EDINBURGH JOURNAL OF BOTANY 63 (2&3): 131–151 (2006)
doi:10.1017/S0960428606000515 © Trustees of the Royal Botanic Garden Edinburgh (2006)
Issued 30 November 2006

A REVISION OF *PHELLODENDRON* (*RUTACEAE*)

JINSHUANG MA[1], WEI CAO[2], QUANRU LIU[3], MING YU[3] & LIJUAN HAN[4]

The genus *Phellodendron* (*Rutaceae*) is revised. This work is based on herbarium collections and field observations in eastern Asia. Two species are recognized: *Phellodendron amurense* Rupr. and *Phellodendron chinense* C.K.Schneid. All other specific and infraspecific names published in the genus are reduced to synonymy or excluded from the genus. Detailed morphology, character variability, an identification key, a distribution map, line drawings, and taxonomic treatments and lists of specimens examined are provided.

Keywords. East Asia, morphology, *Phellodendron*, revision, taxonomy.

INTRODUCTION

Phellodendron Rupr., a small genus in *Rutaceae*, *Toddalioideae*, *Toddalineae*, *Phellodendrinae* (Engler, 1931; Huang, 1958; Chase *et al.*, 1999), is easily recognized by its thickened corky bark, deciduous leaves and dioecy.

The first species, *Phellodendron amurense* Rupr., was described by F. J. Ruprecht (1857) based on R. Maack's 1855 collections from the Amur Valley of the Russian Far East. A second taxon, *Phellodendron amurense* var. *sachalinense* F.Schmidt, was described in 1868 based on collections by F. Schmidt from Sakhalin Island, Russia, and by M. Albrecht near Hokkaido, Japan (Schmidt, 1868). In 1871 *Phellodendron japonicum* Maxim. was described based on C. J. Maximowicz's 1862 collections from Mt. Fuji, Japan (Maximowicz, 1871).

The genus was first revised by Sargent (1905) based on the collections at A and GH, as well as on living collections at the Arnold Arboretum of Harvard University. Sargent recognized and illustrated three species: *Phellodendron amurense* (Manchuria, Mongolia, central China), *P. sachalinense* (Korea; Japan: Hokkaido), and *P. japonicum* (Japan; China: Hubei and Sichuan). He also raised *Phellodendron amurense* var. *sachalinense* to species status as *P. sachalinense* because he perceived it to differ from *P. amurense* in the darker colour of the branchlets; the thinner, not corky, bark; the rufous, rather than silvery-pubescent, winter buds; the leaflets not lustrous adaxially and glabrous on the margins; and the glabrous inflorescence.

[1] Brooklyn Botanic Garden, 1000 Washington Avenue, Brooklyn, NY 11225-1099, USA. E-mail: jinshuangma@bbg.org
[2] Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang, 110016, China.
[3] Department of Botany, College of Biological Science, Beijing Normal University, Beijing, 100875, China.
[4] Department of Biology, Changchun Normal College, Changchun, 130032, China.

Schneider (1907) recognized specimens from central China as a new species, *Phellodendron chinense*, based on the shape of the leaf and the form of the panicle. These had been previously identified by Sargent (1905) as *Phellodendron amurense* and *P. japonicum*. At the same time Schneider also accepted the three species recognized by Sargent (1905).

Dode (1908) published another four new species: *Phellodendron lavallei* from Japan (but based on cultivated materials in Segrez), and *P. macrophyllum*, *P. sinense* and *P. fargesii* from Sichuan, China. He also accepted the four species described previously.

Just before 1920, two species were described from Korea and Japan, respectively: *Phellodendron insulare* Nakai (1918) and *P. molle* Nakai (1919). However, these names have not been used in modern taxonomic work and were only ever applied to plants cultivated in parks, arboreta, and gardens in Europe and in North America (Rehder, 1940).

Sprague (1920) completely revised the genus based on the herbarium specimens and living collections in the Royal Botanic Gardens, Kew. He recognized three species: *Phellodendron amurense* (Russian Far East, Chinese Manchuria, northern China, Korea and Japan), *P. japonicum* (Japan: Fujiyama) and *P. chinense* (China: Hupeh), and two varieties: *P. amurense* var. *lavallei* (Japan) and *P. amurense* var. *sachalinense* (Russian Sakhalin and Korea).

New species which were described from the 1920s to the 1960s but which are not accepted today are: *Phellodendron wilsonii* Hayata & Kanehira (1920), from Taiwan, which was reduced to a variety, *P. amurense* var. *wilsonii*, by Chang & Hartley (1993); *P. piriforme* E.Wolf (1925), from a cultivated plant grown in Berlin with an unknown origin; *P. kodamanum* Makino (1929), from Japan, not accepted by Ohba (1999); *P. nikkomontanum* Makino (1931), from Japan, not accepted by Ohba (1999); *P. sinii* Y.C.Wu (1940), from Guizhou, China, not accepted by Huang (1997); and *P. burkillii* Steenis (1960), from Peninsular Malaysia. The last species is excluded from the genus as a synonym of *Tetradium glabrifolium* (Champ. ex Benth.) T.G.Hartley (1981).

In local floras Shishkin & Bobrov (1949) recorded only one species (without synonyms), *Phellodendron amurense* (Russian Far East: Amur, Primorye and Ussuri), but did not mention *P. amurense* var. *sachalinense* or *P. sachalinense* of Sakhalin Island. In another recent work from the region, two species were recorded by Kharkevych (1989): *Phellodendron amurense* (Russian Far East: Amur, Primorye and Ussuri; China, Japan, Korea) and *P. sachalinense* (southern Sakhalin, Kurie Island, Japan and China). The difference between these species was described as bark thin or bark thick although no detailed measurements were provided.

Huang (1958) revised the Chinese species and recognized six species, including some from Dode's earlier work, plus three new varieties: *Phellodendron chinense* var. *omeiense* (from Sichuan), *P. chinense* var. *yunnanense* (from Yunnan), and *P. chinense* var. *falcatum* (from Yunnan). Later, in *Flora Reipublicae Popularis Sinicae* (Huang, 1997), he recorded two species and one variety: *Phellodendron amurense*

Rupr. (eastern, northern and northeastern China, Japan, Korea, Russian Far East), *P. chinense* C.K.Schneid. (central China: Hubei, northwest Hunan, and east Sichuan), and *P. chinense* var. *glabriusculum* C.K.Schneid. (central, south and southwest China).

In the English edition of the *Flora of Japan* (Ohwi, 1965) only *Phellodendron amurense* was accepted at the rank of species, with three varieties: *P. amurense* var. *sachalinense* F.Schmidt (Hokkaido and Honshu), *P. amurense* var. *japonicum* (Maxim.) Ohwi (Honshu, Shikoku and Kyushu), and *P. amurense* var. *lavallei* (Dode) Sprague (Hokkaido and Honshu). This treatment was largely adopted in the recently updated *Flora of Japan* (Ohba, 1999), except that *Phellodendron amurense* var. *sachalinense* was synonymized into *P. amurense* (Hokkaido, Honshu, Shikoku and Kyushu, the temperate deciduous forests, also in Sakhalin and Amur).

In total, 16 species and 15 infraspecific taxa were described or recombined in the genus from 1857 to 2005. These are from East Asia, i.e. Russian Far East, Japan, the Koreas, north and northeast to central and southwestern China. The main goals of this revision are to determine which taxa should be recognized, what are their distributions, and which characters used to identify the species are reliable and useful. An identification key, descriptions, distribution map and line drawings are also provided.

Materials and Methods

More than 1500 specimens, including types, from different herbaria in North America, Europe and East Asia have been studied by the authors and are cited here (except for a few notes), plus several trips were undertaken to observe and measure the plants in their native environment. More than 113 measurements of bark and trunk characters were recorded from plants growing in the field in East Asia.

Results and Discussion

Bark

The typical character for the genus is corky bark, hence the name, cork-tree; *Phellos* – cork, *dendron* – tree, in Greek. There are two layers in the bark, a true bark, or phloem, its inner part usually yellow to dark yellow, and an outer corky bark, usually grey to dark grey depending upon the time of the collection as well as its geographical distribution. To test the usefulness of the thickness of bark as a taxonomic character, both the outer and inner bark of two taxa from different locations were measured in the field (the taxa from northern and northeastern China, Japan and central China are used here).

These measurements show that the circumference of the trunk at breast height (c.1.3 m high) is positively linearly related to the thickness of the bark in both taxa,

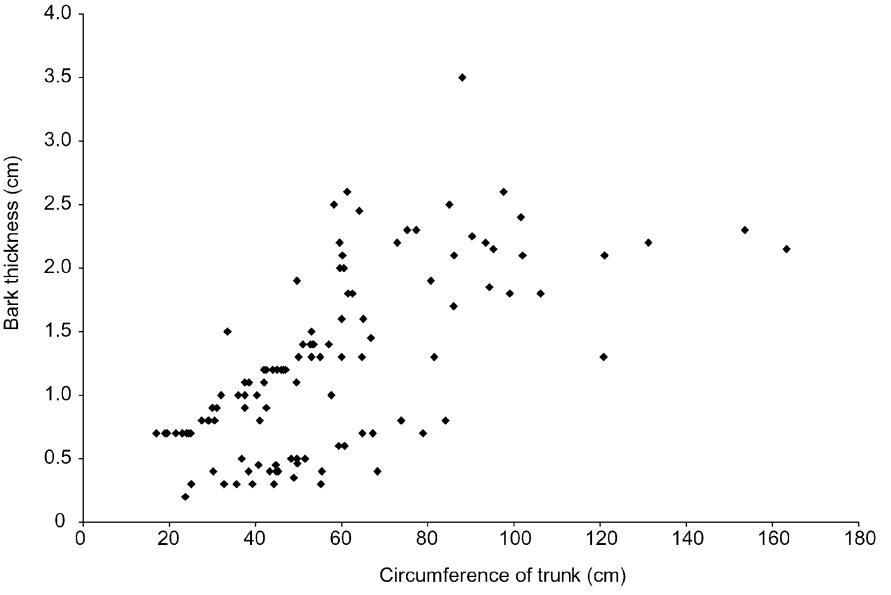

FIG. 1. The relationship between circumference and bark thickness of *Phellodendron*.

i.e. the larger the trunk circumference, the thicker the bark (see Fig. 1). From these results, we found that the taxon in cold temperate regions (northeastern and northern China, Japan, i.e. *Phellodendron amurense*) has thick corky bark, and the taxon in warm temperate regions (central China, i.e. *P. chinense*) has thin corky bark. In *Phellodendron amurense*, the outer layer is much thicker than the inner layer (see Figs 2, 4B: 3–4), and the average ratio of outer to inner is 1.128:0.368 cm (total 1.496 cm thick, average data of 85 examples); but in *P. chinense*, the outer layer is much thinner than the inner layer (see Figs 3, 4A: 3–4), and the average ratio of outer to inner is 0.127:0.336 cm (total 0.463 cm thick, average data of 28 examples). All 113 voucher specimens were collected by J. S. Ma and are kept in BKL (see the index of specimens at the end of this paper). The thickened bark in *Phellodendron amurense* could serve to protect the trees from damage in deep winter in the cold and dry conditions of the northern temperate region. No such thick bark is found in *Phellodendron chinense* which grows in the warm and humid conditions (even in winter) of central China.

Previous authors have noted a few exceptions where the bark is thinner than usual for *Phellodendron amurense* from southern Sakhalin Island and northern Japan (i.e. former *P. sachalinense*, or as *P. amurense* var. *sachalinense*). With detailed comments on the taxon from Sakhalin Island and Hokkaido, Sprague (1920) noted that this was easily observable in living trees. Hara (1935), in his work from southern Hokkaido, stated that 'In Saghalien and North Yezo (Hokkaido), the bark of *Phellodendron sachalinense* is often more smooth than that of the southern plant and such a form seems to be the typical *P. amurense* var. *sachalinense*', without further

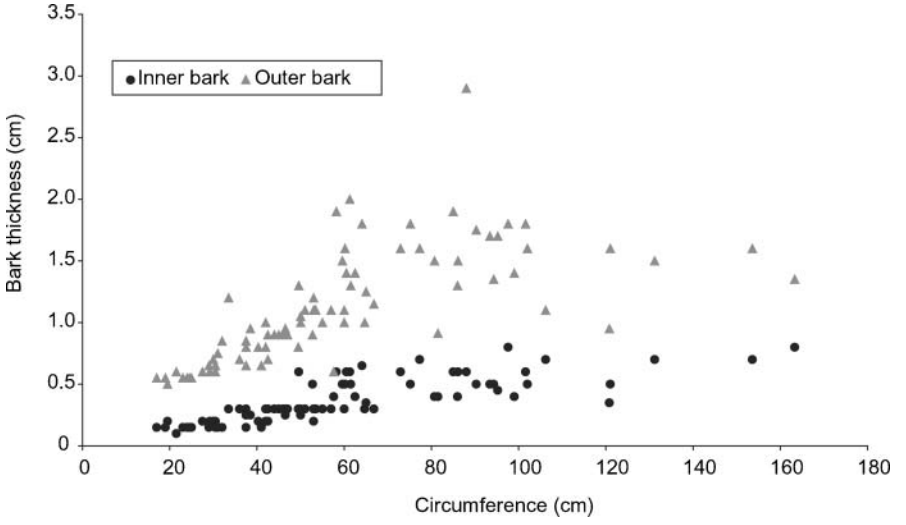

FIG. 2. The relationship between outer and inner bark of *Phellodendron amurense*.

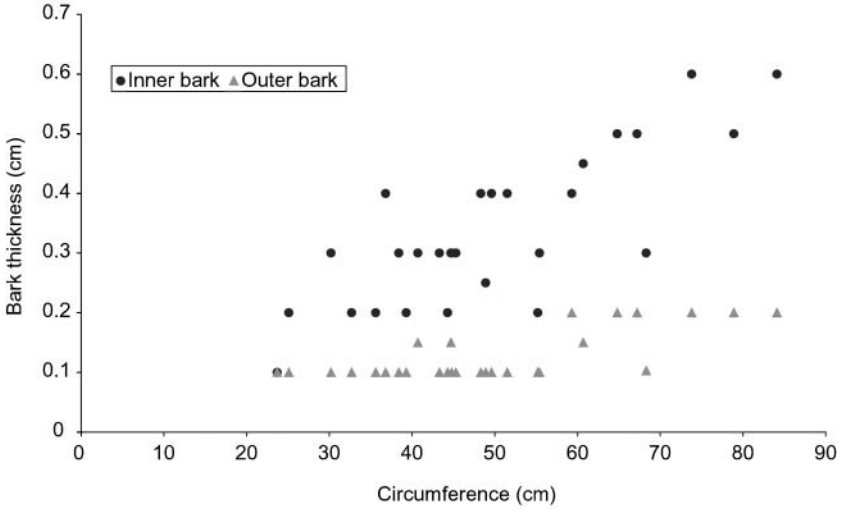

FIG. 3. The relationship between outer and inner bark of *Phellodendron chinense*.

information. In this revision, additional such examples were also observed from Taiwan (*E.H. Wilson* 10909, A & K), Japan (*E.H. Wilson* 6870, A), and Korea (*E.H. Wilson* 8507, A). Since there were no detailed records noting the position of the bark collected for these specimens we are not sure if the bark samples were collected from the upper part of the trunk or from large branches where the bark is usually thinner than on the trunk of the same tree.

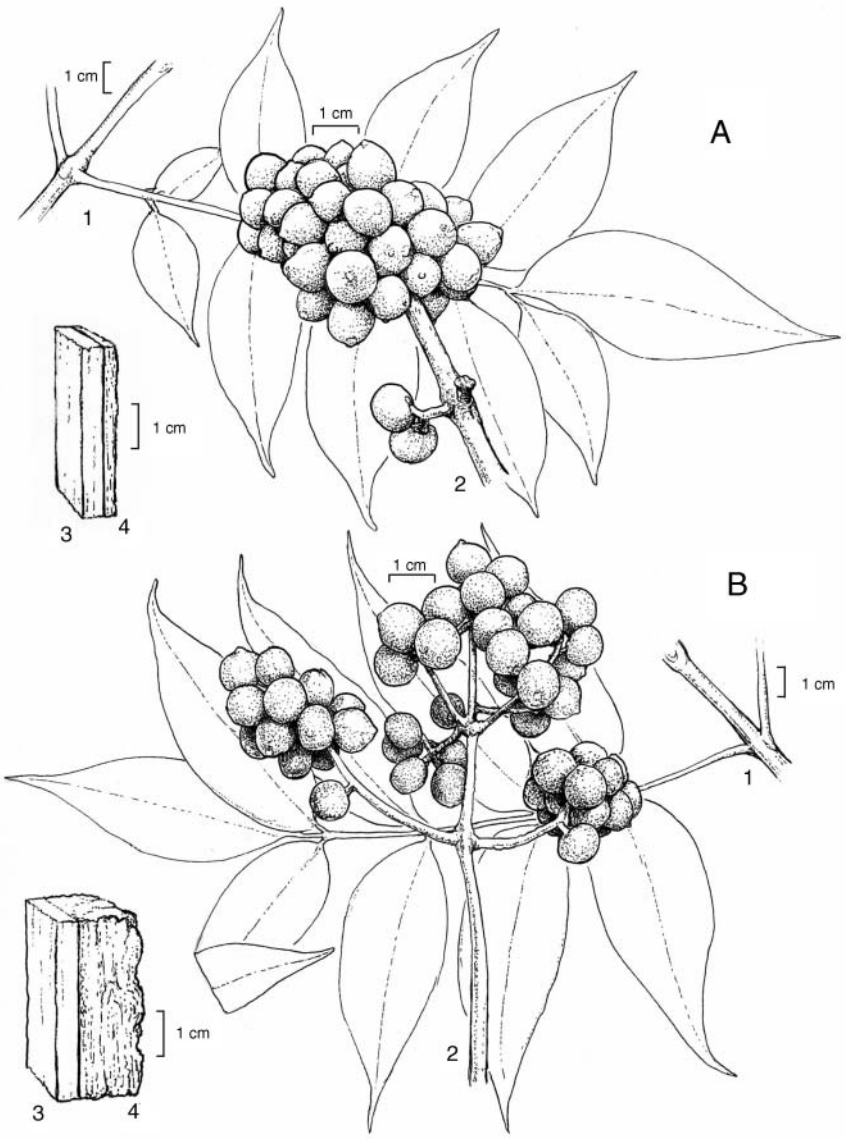

FIG. 4. The differences between *Phellodendron amurense* and *Phellodendron chinense*. A: *P. chinense* from *J.S. Ma* 5055 and 5063 (BKL); B: *P. amurense* from *J.S. Ma* 5032 and 5036 (BKL). 1, branches; 2, infructescence; 3, inner bark; 4, outer bark.

Hairs on the leaves

The usefulness of this character has been argued for a long time (Sargent, 1905, 1914; Schneider, 1907, 1912; Sprague, 1920; Hara, 1935; Huang, 1958, 1997; Ohwi, 1965; Chang & Hartley, 1993; Ohba, 1999). After reviewing the available specimens for the

present study and by identifying the species both in their native area (Japan and China) and in cultivation in northeastern North America, continuous variation from glabrous to glabrescent (such as *Phellodendron amurense*), from pubescent when young to less pubescent when old, and from pubescent along the midribs to pubescent all over the leaves (represented by *P. amurense* or *P. chinense*), was found.

Inflorescence

This is the only character that effectively distinguishes the two accepted species. In *Phellodendron amurense* the panicle is 8.5–13.5 × 6.5–9 cm, loose, the peduncle is 5–8.5 cm long, and the secondary axes have branches at least 1 cm long. In *Phellodendron chinense*, the panicle is 6.5–9.5 × 4–6.5 cm, compact, the peduncle is 4–6 cm long, and the secondary axes are very short or absent, i.e. unbranched (see Fig. 4).

TAXONOMIC TREATMENT

Phellodendron Rupr., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg, sér. 2, 15: 353 (1857). – Type: *Phellodendron amurense* Rupr.

Tree, deciduous, crown spreading and rounded, usually with secretory cavities containing aromatic ethereal oils scattered throughout the parenchymatous tissues. *Stems* upright, when young with many spreading branches, terete; twigs sparsely pilose or not; nodes prominent when young; pith present, white or light brown to brown, round, continuous, sometimes spongy; bark corky; buds solitary, small, always hidden beneath leaf petiole, naked after leaves have fallen; lenticels white, slightly expanded on young branches; buds pubescent, 2 per node, opposite, obovoid to obtriangular, pointed, sessile; vascular bundle scars 3, circular, 2 upper and 1 lower. *Leaves* odd-compound, opposite; exstipulate; petiole terete, pilose or glabrous, 5.5–7.5 mm long; leaflets (7 or)9(or 11), petiolules 2–3(4) mm long, pilose or glabrous; leaflet blade base attenuate, sometimes slightly oblique, margin subentire or with minimal and fine serrulations which are not easily observed, apex acute or acuminate, sometimes caudate, pilose when young or glabrous, but mostly becoming glabrous at maturity, adaxial surface bright green, glabrous, abaxial surface pale green at maturity, sometimes pubescent along main vein; lateral veins pinnate, 6–11 pairs, mostly not prominent abaxially, curved forward to acute, re-divided and disappearing before reaching margin; strongly aromatic with pellucid glands on margin. *Inflorescences* dioecious, nearly corymbose, terminal or opposite to young stem, with many flowers in several clusters. *Flowers* 5-merous; male flowers with stamens longer than petals, filaments linear, anthers 2-lobed, longitudinally dehiscent, with very small disc around pistillode, pistillode clavate; female flowers with staminodes clavate, carpels with 1 ovule per locule, style very short or nearly

absent, stigma capitate, 5-lobed, much shorter than ovary, persistent. *Fruit* a drupe, 5-locular, stone-like, glabrous, most with 5 grooves and angles when dry. *Seed* 1 per locule, brown, sometimes with black pits, ellipsoid, to 4.5 × 2.5–3 mm, slightly compressed, shiny; endosperm oily, cotyledons flattened, embryo straight; germination epigeal (Tiffney, 1980; Zhou *et al.*, 1999, 2002).

The genus is very similar to *Tetradium* (a genus from eastern and southern Asia and the Himalayas with 8–9 species), especially when sterile due to the imparipinnate compound and opposite leaves. However, in *Phellodendron* the buds are sunken in the base of the petiole, protected by the leaf petiole, and are exposed only after the leaves have fallen, but in *Tetradium* the buds are always exposed in the leaf axil, without protection. Additionally in *Phellodendron* the fruit is syncarpous and drupaceous whereas in *Tetradium* the fruit is apocarpous or subapocarpous and follicular (Hartley, 1981). These differences place them in different subfamilies according to the system by Engler (1931).

Key to the species

1a. Panicle 8.5–13.5 × 6.5–9 cm, loose, peduncle 5–8.5 cm long, secondary axes with branches at least 1 cm long; bark with outer layer 3–4 times thicker than inner layer, surface striped or fissured at maturity; tree 25–35 m high (Russian Far East, Japan, Koreas, eastern, northeastern and northern China, Taiwan) _____ **1. P. amurense**

1b. Panicle 6.5–9.5 × 4–6.5 cm, compact, peduncle 4–6 cm long, secondary axes without branches or nearly so; bark with outer layer 3–4 times thinner than inner layer, surface smooth; tree 15–20(–25) m high (central and southwestern China) _____ **2. P. chinense**

1. Phellodendron amurense Rupr., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg, sér. 2, 15: 353 (1857). – Type: Russia, Am rechten Amur-Ufer unterhalb der Sungari-Mundung beim Flusse Bukatscha, *R. Maack* 16 (lecto LE, designated here; iso P; photocopy NA). **Figs 2, 4B**: 1–4.

Phellodendron amurense var. *sachalinense* F.Schmidt, Mem. Acad. Imp. Sci. Saint-Pétersbourg, sér. 7, 12: 120–121 (1868), as *sachalinensis*. – *Phellodendron sachalinense* (F.Schmidt) Sarg., Trees & Shrubs 1: 199, t. 94 (1905). – Type: Russia, Insula Sachalin, Tunai, 9 vii 1860, fruit, *F. Schmidt* s.n. (lecto K, designated here; iso LE).

Phellodendron japonicum Maxim., Bull. Acad. Imp. Sci. Saint-Pétersbourg, sér. 3, 16: 212 (1871). – *Phellodendron amurense* var. *japonicum* (Maxim.) Ohwi, Fl. Jap. 584 (1965). – Type: Japan, Mt. Fuji, 1862, fruit, *C.J. Maximowicz* s.n. (lecto GH, designated here; iso K, L, LE 2 sheets, P, US, W; photocopy NA).

Phellodendron lavallei Dode, Bull. Soc. Bot. France 55: 648 (1908). – *Phellodendron amurense* var. *lavallei* (Dode) Sprague, Bull. Misc. Inform. Kew 1920: 235 (1920). – Type: Culta (originally from Japan): Segrez, 1 vi 1920 & 12 x 1917, fruit & flower, *Lavallee* s.n. (lecto P, designated here; iso K 2 sheets), **syn. nov.**

Phellodendron insulare Nakai, Bot. Mag. Tokyo 32: 107 (1918). – Type: Korea, in insula Oorgongto, in monte Joho, 600 m, 31 v 1917, *T. Nakai* 4379 (lecto TI, designated here), **syn. nov.**

Phellodendron molle Nakai, Bot. Mag. Tokyo 33: 58 (1919). – *Phellodendron amurense* var. *molle* (Nakai) S.H.Li & S.Z.Liou in S.H.Li (ed.), Fl. Liaoning. 1: 1051 (1988). – *Phellodendron amurense* f. *molle* (Nakai) Y.C.Zhu in Y.C.Zhu (ed.), Pl. Medic. Chin. Bor.-Orient. 660 (1989). – Type: Corea sept., in dumosis secus flumen Horogawa, *T. Nakai* 7218 (lecto TI, designated here), **syn. nov.**

Phellodendron wilsonii Hayata & Kanehira in Hayata, Icon. Pl. Formosan. 9: 8 (1920). – *Phellodendron amurense* var. *wilsonii* (Hayata & Kanehira) C.E.Chang, Quart. J. Chin. Forest 7(4): 58 (1974). – Type: Taiwan, Mt. Arison, [27] x 1918, fruit, *R. Kanehira & S. Sasaki* s.n. (holo TI), **syn. nov.**

Phellodendron amurense Rupr. var. *angustifolium* E.Wolf, Mitt. Deutsch. Dendrol. Ges. 1925: 215 (1925). – Type: No type information was given in the original description and no type has been traced.

Phellodendron amurense Rupr. var. *latifolium* E.Wolf, Mitt. Deutsch. Dendrol. Ges. 1925: 215 (1925). – Type: No type information was given in the original description and no type has been traced.

Phellodendron piriforme E.Wolf, Mitt. Deutsch. Dendrol. Ges. 1925: 215 (1925). – Type: No type information was given in the original description and no type has been traced.

Phellodendron kodamanum Makino, J. Jap. Bot. 6: 5 (1929). – Type: Japan, Harima: Tokura-toge, 1928, *T. Makino* s.n. (lecto MAK, designated here; iso TI 2 sheets).

Phellodendron nikkomontanum Makino, J. Jap. Bot. 7: 18 (1931). – Type: Japan, Shimotsuke, Mt. Nikko, *T. Makino* s.n. (holo TI).

Phellodendron sachalinense (F.Schmidt) Sarg. var. *suberosum* H.Hara, Bot. Mag. Tokyo 49: 863 (1935). – *Phellodendron amurense* Rupr. var. *suberosum* (H.Hara) H.Hara, Sci. Res. Ozegahara Moor 446 (1954). – Type: Japan, Kitami, Asajino, viii 1933, *Y. Tomimoto* 2799 (no type material traced, including at TI), **syn. nov.**

Tree, deciduous, to 25–35 m high, and 60–100 cm dbh. *Bark* corky, total c.1.5 cm thick, phloem (inner part) yellow, c.0.37 cm thick, and cork (outer part) grey, c.1.13 cm thick, dark, deeply striped or fissured along the main trunk. *Buds* 4–4.5 × 3–4 mm. *Leaf scars* 7–8 mm in diameter. *Leaves* (17–)21–32 × 13–16 cm; leaflet blades green, elliptic to ovate-oblong, (6–)8–11 × 3.5–4.5(–5) cm, coriaceous to thickly papyraceous. *Inflorescence* panicles 8.5–13.5 × 6.5–9 cm, loose, nearly corymbose; peduncle 5–8.5 cm long, pubescent or without scales; secondary axes up to 5 cm long. *Male flowers* with pedicels c.2 mm long, thin and erect, sepals triangular, c.1.5 mm long, pubescent outside, petals yellow-green, oblong-ovate, 3.5–4.5 × 1.5–2 mm, stamens longer than petals, filaments linear, usually pubescent at base, anthers yellow, globose, c.1 × 1 mm, 2-lobed, longitudinally dehiscent, with very small disc around pistillode, pistillode clavate, white pubescent at apex; female flowers with pedicels 2–3 mm long, thin and erect, sepals small, triangular, pubescent

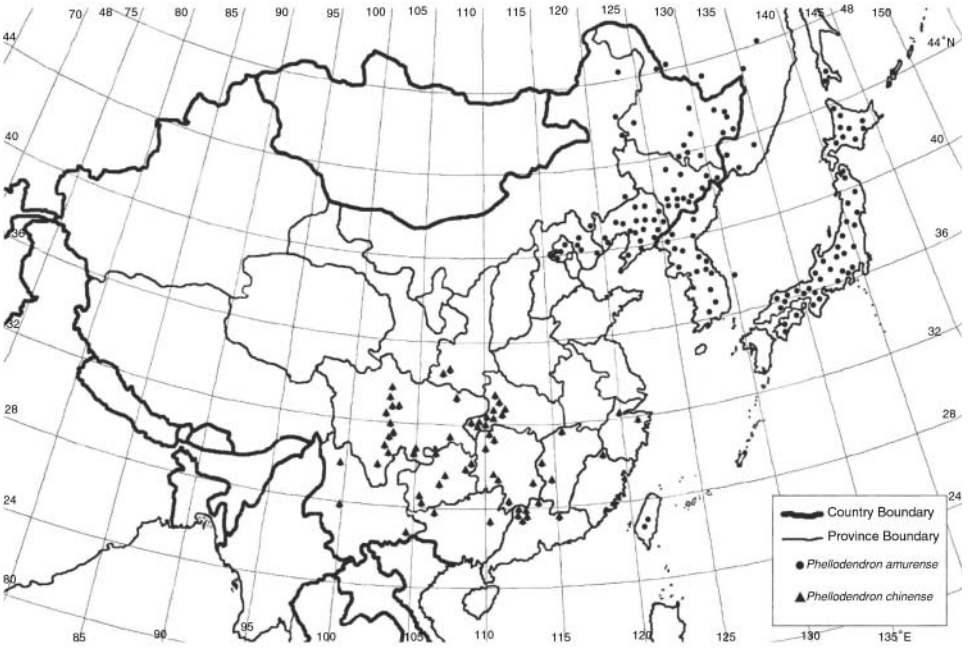

FIG. 5. Native distribution of *Phellodendron* in East Asia.

outside, petals pale- or yellow-green, oblong-ovate, 3–4.5 × 1.5–2 mm, staminodes clavate, carpels black when dried, 3.5–4 × c.2.5 mm, stone-like, ovules 1 per locule, style very short or nearly absent, stigma capitate, 5-lobed, much shorter than ovary, persistent. *Fruit* a drupe, black, 8–9.4 × 7.5–8.7 mm, subglobose, stone-like, glabrous, mostly with 5 grooves and angles when dry, on a pedicel c.0.4 mm long.

Distribution and habitat. Mixed forests, 0–2700 m. China (Beijing, Hebei, Heilongjiang, Jilin, Liaoning, East Nei Mongol, Shandong) at 300–1850 m, Taiwan at 2000–2700 m, Japan at 60–1800 m, Korea at 0–1500 m and the Russian Far East (see Fig. 5); also cultivated in central Asia, Caucasus, parts of Europe and North America (Kern, 1931; Elias, 1986; Noach, 1990). Flowering from late April to early June. Pollination is entomophilous and fruit is present from mid-August to late October but usually remains on the tree until the following spring and is then mainly dispersed by birds (Zhu & Dong, 1990; Lu *et al.*, 2005) or small animals (Tiffney, 1980). It is a shade-intolerant species (Wang & Tao, 1998; Yoshida & Kamitani, 1999). A dormancy period is required for the germination of seeds (Starshova, 1979; Zhu & Dong, 1990; Lin *et al.*, 1994a, 1994b) but a scarification process can promote germination (Goo *et al.*, 1997). Chromosome number: $2n = 78$ (Guerra, 1984).

Economic uses. The inner part, or true bark, is used in traditional Chinese medicine under the names of 'Huang Bai' or 'Huang Po'. The tree has frequently been exploited in its native area, not only for timber (especially by the military in northern

and northeastern China; Zhu & Dong, 1990), but also for medicine (i.e. important alkaloids) (Gan & Dai, 1990).

Selection of specimens examined

China. Beijing: Changping, vii 1930, *H.F. Chow* 40541 (PE 2 sheets); Mentougou (Miaofengshan), 1100 m, 18 viii 2003 (bark), *J.S. Ma* 5074 (BKL); Miyun, 9 v 1972, *Miyun Exped.* 142 (PE). Hebei: Chengde, in 1959, *Nankai University Exped.* 54 (PE); Qinhuangdao, 20 viii 1951, *F.T. Wang* 169 (PE); Qinglong, 21 xii 1959 (fr), *S. Coll.* 1086 (PE); Wulingshan (Xinglong), 1000 m, 29 viii 1953 (fr), *X.Y. Liu* 1622 (IBSC, KUN, PE); Zunhua (Dongling), 22 viii 1930, *H.F. Chow* 40940 (IBSC). Heilongjiang: Aihui, 3 vii 1954, *G.Z. Wang* 184 (IFP); Baoqing, 19 vii 1959 (fr), *Y.L. Zhang et al.* 1785 (IBSC, IFP, PE); Harbin, 22 ix 1950 (fr), *G.Z. Wang et al.* 162 (IFP, PE, cult.); Jixian, 22 vii 1959 (fr), *Y.L. Zhang et al.* 1718 (IFP, PE); Hulin, vii 1955, *Plants Exped.* s.n. (IFP); Mishan, ix 1955, *G.Z. Wang* 4021 (IFP); Nenjiang, 18 vii 1958, *Y.L. Zhang* 39 (IFP); Pingshan, 1 ix 1993 (fr), 44.57°N, 127.23°E, *NACPEC* HLJ-23 (MOAR, MOR, NA); Shangzhi, 16 ix 1950, *G.Z. Wang & Q.T. Li* 109 (IFP, PE); Shuanghe Railway Station (Mudanjiang), 9 viii 1951, *K.S. Hao* 16188 (PE 2 sheets); Tonghe, 20 vii 1986, *Harbin Normal University Exped.* 9226 (IBSC); Wuchang, 19 vii 1983, *Harbin Normal University Exped.* 8391 (IBSC); Yichun, 20 vii 1956 (fr), *China-German Exped. (T.N. Liou)* 7608 (IBSC, IFP, KUN, PE). Jilin: Antu, 600 m, 9 ix 1951, *T.N. Liou* 4227 (IBSC, IFP, PE); Changbaishan, 900 m, 15 viii 1962 (fr), *Temperate Forest Group* 451 (PE); Fusong, 780 m, 14 vii 1950 (fr), *M. Noda et al.* 120 (IBSC, IFP, PE); Helong, 26 viii 1958 (fr), *C.S. Wang et al.* 2513 (IBSC, IFP 2 sheets); Huadian, 600 m, 8 viii 1950 (fr), *Y.C. Ma* 96 (PE); Hunchun, 17 vii 1959, *P.Y. Fu* 795 (IFP); Jiaohe, 31 viii 1950 (fr), *Y.L. Zhang et al.* 959 (IBSC, IFP 2 sheets, PE); Jiutai, 300 m, 28 viii 1950, *Y.L. Zhou* 2076 (IFP); Linjiang (Hunjiang), 1100 m, 8 ix 1963 (fr), *S.X. Li et al.* 1185 (IFP 2 sheets); Liuhe, 640 m, 14 ix 2003 (bark & photo), *J.S. Ma* 5034 (BKL); Manjiang (Jingyu), 11 viii 1957, *Northeast Normal University Exped.* 882 (PE); Wangqing (Changhuangtsailing), 800 m, 24 vii 1931 (fr), *H.W. Kung* 1914 (K, NY, PE, SZ). Liaoning: Benxi, 19 v 1950, *M. Noda et al.* 641 (IFP); Beizhen, 12 vi 1951, *Y.L. Zhou et al.* 2921 (PE 3 sheets); Caohekou (Benxi), *A. Baranov & D.C. Zhao* 641 (PE); Dandong, 3 v 1950, *M. Noda et al.* 94 (IFP); Faku, 28 ix 1988 (fr), *S.Z. Liu* 352 (IFP); Fengcheng, 15 ix 1920, *K. Kondo* s.n. (TI); Fushun, 18 vii 1959 (fr), *W. Wang et al.* 511 (IFP, PE); Fuxian, 23 viii 1958, *IFP Survey Team* 26 (IFP); Haicheng, viii 1895, *K. Jimbo* s.n. (TI); Jianchang, 23 ix 1959 (fr), *C.S. Wang et al.* 3265 (IFP 2 sheets); Huanren, 23 viii 1964, *S.C. Cui* 101 (IFP); Kuandian, 820 m, 11 ix 2003 (bark & photo), *J.S. Ma* 5001 (BKL); Luda (Dalian), 30 vii 1929 (fr), *M. Kitagawa* s.n. (TI); Mukden (Shenyang, Fengtian), xii 1880 (near Mukden, Lao-Yeh Ling & other Hills), *H.E.M. James* s.n. (K); Qianshan (Anshan), 16 viii 1909, *Y. Yabe* s.n. (NAS); Qingyuan, 740 m, 13 ix 2003 (bark), *J.S. Ma* 5024 (BKL); Shenyang, vi 1980, *S.X. Li* 3596 (IFP); Suizhong, 20 vii 1959, *S.X. Li et al.* 529 (IBSC, IFP); Tieling, viii 1959, *H.Z. Cao* 1133 (IFP); Xifeng, 500–600 m, 20 vi 1983, *S.X. Li* 5895 (IFP); Xinbin, 23 ix 1959, *X.F. Tian* 194 (IFP); Xiongyue (Gaixian), 20 v 1950, *T.N. Liou et al.* 265 (IFP, PE cult.); Xiuyan, 8 ix 1959, *W. Wang* 1330 (IFP); Yingkou, 23 ix 1959 (fr), *Yingkou Exped.* 146 (IFP); Yixian, 19 vi 1956, *S.X. Li* 68 (IFP, PE); Zhuanghe, 14 ix 1959, *First Group* 162 (IFP). Manchuria (Northeast China): North Manchuria, 12 viii 1922 (fr), *B.V. Skvortzow* s.n. (A 2 sheets); Xingan (Chingan), in 1859 (fr), *V.L. Komarov* s.n. (BM), 3 vi 1895, *V.L. Komarov* 1013 (BM, K, NY, P, TI, W). Nei mongol: Butha (Zalantun), 1 vii 1959, *S.Q. Zhou* 1181 (HIMC); Horqin Left Wing Bear, 25 viii 1980, *Y.C. Ma* 101 (HIMC); Jalaid, 30 vi 1984 (fr), *Medical Herbs Exped.* 2290 (IFP 2 sheets); Ningcheng, 11 viii 1973, *Y.L. Yang* 798 (IFP); Oroqen Bear, 30 vi 1986, *R. Cao* 83-2 (HIMC). Shandong: Jinan, 12 v 1979, *P.C. Tang* 790001 (MASS, cult.); Taishan, 13

ix 1959, *T. Y. Zhou et al.* 7346 (NAS); Weihai, 6 vi 1959, *T. Y. Zhou et al.* 2178 (NAS). TAIWAN: Arishan, 10 iv 1926, *S. Saito* s.n. (TI), Alishan, 2300 m, 20 viii 1963 (fr), *M. Tamura*, *T. Shimizu & M.T. Kao* 22196 (TI); Morrison, 2666 m, 26 x 1918 (fr), *E.H. Wilson* 10909 (A, K, US).

JAPAN. AKITA, 10 vii 1954, *A. Kimura et al.* s.n. (NA). AOMORI, 25 vii 1953 (fr), *H. Hara* s.n. (TI). EHIME, 4 viii 1927 (fr), *Z. Tashiro* s.n. (MAK). FUKUSHIMA, 14 vii 1935, *M. Honda* 58 (TI). GIFU, 28 vii 1940, *K. Kisaut* 2850 (TI). GUNMA, 13 x 1953, *H. Funakoshi* 680 (TI). HOKKAIDO, 22 vi 1983, *K. Deguchi* 4541 (A, CM), near Hakodate, *M. Albrecht* s.n. (iso GH, NY), Aze-Akaigawa in Mori-Machi, 6 x 1982 (fr), *F.G. Meyer, S.G. March, M. Kaware, D.G. Nielsen & H. Takahashi* 19258 (NA), Kirkham, Coode-Adams, 20 ix 1997 (fr), *Howick and McNamara – Expedition to Hokkaido* EHOK 14 (K), 31 v 1975, *S. Kurosawa & T. Tataishi* s.n. (TI). Hokodate, vii 1887, *Y. Tokubuchi* s.n. (K), 13 viii 1899 (fr), *J. Uatsumura* s.n. (TI); Fukagawa, 15 viii 1961, *S. Kobayashi* s.n. (MAK); Hidaka, 11 ix 1974 (fr), *H. Hara, S. Kurosawa & Y. Tataishi* s.n. (TI); Iburi, 28 vii 1933 (fr), *H. Hara* s.n. (TI); Ishikari, 20 vii 1933 (fr), *H. Hara* s.n. (TI); Kitami, vi 1972, *S. Kobayashi* s.n. (MAK); Kushiro, *D.E. Boufford & E.W. Wood* 19759 (A); Obihiro, 29 viii 1931 (fr), *S. Saito* s.n. (TI); Rishiri, 6 ix 1926, *K. Kondo* 7623 (TI 2 sheets); Sapporo, in 1884, *W.P. Brooks* 34 (A); Shiribeshi, 17 vii 1956, *H. Kanai* s.n. (TI); Teshio, 25 vi 1975, *M. Furuse* 8919 (K, MOR, NA), Is. Kunashiri, 7 viii 1889 (fr), *U. Faurie* 5106 (P, photocopy NA). HONDO, 1800 m, 26 v 1914, *E.H. Wilson* 6770 (A). HONSHU, 11 vi 1926, *T. Kobayashi* 2146 (A, TI). HYOGO, 950–1000 m, 11 viii 1993 (fr), *N. Fukuoka et al.* 7727 (MAK). IWATE, 22 vii 1978, *J. Murata, H. Ohba & S. Akiyama* 5730 (TI). KANAGAWA, 1905 (fr), *U. Faurie* 6871 (A, BM, P). KOCHI, viii 1934, *T. Makino* s.n. (MAK), 10 vii 1988, *Y. Koukami* 3645 (MAK). KOTSUNE, 16 vii 1909 (fr), *K. Sakurai* s.n. (A). KYOTO, 680 m, 11 vi 1991, *T. Fuji et al.* TWT-14821 (TI). MIE, in 1934, *F. Maekawa* s.n. (TI). MIYAGI, 13 vi 1960, *Y. Hayashi & Y. Takeuchi* s.n. (CM). MUTSU, 22 vi 1952, *K. Hosoi* 10987 (A, TI). NAGANO, 30 v 1953, *H. Kanai* 2421 (TI). NAGASHAKI, 100–430 m, 22 viii 1982, *K. Ueda, S. Terabayashi & Y. Ueda* 1321 (TI 2 sheets). NARA, 900 m, 3 viii 1962 (fr), *N. Fukuoka & M. Hotta* s.n. (TI). NIIGATA, 28 vi 1961 (fr), *M. Furuse* s.n. (A, NA). OKAYAMA, vii 1988, *S. Fujii* 197 (CM). SAITAMA, 11 vii 1984 (fr), *H. Funakoshi* 712 (TI). SHIGA, 4 vi 1997, *S. Fujii* 5692 (CM). SHIMANE, 6 ix 1905 (fr), *J.G. Jack* s.n. (A). SHIZUOKA, 950 m, 9 v 1954, *H. Kanai* 5998 (TI). TOCHIGI, vii 1928 & vii 1929, *T. Nakai* s.n. (TI). TOKUSHIMA, 14 viii 1894 (fr), *J. Nakai* 1299 (TI). TOKYO, 24 v 1988, *H. Funakoshi* 1202 (TI). TOTTORI, 25 ix 1955 (fr), *H. Muroi* 5496 (A). TOYAMA, 11 vi 1991, *J. Julila & H. Fujino* 408 (A). WAKAYAMA, viii 1921, *S. Coll.* s.n. (TI). YAMAGATA, 700 m, 24 vii 1980 (fr), *D.E. Boufford et al.* 22293 (CM, GH). YAMANASHI, 980 m, 23 ix 1958 (fr), *M. Furuse* s.n. (A, NA).

KOREA. KANGWON (KANGWON-DO, GANGWON-DO), Chung-wang san, 700 m, 3 vi 1989, *Plant Exploration in the Republic of Korea* 170 (MOAR, NA), Mt. Keumkang, 5 viii 1916, *T. Nakai* 5597 (TI); Mt. Odae, 25 vii 1946 (bark), *I.C. Chung* 1172 (F 2 sheets, MICH), Mt. Sorak, 21 vii 1936 (fr), *T. Nakai* 17482 (TI 3 sheets), Mt. Whaak, 1458 m, 27 vi 1967, *Smithsonian-Korea Ecological Project (Y.N. Lee & Y.S. Lee)* 287 (TI, US). NORTH KYONGSANG (KYONGSANG BUKTO), 620 m, 15 x 1982 (fr), *Beyer, Erskine & Cowley* 301 (K). NORTH HAMGYONG (HAMGYONG BUKTO), Daehungli, 18 vii 1914 (fr), *T. Nakai* 2047 (TI), Taiyudo, 334–1000 m, 15 vi 1917, *E.H. Wilson* 8599 (A, US 2 sheets), Takkori, 100–1000 m, 25 vi 1917, *E.H. Wilson* 8696 (A 2 sheets, E, K, US 2 sheets). NORTH KAMYONG (HAMGYONG BUKTO), 15 viii 1917 (fr), *E.H. Wilson* 8902 (A), Kyonsung, 13 vii 1918, *T. Nakai* 7219 (TI), 17 vii 1918 (fr), *T. Nakai* 7220 (TI 2 sheets). NORTH KYONGSANG (GYEONGSANG BUK DO), Ullung Do (Dagelet Island), 1 x 1982 (fr), *Beyer, Erskine & Cowley* 101 (K). NORTH PYONGAN (PYONGAN-BUKTO), 3 viii 1912 (fr), *T. Nakai* 185 & 186 (TI). SOUTH HWANGHAE (HWANGHAE NAMDO), Changsan, 4 viii 1929, *T. Nakai* 13084 (TI), Taechong, 26 vii 1929, *T. Nakai* 13087 (TI). SOUTH HAMGYONG (HAMGYONG NAMDO), 567–867 m, 2 viii 1917 (fr), *E.H. Wilson* 8874 (A 2 sheets, E, K, US 2 sheets). SOUTH KYONGSANG (GYEONGSANG NAMDO), Mt. Chiri, 7 vii 1913 (bark), *T. Naikai* 656 (TI). SOUTH PYONGAN (PYONGAN NAMDO), 15 vii 1917, *T. Nakai* s.n.

(TI); In silvis Ohbokdong, 3 vi 1917, *T. Nakai* 4380 (TI), 7 vi 1917, and in silvis Miroppon, *T. Nakai* 4381 (TI 2 sheets).

Russia, Far east. Amur, 20 vii 1891 (fr), *L. Kozshinsky* s.n. (A), viii 1900 (fr), *G. Littledale* s.n. (K). Khabarovsk, 23 viii 1903 (fr), *C.S. Sargent* s.n. (A 2 sheets). Kuriles, Shikotan, 11 viii 1927, *K. Kondo* 7880 (TI 3 sheets), 31 viii 1933 (fr), *Y. Tomimoto* s.n. (TI). Primorsky, 2 vii 1972 (fl & fr), *T. Neczaeva & V. Verholat* 5584 (#3627) (A, E, K, MICH, NY, P, US, W). Sachalin, 31 viii 1936, *H. Hara* s.n. (TI). Ussurisk, 1 ix 1920, *A. Kiss* s.n. (MICH).

2. Phellodendron chinense C.K.Schneid., Ill. Handb. Laubholzk. 2: 126, fig. 79 c–d (1907). – Type: China, W Hupeh, fruit, *E.H. Wilson* (for J. Veitch & Sons) 1972 (lecto K, designated here; iso W). **Figs 3, 4A:** 1–4.

Phellodendron chinense var. *glabriusculum* C.K.Schneid., Ill. Handb. Laubholzk. 2: 126 (1907). – Type: No type information was given in the original description and no type has been traced, **syn. nov.**

Phellodendron fargesii Dode, Bull. Soc. Bot. France 55: 649 (1908). – Type: China, Ssu-tchuen oriental, district de Tchen-keou-tin, flower and fruit, *R.P. Farges* 77 bis. (lecto P, designated here; photocopies NA 2 sheets).

Phellodendron macrophyllum Dode, Bull. Soc. Bot. France 55: 648 (1908). – Type: China, Sichuan, 1400 m, 25 vi 1893, flower, and 2 xii 1908, fruit, *R.P. Farges* 1284 (lecto P, designated here; drawn copy L; photocopy NA).

Phellodendron sinense Dode, Bull. Soc. Bot. France 55: 649 (1908). – Type: China, Sichuan, 1863, fruit, *Simon* 16 (lecto K, designated here; iso P; photocopy NA).

Phellodendron sinii Y.C.Wu, Bot. Jahrb. Syst. 71: 185 (1940). – Type: China, Kweichow, Yun-wu-shan, 1700 m, 13 vii 1931, *Sin* 50118 (holo K, but no material traced).

Phellodendron sachalinense f. *longipes* Y.C.Wu, Bot. Jahrb. Syst. 71: 185 (1940). – Type: China, Kweichow, Yun-wu-shan, 1500 m, 5 vii 1931, *Sin* 50389 (holo B, untraced and probably destroyed in WW II).

Phellodendron chinense var. *omeiense* Huang, Acta Phytotax. Sin. 7(4): 335 (1958). – Type: China, Szechuan, Mt. Omei, x 1952, *W.P. Fang & T.W. Sung* 33099 (lecto PE, designated here; iso SZ).

Phellodendron chinense var. *falcatum* Huang, Acta Phytotax. Sin. 7: 336 (1958). – Type: China, Yunnan, in declivibus montis I'cho, Liang-shan, 2100 m, arbor 13 m alta, fruct, immt. Viridulis punctatis, 12 viii 1932, *H.T. Tsai* 51252 (lecto A, designated here).

Phellodendron chinense var. *yunnanense* Huang, Acta Phytotax. Sin. 7: 336 (1958). – Type: China, Yunnan, ad collum proper Far-dor, Si-chour-hsien, 1450 m, 17 ix 1947, *K.M. Feng* 11915 (lecto PE, designated here; as *Phellodendron yunnanense* C.Y.Wu ined.).

Tree, deciduous, to 15–20(–25) m high, and 40–60 cm dbh. *Bark* corky, total c.0.47 cm thick, phloem (inner part) yellow, c.0.34 cm thick, and cork (outer part) grey, c.0.13 cm thick, dark, usually smooth along the main trunk. *Buds* 3–4 × 3–4 mm. *Leaf scars* 7.5–8 mm in diameter. *Leaves* (19–)21–32 × 13–16 cm; leaflet blades green,

elliptic to ovate-oblong, 8–11.5 × 3.5–5 cm, thinly coriaceous to papyraceous. *Inflorescence* panicles 6.5–9.5 × 4–6.5 cm, compact, nearly corymbose; peduncle 4–6 cm long, pubescent or without scales; secondary axes 0–5 cm long. *Male flowers* with pedicels c.2 mm long, thin and erect, sepals triangular, c.1.5 mm long, pubescent outside, petals yellow-green, oblong-ovate, 3.5–4.5 × 1.5–2 mm, stamens longer than petals, filaments linear, usually pubescent at base, anthers yellow, globose, c.1 × 1 mm, 2-lobed, longitudinally dehiscent, with very small disc around pistillode, pistillode clavate, white pubescent at apex; female flowers with pedicels 2–3 mm long, thin and erect, sepals small, triangular, pubescent outside, petals light or yellow-green, oblong-ovate, 3–4.5 × 1.5–2 mm, staminodes clavate, carpels black when dried, 3.5–4 × c.2.5 mm, stone-like, ovules 1 per locule, style very short or nearly absent, stigma capitate, 5-lobed, much shorter than ovary, persistent. *Fruit* a drupe, black, 8.4–9.3 × 7.5–8.5 mm, subglobose, 5-locular, stone-like, glabrous, mostly with 5 grooves and angles when dry, on a pedicel 0.3–0.4 mm long.

Distribution and habitat. Mixed forests, 400–2300 m. China: ?Anhui, ?Fujian, ?Guangdong, ?Guangxi, ?Guizhou, Hubei, Hunan, ?Jiangsu, ?Jiangxi, Shaanxi, Sichuan, Yunnan, ?Zhejiang. Since the species has been long cultivated or naturalized in some places (noted above with '?' before the province name), its native distribution cannot be determined with certainty. This species is also cultivated in Europe and North America, but mainly in gardens and arboreta. It flowers from late April to early June, has entomophilous pollination, and fruits from mid-August to late October. The fruit usually remains on the tree until the following spring and is then dispersed mainly by birds or small animals (Tiffney, 1980). It is a fast-growing tree in full sun. Chromosome number: $2n = 78$ (Guerra, 1984).

Economic uses. The inner part, or true bark, is used in traditional Chinese medicine under the names of 'Guan Huang Bai' or 'Guan Huang Po'. The tree has frequently been exploited in its native area, especially for medicinal uses (i.e. important alkaloids) (Gan & Dai, 1990). This exploitation has increased in the past thirty years and it is now more difficult to find a living plant in the wild, but rather only in semi-cultivation. During a visit to the Shenongjia and *Metasequoia* areas in Hubei, central China, in 2003, the authors did not find any wild populations during a week-long field expedition. None of the cultivated trees found were larger than 25 cm dbh. This species is now very rare in central China.

Selection of specimens examined

China. Anhui: Jinzhai, 14 vii 1959, *S. Coll.* 61017 (NAS). Fujian: Congan, 15 ix 1980, *Wuyishan Exped. Team* 2081 (NAS). Guangdong: Heping, 12 x 1958, *Heping Exped.* 600 (IBSC); Lechang, 11 viii 1968, *P. Y. Chen et al.* 2852 (IBSC); Liannan, 29 v 1951, *Z.S. Zhu* 754 (IBSC); Lianshan, 7 v 1958, *Nanling Exped.* 622 (IBSC); Lianxian, 16 xi 1930, *S.P. Ko* 50896 (IBSC 2 sheets, PE); North Guangdong, in 1940, *T.S. Lau* 301 (IBSC); Shaoguan, 16 vi 1960, *Shaoguan Exped.* 1111 (IBSC); Wengyuan, 4 ix 1984, *Wengyuan Herbs Exped.* 64 (PE);

Yangshan, 1100 m, 5 vi 1956, *L. Deng* 1299 (IBSC, KUN); Yingde, 12 vii 1972, *H.S. Lo* 705 (IBSC, cult.). GUANGXI: Jiuxiu (Dayaoshan), 10 xi 1958, *Y.C. Chen* 1103 (IBK, cult.); Lingle, 13 iv 1960, *F.S. Huang* 2106 (KUN); Lingyun (Yeo iii Shan), 1600 m, 27 viii 1928 (fr), *R.C. Ching* 7168 (A, NY, PE); Longsheng, 20 ix 1984, *B.N. Chang* 406131 (IBK, cult.); Rongshui, 700 m, 27 vi 1957 (fr), *T.C. Chen* 860 (IBK, KUN cult.); Tianlin, 18 vi 1958 (fr), *Z.D. Li* 600845 (KUN); Ziyuan, 8 viii 1958, *Z.Z. Chen* 51884 (IBK, cult.). GUIZHOU: Anlong, 1300 m, 25 v 1960, *Z.S. Zhang & Y.T. Zhang* 3013 (KUN); Guiyang (Qianlingshan), 1400 m, 6 viii 1958, *Z.Y. Cao* 190 (HGAS, PE 2 sheets); Jiangkou, 750–1000 m, 11 ix 1986 (fr), *B. Bartholomew et al.* 1152 (A, cult.); Guiding (Pin-fa), 1908 (fr), *J. Cavalerie* 3437 (E 2 sheets, K); Leishan, 5 x 1977, *Sichuan Forest Institute* 926 (SCFI); Shiqian, 750 m, 26 vii 1988 (fr), *Wulingshan Plants Exped.* 1654 (KUN 2 sheets); Xingren, 1200 m, 25 viii 1960 (fr), *Z.S. Zhang & Y.T. Zhang* 8469 (PE); Wuyi, 28 x 1976 (fr), *Sichuan Forest Institute* 192 (SCFI); Xishui, 19 xi 1927, *P.C. Tsoong* 68 (PE). HUBEI: Badong, 1800 m, 6 x 1958, *F.H. Chen* 5420 (HIB); Changyang, 1800 m, 25 vii 1959, *F.S. Peng* 1307 (HIB, cult.?); Enshi, 1500 m, 3 ix 1957 (fr), *G.X. Fu & Z.S. Zhang* 1508 (IBSC, NAS, PE 3 sheets); Hefeng, 1050 m, 24 viii 1958, *H.J. Li* 6346 (HIB, SZ); Ichang, 1887 (fl), *A. Henry* 4003 (GH, K, P, US, photocopy NA); Jianshi, 6 vii 1951, *L.Y. Dai & C.H. Qian* 115 (PE); Lichuan, 1180 m, 23 ix 2003 (bark & photo), *J.S. Ma* 5060 (BKL 2 sheets); Shennongjia, 1260 m, 21 ix 2003 (fr), *J.S. Ma* 5046 (BKL 5 sheets); West Hubei (Changyang), 1100–1200 m, 7 vi & 7 ix 1907 (fl & fr), *E.H. Wilson* 161 (A 2 sheets, BM, E, GH, K, US); Wufeng, 1500 m, 31 vii 1974 (fr), *Y.Z. Ma* 457 (HIB); Wuhan, 2 vi 1987 (fr), *Z.E. Zhao* 2381 (HIB, cult.); Xingshan, 1300 m, 17 vi 1983, *G.H. Chen* 98 (HIB); Xuanen, 1800 m, 1 vii 1958, *H.J. Li* 4395 (HIB 2 sheets); Yichang, 1300 m, 3 vii 1983 (fr), *G.H. Chen* 398 (HIB). HUNAN: Daoxian, 12 vii 1959, *P.C. Tam* 62780 (IBK, cult.); Dayong, vi 1978, *Z.S. Shen* 1491 (IBSC); Guzhang, 610 m, 17 vii 1985, *Q.S. Wang* 2494 (HIB), Sangzhi, 1150 m, 12 ix 1990 (fr), *T.R. Cao* 90249 (KUN); Jiangyong, 9 vii 1959, *P.C. Tam* 62264 (IBK, cult.?); Xinning, 17 vii 1979, *Z.C. Luo* 57 (IBSC, PE 2 sheets); Xuefengshan (Qianyang), in 1954, *Z.H. Li* s.n. (PE); Yongxing, 14 vii 1979, *W.S. Liao* 15132 (IBSC). JIANGSU: Lianyungan, 14 vii 1974, *R.X. Mi et al.* 74131 (NAS); Xuzhou, 20 vi 1974, *P.P. Ling et al.* 74018 (NAS). JIANGXI: Ruichang, 17 viii 1995, *C.M. Tan* 95589 (IBSC); Suichuan, 28 iv 1959, *S.K. Lai* 296 (PE); Wugongshan (Pingxiang), 14 ix 1954, *Jiangxi Exped.* 1264 (PE), 21 viii 1963, *J.S. Yue* 3610 (PE). SHAANXI: Mianxian, 28 x 1939, *T.N. Liou* 11993 (PE); Yangxian, 2 viii 1952, *P.C. Kuo* 1936 (CDBI, IBSC, NAS, PE). SICHUAN: Baoxing (Mupin), 1600 m, 25 v 1958 (fl), *Sichuan Agriculture University Team* 4966 (CDBI, SCFI); Ebian (Washan), 24 x 1938, *T.N. Liou* 12392 (PE), 17 ix 1908, *E.H. Wilson* 3228 (A, US); Emei Shan (Omeishan), 25 vii 1957, *S.Y. Chen* 3783 (NAS), 5 xi 1952, *W.P. Fang & T.W. Sung* 33486 (IBK, PE); 17 vii 1952 (fr), *J.H. Xiong et al.* 31653 (NAS, PE, SCFI, SZ, ut *W.P. Fang & S.C. Tsiang* 31653); Bao-shing-hsien, 4 vii 1936, *K.L. Chu* 3073 (E, PE); 10 xi 1933, *D.H. Du (T.H. Tu)* 4922 (PE); Kuan-hsien, 1000–1200 m, 8 vii 1928 (fr), *W.P. Fang* 2091 (A, E 2 sheets, K, NY, PE 2 sheets); 1600 m, 3 viii 1930 (fr), *F.T. Wang* 22110 (A, KUN, NAS, PE 2 sheets); Changning, 800 m, 18 v 1959, *Sichuan Economic Plants Exped.* 514 (KUN, PE); Fengjie, 1200 m, 27 ix 1964 (fl), *H.F. Chou & H.Y. Su* 110570 (SCFI); Ganluo, 25 viii 1959, *Sichuan Economic Plants Exped.* 4421 (PE); Guanxian (Kuan Hsien), 8 x 1938, *T.N. Liou* 9975 (PE); Gulan, 1300 m, 28 vii 1983 (fr), *K.H. Mu & Z.H. Dai* 848 (SCFI 3 sheets); Hejiang, 920 m, 20 vii 1990, *G.T. Gong & G.Z. Han* 70 (SCFI 2 sheets); Hongqi (Meigu), 1900 m, 19 vii 1959, *Sichuan Economic Plants Exped.* 1374 (CDBI, KUN, PE); Hongya (Hungyah), 12 vi 1955 (fr), *Sichuan Forest Institute* 2200 (CDBI, SCFI); Junlian, 21 iv 1959, *Sichuan Economic Plants Exped.* 86 (PE); Lixian, in 1956, *D.P. He* 47435 (SZ); Miyi, 28 v 1989 (fl), *H.Y. Liu* 89576 (SCFI); Nanchuan (Jinfoshan, Chin-fu-shan), 14 vi 1935, *K.L. Chu* 1329 (IBSC, PE); Nanjiang, 1060 m, 5 vi 1959, *Sichuan Economic Plants Exped. (B.L. Chen)* 2570 (CDBI, KUN); Pingwu, 920 m, 25 iv 1958, *S. Coll.* 10094 (SCFI); Yongchuan, 21 x 1982 (fr), *D.H. Du* 207 (CM, MICH, NY, PE). YUNNAN: Daguan, 1800 m,

18 viii 1972 (fr), *Northeast Yunnan Exped.* 238 (KUN 2 sheets); Kunming, Botanical Garden, 1900 m, 22 i 1988, *D.D. Tao* 88002 (KUN 2 sheets, cult.); Tengchong, 1740 m, 14 xi 1984 (fr), *C.H. Yang & Q.T. Zhang* 84-667 (KUN, cult.); Weixi, 3 xi 1940, *K.M. Feng* 8716A (KUN 2 sheets, PE); Yongde, 2300 m, 22 iv 2002, *E.D. Liu* 353 (KUN); Zhenxiong, 1800 m, 29 ix 1957, *Kunming Station Exped. (P.H. Yu)* 1065 (KUN 2 sheets, PE). ZHEJIANG: Tianmushan (Linan), 1 ix 1959, *Zhejiang Plant Inventory Team* 29493 (HZU, NAS); Tiantai, 18 vii 1959, *Zhejiang Plant Inventory Team* 28249 (HZU).

EXCLUDED SPECIES

Phellodendron burkillii Steenis, Gard. Bull. Singapore 17: 357 (1960). – Type: Malay Peninsula, Kedah: Enggang Forest Reserve, Sik, *PEP* 78904 (holo L; iso K, KEP, SING n.v.) = *Tetradium glabrifolium* (Champ. ex Benth.) T.G.Hartley.

There are a few fossil species reported from Europe (Huang, 1958; Tiffney, 1980) and North America (Tiffney, 1980).

ACKNOWLEDGEMENTS

We are grateful to the curators of A, BH, GH, IMC, MASS, MOAR, MOR, NY, NYS, PE, PH, SCFI, TI, US, W and WU for use of their collections; to the curators of E, HIB, IFP, K, KUN, KYO, MAK and P for loaning specimens; to Xinfen Gao (CDBI), Bonnie L. Issac and Cynthia Morton (CM), Xiaodong Li and Jianqiang Li (HIB), Rui Cao (HIMC), Chengxin Fu (HZU), Fanan Wei (IBK), Dezhi Fu and Dianxiang Zhang (IBSC), Haiying Ma and Shukun Chen (KUN), Qixin Liu and Rong Mo (NAS), Yuying Geng (PE) and Jie Bai (SZ) for providing distribution data; and to Yuri Roskov (LE) for providing photos of types at LE, Chinlong Zheng (Department of Forestry, the National Taiwan University) for providing literature, and Shuren Zhang (PE) and Mark Tebbitt (BKL) for their kind help in obtaining photos from LE and K, respectively. The senior author's field trip was supported by Brooklyn Botanic Garden and the Institute of Applied Ecology, Chinese Academy of Sciences in Shenyang; Xiaodong Li and Jianqiang Li (HIB) provided key help during our field trip to central China in 2003, and Jin Murata (TI) and Hiroko Murata (Setsunan University, Osaka) provided key help during our field work in Japan in 2004. The senior author especially thanks Kerry Barringer (BKL) for his help with loans, Paul Harwood (BKL) for his drawing, Carsten Glaeser (Glaeser Horticultural Consulting) for his help around the New York Metropolitan Area, and Michael Nee (NY) for his primary work on the identification of the cultivated species of the genus from the New York Botanical Garden and vicinity. We also thank Jacquelyn Kallunki (NY), Anthony Brach (MO at A/GH), anonymous reviewers and David Middleton, the editor of EJB, for their valuable comments and suggestions.

REFERENCES

CHANG, C. E. & HARTLEY, T. G. (1993). Rutaceae. In: HUANG, T. C. (ed.) *Flora of Taiwan,* 2nd edition, 3: 827–829, pl. 272. Taipei: Lungwei Printing Co.

CHASE, M. W., MORTON, C. M. & KALLUNKI, J. A. (1999). Phylogenetic relationships of Rutaceae: a cladistic analysis of the subfamilies using evidence from RBC and ATP sequence variation. *Amer. J. Bot.* 86: 1191–1199.

DODE, M. L. A. (1908). Arbores et frutices novi. *Bull. Soc. Bot. France* 55: 648–649.

ELIAS, T. S. (1986). The distribution and phytogeographic relationships of the woody plants of the Soviet Far East. *Aliso* 11: 335–354.

ENGLER, A. (1931). Rutaceae. In: ENGLER, A. & PRANTL, K. (eds) *Die Natürlichen Pflanzenfamilien,* 2nd edition, 19c: 187–359. Leipzig: Engelmann.

GAN, X. D. & DAI, K. M. (1990). Identification of the botanical origin of the Chinese drug Huang Bo. *J. Shanghai Med. Univ.* 17: 57–60.

GOO, G. H., LEE, K. Y., YOUNG, K. S. & LEE, C. K. (1997). Seed germination, seedling growth and optimal seedling density of *Phellodendron amurense* Rupr. in nursery. *J. Kor. For. Soc.* 86: 443–449.

GUERRA, M. S. (1984). New chromosome numbers in Rutaceae. *Pl. Syst. Evol.* 146: 13–30.

HARA, H. (1935). Preliminary report on the Flora of Southern Hidaka, Hokkaido (Yezo) IX. *Bot. Mag. Tokyo* 49(#588): 863–864.

HARTLEY, T. G. (1981). A revision of the genus *Tetradium* (Rutaceae). *Gard. Bull. Singapore* 34: 110–114.

HAYATA, B. & KANEHIRA, R. (1920). Rutaceae – *Phellodendron*. In: HAYATA, B. (ed.) *Icon. Pl. Formosan.* 9: 8–9.

HUANG, C. C. (1958). Preliminary study on Chinese Rutaceae (2). *Acta Phytotax. Sin.* 7: 329–337.

HUANG, C. C. (1997). Rutaceae. In: WU, C. Y., *Flora Reipublicae Popularis Sinicae* 43/2: 99–103 (in Chinese). Beijing: Science Press.

KERN, E. E. (1931). Velvet tree – *Phellodendron*. *Bull. Appl. Bot.* 27: 1–30.

KHARKEVYCH, S. S. (1989). *Plantae Vasculares Orientis Extremi Sovietici* 4: 341–343, pl. 105. Vladivostok: Dalnauka.

LIN, T. P., CHEN, M. H. & WU, C. T. (1994a). Germination enhancement and storage behavior of *Phellodendron wilsonii* seeds. *Bull. Taiwan For. Res. Inst.* 9: 21–28.

LIN, T. P., CHEN, M. H. & LIN, C. H. (1994b). Dormancy in seeds of *Phellodendron wilsonii* is mediated in part by abscisic acid. *Pl. Cell Physiol.* 59: 557–561.

LU, C. H., CHANG, J. J., YANG, X. F. & CUI, L. M. (2005). Food habit and migrating behavior of frugivorous birds in autumn in Maoershan Mountain. *Chin. J. Zool.* 40: 86–91.

MAKINO, T. (1929). Contributions to Flora of Japan. *J. Jap. Bot.* 6: 5.

MAKINO, T. (1931). Contributions to Flora of Japan. *J. Jap. Bot.* 7: 18.

MAXIMOWICZ, C. J. (1871). Diagnoses breves plantarum novarum Japoniae et Mandshuriae. *Bull. Acad. Imp. Sci. Saint-Pétersbourg* 16: 212.

NAKAI, T. (1918). Notulae ad plantas einiger. *Bot. Mag. (Tokyo)* 32: 107.

NAKAI, T. (1919). Notulae ad plantas einiger. *Bot. Mag. (Tokyo)* 33: 58–59.

NOACH, H. (1990). Das Portrait. *Phellodendron amurense* Ruprecht. *Mitt. Deutsch. Dendrol. Ges.* 79: 165–167.

OHBA, H. (1999). Rutaceae. In: IWATSUKI, K. *et al.* (eds) *Flora of Japan* 2c: 40. Tokyo: Kodansha Ltd.

OHWI, J. (1965). Rutaceae – *Phellodendron*. *Flora of Japan*, pp. 583–584. Washington, DC: Smithsonian Institution.

REHDER, A. (1940). *Manual of Cultivated Trees and Shrubs*, pp. 523–524. New York: The Macmillan Co.

RUPRECHT, F. J. (1857). Die ersten botanischen Nachrichten über das Amurland. Zweite Abtheilung: Bäume und Sträucher, beobachtet von Richard Maack. *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg* 15(23): 353–354.

SARGENT, C. S. (1905). *Trees and Shrubs, Illustrations of New or Little Known Ligneous Plants* 1: 199, pl. XCIV. Boston: Houghton, Mifflin and Co.
SARGENT, C. S. (1914). *Phellodendron*, Rutaceae. In: SARGENT, C. S. (ed.) *Plantae Wilsonianae* 2: 136–137. Publications of the Arnold Arboretum, No. 4. Cambridge: The University Press.
SCHMIDT, F. (1868). Reisen im Amurland und auf der Insel Sachalin. *Mem. Acad. Imp. Sci. Saint-Pétersbourg, sér. 7*, 12: 120.
SCHNEIDER, C. K. (1907). *Phellodendron. Ill. Handb. Laubholzk* II: 124–126. Jena: G. Fischer.
SCHNEIDER, C. K. (1912). *Phellodendron. Ill. Handb. Laubholzk* II: 1018. Jena: G. Fischer.
SHISHKIN, B. K. & BOBROV, E. G. (1949). Rutaceae. In: KOMAROV, V. L. (ed.) *Flora of USSR* 14: 178–179, & pl. 13, 181. Leningrad: Akademiya Nauk SSSR.
SPRAGUE, T. A. (1920). *Phellodendron. Bull. Misc. Inform. Kew* 1920: 231–235.
STARSHOVA, N. P. (1979). Biology of seed germination in *Phellodendron amurense* Rutaceae. *Bot. Zhurn.* 64: 1159–1168.
STEENIS, C. G. G. J. VAN (1960). *Phellodendron*, a genus of trees new to the Malayan flora (Rutaceae). *Gard. Bull. Singapore* 17: 357–360.
TIFFNEY, V. H. (1980). Fruits and seeds of the Brandon Lignite, V. Rutaceae. *J. Arnold Arbor.* 61: 1–40.
WANG, M. & TAO, D. L. (1998). Drought-tolerance of main tree species in Changbai Mountain. *Acta Appl. Ecol.* 9: 7–10.
WOLF, E. (1925). Die Korkbäume, *Phellodendron*, in Arboretum des Leningrader Forstinstitutes. *Mitt. Deutsch. Dendrol. Ges.* 1925: 215–218.
WU, Y. C. (1940). Beitrage zur Kenntnis der Flora Süd-Chinas. *Bot. Jahrb. Syst.* 71(2): 185–188.
YOSHIDA, T. & KAMITANI, T. (1999). Growth of a shade-intolerant tree species, *Phellodendron amurense*, as a component of a mixed-species coppice forest of central Japan. *Forest Ecol. Manag.* 113: 57–65.
ZHOU, Q. Y., JIN, X. B. & MU, X. J. (1999). Embryological studies on *Phellodendron amurense*. *Acta Bot. Yunnan.* 21: 317–322.
ZHOU, Q. Y., WANG, Y. Z. & JIN, X. B. (2002). Ontogeny of floral organs and morphology of floral apex in *Phellodendron amurense* (Rutaceae). *Amer. J. Bot.* 50: 633–644.
ZHU, N. & DONG, D. F. (1990). Seed dispersal, dormancy, seed bank and regeneration of Amur Corktree. *J. N.-E. For. Univ.* 1: 16–22.

Received 25 January 2006; accepted for publication 15 August 2006

INDEX TO THE SPECIMENS EXAMINED: (1) *P. AMURENSE* AND (2) *P. CHINENSE*

M. Albrecht s.n. (1).

A. Baranov & D.C. Zhao 641 (1); *B. Bartholomew et al.* 1152 (2); *Beyer, Erskine & Cowley* 101 (1), 301 (1); *E. Bodinier* 7689 (2); *D.E. Boufford & E.W. Wood* 19759 (1); *D.E. Boufford et al.* 22293 (1); *W.P. Brooks* 34 (1), 704 (1).

H.Z. Cao 1133 (1); *R. Cao* 83-2 (1); *T.R. Cao* 90249 (2); *Z.Y. Cao* 190 (2); *J. Cavalerie* 1776 (2), 3437 (2); *B.N. Chang* 406131 (2); *H.F. Chao* 40699 (1); *F.H. Chen* 398 (1), 5235 (2), 5420

(2), 5557 (2); *G.H. Chen* 98 (2), 398 (2); *P.Y. Chen et al.* 2852 (2); *S.Y. Chen* 3783 (2); *T.C. Chen* 860 (2); *Y.C. Chen* 1103 (2); *Z.Z. Chen* 51884 (2); *W.C. Cheng* 6795 (2); *China-German Exped. (T.N. Liou)* 7608 (1); *R.C. Ching* 7168 (2); *H.F. Chou & H.Y. Su* 110570 (2); *H.F. Chow* 40541 (1), 40940 (1), 41053 (1), 42007 (1); *K.L. Chu* 1329 (2); *S.H. Chun* 15546 (2), 15808 (2), 16640 (2); *W.Y. Chun* 3578 (2), 3662 (2), 3923 (1); *I.C. Chung* 1172 (1), 3220 (1), 3259 (1); *T.H. Chung* 1170 (1), 9949 (1); *S.C. Cui* 101 (1).

L.Y. Dai & C.H. Qian 115 (2), 1583 (2); *R.S. David* s.n. (1); *Dayaoshan Exped.* 10345 (2), 12011 (2); *K. Deguchi* 4541 (1); *L. Deng* 1299 (2); *D.H. Du (T.H. Tu)* 207 (2), 4948 (2).

W.P. Fang 10184 (2), 15616 (2); *U. Faurie* 179 (1), 767 (1), 3374 (1), 5044 (1), 5106 (1), 6871 (1); *K.M. Feng* 8716A (2); *G. Fenzel* 44 (1); *First Group* 162 (1); *G.X. Fu & Z.S. Zhang* 1007 (2), 1508 (2), 1667 (2); *P.Y. Fu* 795 (1); *S. Fujii* 197 (1), 5692 (1); *T. Fujii et al.* TWT-14821 (1); *N. Fukuoka & M. Hotta* s.n. (1); *N. Fukuoka et al.* 7727 (1); *H. Funakoshi* 680 (1), 712 (1), 1202 (1); *M. Furuse* 6815 (1), 7185 (1), 8854 (1), 8919 (1), 9549 (1), 11055 (1), s.n. (1); *N. Furuse* 34591 (1).

G.T. Gong & G.Z. Han 70 (2); *J.L. Gressitt* 2451 (2).

K.S. Hao 16188 (1); *H. Hara* s.n. (1); *H. Hara et al.* s.n. (1); *Harbin Normal University Exped.* 8391 (1), 9226 (1); *Y. Hayashi & Y. Takeuchi* s.n. (1); *H. Hayata* s.n. (1); *D.P. He* 47435 (2); *X.Y. He* 5542 (2), 7106 (2); *Heping Exped.* 600 (2); *M. Hiroe* 6828 (1); *K. Hisauchi* 826 (1), 2374 (1); *M. Honda* 58 (1); *K. Hosoi* 10987 (1), 11013 (1); *Howick and McNamara – Expedition to Hokkaido* EHOK 14 (1); *C.M. Hu* 7502 (2); *D.A. Huang* 60341 (2), 60937 (2); *F.S. Huang* 2106 (2); *R.H. Huang* 655 (2); *Hubei Bot. Exped.* 2403 (2); *J. Hurusawa* s.n. (1); *C.T. Hwa* 13 (2).

H. Idzumi 680 (1); *IFP Survey Team* 26 (1); *H.T. Im* 10501 (1); *Institute of Botany Exped.* 30316 (1); *J. Ishidoya* 73 (1); *H. Ito* s.n. (1).

J.G. Jack s.n. (1); *H.E.M. James* s.n. (1); *Jiangxi Exped.* 1264 (2); *K. Jimbo* s.n. (1); *J. Julila & H. Fujino* 408 (1).

Y. Kadota 2442 (1); *H. Kanai* 1664 (1), 2421 (1), 3502 (1), 4069 (1), 4671 (1), 5998 (1), 7299 (1), 731260 (1), s.n. (1); *B. Kasapligil* 3570 (1); *A. Kimura et al.* s.n. (1); *K. Kisaut* 2850 (1); *A. Kiss* s.n. (1); *M. Kitagawa* s.n. (1); *S.P. Ko* 50896 (2); *S. Kobayashi* s.n. (1); *T. Kobayashi* 2146 (1); *G. Koidzumi* s.n. (1); *G. Koidzumi & Y. Okamoto* s.n. (1); *V.L. Komarov* s.n. (1), 1013 (1); *S. Komat* s.n. (1); *Y. Komori* 1964; *K. Kondo* 7623 (1), 7880 (1), s.n. (1); *Y. Koukami* 3645 (1); *N. Kozlow* 14023 (1); *L. Kozshinsky* s.n. (1); *Y. Kumori* s.n. (1); *Kunming Station Exped. (P.H. Yu)* 1065 (2); *H.W. Kung* 1914 (1); *P.C. Kuo* 1936 (2); *S. Kurosawa* s.n. (1); *S. Kurosawa & T. Tataishi* s.n. (1).

S.K. Lau 296 (2), 28764 (2); *T.S. Lau* 301 (2); *T.C. Lee* 4588 (2); *B.G. Li & S.F. Wan* 750105 (2); *C.F. Li* 10047 (1); *G.F. Li* 1957 (2), 61492 (2), 61954 (2), 62315 (2), 63312 (2), 63613 (2), 64267 (2); *H.J. Li* 4395 (2), 6346 (2), 8069 (2); *S.X. Li* 68 (1), 3596 (1), 5895 (1); *S.X. Li et al.* 529 (1), 1185 (1); *Y.K. Li & D.S. Zhang* 8253 (2); *Z.D. Li* 600845 (2); *Z.H. Li* s.n. (2); *C.F. Liang* 34348 (2); *W.S. Liao* 15132 (2); *P. Licent* 8526 (1); *W.B. Lin* 485 (2); *Z.Q. Lin* 10018 (2); *P.P. Ling et al.* 74018 (2); *T.N. Liou* 1269 (1), 4227 (1), 9975 (2), 11993 (2), 12392 (2); *T.N. Liou & P.C. Tsoong* 3746 (2); *T.N. Liou et al.* 265 (1), 3468 (1); *G. Littledale* s.n. (1); *D. Litvino* s.n. (1); *E.D. Liu* 353 (2); *H.Y. Liu* 89576 (2); *L.H. Liu* 9071 (2); *S.Z. Liu* 352 (1), 600 (1); *X.Y. Liu* 1622 (1); *Z.Y. Liu* 469 (2), 1973 (2), 8782 (2), 10641 (2), 14767 (2); *H.S. Lo* 705 (2); *Z.C. Luo* 57 (2).

J.S. Ma 5001 (1), 5002 (1), 5003 (1), 5004 (1), 5005 (1), 5006 (1), 5007 (1), 5008 (1), 5009 (1), 5010 (1), 5011 (1), 5012 (1), 5013 (1), 5014 (1), 5015 (1), 5016 (1), 5017 (1), 5018 (1), 5019 (1), 5020 (1), 5021 (1), 5022 (1), 5023 (1), 5024 (1), 5025 (1), 5026 (1), 5027 (1), 5028 (1), 5029 (1), 5030 (1), 5031 (1), 5032 (1), 5033 (1), 5034 (1), 5035 (1), 5036 (1), 5037 (1), 5038 (1), 5039 (1), 5040 (1), 5041 (1), 5042 (1), 5043 (1), 5044 (1), 5046 (2), 5047 (2), 5048 (2), 5049 (2), 5050 (2), 5051 (2), 5052 (2), 5053 (2), 5054 (2), 5055 (2), 5056 (2), 5057 (2), 5058 (2), 5059 (2), 5060 (2),

5061 (2), 5062 (2), 5063 (2), 5064 (2), 5065 (2), 5066 (2), 5067 (2), 5068 (2), 5069 (2), 5070 (2), 5071 (2), 5072 (2), 5073 (2), 5074 (1), 5075 (1), 5076 (1), 5077 (1), 5078 (1), 5079 (1), 5080 (1), 5081 (1), 5082 (1), 5083 (1), 5084 (1), 5085 (1), 5086 (1), 5087 (1), 5088 (1), 5089 (1), 5090 (1), 5091 (1), 5092 (1), 5093 (1), 5094 (1), 5095 (1), 5096 (1), 5097 (1), 5098 (1); *Y.C. Ma* 96 (1), 101 (1); *Y.Z. Ma* 333 (2), 457 (2); *R. Maack* s.n. (1); *F. Maekawa* s.n. (1); *T. Makino* s.n. (1); *Mr. Maries* s.n. (1); *J. Matsumura* s.n. (1); *C.J. Maximowicz* s.n. (1); *Medical Herbs Exped.* 2290 (1); *F.G. Meyer et al.* 19003 (1), 19258 (1); *R.X. Mi et al.* 74131 (2); *O. Michihito* 38533 (1); *K. Miyabe* s.n. (1); *Miyun Exped.* 142 (1); *M. Mizushima* 241 (1), 2290 (1), 2821 (1), 11621 (1), 13808 (1), s.n. (1); *Y. Momiyama* s.n. (1); *K.H. Mu & Z.H. Dai* 848 (2); *T. Murakami* 177 (1); *H. Muramatu* s.n. (1); *G. Murata & M. Togashi* 167 (1); *J. Murata* 30395 (1); *J. Murata & T.T. Chen* 7666 (1); *J. Murata*, *H. Ohashi & Y. Tateishi* 1804 (1); *J. Murata*, *H. Ohba & S. Akiyama* 5730 (1); *H. Muroi* 391 (1), 3389 (1), 3573 (1), 3751 (1), 4336 (1), 4624 (1), 4680 (1), 5383 (1), 5496 (1).

NACPEC HLJ-23 (1); *T. Nakai* 185 (1), 186 (1), 656 (1), 1299 (1), 2047 (1), 2048 (1), 2049 (1), 2050 (1), 4380 (1), 4381 (1), 5597 (1), 5598 (1), 7219 (1), 7220 (1), 12385 (1), 13084 (1), 13085 (1), 13086 (1), 13087 (1), 17136 (1), 17482 (1), s.n. (1); *T. Nakai et al.* s.n. (1); *Nankai University Exped.* 54 (1); *Nanling Exped.* 622 (2); *T. Neczaeva & V. Verholat* 5584 (#3627) (1); *M. Noda et al.* 94 (1), 120 (1), 641 (1); *Northeast Normal University Exped.* 882 (1); *Northeast Yunnan Exped.* 238 (2).

H.G. Oga 5748 (1); *H. Ohashi & Y. Fukuda* s.n. (1); *H. Ohashi & Y. Tateishi* 686 (1).

N. Palczewsky 3627 (1), s.n. (1); *C. Pei* 7213 (2), 10239 (2); *PE Exped.* 1239 (1); *F.S. Peng* 473 (2), 1307 (2); *Plant Exploration in the Republic of Korea* 170 (1); *Plant Geography Exped.* 723 (2); *Plants Exped.* s.n. (1).

Y. & N. Quadota 3329 (1).

G. Raddle s.n. (1); *Regel* s.n. (1).

S. Saito s.n. (1), A-189 (1), 3582 (1), 7151 (1); *K. Sakurai* s.n. (1); *C.S. Sargent* s.n. (1); *J. Sato* s.n. (1); *M. Savatier* s.n. (1); *T. Sawada* s.n. (1); *L. Schrenk* s.n. (1); *Shaoguan Exped.* 1111 (2); *Z.S. Shen* 1491 (2); *Shennongjia Plants Exped.* 11638 (2); *Sichuan Agriculture University Team* 4966 (2), 5202 (2), 5254 (2); *Sichuan Economic Plants Exped.* 86 (2), 305 (2), 514 (2), 1374 (2), 2570 (2), 4421 (2); *Sichuan Forest Institute* 192 (2), 926 (2), 2200 (2), 6317 (2); *Sino-American Bot. Exped.* 4173 (2), 4514 (2), 5241 (2); *B.V. Skvortzow* s.n. (1); *Smithsonian-Korea Ecological Project (Y.N. Lee & Y.S. Lee)* 287 (1); *C.S. Song* 200 (1), 82-2 (1); *South Central China Forest University Exped.* 30914 (2); *T. Sugawara* 1072905 (1), 2080913 (1), s.n. (1); *T. Sugawara & A. Makmoto* s.n. (1); *T. Sugawara & Y. Sugawara* 1090805 (1); *D.Y. Sun* 80018 (1); *S.C. Sun & K. Chang* s.n. (2).

M. Takahasi s.n. (1); *P.C. Tam* 62264 (2), 62780 (2); *M. Tamura et al.* 22196 (1), 22202 (1); *C.M. Tan* 95589 (2); *G.G. Tang et al.* 388 (2); *P.C. Tang* 790001 (1); *D.D. Tao* 11534 (2), 88002 (2); *L. Taquet* 4088 (1); *Z. Tashiro* s.n. (1); *Y. Tateishi et al.* 15055 (1); *Temperate Forest Group* 451 (1); *X.F. Tian* 194 (1); *M. Togashi* 668 (1), 7630 (1), s.n. (1); *Y. Tokubuchi* s.n. (1); *Y. Tomimoto* s.n. (1), 2797 (1); *P.C. Tsoong* 68 (2); *K. Tsuchiya* 1390 (1); *M. Tsuchiya* 5919 (1); *M.K. Tsugaru* 3213 (1); *S. Tsugaru & T. Takahashi* 6816 (1), 13565 (1), 13636 (1), 13655 (1), 13714 (1), 26198 (1), 27840 (1), 29433 (1).

J. Uatsumura s.n. (1); *K. Ueda*, *S. Terabayashi & Y. Ueda* 1321 (1); *K. Uno* 24139 (1); *F.H. Utech & M. Hoshi* 89-155 (1); *F.H. Utech et al.* 91-360 (1).

C.S. Wang 4375 (1); *C.S. Wang et al.* 2513 (1), 3265 (1); *D. Wang* 2290 (1); *F.T. Wang* 169 (1); *G.Z. Wang* 184 (1), 4021 (1); *G.Z. Wang & Q.T. Li* 109 (1); *G.Z. Wang et al.* 162 (1); *Q.L. Wang & J.L. Zhang* 188 (1); *Q.S. Wang* 1961 (2), 2102 (2), 2494 (2); *W. Wang* 1330, 2418 (1); *W. Wang et al.* 511 (1); *Y.M. Wang* 457 (2); *Z. Wang & Y.X. Liu* 1458 (1); *Z.T. Wang et al.* 870190 (2); *Wengyuan Herbs Exped.* 64 (2); *E.H. Wilson* 161 (2), 1286 (2), 2739 (2), 3227 (2), 3228 (2), 3566 (2), 3567 (2), 4217 (2), 6770 (1), 6771 (1), 6870 (1), 6893 (1), 6898 (1), 7058 (1),

7626 (1), 8507 (1), 8599 (1), 8696 (1), 8874 (1), 8902 (1), 9606 (1), 10909 (1), s.n. (1); *Q.R. Wu* 9 (1); *S.Z. Wu* 70092 (2); *Wulingshan Plants Exped.* 1381 (2), 1654 (2), 2896 (2); *Wuyishan Exped. Team* 2081 (2); *Xinning Exped.* 1028 (2).

J.H. Xiong & Z.L. Zhou 91117 (2), 91464 (2), 91916 (2), 92732 (2); *J.H. Xiong et al.* 33484 (2).

Y. Yabe s.n. (1); *J. Yamazaki* 162 (1); *T. Yamazaki* M75-324 (1), s.n. (1); *Yanbian First Group* 322 (1); *Yanbian Second Group* 60 (1), 761 (1); *C.H. Yang & Q.T. Zhang* 84-667 (2); *G.H. Yang* 56125 (2); *W.H. Yang* 96 (1); *Y.L. Yang* 798 (1); *Z.C. Ye* 193 (2), 504 (2), 671 (2); *Yingkou Exped.* 146 (1); *I. Yokouchi* s.n. (1); *K. Yonekura* 5959 (1); *O. Yongsok* 6083 (1); *S.W. Yu* 86025 (2); *J.S. Yue* 3610 (2); *J.S. Yue et al.* 4233 (2).

G.C. Zhang 351 (2); *J.Z. Zhang & X.R. Chen* s.n. (2); *Y.L. Zhang* 39 (1); *Y.L. Zhang et al.* 294 (1), 959 (1), 1718 (1), 1785 (1); *Z.S. Zhang & Y.T. Zhang* 3013 (2), 3383 (2), 8469 (2); *Z.E. Zhao* 2381 (2); *Zhejiang Plant Inventory Team* 28249 (2), 29493 (2); *S.Q. Zhou* 1181 (1); *T.Y. Zhou et al.* 2178 (1), 7346 (1); *Y.L. Zhou* 2076 (1); *Y.L. Zhou et al.* 2921 (1); *H.Q. Zhu* 679 (2), 773 (2); *Z.S. Zhu* 754 (2).