Tree of the Year:
Corylus fargesii (Franch.) C. K. Schneid.

Although described in the late nineteenth century this attractive small tree species does not seem to have been introduced into cultivation for another 100 years. KOEN CAMELBEKE[1] and ANTHONY S. AIELLO[2] have identified many plants now in botanical collections.

Introduction

Every now and then a plant can unexpectedly become the subject of a hype. Visiting gardens, collections or nurseries one encounters fellow plant enthusiasts and the typical questions pop up: do you know where I can get or buy…? Can you provide me with some propagation material of…? Look what I am growing. Have you seen my…? Although *Corylus fargesii* is more or less well established in several American arboreta, it remains very rare in collections on the other side of the Atlantic Ocean. However, this will undoubtedly soon change and we hope this article can be instrumental in the spreading of this marvellous species.

Systematic position

(after Stevens 2001, Mabberley 2008 and Li & Skvortsov, 1999)

Corylus belongs to the core eudicot order Fagales. Fagales are the largest clade of extant seed-plants in which ectomycorrhizal associations are pervasive. Other (possible) shared derived character states within this order include the presence of a perianth which is uniseriate, the absence of a nectary, the staminate inflorescence being a catkin, oblate pollen (i.e. shorter than wide), unitegmic ovules which are poorly developed at pollination, delayed fertilization and vascularized testa (= outer part of the seed coat). Fagales are the core of the old 'Englerian' Amentiferae (= those that bear aments or catkins) which have since been comprehensively demolished and consists now of seven families: Nothofagaceae, Fagaceae, Myricaceae, Juglandaceae, Ticodendraceae, Betulaceae and Casuarinaceae.

Members of the Betulaceae are usually deciduous trees or shrubs that may be recognised by their simple, stipulate, usually doubly serrate leaves which are spirally arranged, catkinate inflorescences (both staminate and often also carpellate), flowers arranged in dichasia subtended by bracts and fruits that are either small and flattened (<3 mm long) or associated with large, leafy, bract-like structures. Betulaceae contains two monophyletic subfamilies (sometimes recognized as families, Betulaceae and Corylaceae (syn. Carpinaceae)): Betuloideae with two genera *Alnus* and *Betula*, and Coryloideae

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Corylus fargesii from *New Trees, Recent Introductions to Cultivation* by John Grimshaw and Ross Baynton, 2009, Kew Publishing.

with four genera *Carpinus*, *Corylus*, *Ostrya* and *Ostryopsis*. Important characters separating the two subfamilies are the presence of spirally thickened vessel-elements in Coryloideae, not spirally thickened in Betuloideae (see also Chen et al. 1999). Moreover, Coryloideae are recognized by less than 3 flowers per cymule, staminate flowers without perianth and with hairy anthers, carpellate inflorescences with 1–5 erect flowers and perianth present, fruit with accrescent leafy bracteoles (involucre) from one or two orders of branching,

photograph © Koen Camelbeke

Carpellate inflorescence of *Corylus fargesii* clearly showing the red styles of the pistils mostly covered by imbricate bracts. Arboretum Wespelaar #11107, 16 February 2017.

nuts large and not or scarcely flattened.

Corylus is a genus of 16(-18)[3] species of deciduous, monoecious, anemophilous (wind pollinated) trees or shrubs native to the temperate Northern Hemisphere. Leaves alternate, petiolate, margin doubly serrate or lobulate. Staminate inflorescence pendulous, subsessile, cylindric, spicate-cymose, naked during winter, with numerous overlapping bracts; bracts each usually subtending 2 bracteoles and 1 male flower; stamens 4, inserted at middle part of bracts; anthers with 2 separate thecae and deeply split (therefore often wrongly interpreted as flowers having eight stamens), often pubescent at apex. Carpellate inflorescence a compact cluster of several flowers, small bud-like; flowers paired, enclosed by a bract; perianth adnate to ovary, 4-8-lobed at apex; ovary with 1 or rarely 2 ovules in each cell; style 2-cleft to base, red and clearly visible in flowering period. Fruit a subglobose or ovoid nut, enclosed or surrounded by enlarged bracts (involucre) with edible seeds in nuts (excellent illustration of inflorescences, flowers and fruit in Graf, J. 1975). Pollination to fertilization may take up to four months. In *Corylus avellana* in particular, there may be three to five months between pollination and fertilization. Ovules start to develop about halfway through this period and the developing nuts are already 7–10mm across at the time of fertilization. If

[3] The species now recognized are *C. americana*, *avellana*, *chinensis*, *colchica*, *colurna*, *cornuta*, *fargesii*, *ferox*, *heterophylla*, *jacquemontii*, *maxima*, *potaninii*, *sieboldiana*, *wangii*, *wulingensis* and *yunnanensis*.

pollination does not occur, the stigma may remain receptive for up to three months.

Most of the 300,000 species of flowering plants keep inbreeding to a minimum by genetic self-incompatibility or morphological outcrossing mechanisms such as dioecy or heterostyly. A special phenomenon however was discovered in walnuts and hazelnuts but has gone almost unnoticed for many years: heterodichogamy. Heterodichogamy differs from normal dichogamy, the temporal separation of male and female functions in flowers, in that it involves two genetic morphs that occur at a 1:1 ratio in natural populations. Flowers of both morphs open simultaneously, but one morph is protogynous (female stage precedes male stage), the other protandrous (male stage precedes female stage). This is exactly the type that was discovered in *Corylus avellana* and other species. In natural populations of *Corylus* one encounters self-incompatible monoecious trees or shrubs which are wind pollinated and with a morph ratio of 1:1 (protandrous versus protogynous). This temporal separation usually takes several days (Renner 2001).

photograph © Koen Camelbeke

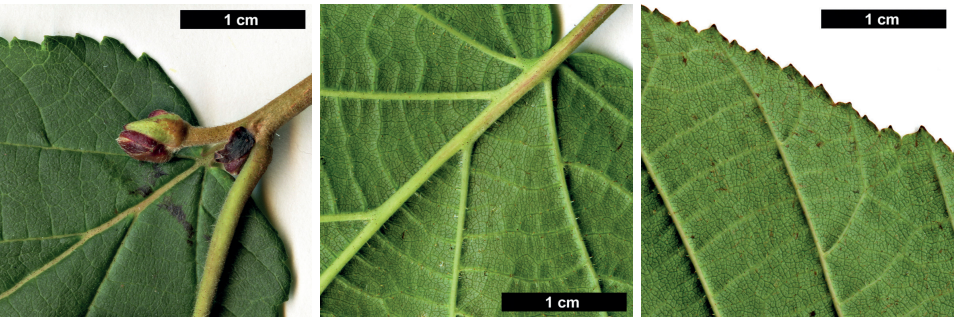
Even at a very young age branches of *Corylus fargesii* show the typical, attractive exfoliation in thin flakes. Arboretum Wespelaar #1159, 9 December 2015.

Description of *Corylus fargesii* (after Li & Skvortsov, 1999, Grimshaw & Bayton, 2009 and Aiello, 2016)
Corylus fargesii (Franch.) C. K. Schneid., Ill. Handb. Laubholzk. 2: 896. (1912)
Synonyms (Frodin & Govaerts, 1998):

Corylus rostrata var. *fargesii* Franch., J. Bot. (Morot) 13: 199 (1899)
Corylus mandshurica var. *fargesii* (Franch.) Burkill, J. Linn. Soc., Bot. 26: 505 (1899)

Tree to 25(-40?) m tall; bark yellowish brown, fissured, exfoliating in thin flakes. Branchlets grey, slender, pubescent with occasional glandular hairs. Leaf deciduous with petiole 1–1.5 cm long, densely pubescent; leaf

High definition scan of branch and leaves of *Corylus fargesii* by Jan De Langhe. Arboretum Wespelaar #11095, 15 September 2011.



Above, a series of high definition scans produced by Jan De Langhe of *Corylus fargesii* showing coarsely serrate leaf margin, terminal bud, pubescence on branchlet and stipule (left), leaf underside showing pubescence on main veins (middle), and part of leaf of *Corylus fargesii* showing serrate leaf margin (right). Arboretum Wespelaar #11095, 15 September 2011.

blade oblong-lanceolate, obovate-oblong, or lanceolate, 6–9 × 3–5 cm, both surfaces sparsely pubescent especially along midrib and lateral veins, base obliquely cordate or subrounded, margin coarsely and irregularly double-serrate, apex acuminate; lateral veins 6–10 on each side of the midrib. Staminate catkins in clusters of 2–8, cylindric, 2–6 cm long; bracts ovate-triangular, apex acute with a stipitate gland. Carpellate flowers in clusters of 2–4; bracts forming a tubular sheath, 2–5 cm long, densely yellow-tomentose, sparsely stipitate glandular when young, with faint veins, apex divided into triangular-lanceolate lobes usually not forked at apex. Nut enclosed by bracts, ovoid-globose, 1–1.5 cm in diameter, with greyish white pubescence on the apex.

photograph © Laura Wester

Cylindric staminate catkins are grouped in clusters of 2-8. Arboretum Wespelaar #11107, 6 February 2017.

Distribution and habitat
China: southern Gansu, Guizhou, Henan, Hubei, Jiangxi, southern Ningxia, Shaanxi, Sichuan, Chongqing. Forests in mountain valleys between 800–3,000 m asl.

Flowering time May to July (*sic*), fruiting July to September (but of

course very dependent on altitude; flowering time definitely much earlier (February to March) in Belgium).

USDA Hardiness Zone 5a (or possibly lower) to 7b.

Conservation Status Assessed as Least Concern on the Chinese Red List (Shaw et al., 2014: 52).

Common name Farges' Filbert or Paperbark Filbert. However, the English name Filbert usually refers to one single species, *Corylus maxima* and it is therefore better to use Farges' hazel or paperbark hazel for this species (Chris Lane & Chris Sanders, pers. comm.). In Chinese (Pinyin) two orthographic variants are encountered: Pi zin ye zin and Pi zhen ye zhen.

This tree's highly ornamental exfoliating bark and rapid growth rate indicate great potential as an ornamental tree for a range of situations, and it promises to be an excellent addition to landscapes in the future (Aiello 2010).

Introduction of *Corylus fargesii* to cultivation

Corylus fargesii was first described in China by Western botanists in the late 1800s and early 1900s (Wilson, 1916). Although herbarium specimens were collected during this golden age of plant exploration, there is no evidence that living specimens from these early collections were grown in arboreta or botanic gardens (Aiello & Dillard, 2007).

As far as we can tell, the first plants in cultivation in the U.S. were those of Mr Cecil W. Farris (Lansing, MI) who received seed in 1981 through a contact in Canberra, Australia. Mr Farris described these as paper barked hazel (*sic*), and his seed originated with the Chinese Academy of Forestry. The parent tree was located in a mountainous area near Tianshui, Gansu Province, growing at 1,500 m, 34°40'N, 105°40'E. (Farris reported this in a paper presented in 1995 to the Northern Nut Growers Association annual meeting in Rivers Falls, Wisconsin, USA; this correspondence was provided by Dr Shawn Mehlenbacher (Corvallis, Oregon, USA)). One of Farris's trees is represented in the US Department of Agriculture's (USDA) germplasm repository in Corvallis as PI # 665922.

A subsequent introduction of the species dates to 1992 when William McNamara of Quarryhill Botanical Garden collected seed of a tree in Sichuan under the number #M0034. The seed was collected on 2 October, 1992 at 2,690 m from a deciduous tree frequent in partial shade on a very steep north facing mountainside of regenerating secondary trees and shrubs on the road between New Muli and Old Muli on the south side of Kangwuliangzhi Shan, Muli county, Sichuan, China. The plant was not identified until several years after the collection, by McNamarra. Two trees from this original introduction

Corylus fargesii (MOAR #1996-574*A) at the Morris Arboretum with excellent bark patterning, revealing patches of copper and russet. 21 October 2014.

are still growing at Quarryhill Botanical Garden and seem to differ in habit from more recent introductions; fairly smooth-barked, more shrubby and multi-stemmed (Howard Higson, pers. comm.). Keith Rushforth recently confirmed that they are not *Corylus fargesii*, but probably *C. yunnanensis*; email dated 2 May 2017.

Since then three important introductions of *Corylus fargesii* took place, one

each in 1996, 2005, and in 2015, all through the North America-China Plant Exploration Consortium (NACPEC).

Corylus fargesii was collected on the 1996 NACPEC expedition to Shaanxi & Gansu Province (QLG-231) and the collectors described it as a truly beautiful tree with exquisite copper and tan exfoliating bark. The original collectors' data read as follows: 'China. Gansu Province. Tian Shui City District, Xiao Long Shan Forest Bureau, Dang Chuan Forest Station, Mai Chao Gou. Alt. 1,650 m. Coordinates 34°18'14.5"N, 106°12'26.8"E. < 3 degree slope; north-facing; growing among rocks in sandy-silt loam soils deposited by stream. This species was growing two meters above the stream in an open woodland setting along the path in the zone where periodic flooding takes place; in association with *Lonicera* sp., *Juglans* sp., *Salix* sp., *Carpinus* sp., *Quercus* sp. and several herbaceous species. Seed collected from more than five single-stemmed, deciduous trees with pyramidal spreading habit; 12 to 15 m tall; 15 to 25 cm DBH; papery copper exfoliating bark—exquisite! Beautiful tree that grows here in large numbers; the bark on young trees looks a lot like immature *Betula nigra* bark. Collected on 4 Oct 1996.' Trees from this introduction are doing particularly well at the Morris Arboretum, where they have reached 8 to 9 metres after 19 years, with strong central leaders and very uniform broadly ovate habits. They have excellent bark patterning, exfoliating to reveal patches of copper and russet, and for this alone are most ornamental, rivalling 'the most attractive birches' (Aiello, 2006).

photograph © Michael Dosmann

Opposite, a mature specimen of *Corylus fargesii* (NACPEC15-038) in Shaanxi Province.

Right, detail showing its trunk and characteristic 'exfoliating' bark.

In September 2005 a new NACPEC expedition was organized to southern Gansu (western limits of the Qinling Mountain range). Participants in this trip were Anthony Aiello of the Morris Arboretum, Kris Bachtell of the Morton Arboretum, Martin Scanlon of the US National Arboretum, Wang Kang of Beijing Botanical Garden and Sun Xue Gang from the Forestry College of Gansu Agricultural University. Near Chagang (Zhou Qu county, near the Sha Tan Forest Station in the Min Shan mountain range), on a hike through pastures and woodland with numerous cattle, the team came across *Corylus fargesii*. The parent plants of which seed was collected (NACPEC05-047) were growing in mesic mixed deciduous forest and were likewise located a few meters above a stream. Many *C. fargesii* were seen throughout the area

photograph © Anthony S. Aiello

A young tree of *Corylus fargesii* (MOAR #1996-574*D) showing the very regular broadly ovate habit.

and all of the plants had been coppiced but had re-sprouted vigorously. The collectors were once again impressed with the highly attractive exfoliating bark of these plants.

Another seed collection in China was made in September 2008 by Henning Petterson, Henrik Sjöman, and Henrik Zetterlund of the Gothenburg Botanical Garden (HeHeHe 265) in the Qin Ling Mountains, Shaanxi, south of Xi'an near the town of Houditang. Plants from this collection are currently growing at

photograph © Laura Wester

The clean summer foliage of *Corylus fargesii*. Arboretum Wespelaar #11157, 16 June 2016.

the Gothenburg Botanical Garden. (Aiello, 2016).

The most recent collection was made in September 2015 by the NACPEC Expedition to China while in southern Shaanxi Province at Baixian Forest Station. While searching for a venerable *Acer griseum* specimen, the team came across an immense tree (1.25 m DBH), again growing along a streambank. The bark on the main trunk of this old tree was peeling in long brown strips, and exhibited the copper-coloured exfoliation on younger stems. (Aiello, 2016). In November 2015 Arboretum Wespelaar received five seeds of this collection (NACPEC15-038) and three of those germinated and are after one year about 25 cm tall.

Corylus fargesii in cultivation

The Hillier *Manual of Trees & Shrubs* (2014) summarizes the current situation correctly as follows: '*Corylus fargesii* appears to thrive in the continental climate of northeast U.S.A. but is as yet unproven in the British Isles.' This woody gem however really deserves to be planted more frequently as it combines some of the most desirable character states: it is a fast growing tree with strong central leader and very regular broadly ovate habit, there is an attractive variation in level of exfoliation and colour of the bark (deep copper to pale cream), it has clean summer foliage with no insect or disease problems and the autumn colour is a good yellow.

Botanic Gardens Conservation International PlantSearch database gives users the possibility to search simultaneously the collection records of 1,144 contributing institutions[4]. Our search of 19 October 2016 yielded 29 collections

[4] https://www.bgci.org/plant_search.php

holding this taxon and these institutions were all contacted on the same day. Fifteen collection holders kindly replied to our request for information:

The Sir Harold Hillier Gardens in Hampshire, U.K.; The Arnold Arboretum, Massachusetts, U.S.A.; Longwood Gardens, Pennsylvania, U.S.A.; Chicago Botanic Garden, Illinois, U.S.A.; Morris Arboretum of the University of Pennsylvania, U.S.A.; Quarryhill Botanical Garden, California, U.S.A.; Germplasm Resources Information Network (GRIN) of the USDA.; Agricultural Research Service, U.S.A.; The Dawes Arboretum, Ohio, U.S.A.; Les Jardins Suspendus, Le Havre, France; Yew Dell Botanical Gardens, Kentucky, U.S.A.; Atlanta Botanical Garden, Georgia, U.S.A.; Keith Arboretum, North Carolina, U.S.A.; Green Spring Gardens, Virginia, U.S.A.; The Polly Hill Arboretum, Massachusetts, U.S.A.; Arboretum Wespelaar, Belgium.

The plant growing at The Sir Harold Hillier Gardens was received as seed from Catchflower in Beijing in 2003 and could thus be a separate introduction of the species but confirmation of identification is needed. The tree is now about 3 meters tall (Barry Clarke, pers. comm.). Keith Rushforth (pers. comm.) suspects this introduction will prove to be *C. chinensis* because of the strongly glandular hairy shoots.

Longwood Gardens holds one accession #1999-0001. The garden received three seedlings from the Morris Arboretum in 1998 of which two survived. The remaining trees appear to be completely hardy and have not suffered any dieback or other cold damage. They are planted on a gentle west facing slope on unimproved, but naturally fertile clay-loam soil. The trees are sited near a gravel nursery pad where there is irrigation runoff and the soil stays quite moist. This does not seem to have hindered their growth. On 20 July, 2007, they were 4.6 m in height and 3.6 m in width. Now they are almost 8 m high and 5.5 m wide. The trees have flowered but not produce fruit so far. In 2016 the fall colour was an unappreciable pale yellow-green. The habit of both trees is upright pyramidal. The bark is similar on both trees, but 1999-0001*A tends to produce large white patches of smooth bark. There have not been any significant disease or insect problems and they have not been damaged by animals, however, they grow in an area that white-tailed deer cannot access. All attempts to propagate these from stem cuttings have been unsuccessful (Peter Zale, pers. comm.).

The accession at Chicago Botanic Garden was received as seed in 2015 and is currently still in the Production Nursery (Boyce Tankersley, pers. comm.).

The Morris Arboretum in Philadelphia undoubtedly has the most comprehensive collection of *Corylus fargesii* with plants from both the 1996 and 2005 expeditions and seedlings from the 2015 expedition. They have had excellent success with these trees and for several years have been collecting seed

from the 1996 trees for distribution as seed or as plant (36 different recipients in the 1999–2012 period). Some stem canker issues on the older trees have been reported possibly as a result of pruning lower stems during the dormant season. Obviously, most of the hands-on data and observations in this article are based on the plants growing at the Morris Arboretum.

The Dawes Arboretum grows three specimens of two accessions (2006 and 2012) from the above mentioned 1996 expedition. The bark is already becoming attractive on the young specimens and they seem fully hardy (-31 °C a couple of years ago!). Deer can be a major concern; their browsing is minor but buck rubbing can be ravaging (Gregory Payton, pers. comm.).

photograph © Brenda Skarphol

Bark of *Corylus fargesii* at Green Spring Gardens (#1997143). 3 March 2017.

According to Michael Dosmann (pers. comm.), ever since the wonderful introduction of this species to North America in 1996, The Arnold Arboretum has been celebrating it. They currently grow over a dozen plants representing all three wild-collected NACPEC lineages, as well as open-pollinated seedlings that arose from the Morris Arboretum's trees. The four trees from the initial collection (QLG-231) have grown incredibly well in their climate, even after the February 2016 low of -26 °C. A trio (112-98*A, B, and C) are grow in an opening is surrounded by the high shade of the *Carya* collection. Two are single-stemmed, the largest with a DBH of 25 cm and a height of just over 12 m. The third is 15 m in height and has three primary leaders, the largest with a DBH of 21.5 cm. Each of these three trees has a graceful, open form, which easily allows the eyes to enjoy the exquisite ornamental bark for which the species is known. A fourth accessioned tree (3-98*A) grows in full sun near Rehder Pond and is similar in height (13.7 m) as the others. However, this individual has a much denser canopy that mostly obscures the beautiful bark during the summer months, likely due to the full-sun conditions.

The accession at Le Havre in France is in fact seed collected from a tree at the Domaine de Segrez just south of Paris (Albéric Levain, pers. comm.). This tree although labelled *C. fargesii* is in fact *C. chinensis* and it appears that an introduction of *C. chinensis* has been erroneously spread as *C. fargesii* in some

The two trees of *Corylus fargesii* at Longwood Gardens (#1999-0001*A and *B).

Branch and leaves of *Corylus fargesii* at Longwood Gardens (#1999-0001*A and *B). The bark is similar on both trees, but 1999-0001*A tends to produce large white patches of smooth bark.

collections in France and Belgium (and around?). The two species are easily distinguished: the leaves of *C. chinensis* are bigger, the shoot and petiole have obvious glandular hairs, the bark is fissured not exfoliating, the involucre is prominently ribbed, and the habit is more tree-like than that of *C. fargesii*. The tree labelled *C. fargesii* at Tregrehan, Cornwall, U.K. also comes from Segrez

seed and is therefore *C. chinensis* or a *C. chinensis* hybrid (Keith Rushforth, pers. comm.).

Yew Dell Botanical Gardens in Kentucky is growing one specimen of *C. fargesii* that they originally received from Mark Krautmann of Heritage Seedlings in Salem, Oregon. Yew Dell is in USDA zone 6a and their young plant already had to cope with temperatures down to -20 °C (Paul Cappiello, pers. comm.).

The specimen at Atlanta Botanical Garden came as a seedling from the Morris Arboretum. Surprisingly, they report that it has begun to sucker a bit at the base (Tiffany Jones, pers. comm.). This is not typical for *C. fargesii* on its own roots.

Arboretum Wespelaar is growing 11 specimens of *C. fargesii* which were all planted in 2011 and although young, they are doing particularly well and are already demonstrating excellent bark pattern and peeling. A twelfth specimen died in 2016 after being badly damaged by a male roe deer in the spring of 2014. Protection of young plants is advisable or even required. All plants were grafted by Carlos Verhelst from Jabbeke, Belgium and can be traced back to the 1996 introduction. Some material came directly from the Morris Arboretum while other scions were given to us by Maurice Foster from Kent, U.K. who got the material from Kim Kunso (then at the Morton Arboretum, U.S.A.) who in turn got it from the Morris Arboretum. In November 2015 Arboretum Wespelaar received five seeds of the 2015 NACPEC collection and three of those germinated and are now about 25 cm tall one-year old seedlings. Arboretum Wespelaar is further distributing this species in Belgium and Europe.

In addition to the aforementioned tree at the USDA Repository in Corvallis, Oregon, there are seven other trees, all originating from the 1996 (QLG-231) collection. On these, nut production has been very limited, even with other trees of the same species nearby. Only one tree of the eight at the Repository has more than a few nuts. These trees also exhibit some graft incompatibility on their *Corylus colurna* rootstock. There was some success in crossing *C. colurna* with *C. fargesii*, but no crosses of *C. fargesii* with *C. chinensis* were successful (all information, Shawn Mehlenbacher, pers. comm.).

There are also specimens reported growing at The Holden Arboretum, Ohio, U.S.A., the US National Arboretum, Washington D.C., U.S.A., the Morton Arboretum, Illinois, U.S.A., the Willowwood Arboretum, New Jersey, U.S.A. (Aiello & Dillard, 2007) and the Von Gimborn Arboretum in Doorn, The Netherlands (de Jong, 2016), and in the private arboretum of Keith Rushforth in Devon, U.K. The on-line multisite search page[5] of 24 gardens using BG-BASE as their collection database software revealed also following collections growing *Corylus fargesii*: The New York Botanical Garden, New York, U.S.A., The Botanic Garden of Smith College, Massachusetts, U.S.A. and Bartlett Tree

[5] http://rbg-web2.rbge.org.uk/multisite/multisite3.php

photographs © Laura Wester and Koen Camelbeke

Above, left, Peeling bark (white and reddish brown) on young specimen of *Corylus fargesii* at Arboretum Wespelaar (#11107), 16 January 2017. **Right**, peeling bark (green and beige brown) on young specimen of *Corylus fargesii* at Arboretum Wespelaar (#11095), 1 September 2015.

Experts, U.S.A. Tiffany Jones from Atlanta Botanical Garden reports that the species is also being grown in Georgia, U.S.A. by Dr Michael Dirr who reports good success.

The above lists illustrate and confirm that *Corylus fargesii* has become well spread in northeastern U.S.A. but otherwise remains very absent. The distribution also shows that this strong growing tree appears to be able to cope with high summer temperatures and humidity as well as cold winters.

According to the online RHS Plant Finder (consulted 24 January 2017)[6] *Corylus fargesii* is available in the U.K. through one single nursery, Pan-Global Plants in Gloucestershire. It is obviously more readily available in the U.S.A.

Propagation of *Corylus fargesii*

Propagation of *Corylus fargesii* from seed is easy and normally highly successful (60% or higher germination rate). Three months of cold stratification in moist perlite and peat is recommended (Aiello & Dillard, 2007). There is no information on whether the species hybridises easily in collections. *Corylus fargesii* being a wind pollinator, caution is needed with seed collected in gardens or arboreta where several species are growing together.

Cutting propagation of *Corylus* species is generally found to be very

[6] https://www.rhs.org.uk/plants/search-form

difficult with poor root initiation or abscission of the vegetative buds on well-rooted cuttings (Proebsting & Reihs, 1991). Despite many attempts at rooting stem cuttings of *C. fargesii* both at the Morris Arboretum and at Arboretum Wespelaar, we have had no success with this method of propagation. In contrast, Tim Brotzman (Madison, Ohio, U.S.A., pers. comm.) reports success with rooting cuttings. He takes softwood cuttings in late June as they harden, uses IBA and NAA in solution, slightly wounds the cuttings, and roots them under mist.

In comparison to vegetative cutting propagation, winter grafting provides the best opportunity for vegetative propagation of *C. fargesii*. Two possible rootstocks can be used. Grafting on *Corylus avellana* is generally very successful and some report even more successful than grafting on *C. colurna* with a success rate of 70–80% (Carlos Verhelst, pers. comm.). Growth of young plants is also much stronger but there is always the real danger of suckering of the *C. avellana* rootstock, even after many years. A possible solution is to plant deeper than usual but no real scientific proof of the success of this method has been found. Once suckering starts, the process cannot really be stopped. Grafting on *C. colurna* rootstock is often less successful (around 55% but some plant breeders mention a success rate of up to 90%). Moreover, initial growth is reported to be slower (Carlos Verhelst, pers. comm.). However, this seems to be the best option in the long run.

Vegetative key to *Corylus* species cultivated in western Europe[7]
(by Jan De Langhe[8])

01 a Shoot and petiole densely tomentose AND simultaneously with many spreading glandular hairs (use 10× lens) [involucre +/- as long as nut]. . . . . ***C. yunnanensis***
b Shoot and petiole different. 02

02 a Lamina margin usually +/- irregularly dentate, rarely with 1 shallow lobe/side usually in basal half. 03
b Lamina margin at least in part of the leaves shallowly lobed, with several shallow lobes/side especially in upper half. 05

03 a Lamina apex clearly caudate [involucre densely spiny, often several together and resembling a *Castanea* bur]. . . . . ***C. ferox***
– Involucre densely spiny.
– Lamina ovate oblong to obovate oblong, L/W ratio +/- 2/1. . . . . ***C. ferox* var. *ferox***
– Lamina elliptic to obovate, L/W ratio <2/1. . . . . ***C. ferox* var. *tibetica***
– Involucre +/- linearly divided and partly spiny, *C. avellana* hybrid. . . . . ***C. ×spinescens***
b Lamina apex acute to acuminate or slightly caudate [involucre spineless, enclosing nut—except hybrids]. 04

04 a Lamina >10 × 6 cm. Shoot and petiole clearly glandular pubescent (use 10× lens). Bark fissured [involucre prominently ribbed]. . . . . ***C. chinensis***

[7] Accompanying high-resolution scans can be consulted at http://www.arboretumwespelaar.be/EN/Identification_keys_and_illustrations/List_of_illustrated_taxa/
[8] Dendrologist at Ghent University Botanical Garden, Belgium

– Involucre not or partly enclosing nut, *C. avellana* hybrid. . . . . ***C. ×vilmorinii***
b Lamina predominantly ≤10 × 6 cm. Shoot and petiole eglandular pubescent or almost so (use 10× lens). Bark exfoliating to fissured [involucre slightly ribbed]. . . . . ***C. fargesii***

05 a Shoot clearly more tomentose than glandular pubescent (use 10× lens). 06
b Shoot +/- glabrous, OR clearly more glandular pubescent than tomentose . . (use 10× lens). 07

06 a Shoot with large raised lenticels (use 10× lens). Shrub or small tree, bark fissured to shaggy [involucre tubular, enclosing nut and narrowing at apex]. . . . . ***C. sieboldiana***
– Secondary veins except those ending in acumen 6-10/side. Lamina ovate to ovate-oblong, L/W ratio usually +/- 2/1. . . . . ***C. sieboldiana* var. *sieboldiana***
– Secondary veins except those ending in acumen ≤7/side. Lamina broadly ovate, L/W ratio often <2/1. . . . . ***C. sieboldiana* var. *mandshurica***
b Shoot with inconspicuous lenticels (use 10× lens). Shrub or small tree, bark smooth [involucre tubular, enclosing nut and widening at apex]. . . . . ***C. cornuta***

07 a Lamina apex often appearing truncate and simultaneously with a prominent acumen. Midvein length often almost as long as largest lamina width [involucre with +/- erect and +/- entire lobes]. . . . . ***C. heterophylla***
b Lamina apex gradually or abruptly narrowing, rarely appearing truncate. Midvein length usually clearly >largest lamina width [involucre tubular or with dentate lobes]. 08

08 a Lamina base variable from roundish to cordate. 09
b Lamina base variable from clearly cordate to deeply cordate. 10

09 a Secondary veins 6-10/side [involucre bristly pubescent, tubular and enclosing nut]. . . . . ***C. sieboldiana***
b Secondary veins ≤7/side [involucre not bristly pubescent, ≤2 × longer than nut, deeply divided]. . . . . ***C. americana***

10 a Petiole 2-4(-5) cm. Tree, bark scaly to corky [involucre linearly divided >middle, lobes +/- spreading]. . . . . ***C. colurna***
– Leaves more sharply serrate and involucre not glandular. . . . . ***C. jacquemontii***
b Petiole 1-2(-3) cm. Shrub or tree, bark smooth, peeling or fissured [involucre linearly divided ≤middle, or enclosing nut]. 11

11 a Shoot with a few large raised lenticels (use 10× lens). Shrub [involucre bristly pubescent, tubular, enclosing nut]. . . . . ***C. sieboldiana* var. *mandshurica***
b Shoot with a few to many minute lenticels (use 10× lens). Shrub or tree [involucre not bristly pubescent, linearly divided ≤middle, or enclosing nut]. 12

12 a Midvein length average lamina usually ≥10 cm [involucre enclosing nut, ≤2 × longer than nut]. 13
b Midvein length average lamina usually ≤10 cm [involucre not enclosing nut, narrowly lobed]. 14

13 a Shrub with all laminas similarly shaped. . . . . ***C. maxima***
– Purple leaved form (reddish green by summer), involucre purplish. ***C. maxima* 'Purpurea'**
– Involucre in part of the fruits slightly >nut and/or splitting towards base. . . . . ***C. avellana* × *C. maxima***
b Tree with laminas variably shaped, reminiscent of both parents (*C. avellana* and *C. chinensis*). . . . . ***C. ×vilmorinii***

14 a Tree (or large shrub). Lamina margin sharply serrate [involucre lobes +/- spreading and +/- glandular pubescent]. . . . . ***C. ×colurnoides***
b Shrub, rarely tree. Lamina margin coarsely serrate [involucre lobes +/- erect]. . . ***C. avellana***
– Very similar, but involucre pubescent and with glandular hairs at base. . . . . ***C. heterophylla* var. *sutchuenensis***

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References

Aiello, A. S. (2006). Plant collecting on the eaves of the world. *The Plantsman* December 2006: 220-225.

Aiello, A. S. (2010). Farges Filbert. *Corylus fargesii*. *Arnoldia* 68(2): 71-72.

Aiello, A. S. (2016). 825.*Corylus fargesii*. A rare tree-forming hazel, with exfoliating bark. Corylaceae. *Curtis's Botanical Magazine* 33(1): 48-59.

Aiello, A. S. & Dillard, S. (2007). *Corylus fargesii*: A New and Promising Introduction from China. *Combined Proceedings International Plant Propagators' Society* 57: 139-143.

Chen, Z.-D., Manchester, S. R. & Sun, H.-Y. (1999). Phylogeny and evolution of the Betulaceae as inferred from DNA sequences, morphology, and paleobotany. *American Journal of Botany* 86(8): 1168-1181.

de Jong, P. (2016). *Acer tsinglingense* en *Corylus fargesii*, twee recente introducties uit China. *Arbor Vitae* (2-26): 12-13.

Frodin, D. G. & Govaerts R. (1998). *World Checklist and Bibliography of Fagales* (Betulaceae, Corylaceae, Fagaceae and Ticodendraceae). Kew: Royal Botanic Gardens. p. 98.

Graf, J. (1975). *Tafelwerk zur Pflanzensystematik*. Springer-Verlag Berlin Heidelberg. pp.42-43.

Grimshaw, J. & Bayton, R. (2009). *New Trees: recent introductions to cultivation*. International Dendrology Society and Kew Publishing, Kew. pp. 273-274.

The Hillier Manual of Trees & Shrubs (2014). Hillier Nurseries & The Royal Horticultural Society, London. p.93.

Li, P. & Skvortsov, A. K. (1999). Betulaceae. In: Wu, Z. Y. & Raven, P. H. (eds.). *Flora of China 4*: 286-313. Science Press, Beijing and Missouri Botanical Garden Press, St. Louis.

Mabberley, D. J. (2008). *Mabberley's Plant-book: a portable dictionary of plants, their classification and uses*. 3rd ed., completely rev. Cambridge University Press.

Proebsting, W. M. & Reihs, M. A. (1991). Propagation of filberts by stem cuttings. *Proceedings International Plant Propagator's Society* 41: 214-218.

Renner, S. S. (2001). How common is heterodichogamy? *Trends in Ecology & Evolution* 16(11): 595-597.

Shaw, K., Stritch, L., Rivers, M., Roy, S., Wilson, B. & Govaerts, R. (2014). *The Red List of Betulaceae*. Botanic Gardens Conservation International, Richmond, UK.

Stevens, P. F. (2001 onwards). Angiosperm Phylogeny Website. Version 12, July 2012 [more or less continuously updated since]. http://www.mobot.org/MOBOT/research/APweb/.

Wilson, E. H. (1916). Plantae Wilsonianae. Vol.2: 444-445. (C.S. Sargent, ed.). Cambridge University Press.

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