IDENTITY OF *CATALPA TIBETICA* (BIGNONIACEAE)

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ABSTRACT

Catalpa tibetica (Bignoniaceae) is included within the circumscription of *C. bignonioides*, a North American species. The genus *Catalpa* is thereby reduced from 10 species to nine, and the number of native Chinese species from four to three. A preliminary synonymy for *C. bignonioides* is presented, including *C. tibetica*. The correct neotype and epitype for *C. bignonioides* are indicated.

RESUMEN

Catalpa tibetica (Bignoniaceae) se incluye dentro de los límites de *C. bignonioides*, una especie de Norte América. El número de especies del género *Catalpa* se reduce de 10 a nueve especies, y las especies nativas de China pasan de cuatro a tres. Se presenta una sinonimia preliminar para *C. bignonioides*, incluyendo *C. tibetica*. Se indican el neotipo y epitipo correctos para *C. bignonioides*.

INTRODUCTION

The genus *Catalpa* Scop. (Bignoniaceae Juss.) has been treated as composed of 10 species in two well-defined sections, *Catalpa* and *Macrocatalpa* Griseb. (Paclt 1952; Gentry 1992). *Catalpa* section *Catalpa* contained six species of deciduous trees with a disjunct distribution between temperate East Asia (four species) and eastern North America (two species). The two North American species, *C. bignonioides* Walter (common catalpa or Indian bean) and *C. speciosa* E.Y. Teas (hardy catalpa), are frequently cultivated and widely naturalized in urban areas of the eastern United States (Rehder 1940). *Catalpa* section *Macrocatalpa* was composed of four species of evergreen or semi-evergreen trees restricted to the Antilles, and with the exception of *C. longissima* (Jacq.) Dum. Cours., are not in cultivation (Gentry 1992). While the North American species are well known, the Asian and Antillean species are not. Of the four species of Asian *Catalpa* currently recognized (*C. bungei* C.A. Mey., *C. fargesii* Bureau, *C. ovata* G. Don, and *C. tibetica* Forrest) (Zhang & Santisuk 1998), all but *C. tibetica* exist in cultivation.

The temperate catalpas are often described as some of the most beautiful of hardy flowering trees, with showy panicles of white, yellow, or pink flowers, depending on the species (Clarke & Taylor 1980; Dirr 1998). Furthermore, their broad adaptability, both in hardiness and abiotic stress tolerances, provides ample opportunity through systematic breeding to develop novel cultivars for the urban landscape (Olsen et al. 2006a, b). Olsen et al. (2006a) amassed a collection of catalpa and catalpa-relatives that was transferred to the U.S. National Arboretum and forms the foundation for our catalpa research and breeding program. The collection has been expanded, and now contains over 40 accessions representing both wild material and cultivated varieties. Trueness-to-type was questioned by Olsen et al. (2006a) for several accessions of *Catalpa bungei* and *C. fargesii* in the collection, and only a handful of correctly identified accessions have been located in the U.S. and Europe. During the search for cultivated species of *Catalpa* for inclusion in our breeding work, we were unable to locate living plants of *C. tibetica,* a species collected and described by George Forrest from southeastern Tibet, and known only from the type specimens. The locality data provided by Forrest suggested that *C. tibetica* might represent a significantly improved source of cold-hardiness for catalpa breeding.

GEORGE FORREST

George Forrest was one of the most productive explorers and collectors in western Yunnan, China, and the southeastern corner of Tibet in the early 20th Century (Cooper et al. 1935; Cox 1945; Cowan 1952; McLean

2004). Over more than 25 years, from 1906 to 1931, Forrest carried out seven expeditions to China. His collecting efforts ranged from seven months to two years and 10 months in duration. He made more than 24,155 plant collections, and died in China near Tengyueh, present day Tengchong, on the 5th of January, 1932 near the end of what was supposed to be his last expedition.

During his first expedition to Yunnan from 1904 to 1906, Forrest learned the local languages and dialects and developed an organization for efficient, highly productive collecting in Yunnan and Tibet (Cox 1945; McLean 2004). He trained a cadre of men, mostly of the Nakhi (Naxi) people from U-lu-kay (Snow Mountain Village) about 15 miles (24 km) north of Lichiang (Lijiang), as collectors, until he had more than 20 trained men in whom he had full confidence that they could work without his immediate supervision (Cox 1945; McLean 2004). For a collecting season, he would establish his headquarters in a suitable village or town. Forrest would collect in the region around his headquarters, and send teams of men to collect in various locations outside of the headquarters' region. Sometimes teams would be gone two to three months at a time, traveling long distances and collecting in difficult terrain. This system of collecting was very productive because of the extensive, widely separated areas that would be worked during a single collecting season. In addition most, if not all, areas of interest were visited at least two or more times during the flowering and fruiting seasons to insure that plants of horticultural interest were collected in both flowering and fruiting states, facilitating their study, identification, and seed collection for propagation. There are several drawbacks to this system, which we have experienced in our own and colleagues' collecting expeditions. When large volumes of material are collected and processed, specimens of different species can be accidently mixed or switched. Collection data, including collection numbers, descriptive information, or locality data, can be assigned to the wrong materials. Attempting to gather materials from the complete life-cycle of a species can lead to the association of materials of different species that are very similar. Cox (1945) reported that "on several occasions mistakes were made and [Forrest's] seed did not correspond with the name."

Forrest was seriously ill during most of 1919 (McLean 2004: 147). His doctor advised him to remain in Tengyueh (Tengchong), so he established his headquarters there and remained there for the entire year (McLean 2004: 147). He still managed to send collecting teams to at least six different mountain ranges during the year covering 25–29° N latitude and reaching as far as 250 miles (400 km) away in Tibet (McLean 2004: 147). In May, he dispatched three collectors with two mules to work in Tsarong, Tibet under the supervision of Père Valentin at the Roman Catholic Mission in Tsedjrong just north of Tsekou (Chigu) (McLean 2004: 142, 144). The three collectors were told that they would be paid "a small reward for each new species found" (McLean 2004: 144). This team was probably the one that worked furthest from Tengyueh (Tengchong) during 1919.

In 1919 this three-man collecting team made two collections of *Catalpa* to which Forrest assigned his nos. *18926* collected in August and *18950* in June and described as *Catalpa tibetica* citing his collections *18926* and *18950* without indicating either to be the type (Forrest 1921). According to data on the labels, they were both collected in Tsarong on the Salween-Kiu-chiang divide at latitude 28º 40' N and longitude 98º 15' E. In Google Earth (release 5.0), this latitude and longitude indicates a place over 4,300 m above sea level. *Forrest 18926* consists of fruiting specimens with mature seeds; *Forrest 18950* comprises flowering specimens. The herbarium label of *Forrest 18950* describes the flowers as "creamy-yellow, flushed and marked pale purple and yellow". Forrest's hand-written field book, volume IV, F12345 (Forrest 1929) describes the flowers as "creamy white, flushed and marked pale purple and yellow". Forrest compared his new species to *C. ovata*, and concluded that his species "does not agree in size of flower, in size and shape of fruit, nor in the seeds with numerous specimens of the well known *C. ovata* G. Don."

The Royal Botanic Garden, Edinburgh holds in their archives George Forrest's field books and his correspondence with their staff. Volume IV, F12345, of his field books covers the collection numbers 17906–19054 from April to November of 1919. The page and collection numbers are stamped in blue ink, and the remainder was hand written also in blue ink. Entry number 18926 is on page 188, and number 18950 is on page 193. The collection data exactly matches that published by Forrest (1929) in his field notes of 1917–19 for non-rhodo-

dendrons, but differs in the description of the corolla color, "cream-white" in the field book and "creamy-yellow" on the herbarium labels and in the protologue of *C. tibetica* (Forrest 1921). Forrest wrote "*Catalpa* ? *tibetica* Forr." as the determination for *Forrest 18926* and "*C. tibetica* G. Forr." as the determination for *Forrest 18950*.

We examined Forrest's correspondence with the Royal Botanic Garden staff for 1919 through August 1922, including letters from him and copies of letters sent to him, mainly to and from Sir Isaac Bayley Balfour, Regius Keeper during that period. The principal topics of the letters were Forrest's collecting and the genera *Rhododendron* L. and *Primula* L., both of special interest to Sir Isaac. There was no mention of *Catalpa* or collection numbers *18926* and *18950*, and no reference to Forrest's publication of *Catalpa tibetica* (Forrest 1921).

Catalpa tibetica has been accepted in the principal Chinese floras (Kunming Institute of Botany 1979; Wang et al. 1990; Zhang & Santisuk 1998), where the corolla was described as yellowish white and the fruit as approximately 1 cm in diameter. Yao and Huang (1980) presented a synopsis of all taxa of *Catalpa* without keys or descriptions. They did not examine the syntypes of *C. tibetica*, but examined a specimen purported to be *C. tibetica* (China, Yunnan Province, at bank of a creek near the front gate of the Construction Bureau of Lijiang, 4 Sep 1948, *Qin Ren Chang 31019*). They concluded that the specimen was of *C. bignonioides*, a species not native to China. They never saw an authentic specimen of *C. tibetica*.

In July of 2009 we examined the specimens of *Forrest 18926* and *18950* in the herbaria of the Royal Botanic Garden, Edinburgh (E), Royal Botanic Gardens, Kew (K), and Muséum National d'Histoire Naturelle, Paris (P). Images of those collections are available for viewing on the Internet sites of those institutions. We were immediately struck by the similarity of the syntypes of *C. tibetica* and the North American *C. bignonioides* and *C. speciosa*. Comparison of the Forrest collections to wild and cultivated specimens of the North American species convinced us that the syntypes of *C. tibetica* fall within the circumscription of *C. bignonioides*. The large white corollas and the large fruits and seeds are exactly like those of *C. bignonioides* and unlike those of the Chinese *C. bungei*, *C. fargesii*, and *C. ovata*. Therefore we here lectotypify *C. tibetica*, and place it in synonymy under *C. bignonioides*.

Forrest 18926 and *18950* were not collected in Tsarong, Tibet. Because Forrest had sent the three-man collection team to Tsarong, he erroneously labeled the two collections as having been made there. In 1904 Forrest traveled from Tengyueh (Tengchong) to Tseku (Chigu) by way of Tali (Dali), Lichiang (Lijiang), Chung-tien (Zhongdian) and then crossed the Yangtze (Jinsha Jiang) River, Beima Shan mountains, and finally the Salween (Nu Jiang) River (Davies 1909; McLean 2004). In 1919 Forrest's three-man collecting team possibly traveled via Tali (Dali) and Lichiang (Lijiang) and then up the Yangtze (Jinhsa Jiang) River valley to reach Tsarong. Spurred on by the promise of a monetary reward for each new species, the three-man collection team encountered a mature tree of *C. bignonioides*, either cultivated or adventive, somewhere along their route in Yunnan, China and collected it. Forrest correctly recorded its flower color as creamy-white in his field book, but when preparing the herbarium labels for *Forrest 18950* and publishing *C. tibetica*, changed the flower color to creamy-yellow, which was wrong. In his field book Forrest recorded the habit of *18926* as "Tree of _____ ?" and of *18950* as "Shrub or tree of _____?," a further indication of his personal lack of knowledge concerning these two collections. This uncertain habit data was placed on the herbarium labels of *Forrest 18926* and *18950*, but not included in the publication of *C. tibetica* (Forrest 1921).

CATALPA BIGNONIOIDES AND SELECTED SYNONYMS

Catalpa bignonioides Walter, Fl. carol. 64. 1788. TYPE: UNITED STATES. SOUTH CAROLINA: *Fraser 28-D* (NEOTYPE (Reveal et al. 1990, as "holotype"): BM-SL, f. 28!, Rembert 1980: Fig. 7); Lexington Co.: 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 18315* (EPITYPE (Ward 2007d, as "neotype"): GH!; ISOEPITYPE: USCH).

Bignonia catalpa L., Sp. pl. 622. 1753; *Catalpa cordifolia* Moench, Methodus 464. 1794, nom. superfl.; *Catalpa ternifolia* Cav., Descr. pl. 26. 1801, nom. superfl.; *Catalpa communis* Dum. Cours., Bot. cult. 2:189. 1802, nom. superfl.; *Catalpa syringifolia* Sims, Bot. Mag. 27: t. 1094. 1806, nom. superfl.; *Catalpium amena* Raf., Fl. ludov. 139. 1817, nom. superfl.; *Catalpa catalpa* (Linnaeus) H. Karsten, Deut. Fl. 927. 1882, nom. inval. TYPE: *Bignonia urucu foliis, flore cordide albo*, Catesby, Nat. hist. Carolina 1: t. 49. 1730 (LECTOTYPE (Reveal et al. 1990)).

Catalpa syringifolia Sims var. *nana* Ed. Otto & A. Dietr., Allg. Gartenzeitung 19(14):112. 1851. TYPE: not designated.

Catalpa syringifolia var. *aurea* anon., Gard. Chron. 41:1322. 1871. TYPE: not designated.

Catalpa arborea Baill. in Payer & Baillon, Leçons fam. nat. 214. 1872. TYPE: not designated (not found in P-Baillon, 2009).

Catalpa umbraculifera G. Ugolini, Bull. Reale Soc. Tosc. Ortic. 13:330. 1888. TYPE: not designated.

Catalpa bignonioides Walter var. *aurea* Lavallée ex Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6:183. 1894; *Catalpa bignonioides* Walter f. *aurea* (Bureau) Paclt, Candollea 13:263. 1952. TYPE: not designated.

Catalpa bignonioides Walter var. *nana* Bureau, Nouv. Arch. Mus. Hist. Nat., ser. 3, 6:183. 1894; *Catalpa bignonioides* Walter f. *nana* (Bureau) Paclt, Candollea 13:261. 1952. TYPE: not designated.

Catalpa bignonioides Walter var. *variegata* Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6:183. 1894; *Catalpa bignonioides* Walter f. *variegata* (Bureau) Paclt, Candollea 13:261. 1952. TYPE: not designated.

Catalpa bignonioides Walter var. *koehnei* Dode, Bull. Soc. Dendrol. France 1907(6): 206. 1907; *Catalpa bignonioides* Walter f. *koehnei* (Dode) Paclt, Candollea 13:262. 1952. TYPE: not designated.

Catalpa syringifolia Sims var. *pulverulenta* W. Paul & G. Paul in Anonymous, Gard. Ill. 30:289. 1908; *Catalpa bignonioides* Walter var. *pulverulenta* (W. Paul & G. Paul) Bean, Trees and Shrubs Hardy in the British Isles 1:312. 1914; *Catalpa bignonioides* Walter f. *pulverulenta* (W. Paul & G. Paul) Paclt, Candollea 13:263. 1952. TYPE: not designated.

Catalpa speciosa E.Y. Teas var. *albo-variegata* F. G. Schwer., Mitt. Deutsch. Dendrol. Ges., ed. 2, 2:289. 1910; *Catalpa speciosa* E.Y. Teas f. *albo-variegata* (F. G. Schwer.) Rehder, Bibl. cult. trees 659. 1949. TYPE: not designated.

Catalpa speciosa E.Y. Teas var. *pulverulenta* W. Paul & G. Paul in W.T., Gard. Mag. (London) 53:30. 1910; *Catalpa speciosa* E.Y. Teas f. *pulverulenta* (W. Paul & G. Paul) Rehder, Bibl. cult. trees 659. 1949. TYPE: not designated.

Catalpa tibetica Forrest, Notes Roy. Bot. Gard. Edinburgh 13:155. 1921, syn. nov. TYPES: CHINA. YUNNAN: Jun 1919, *Forrest 18950* (LECTOTYPE, here designated: E No. 00287957!; ISOLECTOTYPES: E No. 00287958!, K!, P!); same locality, Aug 1919, *Forrest 18926* (SYNTYPES: E No. 00287955!, E No. 00287956!).

Catalpa bignonioides Walter f. *rehderi* Paclt, Candollea 13: 259. 1952. TYPE: CZECH REPUBLIC. Central Bohemia, Prague, ca. 290 m elev, *Paclt 3* (HOLOTYPE: PR).

This large list of synonyms is preliminary. Numerous minor variants of *C. 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 *International Code of Nomenclature for Cultivated Plants* (Brickell et al. 2004), and not given formal scientific recognition.

EARLY EUROPEAN INTRODUCTIONS OF *CATALPA BIGNONIOIDES*

Mark Catesby (1730) discovered *Catalpa bignonioides* in the western Carolinas, and introduced it into cultivation in eastern South Carolina. He also introduced it into England in 1726 (Aiton 1789; Saint-Hilaire 1804; Sweet 1826; Loudon 1838; Beck von Mannagetta & Abel 1890; Sargent 1894; Boulger 1904; Elwes & Henry 1912; Bean 1914), and by 1754 (Duhamel du Monceau 1755) it was being successfully cultivated in France. By 1812 (Loudon 1838) it was widely cultivated all over Europe, including Austria, France, Germany, Ireland, and Italy. Because of its abundant, beautiful spring flowering, it was rapidly and widely distributed to various temperate countries. By the early 18th Century, French Jesuits were resident in China (Lécrivain 2004; Thevenet 2004). Some of the Jesuit fathers, such as Armand David, Pierre-Nicolas Le Chéron d'Incarville, and Jean-André Soulié, were enthusiastic botanists and collectors. They made extensive collections of Chinese flora, both propagules and herbarium specimens, which they sent to Paris, and requested and received propagules of various plants from Paris. Perhaps *C. bignonioides* was one of the species that the French Jesuits introduced into China in the 18th or 19th Century.

The native distribution of *Catalpa bignonioides* has long been recognized as southwestern Georgia, western Florida, southern and central Alabama, Mississippi, and Louisiana, and perhaps the southeastern edge of Texas (Sargent 1894; Bureau 1894; Elwes & Henry 1912; Paclt 1952; Weniger 1996; Manning 2000), and modern treatments of all species of Chinese *Catalpa* (Kunming Institute of Botany 1979; Yao & Huang 1980; Wang et al. 1990; Zhang & Santisuk 1998; Fang et al. 2009) have not included *C. bignonioides* as a native Chinese species. In our opinion *C. bignonioides* is endemic to the southeastern United States, and was introduced into China as a horticultural plant because of its great beauty in the spring when flowering.

TYPIFICATION OF *CATALPA BIGNONIOIDES*

Traditionally, *Catalpa bignonioides* Walter has been treated as a replacement name for the earlier *Bignonia catalpa* L. or as a new species (Paclt 1952; Reveal et al. 1990; Ward 2006, 2007a). The alternative treatments have

resulted from varying interpretations of Walter's (1788:64) *C. bignonioides*. His treatment of the genus and species in *Flora Caroliniana* is brief:

> 12. *CATALPA*. *Cor.* monopetala, campanulata.
> *Cal* 5-phyllus. *Rudimenta* tria staminum.
> *bignonioides* 1. arbor. fol. cordatis.

Throughout the work, Walter gave neither authorities nor references for the names of the taxa nor did he cite specimens. In the preface, Walter stated that he had only Linnaeus' *Systema naturae* (1735), *Genera plantarum* (1737), and *Species plantarum* (1753) to work from (Walter 1788; Rembert 1980). When he followed Linnaeus the text was generally placed in Roman type, and when his treatment differed from Linnaeus, those differences were usually placed in italics (Reveal & Jarvis 2009).

Paclt (1952) was the first to inadvertently typify *C. bignonioides* in his synopsis of the genus. He gave the type of *C. bignonioides* as, "*Linnaeus* [?] in hb. BM. (Herb. Hort. Cliffort.), actually missing". Apparently Paclt assumed that *C. bignonioides* was a replacement for Linnaeus' *B. catalpa*, and so cited a specimen in the Clifford Herbarium, which was supposedly the basis for the first synonym cited by Linnaeus (1738, 1753) under *B. catalpa*, the polynomial in the *Hortus cliffortianus* (Linnaeus 1737:317). 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, b, c, d, 2008a, b) demonstrated that the Walter Herbarium actually is composed of John Fraser's collections. Of the identified specimens in the Walter Herbarium, 50% of the identifications are in the handwriting of Walter, and 33% in the handwriting of Fraser (Ward 2007a). The specimen of *C. bignonioides* in the Walter Herbarium bears the identification "*Catalpa bignonioides*" in Fraser's hand (Ward 2007d). Ward (2007d), after rejecting Fraser's specimen as a type because it is "a single broken leaf" and because it lacks linkage to Walter, effectively selected *John B. Nelson 18315* (GH) as the neotype for *C. bignonioides*, meeting all the requirements of Art. 7.11 of the ICBN (McNeill et al. 2006). Ward (2007d) did not cite nor mention the designation of a type for *C. bignonioides* by Reveal et al. (1990).

Catalpa bignonioides is in italics in Walter's (1788:64) *Flora Carolina*, signifying that it is different from Linnaeus' (1735, 1737, 1753) species. Walter placed *Catalpa bignonioides* in *Diandria*, *Monogynia*, probably a significant factor in his recognition of it as a new genus; Linnaeus (1737, 1753) placed *Bignonia catalpa* in *Didynamia*, *Angiospermia*. Finally, Walter used the specific epithet *bignonioides* rather than transforming Linnaeus' generic epithet *Bignonia* into a specific epithet for his species. We conclude that there is no homotypic linkage between Linnaeus' *B. catalpa* and Walter's *C. bignonioides*.

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 2007d), selection of a neotype is required. Article 9.8 of the *International Code of Botanical Nomenclature* (ICBN; McNeill et al. 2006) states, "the use of a term defined in the *Code* (Art. 9.1–9.7) as denoting a type, in a sense other than that in which it is so defined, is treated as an error to be corrected…" 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. 9.8 is a correctable error, and can be taken as a neotypification of *C. bignonioides* on *Fraser* (BM-SL 48-D).

Ward's (2007d) designation of *John B. Nelson 18315* (GH) as neotype of *C. bignonioides* could be considered an attempt to supersede the neotype of Reveal et al. (1990) under Art. 9.17, but there are no justifiable grounds for this, so the neotype of Reveal et al. (1990) cannot be superseded. The reason Ward gave for not choosing *Fraser* (BM-SL 48-D) as neotype was that it consists of a single, partial, broken leaf, an inadequate specimen for a neotype. Article 9.7 of the ICBN (McNeill et al. 2006) states, "an epitype is a specimen or illustration selected to serve as an interpretative type when the … previously designated neotype … is demonstrably ambiguous and cannot be critically identified for purposes of the precise application of the name…" Because of the very poor condition of *Fraser* (BM-SL 48-D), Ward (2007d) chose *Nelson 18315* (GH) as the neotype of *C. bignonioi-*

des. Ward's reasons for selecting *Nelson 18315* (GH) over *Fraser* (BM-SL 48-D) are also the reasons for selecting an epitype, so Art. 9.8 (McNeill et al. 2006) applies to Ward's type selection, which is actually an epitype.

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