Grisebach, A. H. R.** 1866. Catalogus plantarum Cubensium. Wilhelm Engelmann, Leipzig.
- Hall, W. L.** 1902. I. The hardy catalpa in commercial plantations. In: The hardy catalpa. U.S. Dept. of Agric. Bureau of Forestry. Bulletin no. 37. Government printing office, Washington.
- Harris, J. G. & M. W. Harris.** 1994. Plant identification terminology: an illustrated glossary. Spring Lake Publishing, Spring Lake, Utah.
- Henry, A.** 1912. *Catalpa bungei*. In: H. J. Elwes & a. Henry, the trees of Great Britain & Ireland 6: 1489–1490. Privately printed, Edinburgh.
- Hickey, L. J.** 1977. Stratigraphy and paleobotany of the Golden Valley formation (early tertiary) of western North Dakota. The Geological Society of America Memoir 150: 1–181.

- Hooker, J. D.** 1882. *Catalpa kaempferi*: native of Japan. Curtis's Botanical Magazine 108(ser. 3, vol. 38): t. 6611, 2 pages of unnumbered text.
- Howard, R. A.** 1988. Charles Wright in Cuba, 1856–1867. Chadwyck-Healey, Alexandria, Virginia.
- Jacques, H. A.** 1855. Première floraison du *Catalpa bungei*. DC. Revue Horticole, sér. 4, 4: 368–369.
- Jacquín, N. J.** 1760. Enumeratio systematica plantarum. Theodorum Haak, Leiden.
- _____. 1763. Selectarum stirpium Americanum historia, ed. 1. Wien: ex officina Krausiana.
- _____. 1780. Selectarum stirpium Americanum historia, ed. 2. Wien.
- Kämpfer, E.** 1712. Amoenitatum exoticarum politico-physico-medicae, fasc. 5. Henricis Wilhelmi Meyeri, Lemgo, Lippe.
- Keng, H.** 1974. Economic plants of ancient North China as mentioned in *Shih Ching* (book of poetry). Economic Botany 28: 391–410.
- Kiger, R. W. & D. M. Porter.** 2001. Categorical glossary for the Flora of North America project. Hunt Institute for Botanical Documentation, Pittsburgh.
- Kirkbride, J. H., Jr. & R. T. Olsen.** 2011a. Neotypification of *Catalpa speciosa* (Bignoniaceae). Taxon 60: 1760–1763.
- _____. 2011b. Identity of *Catalpa tibetica* (Bignoniaceae). Journal of the Botanical Research Institute of Texas 5: 625–631.
- Kok, R. de** 2012. A revision of the genus *Gmelina* (Lamiaceae). Kew Bulletin 67: 293–329.
- Kunming Institute of Botany.** 1979. Flora Yunnanica, vol. 2. Scientific Press, Beijing.
- Kvaček, Z. & V. Wilde.** 2010. Foliage and seeds of malvalean plants from the Eocene of Europe. Bulletin of Geosciences 85: 163–182.
- Laird, M.** 1998. From callicarpa to catalpa: the impacts of mark Catesby's plant introductions on English gardens of the eighteenth century, p. 184–227. In: A.R.W. Meyers & M.B. Pritchard (eds.), Empire's nature: mark Catesby's new world vision. University of North Carolina Press, Chapel Hill.
- Lavallée, P. A. M.** 1880. Icones selectae arborum et fructuum in hortis Segrezianis. Librairie de J.-B. Baillièrre et fils, Paris.
- Lawrence, G. H. M.** 1955. An introduction to plant taxonomy. Macmillan Company, New York.
- Leighton, A.** 1976. American gardens in the eighteenth century: for use and delight. Houghton Mifflin, Boston.
- Lesquereux, M. L.** 1860. Botanical and palaeontological report on the geological state survey of Arkansas. Pp. 295–399 In: D. D. Owen (ed.), Second report of a geological reconnaissance of the middle and southern counties of Arkansas, made during the years 1859 and 1860, C. Sherman and Son, Printers, Philadelphia.
- Li, H.-L.** 1952. Floristic relationships between eastern Asia and eastern North America. Transactions of the American Philosophical Society, new ser., 42: 371–429.
- Li, J.** 2008. Phylogeny of *Catalpa* (Bignoniaceae) inferred from sequences of chloroplast *ngH*F and nuclear ribosomal DNA. Journal of Systematics and Evolution. 46: 341–348.
- _____, **S. Shoup & T. S. Elias.** 2006. Molecular confirmation of intergeneric hybrid \times *Chitalpa tashkentensis* (Bignoniaceae). HortScience 41: 1162–1164.
- Li, Z.-H.** 2007. Distinguishing *Catalpa ovata* and *Catalpa bungei* in ancient China. Journal of Beijing Forestry University (Social Sciences) 6(4): 20–24.
- Linnaeus, C.** 1735. Systema naturae, ed. 1. Lugduni batavorum, Leiden.
- _____. 1737. Genera plantarum, ed. 1. Lugduni batavorum, Leiden.
- _____. 1753. Species plantarum, ed. 1, vol. 2. Holmiae, Stockholm.
- _____. 1763. Species plantarum, ed. 2, vol. 2. Holmiae, Stockholm.
- Loddiges, G. L.** 1828. *Catalpa syringifolia*. The Botanical Cabinet 13(9): t. 1285, 1 page of text.
- Loudon, J. C.** 1838. Arboretum et fruticetum Britannicum, vol. 7. Longman, Hurst, Rees, Orme, and Brown, London.
- Makowska, B.** 2014. Integrating architecture and the created landscape in Japanese gardens. International Journal of Arts & Sciences. 7(5): 597–604.
- McNeill, J.** 2014. Holotype specimens and type citations: general issues. Taxon 63: 1112–1113.
- _____, **F. R. Barrie, W. R. Buck, V. Demoulin, W. Greuter, D. L. Hawksworth, P. S. Herendeen, S. Knapp, K. Marhold, J. Prado, W. F. Prud'homme van Reine, G. F. Smith, J. H. Wiersma & N. J. Turland.** 2012. International code of nomenclature for algae, fungi, and plants (Melbourne code). Regnum Veg. 154: 1–208.
- Meehan, T.** 1875a. The teas catalpa. The Gardener's Monthly and Horticultural Advertiser 17: 67.
- _____. 1875b. *Catalpa speciosa*. The Gardener's Monthly and Horticultural Advertiser 17: 180–181.
- Meisner, C. F.** 1840. Plantarum vascularium genera, Tab. Diag., Bignoniaceae, pp. 299–301. Libraria Weidmannia, Leipzig.
- Meyer, C. A. von.** 1837. Beschreibung einer neuen Art der Gattung *Catalpa*. Bulletin Scientifique publié par l'Académie Impériale des Sciences de Saint-Petersbourg 2: 49–52.
- Meyer, F. N.** 1907. *Catalpa bungei*. U.S.D.A. Bureau of Plant Industry Bulletin 106: 73.
- Michaux, A.** 1803. Flora boreali-Americana. Frates Levrault, Paris.
- Michaux, F.-A.** 1812. Histoire des arbres forestiers de l'Amérique septentrionale, vol. 3, part 4. L. Haussman, Paris.
- Morton, C. V.** 1967. Freeman and Custis' account of the Red River expedition of 1806: an overlooked publication of botanical interest. Journal of the Arnold Arboretum 48: 431–459.
- Newberry, J. S.** 1870. Notes on the later extinct floras of North America, with descriptions of some new species of fossil plants from the cretaceous and tertiary strata. Annals of the Lyceum of Natural History of New York 9: 1–76.
- Nicolson, D. H., C. R. Suresh & K. S. Manilal.** 1988. An interpretation of van Rheedee's Hortus Malabaricus. Regnum Vegetabile 119: 1–378.
- Nogueira, A., J. H. L. El Ottra, E. Guimarães, S. R. Machado & L. G. Lohmann.** 2013. Trichome structure in Neotropical lianas. Annals of Botany 112: 1331–1350.
- Nuttall, T.** 1818. The genera of north American plants and a catalogue of the species, to the year 1817. The author, Philadelphia.
- _____. 1836. Collections towards a flora of the territory of Arkansas. Transactions of the American Philosophical Society, new ser., 5: 139–203.
- Olmstead, R. G.** 2013. Phylogeny and biogeography in Solanaceae, Verbenaceae and Bignoniaceae: a comparison

- of continental and intercontinental diversification patterns. *Botanical Journal of the Linnean Society* 171: 80–102.
- _____, **K.-J. Kim, R. K. Jansen & S. J. Wagstaff.** 2000. The phylogeny of the Asteridae, sensu lato, based on chloroplast *ndhF* gene sequences. *Molecular Phylogenetics and Evolution* 16: 96–112.
- _____, **M. L. Zjhra, L. G. Lohmann, S. O. Grose & A. J. Eckert.** 2009. A molecular phylogeny and classification of Bignoniaceae. *American Journal of Botany* 96: 1731–1743.
- Olsen, R. T. & J. H. Kirkbride, Jr.** 2010. Manchurian catalpa: *Catalpa bungei*. *Arnoldia* 68: 75–76, inside back cover.
- _____, **T. G. Ranney & C. S. Hodges.** 2006a. Susceptibility of *Catalpa*, *Chilopsis* and hybrids to powdery mildew and catalpa sphinx larvae. *HortScience* 41: 1629–1634.
- _____, **T. G. Ranney & Z. Viloría.** 2006b. Reproductive behavior of induced allotetraploid \times *Chitalpa* and in vitro embryo culture of polyploid progeny. *Journal of the American Society of Horticultural Science* 131: 716–724.
- Oman, A. E.** 1911. Hardy catalpa—a study of conditions in Kansas plantations. *Proceedings of the Society of American Foresters* 6: 42–52.
- Pactl, J.** 1947. Sur la cloison dans les capsules du genre *Catalpa* de la famille Bignoniacées. *Berichte der Schweizerischen Botanischen Gesellschaft.* 57: 115–121.
- _____. 1948a. Sur la métamorphose des étamines chez le *Catalpa ovata* \times *C. bignonioides* (Bignoniaceae). *Berichte der Schweizerischen Botanischen Gesellschaft.* 58: 381–382.
- _____. 1948b. Monografie rodu *Catalpa* (monograph on the genus *Catalpa*). Spisy Vydávané Přírodovědeckou Fakulou University Karlovy 194: 78–81.
- _____. 1950. Synopsis of the genus *Catalpa* (Bignoniaceae) II, chapters on physiology and biochemistry. *Berichte der Schweizerischen Botanischen Gesellschaft* 60: 591–595.
- _____. 1951a. Synopsis of the genus *Catalpa* I, general part including chapters on anatomy, morphology and taxonomy. *Studia Botanica Českoslovačka* 12: 255–260.
- _____. 1951b. Synopsis of the genus *Catalpa* IV, fungus and related diseases of the genus *Catalpa* (Bignoniaceae). *Sydowia* 5: 160–168.
- _____. 1952a. Synopsis of the genus *Catalpa* (Bignoniaceae) III, special part. *Candollea* 13: 241–288.
- _____. 1952b. Synopsis of the genus *Catalpa* V, pests of the genus *Catalpa*. *Biologisch Jahrbuch* 19: 60–73.
- _____. 1953. Synopsis of the genus *Catalpa* (Bignoniaceae) VI (addenda). *Phyton Annales rei Botanicae* 5: 118–127.
- _____. 1954. Synopsis of the genus *Catalpa* (Bignoniaceae) VII (addenda 2). *Phytopathologische Zeitschrift* 21: 329–332.
- _____. 1956. *Catalpa* and *Cumbulu*. *Taxon* 5: 147.
- _____. 1962. *Shiuyinghua*, a new genus of Scrophulariaceae from China. *Journal of the Arnold Arboretum* 43: 215–217.
- Pampanini, R.** 1910. Le piante Vascolari raccolte dal Rev. P. C. *silvestri* nell' Hu-peh durante gli anni 1904–1907. *Nuovo Giornale Botanico Italiano, nuova serie* 17: 669–735.
- Pan, Q.-K., Z.-L. Mao & C.J. Guo.** 1980. On some varietal forms of *Catalpa bungei* C. A. Mey. And *C. fargesii* bur. In western Henan. *Scientia Silvae Sinicae* 16: 157–160.
- Patterson, H. N.** 1876. Catalogue of the phaenogamous and vascular cryptogamous plants of Illinois: native and introduced. Spectator Print, Oquamka, Illinois.
- Pépin, P. D.** 1856. Sur le *Catalpa bungei*, DC. *Revue Horticole, sér. 4, 5*: 361–363.
- Plumier, C.** 1755–1760. *Plantarum Americanarum S.* Schouten, Leiden.
- Poinar, G. O.** 2016. The first fossil flowers of Bignoniaceae (Lamiales): *Catalpa hispaniolae* sp. nov. in Dominican Republic amber. *Novon* 25: 57–63.
- Radford, A. E.** 1986. *Fundamentals of plant systematics.* Harper & Row, Publishers, New York.
- Refugio-Rodriguez, N. F. & R. G. Olmstead.** 2014. Phylogeny of Lamiidae. *American Journal of Botany* 101: 287–299.
- Rehder, A.** 1914. *Catalpa*. In: L. H. Bailey (ed.), *The standard cyclopedia of horticulture* 2: 684–685. Macmillan, New York.
- Reid, E. M. & M. E. J. Chandler.** 1926. *The Bembridge flora, vol. 1.* British Museum (Natural History), London.
- Rembert, D. H.** 1980. Thomas Walter, Carolina botanist. *Museum Bulletin South Carolina Museum Commission* 5: 1–33.
- Reveal, J. L., C. E. Jarvis & F. R. Barrie.** 1990. On the typification of *Bignonia catalpa* L. (Bignoniaceae). *Bartonia* 56: 17–18.
- Richard, A.** 1850. *Botanica, segunda parte.* In: R. de la Sagra (ed.), *Historia Fisica Politica y Natural de la Isla de Cuba, vol 11.* Imprenta de Maulde y Renou, Paris.
- Robinson, W.** 1908. *Catalpa syringaefolia pulverulenta.* *Gardening Illustrated for Town & Country* 30: 289.
- Rusanov, N. F.** 1964. On the intergeneric hybrids of *Catalpa* and *Chilopsis*. *Byulleten Glavnogo Botanicheskogo Sada* 55: 44–47. [in Russian]
- Rusanov, N. F.** 1971. Intergeneric hybrids of *Catalpa* and *Chilopsis* and their significance for understanding phylogeny. *Introduktsiya i Akklimatizatsiya Rastenii* (Tashkent) 8: 50–58. [in Russian]
- _____. 1981. New decorative forms of woody plants obtained by remote hybridization (*Catalpa*, *Chilopsis*, *Koelreuteria*). *All Union Bulletin on Remote Hybridization of Plants and Animals* 1981: 466–467. [in Russian]
- _____. 1862. La végétation du sud-est de la France. *Annales des Sciences Naturelles, Botanique, sér. 4, 17*: 191–311.
- Saporta, G.** 1889. Dernières adjonctions a la flore fossile d'Aix-en Provence. *Annales des Sciences Naturelles, Botanique, sér. 7, 10*: 1–192.
- Sargent, C. S.** 1886. Some additional notes upon trees and tree planting in Massachusetts. *Annual Report of the Massachusetts State Board of Agriculture.* Wright and Potter Printing Co., Boston.
- _____. 1889. New or little known plants: a hybrid *Catalpa*. *Garden and Forest* 2: 303–305.
- _____. 1894. *The silva of North America, vol. 6.* Mifflin and Company, Boston.
- Sauvalle, F. A.** 1870. *Flora Cubana: revisio catalogi Grisebachiana vel index plantarum Cubensium.* *Annales de la Academia de Ciencias Médicas, Físicas y Naturales de la Habana* 6: 314–322.
- _____. A. 1873. *Flora Cubana. Imp. “La Antilla,” de Cacho-Negrete, Habana.*
- Schneck, J.** 1876. Catalogue of the flora of the Wabash Valley below the mouth of the White River and observations thereon. *Annual Report of the Geological Survey of Indiana* 7: 504–579.

- Schneider, C. K.** 1911. Gattung 386. *Catalpa*. Illustriertes Handbuch der Laubholzkunde 2: 623–627. Gustav Fischer, Jena.
- Schumann, K.** 1894–1895. Bignoniaceae. In: A. Engler and K. Prantl (eds.), Die Natürlichen Pflanzenfamilien 4(3b): 189–252. Wilhelm Engelmann, Leipzig.
- Schwerin, F. G.** 1910. Neue Gehölze. Mitteilungen der Deutschen Dendrologischen Gesellschaft 19: 286–290.
- Scopoli, G. A.** 1777. Introductio ad Historiam Naturalem. Wolfgangang Gerle, Praha.
- Scott, C. H.** 1912. The hardy catalpa. Kansas State Agricultural College. Experiment Station Circular No. 20.
- Seemann, B.** 1856. Bignoniaceae. Botany of the Voyage of H. M. S. Herald, p. 326. Lovell Reeve, London.
- Short, C. W.** 1845. Observations on the botany of Illinois, more especially in reference to the autumnal flora of the prairies, in a letter to Daniel Drake, M.D. The Western Journal of Medicine and Surgery, ser. 2, 3(3): 185–198.
- Sims, J.** 1808. *Catalpa syringifolia*: common catalpa. Curtis's Botanical Magazine 27: t. 1094, 2 pp. un-numbered.
- Smith, E. C.** 1941. Chromosome behavior in *Catalpa hybrid* Spaeth. Journal of the Arnold Arboretum. 22: 219–221.
- Spangler, R. E. & R. G. Olmstead.** 1999. Phylogenetic analysis of Bignoniaceae based on the cpDNA gene sequences *rbcl* and *ndhF*. Annuals of the Missouri Botanical Garden 86: 33–46.
- Späth, L.** 1898. *Catalpa hybrida* Hrt. Gartenflora Zeitschrift für Garten- und Blumenkunde 47: 481.
- Staffeu, F. A. & R. S. Cowan.** 1976. Taxonomic literature, volume I: A–G, ed. 2. Regnum Vegetabile 94: 1–1136.
- Stephenson, A. G.** 1979. An evolutionary examination of the floral display of *Catalpa speciosa* (Bignoniaceae). Evolution 33: 1200–1209.
- _____ & **W. W. Thomas.** 1977. Diurnal and nocturnal pollination of *Catalpa speciosa* (Bignoniaceae). Systematic Botany 2: 191–198.
- Stephyrtza, A. G. & A. G. Negru.** 1987. On the Sarmatian flora of Bravichi village of Moldavia. Flora and Vegetation, pp. 50–69. Grădina Botanică (Institut), Chişinău, Moldova.
- Stevens, P. F.** 2001 onwards. Angiosperm Phylogeny Website. Version 12, July 2012 [and more or less continuously updated since]. <http://www.mobot.org/MOBOT/research/APweb/>
- Stone, W. G. M.** 1908a. More catalpa talk – buying and planting a dangerous risk. Arboriculture a Journal of the Forests. 7(5): 130–131.
- _____. 1908b. Some more catalpa talk and some object lessons. Arboriculture a Journal of the Forests 7(6): 144–148.
- Sweet, R.** 1826. Sweet's Hortus Britannicus: or, a catalogue of plants cultivated in the gardens of great Britain. James Ridgway, London.
- T., W.** 1910. New hardy tree and shrubs of 1909. The Gardener's Magazine (London) 53: 30.
- Teas, E. Y.** 1875. *Catalpa speciosa*. In: T. Meehan (ed.), The Gardener's Monthly and Horticultural Advertiser 17(6): 180–181.
- Teas, J. C.** 1866. Raysville Nursery, No. 3 Trade List for fall of 1866. John C. Teas, Raysville, Indiana.
- Thunberg, C. P.** 1784. Flora japonica. J. G. Mülleriano, Leipzig.
- Timyan, J., Y. Elie, C. A. Béliard & L. Verret.** 1997. Haitian oak (*C. longissimi* (Jacq.) Dum. Cours.) seed orchards and progeny trials in Haiti: 1988–1996. SECID/Aubum PLUS Report No. 41. USAID/Economic Growth Office.
- Tussac, F. R. de.** 1828. *Bignonia*. Flore des Antilles 4: 118–121, t. 37. The author, Paris.
- Urban, I.** 1898–1928. Symbolae antillanae seu fundamenta florum Indiae occidentalis, vols. 1–9. Fratres Bomtraeger, Berlin.
- _____. 1927. Sertum antillanum XXVIII. Repertorium specierum novarum regni vegetabilis 24: 1–13.
- _____. 1929. Plantae Haitiensis et Domingenses novae vel rariores VI. A cl. E. L. Ekman 1924–1928 lectae. Arkiv för Botanik 22A(10): 1–108.
- Valder, P.** 1999. The garden plants of China. Timber Press, Portland, Oregon.
- _____. 2002. Garden in China. Timber Press, Portland, Oregon.
- Walter, T.** 1788. Flora caroliniana. J. Wenman, Fleet Street, London.
- Wang, W., K. Pan, Z. Zhang, Z. Li, D. Tao & W. Yin.** 1990. 6. *Catalpa* Scop. In: W. Wang (ed.), Flora Republicae Sinicae 69: 13–18. Science Press, Beijing.
- Ward, D. B.** 2006. Thomas Walter typification project, I: observation on the John Fraser folio. Sida 22: 1111–1118.
- _____. 2007a. The Thomas Walter herbarium is not the herbarium of Thomas Walter. Taxon 56: 917–926.
- _____. 2007b. Thomas Walter typification project, IV: neotypes and epitypes for 43 Walter names of genera a through C. Journal of the Botanical Research Institute of Texas 1(2): 1091–1100.
- Warder, J. A.** 1879a. The western catalpa tree: an open letter to Robert Douglas & sons. Dr. John A. Warder, North Bend, Ohio.
- _____. 1879b. Dr. Warder's report on the *Catalpa*. Pp. 17–28. In: E. E. Barney (ed.), Additional facts and information in relation to the catalpa tree, *Catalpa bignonioides* and its variety? Speciosa, Dayton Journal Book and Job Printing Establishment, Dayton, Ohio.
- _____. 1881. The relations of forestry to agriculture, the western catalpa tree. The Journal of the American Agricultural Association 1: 79–102. Alternative title when published as a separate: The western catalpa, a memoir of the shavanon, or the *Catalpa speciosa*, (Engelmann).
- _____ & **R. W. Steele.** 1853. A new *Catalpa*. The Western Horticultural Review 3: 533–534.
- _____, **D. L. James & J. F. James.** 1882. Woody plants of Ohio, arranged under their appropriate botanical orders, with remarks upon their uses, qualities and sources. Ohio Agricultural Experiment Station Annual Report 1881: 1–40.
- Wawra von Fernsee, H. R. & F. Abel.** 1886. *Catalpa syringaeifolia* purpurea. Wiener Illustrierte Garten-Zeitung 11: 40.
- Wen, J.** 1999. Evolution of eastern Asian and eastern north American disjunct distributions in flowering plants. Annual Review of Ecology and Systematics 30: 421–455.
- Weniger, D.** 1996. *Catalpa (Catalpa bignonioides, Bignoniaceae) and bois d'Arc (Maclura pomifera, Moraceae) in early Texas records.* Sida 17: 231–242.
- Williams, R. L.** 2004. An intellectual biography of Élie-Abel Carrière (1818–1896). Brittonia 56: 365–374.
- Wolfe, J. A. & H. E. Schorn.** 1990. Taxonomic revision of the Spermatopsida of the Oligocene Creede flora, southern Colorado. Bull. U.S. Geological Survey Bulletin 1923: 1–40.
- Yih, D.** 2012. Land bridge travelers of the tertiary: the eastern Asia-eastern North America floristic disjunction. Arnoldia 69: 14–23.