

***Aphananthe aspera* (Cannabaceae) at The Arboretum**

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As the new Garden of Quiet Reflection nestled within the temperate Asian collection at the Los Angeles County Arboretum and Botanic Garden in Arcadia, California was being developed, co-authors Henrich and Hodel would visit it regularly to check on its progress and investigate botanical curiosities in the vicinity. In doing so, several large, impressive trees with gray, smooth bark of the genus *Celtis* caught Hodel's attention. He was immediately smitten with these trees and decided to prepare a paper on the genus at The Arboretum.

In gathering information and photographs about the collections of *Celtis* at The Arboretum for our future paper, we came across an unusual and somewhat perplexing tree that, while labeled as *C. sinensis*, its rough, scaly bark was quite different from the mostly smooth bark of all the other species of the genus at The Arboretum.

Nonetheless, we continued to consider it as *Celtis sinensis* until a year later when co-author Hodel sent photos of leaves and flowers of the various *Celtis* in The Arboretum's holdings to co-author Whittemore for identification. Whittemore, formerly a research botanist at the United States National Arboretum in Washington, D. C., headed up a project investigating the taxonomy and genetic diversity assessment of landscape trees and shrubs with a particular focus on *Ulmus*, *Celtis*, and *Quercus* before relocating to the Morton Arboretum in Illinois in 2022.

Much to our surprise, Whittemore declared that the leaves and flowers of the unusual rough-and scaly-barked tree labeled as *Celtis sinensis* was not even a *Celtis*! Rather it was in the closely related genus *Aphananthe*, distinguished by its narrow, ciliate-toothed leaves and strictly unisexual staminate and pistillate flowers on the same plant. In contrast, *Celtis* has unisexual staminate and bisexual flowers on the same plant, but no unisexual pistillate flowers. Whittemore noted that the species was *A. aspera* (Figs. 1–2).

Here we provide an illustrated account of *Aphananthe aspera*, including its history, taxonomy and nomenclature, a description, distribution and ecology, miscellaneous notes, and cultivation.



1. Co-author Elizabeth Mendoza provides scale for The Arboretum's *Aphananthe aspera* (1956-1326-S*1). Note the upright habit and rounded canopy.

History

Carl Peter Thunberg (11 November 1743, Jönköping, Sweden – 8 August 1828, Tunaberg, Sweden), a former medical student and then later a naturalist, named and described *Prunus aspera* (Thunberg 1784a) from specimens that he had collected in southern Japan during a year's stay there from 1775 to 1776. Unfortunately, he did not designate a holotype among his collections, which creates a problem for typification that we will address later.

Thunberg was an “apostle” of Carl Linnaeus, the Swedish naturalist and taxonomist who formalized the binomial system of nomenclature and is considered the “father of modern taxonomy.” Apostles of Linnaeus were students who traveled the world, conducting botanical and zoological expeditions that Linnaeus devised or approved (Blunt 2004).

A friend of Linnaeus, Johannes Burman, encouraged and helped Thunberg to land a position as surgeon with the Dutch East Indies Company, enabling him to travel to the East Indies to collect plants for the botanical garden at Leiden (Thunberg 1791). Thunberg departed Europe in December, 1771 for South Africa, Java, and Japan (Skuncke 2014). He reached South Africa in March, 1772, and stayed three years to collect plant and animal specimens. He departed South Africa in March, 1775 for Java, arriving in May, 1775, and then departed for Japan in June 1775, finally arriving on Dejima Island off the coast of Nagasaki, Japan in August 1775.

Dejima was an artificial island, connected to the Japanese mainland by a small bridge and created to house foreigners, nearly entirely Dutch, and keep them isolated from most of the Japanese populace because of the unfavorable earlier impressions of Portuguese missionaries (Totman 2000). Initially, the only outside contact Thunberg had was with Nagasaki interpreters, whom he encouraged to collect plant and animal specimens for him. As time passed and with the help of his medical and surgical skills and knowledge, Thunberg gained favor with Japanese officials and was allowed freedom to travel off Dejima, eventually making a trip to as far as present-day Tokyo. He collected plant and animal specimens extensively on these trips, as well as from gardens on Dejima (Thunberg 1796), and began to write his *Flora Japonica* (Nordenstamm 2013).

After more than a year in Japan, Thunberg departed in November, 1776, making stops in Java, Ceylon, and South Africa before arriving back in Amsterdam in October 1778 and Sweden in March 1779.

After his return to Europe, Thunberg published three accounts of *Prunus aspera*, all in 1784 and all with a Latin description. The first, published in May and June (Stafleu and Cowan 1986), was in Johan Andreas Murray's *Systema Vegetabilium* (Thunberg 1784a), a continuation of Linnaeus's *System Naturae*. The second, published in August (Stafleu and Cowan 1986), was in Thunberg's *Flora Japonica* (Thunberg 1784b).



2. When deciduous in winter, The Arboretum's *Aphananthe aspera* clearly shows its strongly upright habit and multiple trunks or leaders

The third, published after October, was in *Nova acta Regiae Societatis Scientiarum Upsaliensis* (Thunberg 1784c) and is a review of the enumeration of the plants that German naturalist, physician, explorer, botanist, and author Engelbert Kaempfer (16 September 1651, Lemgo, Germany—2 November 1716, Lieme, Lemgo, Germany) had seen in Japan during his stay there from 1690 to 1692. Kaempfer had published his findings in *Amoenitatum Exoticarum* (Kaempfer 1712), of which Part 5 was his own *Flora Japonica*, the first extensive account and description of Japanese plants for the Western World (Michel 2005). In referencing Kaempfer's account, Thunberg noted Kaempfer's use of the vernacular name *muk no ki* for the plant that Thunberg would name *Prunus aspera*. Kaempfer even provided a binomial for his *muk no ki*, *Prunus sylvestris*, and a Latin description, which ordinarily would have constituted valid publication, but because it was before 1753, the publication of Linnaeus's *Species Plantarum*, the starting point for vascular plant names, the name has no botanical standing.

The imprecision of the publication date of Thunberg (1784c) is unfortunate for the purposes of establishing priority of publication. Although some references refer to the publication date as early as 1783, based on the minutes of the Royal Academy of Sciences (Liljencrantz 1957), those for 17 March 1784 say the Society had 30 signatures (240 pages) of Volume 4 printed up so far, and one of their members, Aurivillius, stated that they better have the remainder printed by the summer (p. 95, No. 6). That quantity of pages, 240, would have easily included Thunberg's work on Kaempfer's article, which began on page 31. Thus, Thunberg (1784c) would have been printed by 17 March 1784, but those printed pages would have been sitting somewhere waiting for the rest to come off the printing press.

The minutes for 25 October 1784 indicate that they had everything printed (pp. 96–97, No. 4), but were still waiting to add a list of members, which would go after the title page, and set a price at which to sell each issue (p. 97, No.7). Thus, it seems that they had everything printed, but they had yet to release it to the public as of 25 October 1784. Because the printed pages were not available to the public in March, or even by late October, they were not yet published, and cannot contend with the May-June publishing of Thunberg (1784a) or even the August publication of Thunberg (1784b) for priority of publication.

Thus, the official, recognized publication of Thunberg's *Prunus aspera* is in *Systema Vegetabilium* because it is the earliest account, published in May and June and has priority, while his other two accounts were published in August and late October or perhaps even later.

In 1848, Jules Émile Planchon (21 March 1823, Ganges, Herault, France – 1 April 1888, Montpellier, France), a French botanist recognized for his significant contributions to plant classification, established the genus *Aphananthe*, basing it on a collection of Hugh Cuming (1311)

from Luzon, Philippines (Planchon 1848). Planchon noted that *Aphananthe* was close to *Celtis* but differed in the unisexual staminate and pistillate flowers.

Later, Planchon (1873), in his treatment of the Ulmaceae for *Prodromus Systematis Naturalis Regni Vegetabilis*, a summary of all known seed plants at the time and initiated by the late Augustin Pyramus de Candolle, transferred Thunberg's *Prunus aspera* to *Aphananthe*, making the new combination *A. aspera*.

Taxonomy

***Aphananthe aspera* (Thunb.) Planch.**, Prodr. 17: 208. 1873. \equiv *Prunus aspera* Thunb., Syst. Veg. (ed. 14) (J. A. Murray). 463. 1784. \equiv *Cerasus aspera* (Thunb.) Loisel. in H. L. Duhamel du Monceau, Traité Arbr. Shrub., nouv. ed., 5: 33. 1812. \equiv *Microcerasus aspera* (Thunb.) M. Roem., Fam. Nat. Syn. monogr. 3: 96. 1847. \equiv *Homoioceltis aspera* (Thunb.) Blume, Mus. Bot. 2: 64. 1852. Type: Japan, *Thunberg s. n.* (neotype, designated here, UPS-THUNB 11786) (**Fig. 3**).

= *Sponia nudiflora* Siebold & Zucc. in Abh. Math.-Phys. Cl. Königl. bayer. Akad. Wiss. 4(3): 223. 1846. Type: Japan, *H. Bürger s. n.*, (lectotype [designated by Akiyama et al. 2013: 351, Herbarium Zuccarinii M0120937] [**Fig. 4**]; isoelectotypes: L0327542, M0120836). MO TYPE M0120835, is from another collector].

= *Aphananthe aspera* var. *pubescens* C. J. Chen, Acta Phytotax. Sin. 17(1): 49. 1979. Type: China, Yunnan, Zhen-kang, *Yu 17366* (holotype PE) (**Fig. 5**).

– “*Prunus aspera*” Thunb., Fl. Jap. 201. 1784, later isonym.

– “*Prunus aspera*” Thunb., Nova Acta Regiae Soc. Sci. Upsal. ser.2(4): 38. 1784, later isonym.

– “*Celtis muku*” Siebold, in Verh. Batav. Genootsch. Kunst. 12: 28. 1830. \equiv *Celtis mukii* Siebold & Zucc., Abh. Math.-Phys. Cl. Königl. bayer. Akad. Wiss. 4(3): 223. 1846, nom. nud.

– “*Celtis sinensis*” Planch., Ann. Sci. Nat., Bot., ser. 3, 10: 286. 1848. Illegitimate name.

– “*Celtis sinensis*” Dunn & Tutcher, Kew Bull. Addit. Ser. 4:243:1912. Illegitimate name.



3. Neotype of *Prunus aspera* (*Aphananthe aspera*), Thunberg s. n. (UPS-THUNB 11786). © 2023 and courtesy of UPS.



4. Lectotype of *Sponia nudiflora*, a synonym of *Aphananthe aspera*, H. Bürger s. n. (M-Herbarium Zuccarinii M0120937). © 2023 and courtesy of M.



5. Holotype of *Aphananthe aspera* var. *pubescens*, Yu 17366 (PE 00022972). © 2023 and courtesy of PE.

Typification: Thunberg (1784a) never designated a holotype and, in fact, he did not associate any material with the name *Prunus aspera*; thus, due to the absence of original material, it is necessary to designate a neotype (Turland et al., 2018; see Art. 9.13). As the neotype, we select the specimen *Thunberg s. n.*, in the Thunberg collection at UPS, UPS-THUNB 11786, which has long been considered, but erroneously so, the holotype.

Three heterotypic Siebold names require an explanation as to their status. One, the synonym *Sponia nudiflora*, was validly published, and Akiyama et al. (2013) selected a lectotype for it. The other two heterotypic Siebold names are *nomen nuda*; *Celtis muku* (Siebold 1830) was published without a description, rendering it a *nomen nudum* while *C. mukii* (Siebold and Zuccarini 1846) was itself based on *C. muku*, making it a synonym of the former and also rendering it a *nomen nudum*.

The two *Celtis sinensis* names are superfluous and illegitimate because the epithet was already in use.

Vernacular names: (Chinese) 糙叶树 糙叶树(原变种) *cao ye shu (yuan bian zhong)* (*A. aspera* var. *aspera*); 柔毛糙叶树 *rou mao cao ye shu* (*A. aspera* var. *pubescens*) (Fu et al. 2023); (Japanese) *muk no ki* (Kaempfer 1712), *mukunoki* (TN 2023).

Etymology: The genus *Aphananthe* is from the Greek *aphanes*, meaning invisible, obscure, or unseen, and *anthos*, meaning flower, and likely alludes to the small, insignificant flowers. The specific epithet *aspera* means rough or prickly, and likely alludes to the rough, scabrid leaves.

Habit: Medium to large, deciduous, monoecious, strongly upright, forest trees, rarely shrubs, to 25 m tall and 20 m wide; forming a broadly rounded canopy in the open, sometimes with multiple leaders; main branches or trunks strongly upright (**Figs. 1–2**).

Trunk: To 50 cm DSH (**Fig. 6**); in the open in cultivation with a short trunk to 2 m tall above which branched into 2, strongly upright, straight, main trunks or leaders (**Fig. 7**) and forming a broadly rounded canopy; bark brown to grayish white, slightly gray- or brown-mottled, rough, longitudinally fissured, scaly, peeling in irregular rectangular strips (**Fig. 8**); short-buttressed and slightly fluted (**Fig. 6**); current- or 1st-year twigs or branchlets green to yellow-green (**Fig. 9**), 2nd-year greenish brown to reddish brown, older ones grayish brown to purplish brown with distinct, reddish brown to brown, oblong-elliptic to round lenticels (**Fig. 10**); 1st and 2nd-year twigs moderately to densely white-pubescent, hairs 1–1.5 mm long, erect to appressed, older twigs only slightly pubescent or glabrescent, sometimes with grayish-white waxy-like coating or epidermis and this flaking off in irregular patches.



6. Co-author Lauren Scott provides scale for the trunk of The Arboretum's *Aphananthe aspera*. Note the short buttresses at the base.



7. The short main trunk of The Arboretum's *Aphananthe aspera* quickly branches into two, strongly upright trunks or leaders.



8. Bark of *Aphananthe aspera* is rough, scaly, and peels or flakes off in vertical strips.



9. Current- or 1st-year twigs or branchlets of *Aphananthe aspera* are green to yellow-green and older wood is brown. Note the fine hairs on current year's growth, brown stipules, and staminate flowers.



10. Older twigs of *Aphananthe aspera* are grayish brown to purplish brown with distinct, oblong-elliptic to round lenticels.



11. Stipules of *Aphananthe aspera* are brown, densely white-pubescent along the midrib abaxially and sometimes persistent.



12. Leaves of *Aphananthe aspera* are alternate, spaced about 1.5 cm distant on opposing side of the twig and spaced 3 cm on the same side of the twig.

Leaves: Stipules appearing to be 1 but deeply split into 2 lobes, or simply 2 stipules, to 5–13 × 1.5–4 mm, linear-lanceolate, long-acuminate, brown, densely white-pubescent along midrib abaxially, sometimes persistent (**Fig. 11**); alternate, spaced about 1.5 cm distant on opposing side of twig, spaced 3 cm on same side of twig (**Fig. 12**); petiole 0.5–1.5 cm, finely pubescent; blade 5–10 × 3–5 cm, broadly ovate to narrowly ovate to ovate-elliptic, base broadly cuneate to nearly cordate, sometimes slightly asymmetrical, apex acuminate to long acuminate, green abaxially and adaxially (**Figs. 13–14**); 3-veined from base, lateral veins up to 12 per side of rachis, exiting rachis at ca. 45° angle toward apex, all veins prominently raised abaxially, barely to moderately raised adaxially, greenish white to light green abaxially and adaxially, all except most proximal one on each side branching once near margin and each branch terminating in a straight or slightly hooked bristle-like tooth, most proximal vein with 5 lateral veins toward margins and each of these terminating in a similar bristle-like tooth, abaxial and adaxial surfaces with short, white, somewhat appressed hairs, especially along rachis and lateral veins, giving them a rough or scabrid texture (**Fig. 15**).

Inflorescences: Staminate flowers in small, tight, congested, multi-branched clusters 2–5 cm wide in leaf axils of current-, one-, and perhaps two-year-old twigs, whitish (**Figs. 16–17**);



13. Adaxial leaf blade surface of *Aphananthe aspera* showing veins and bristle-toothed margins.



14. Abaxial leaf blade surface of *Aphananthe aspera* showing veins and bristle-toothed margins.



15. Abaxial leaf blade surface of *Aphananthe aspera* showing the small, short, white, appressed hairs, giving them a rough or scabrid texture.



16. Staminate inflorescences of *Aphananthe aspera* are small, congested, multi-branched clusters in leaf axils of current-, one-, and perhaps two-year-old twigs.



17. Staminate inflorescences of *Aphananthe aspera* are 2–5 cm wide and whitish.



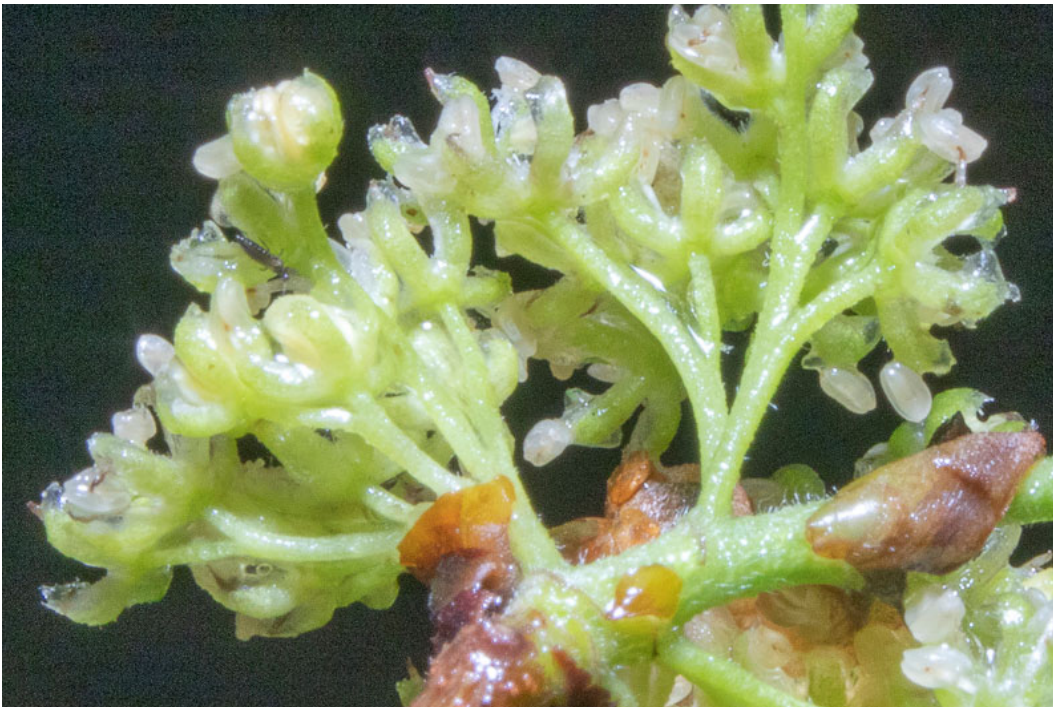
18. Pistillate inflorescences of *Aphananthe aspera* are one- or few-flowered clusters in distal leaf axils on current-year growth.

pistillate flowers solitary or in a few-flowered cluster in distal leaf axil on current-year growth (**Fig. 18**).

Flowers: Staminate nearly sessile or on stalk or pedicel up to 5 × 0.5 mm, green, with widely scattered, short, white hairs; flowers 5 × 7.5 mm (**Figs. 19–20**); tepals 4–5, 5mm long, 1.5 mm wide at base, widened distally with translucent, clear, slightly cupped, wing-like margins making the tepal 2.5 mm wide at apex and appearing like a cobra’s expanded hood, free to base, spreading-curved upwards making the flower appear claw-like, convex abaxially, concave and sparsely to densely white pubescent adaxially, green, each subtending a stamen; stamens 4–5, filaments 4 × 0.5 mm, white, nestled in the concave surface of the tepal, anthers 3 × 1.5 mm, held at tip of tepal or just beyond it, green becoming swollen and whitish like a cooked grain of rice, dorsifixed near middle, bilobed. Pistillate on stalk or pedicel 3.5–10 × 1.5–2 mm, green, with scattered, short, white, somewhat appressed hairs, sometimes subtended by a bracteole or stipule 11.5 × 0.8 mm, cylindrical, green, with an expanded, sheathing base and a few, short, white hairs; flowers 12 × 7.5 mm, obovoid (**Fig. 21**); tepals 5(–6?), 2–7.5 × 0.5–1mm, linear-lanceolate, base swollen and bulbous to 2 mm wide, exceeding ovary, green, with short, white



19. Staminate flowers of *Aphananthe aspera* have greenish tepals, each subtending a stamen.



20. Staminate flowers of *Aphananthe aspera* viewed from below show the greenish tepals and branched inflorescence.



21. Pistillate flowers of *Aphananthe aspera* are obovoid in shape and have slender green tepals and hairy, white, dominant stigmatic lobes.



22. Fruits of *Aphananthe aspera* are mostly globose, dark purple with a glaucous bloom, and fleshy. Note the fruiting perianth and stigmatic remains.

hairs especially on margins and distally, free to base, erect and appressed to ovary or sometimes apical portion recurved or flared outwards; ovary 6×3.5 mm, cylindrical, green, densely white pubescent; stigmatic lobes 2, prominent, well exposed above ovary, 6×2.5 mm, white, swollen, longitudinally lobed, divaricately spreading, densely hairy; March to May.

Fruits: Drupe, $8\text{--}12 \times 6\text{--}13$ mm, globose, ovoid-globose, or ellipsoid, green maturing dark purple with a slight glaucous bloom when soft ripe, mesocarp fleshy, fruiting perianth and stigmatic remains typically present (**Figs. 22–23**); seed $6\text{--}8 \times 4\text{--}6.5$ mm, ovoid but asymmetrical, dark brown to black with a conspicuous white ridge, otherwise without other ridges or grooves, somewhat rough (**Fig. 23**); peduncle $7\text{--}10 \times 0.8\text{--}1$ mm; September to October.

Distribution and Ecology: Hills, valleys, streamsides, slopes in moist, mixed, evergreen to deciduous, tropical to temperate forests, 100 to 1600 m elevation. China (Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangsu, Jiangxi, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Zhejiang), Vietnam, Taiwan, Korea, Japan. TN (2023) reports that the fossil



23. Fruits of *Aphananthe aspera* are green when full size then mature and become soft ripe when dark purple with a glaucous bloom. Seeds (left) are ovoid but asymmetrical and dark brown to black with a conspicuous white ridge.

record shows that *Aphananthe aspera* and *Celtis sinensis* dominated the broad-leaved forests of the Kyoto region 5,000 to 8,000 years ago.

Economic Uses: Fu et al. (2023) noted that the wood is fine and strong, bark fiber is used for making ropes and staple rayon, and leaves are used as horse feed. Because both sides of leaves of *Aphananthe aspera* are hairy and rough, leaves are collected in the autumn and used for sandpaper (TN 2023, Uphof 1959, Usher 1974). Fruits are listed as edible (Kunkel 1984, Tanaka and Nakao 1976). TN (2023) reports that they have the flavor of raisins, apricots, and dried persimmons and that they are favorites of Japanese children. The species also holds potential as a source of pharmaceutical compounds (Momtaz et al. 2022).

Threatened Status: The IUCN (2023) lists *Aphananthe aspera* as a species of Least Concern; thus, it is not threatened.

Phylogeny: *Aphananthe*, along with its close relative *Celtis*, was traditionally placed in Ulmaceae, the elm family. However, relatively recent molecular evidence has split both genera out of Ulmaceae and into Cannabaceae, the hemp family (*Cannabis* or marijuana) (Stevens 2017). Stevens (2017) also noted that strong support exists for *Aphananthe* as a member of Cannabaceae (Song et al. 2001, Song and Li 2002, Systma et al. 2002, Ueda et al. 1997, Wiegrefe et al. 1998, and Yang et al. 2013) and as sister to the remainder of the family (Li et al. 2015; Sun et al. 2016; Van Velzen et al. 2006; Yang et al. 2013, 2017).

Yang et al. (2017) resolved *Aphananthe* as monophyletic and *A. aspera* as sister to the clade of the four remaining species. They suggested that *Aphananthe* originated in the Late Cretaceous (71.5 mya) with its crown age in the early Miocene (19.1 mya). Based on the fossil record and extant species, they suspect that *Aphananthe* originated in Europe but eastern Asia is the present center of diversity.

Aphananthe contains five species of deciduous to semi-deciduous trees and shrubs, with three species from eastern and southeastern Asia and Australia, one from Mexico, and one from Madagascar (Leroy 1946, Yang et al. 2017). This distribution is unusual but not without parallel, and is likely the result of migration across the Bering land bridge and long-distance dispersal, probably by birds, out of Asia to Mexico and Madagascar (Yang et al. 2017).

Miscellaneous Notes: Our description is from Fu et al. (2023) and supplemented from our observations of The Arboretum's living plant.

Fu et al. (2023) recognized two varieties of *Aphananthe aspera* distinguished by the following key:

- Young branchlets, petioles, and abaxial leaf blades sparsely pubescent var. *aspera*
- Young branchlets and petioles with gray pubescence of elongate hairs, abaxial leaf blades
densely pubescent with erect hairs var. *pubescens*

Based on this key, and the sparsely pubescent branchlets, petioles, and abaxial leaf blades, The Arboretum's plant is *Aphananthe aspera* var. *aspera*, which is widespread throughout its range. The other variety, *A. aspera* var. *pubescens*, occurs from 300 to 600 m elevation and is restricted to China (Guangxi, Jiangxi, Yunnan, Zhejiang) and Taiwan. However, the differences between the two varieties seem minor when taken across the entire range of this species and many intermediate forms exist. The two major on-line plant databases differ in the status of this latter variety. Tropicos (2022) recognizes it as distinct while POWO (2022) considers it a synonym.

Aphananthe aspera could be confused with some species of *Celtis*, as we initially did, However, the smooth bark and unisexual staminate and bisexual flowers on the same plant readily distinguish species of the latter genus.

Thunberg had a team of illustrators, mostly his students, preparing drawings of his botanical collections. Fifty of these were published in his *Icones Plantarum Japonicarum* (Thunberg 1794–1805), 39 appeared in his *Flora Japonica* (Thunberg 1784b), and 19 appeared in other publications (Kimura and Ohba 1994). It seems that a drawing of Thunberg's *Prunus aspera* did not make it into any of these publications. However, a collection of 305 unpublished Thunberg drawings of Japanese plants, which C. J. Maximowicz, an expert on eastern Asian plants, had acquired for the Russian Imperial Academy of Sciences in 1871 (Kimura and Ohba 1994), had remained largely neglected in the library of the Komarov Botanical Institute, St. Petersburg, Russia for over a century (Noltie 1995). Kimura and Leonov (1994) published this collection of previously unpublished Thunberg drawings, which included one of *Prunus* (*Aphananthe*) *aspera* [along with the 50 previously published Thunberg drawings that had appeared in Thunberg (1794–1805)] (Noltie 1995). The rendition of *Aphananthe aspera* is strikingly similar to the type specimen, upon which it was undoubtedly based.

TN (2023) explains that the Japanese name for *Aphananthe aspera*, *mukunoki*, alludes to the tree's ecological role as a contributor to biodiversity, including serving as a source of food for local and migratory birds; however, the name sometimes is associated with the *muku* bird, the white-cheeked starling (*Sturnus cineraceus*), which feeds on the tree's edible fruits, as do many other types of birds, including the dusty and brown-haired thrushes.

Cultivation

The one tree at The Arboretum, accessioned as 1956-1326-S*1, was grown from seeds received in 1956, likely from an unknown location in Japan. Unfortunately, the data accompanying the accession does not explicitly state its origin, not even Japan, but the Japanese name “Suzuki” is handwritten on the original accession card and appears on the Institution line in the database, suggesting that said entity provided the seeds. On August 17, 1956, the seeds were stratified in sand and planted on January 30, 1957. Germination took about two weeks, and seedlings were potted up individually into 5-cm containers on February 18, 1957. On March 18, 1957, they were potted up into 3.8 l containers and two of these were planted out to the present location in what became the Garden of Quiet Reflection in the Temperate Asia collection. By May, 1966 one of the two had died, leaving the present specimen. As of November 2022, it was 23.1 m tall, had a DSH of 93.8 cm, and a north-south canopy spread of 22.3 m and an east-west canopy spread of 21.1 m, making it one of the largest, if not the largest, specimen in the United States.

The plant at the Arboretum, which is at 34°N latitude, has withstood a wide range of temperatures. Summer maximum temperatures in the low to mid 30s C (with an all-time high of 48.3 C in 2018) and winter minimums near or several degrees below 0 C are a yearly occurrence. It has tolerated episodes of strong, dry, cool, winter winds although the tree is among other trees that provide some protection. Average annual rainfall is about 400 mm, nearly all occurring from November through March, which means that the tree must be irrigated during rainless times of the year (one to two times per month late spring through fall), an increasingly precarious proposition in ever-drying, -warming, and -water-short California.

The Arboretum’s specimen is mostly pest- and disease-free and is structurally sound, with little or no structural issues or branch failures, even during intensely windy periods. However, it has tended to develop multiple, upright branches or leaders on a short trunk, which were never corrected, and has resulted in a less-than-desirable overall form; one, strong central leader with high-up lateral branches is more advantageous and desirable. Considering its natural habitat of moist tropical, subtropical, and temperate forests, *Aphananthe aspera* is likely poorly adapted to a Mediterranean climate (moist cool winters and warm to hot, rainless summers), especially one like in California now where, because of global warming, aridity and temperatures are increasing and rain and available water, especially for landscape irrigation, are decreasing.

Aphananthe aspera is rare in the United States. The Arboretum has one of the few in a public garden in California or in the United States. In California, Ryan Guillou of the San Francisco Botanical Garden in Golden Gate Park reports (pers. comm.) that they have two specimens of *A. aspera* that they grew from wild-collected seeds gathered in Wuhsheh, Taiwan at 1,025 m elevation, which the Taiwan Forestry Institute provided in 1998. Guillou notes that both

specimens have grown well; one is about 12 m tall and the other is 15 m tall. Both are moderately vigorous growers with no pest issues, but they do have fairly poor branching habit, and sizeable branches cracked in windy weather twice in a recent five-year period.

Michael Wenzel of the Sonoma Botanical Garden in Glen Ellen in northern California reports (pers. comm.) that they have four *Aphananthe aspera*, all from the same accession, 2004.076, from the Chiba University Index Seminum, indicating that the seed came from cultivated material. They were all planted in the winter of 2005. They range in size; the largest one is about 11 m tall and has a canopy spread of 4.5 m and a trunk DSH of 11.4 cm. The smallest is about 4.5 m tall and has a canopy spread of 1.8 m and a trunk DSH of 5 cm.

Elsewhere in the United States, Mark Weathington, Director of the JC Raulston Arboretum at North Carolina State University in Raleigh, reports (pers. comm.) that they have a specimen of *Aphananthe aspera* (xxo466) that they obtained from the United States National Arboretum in Washington, D. C. sometime prior to 1986. By June, 1991 it was 6.5 m tall and by May, 2000 had attained 9 m in height. By April, 2022, it was 21 m tall, had a DSH of 63.5 cm, and a canopy spread of nearly 13 m, making it one of the larger specimens in the United States.

Emily K. Johnson of the United States National Arboretum in Washington, D. C. reports (pers. comm.) that they have three specimens of *Aphananthe aspera* (**Table 1**), all grown from seeds wild collected in 1989 on Ullung Island, a mild-climate site in South Korea.

Table 1. *Aphananthe aspera* at the National Arboretum, Washington, D. C., January, 2023.

Accession No.	Date Planted	DSH (multi-stemmed, cm)	Canopy Spread (m)	Height (m)
NA 61790-H	19 October 1989	26.4, 22.1, 33.0	9.4	15.5
NA 61790-J	19 October 1989	27.9, 23.6, 21.1, 22.6, 14.7	8.5	13.0
NA 61790-L	19 October 1989	22.4, 53.6, 14.2, 23.6	7.6	15.0

Rehder (1940), who referred to it as a “handsome tree with a dense round head,” noted that *Aphananthe aspera* was first introduced to North America around 1880, making it possible that the United States Department of Agriculture brought it from Japan or China and cultivated it in Washington D. C. However, it is not included on the Sudworth and Fernow (1891) list of Trees of Washington, D. C.

Rehder (1940) also listed the hardiness limit of *Aphananthe aspera* as Zone VIII; if correct, it is not expected to survive at gardens north of Washington, D. C. The trees at the United States National Arboretum look good, but they are in a sheltered location.

USF (2023) has a specimen of *Aphananthe aspera* (161568) in its herbarium. It was collected 21 September 1979 in Athens, Georgia and at the time was about nine m tall with a DSH of 61 cm. The collector was *Berry s. n.* and the tree was purportedly planted about 1893.

Aphananthe aspera has been cultivated in British Columbia, Canada. Erica's Notebook (EN 2023) noted that a specimen was in the Fern Dell at VanDusen Botanical Garden, Vancouver. It came from the University of British Columbia Botanical Garden in 1987, originally grown from seeds collected in Hyang Dong Village, South Korea in 1985. However, Daniel Mosquin of the University of British Columbia Botanical Garden reports (pers. comm.) that they had received seeds of *A. aspera* but lost the resulting seedlings.

Outside of North America, *Aphananthe aspera* was introduced to the Royal Botanic Gardens, Kew, England, in 1895 and was about nine m tall in 1988 (Bean 2023). TSO (2023) noted that one young tree at Kew (*KFBX 175*), planted in 1989 appeared to be about 7 m tall in 2022 while another at the Oxford Botanic Garden and Arboretum was about 10 m tall in June, 2014.

In general, *Aphananthe aspera* does well in any type of potting and landscape soil as long as it is well drained (PFAF 2023). Young plants are frost tender but recover quickly while old plants are not frost tender (Bean 2023). Tenderness to frost is likely dependent on provenance of seed-bearing plants; more cold tolerance is inferred from high elevations and latitude. Plants are easily propagated by seeds, which germinate best if stratified for two to three months (PFAF 2023) and if pulp is removed from the seeds prior to sowing (Huxley and Griffiths 1992).

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