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Research Article

Taxonomic revision of the *Symplocos nakaharae* complex (Symplocaceae) with special reference to fruit morphology

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Abstract Over 70 species and infraspecific taxa have been described in the *Symplocos nakaharae* (Hayata) Masam. complex (Symplocaceae), and the taxonomy of this complex has been controversial. To provide a rational taxonomic revision of the complex, extensive field observations were carried out and approximately 800 herbarium specimens, covering the whole distribution range, were examined to evaluate the taxonomic importance of morphological characteristics. Our studies recognized 13 species and one subspecies, including *S. boninensis*, *S. henryi*, *S. kawakamii*, *S. lucida*, *S. nakaharae*, *S. migoi*, *S. multipes*, *S. pergracilis*, *S. setchuensis*, *S. shilanensis*, *S. tanakae*, *S. tetragona*, *S. theifolia*, and *S. lucida* subsp. *howii* comb. nov. One new combination is made and two new synonyms, *S. ernestii* Dunn var. *pubicalyx* C. Chen syn. nov. and *S. kuroki* Nagam. syn. nov., are recognized. Two identification keys are provided, based primarily on flower and fruit characters. Detailed morphological descriptions and geographical distribution information of the 14 taxa are given.

Key words fruit morphology, Symplocaceae, *Symplocos nakaharae* complex, taxonomic revision.

The genus *Symplocos* Jacq., first established by Jacquin (1760), is composed of approximately 340 species worldwide (Fritsch et al., 2008). The *Symplocos nakaharae* (Hayata) Masam. complex belongs to subgenus *Symplocos* Jacq. Section *Lodhra* G. Don. The complex consists of closely related species with morphological similarities and they are distributed in Bhutan, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Thailand, and Vietnam. This group differs from other species in the section in having glabrous twigs, adaxially prominent midvein, and long white hairs on the disc. The complex is also supported by molecular evidence. According to Wang et al. (2004), the Bayesian inference tree of *Symplocos* based on internal transcribed spacer region DNA sequence analysis shows that 11 taxa of the *S. nakaharae* complex form a monophyletic clade.

The current taxonomy of the *S. nakaharae* complex has been disputed and is inconsistent, due to the morphological attributes underlying the separation of the taxa within the group being inadequate and the researchers' methodologies and concepts applied to the revisions being different.

It is difficult to procure an adequate number of specimens to cover the whole variation and distribution range of the complex. In addition, the available herbarium specimens usually lack flowers and/or mature fruits. Furthermore, collecting the living materials of some taxa in the field is challenging, as they are often distributed sparsely or occur in small populations, such as *S. henryi* Brand, *S. tetragona* F. H. Chen ex Y. F. Wu, and *S. boninensis* Rehder & E. H. Wilson.

Since the first name *Laurus lucida* Thunb. was described by Thunberg in 1784 (Thunberg, 1784), 70 taxonomic names have been published for species and infraspecific taxa in the *S. nakaharae* complex. As shown in Table 1, where a comparison of different treatments is presented, the number of species of the complex varies greatly according to different authors.

Brand (1901) recognized seven species in the complex in his contribution of Symplocaceae to Engler's *Das Pflanzenreich*. He attributed *S. crassifolia* Benth., *S. japonica* A. DC., *S. phyllocalyx* C. B. Clarke, and *S. setchuensis* Brand ex Diels to subg. *Hopea* (L. f.) C. B. Clarke sect. *Palaeosymplocos* Brand; *S. acutangula* Brand, *S. henryi*, and *S. theifolia* D. Don to subg. *Hopea* (L. f.) C. B. Clarke sect. *Bobua* (DC.) Brand. The stamens of the former section are conspicuously pentadelphous. The species are also distinguished by stamen characters. The number of stamens

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Table 1 Previous assignments of the species currently included in *Symplocos nakaharae* complex

Brand (1901)	Handel-Mazzetti & Peter-Stibal (1943)	Wu (1987)	Nagamasu (1993)	Nagamasu (1998)	Wang (2000)	Nooteboom (1975, 2005), Wu & Nooteboom (1996)	Present study
S. crassifolia Benth.	*S. crassifolia* Benth.	*S. crassifolia* Benth.	—	—	—	*S. lucida* (Thunb.) Siebold & Zucc.	*S. lucida* Wall. ex G. Don subsp. *lucida*
/	/	—	—	—	—	—	*S. lucida* Wall. ex G. Don subsp. *howii* (Merr. & Chun ex L. H. Li) Bo Liu & H. N. Qin
S. henryi Brand	*S. henryi* Brand	*S. henryi* Brand	—	—	—	—	*S. henryi* Brand
/	*S. multipes* Brand	*S. multipes* Brand	—	—	—	—	*S. multipes* Brand
/	/	*S. tetragona* F. H. Chen ex Y. F. Wu	—	—	—	—	*S. tetragona* F. H. Chen ex Y. F. Wu
S. setchuensis Brand ex Diels	*S. setchuensis* Brand ex Diels	*S. setchuensis* Brand ex Diels	—	*S. setchuensis* Brand	*S. lucida* (Thunb.) Siebold & Zucc. *p. p.*	—	*S. setchuensis* Brand ex Diels
S. acutangula Brand	*S. acutangula* Brand	—	—	—	—	—	—
/	*S. sinuata* Brand	—	—	—	—	—	—
S. theifolia D. Don	*S. theifolia* D. Don	*S. theifolia* D. Don	—	—	—	—	*S. theifolia* G. Don
S. phyllocalyx C. B. Clarke	*S. phyllocalyx* C. B. Clarke	*S. phyllocalyx* C. B. Clarke	—	—	—	—	—
/	*S. ernesti* Dunn	—	—	—	—	—	—
/	*S. discolor* Brand	—	—	—	—	—	—
—	—	—	*S. tanakae* Matsum.	—	—	—	*S. tanakae* Matsum.
—	—	—	*S. nakaharae* (Hayata) Masam.	—	*S. japonica* A. DC. var. *nakaharae* Hayata *auct. non.*	—	*S. nakaharae* (Hayata) Masam.
S. japonica A. DC.	—	—	*S. kuroki* Nagam.	—	*S. lucida* (Thunb.) Siebold & Zucc. *p. p. auct. non.*	—	—
—	—	—	*S. pergracilis* (Nakai) T. Yamaz.	—	—	*S. boninensis* Rehder & E. H. Wilson	*S. pergracilis* (Nakai) T. Yamaz.
—	—	—	*S. boninensis* Rehder & E. H. Wilson	—	—	—	*S. boninensis* Rehder & E. H. Wilson
—	—	—	*S. kawakamii* Hayata	—	—	—	*S. kawakamii* Hayata
/	/	/	/	*S. migoi* Nagam.	*S. lucida* (Thunb.) Siebold & Zucc. *p. p.*	—	*S. migoi* Nagam.
/	/	—	—	*S. shilanensis* Y. C. Liu & F. Y. Lu	*S. shilanensis* Y. C. Liu & F. Y. Lu	—	*S. shilanensis* Y. C. Liu & F. Y. Lu

/, not published at that time; —, not referred to or mentioned.

was recognized as a significant character for species circumscription.

Handel-Mazzetti & Peter-Stibal (1943) made a revision of Chinese *Symplocos*. They recognized 10 species in the *S. nakaharae* complex, including *S. ernestii* Dunn, *S. setchuensis*, *S. sinuata* Brand, *S. discolor* Brand, *S. phyllocalyx*, *S. acutangula*, *S. theifolia*, *S. multipes* Brand, *S. henryi*, and *S. crassifolia*. They are all placed into subg. *Eosymplocos* Hand.-Mazz. sect. *Palaeosymplocos* Brand based on the characters: stamens pentadelphous; ovary pilous; and midvein prominent on the upper surface. The characters that he used to classify the species within the complex are the shape of leaves, number of stamens, and type of inflorescences.

The truly worldwide revision of *Symplocos* was made by Nooteboom (1975, 2005). He recognized only two species in the complex, *S. lucida* (Thunb.) Siebold & Zucc. and *S. boninensis*, all other species proposed by Brand (1901) and Handel-Mazzetti & Peter-Stibal (1943) being reduced to synonyms of *S. lucida* (Thunb.) Siebold & Zucc., including some obviously vegetatively distinct entities in the complex. He considered the different types of inflorescences, raceme, spike, and glomerule, as just continuous variation in this complex. He paid no attention to the fruit anatomy characters within the complex.

There are a number of limitations to his revision. First, the revision was based on examinations of only a limited number of herbarium specimens, as listed in his monograph (Nooteboom, 1975). Most specimens that he examined focused on four specimen-abundant species, including *S. lucida* Wall. ex G. Gon, *S. nakaharae*, *S. setchuensis*, and *S. theifolia*. For other species not frequently seen, he checked only the type specimens. Second, he went only to Thailand, Malaysia, and West Java to collect *Symplocos* species in the field, as referred to in his monograph (Nooteboom, 1975). Consequently, except for a few populations of *S. theifolia* and *S. lucida* Wall. ex G. Gon in tropical areas, he did not see other species in the wild. This is not adequate to study variability within species.

Wu (1986a, 1986b, 1987) disagreed with the standpoint of Nooteboom (1975, 1976, 1977) about the revision of the complex. She recognized seven species in China, mainly using inflorescence characters as diagnostic characters. She mostly agreed with Handel-Mazzetti & Peter-Stibal's concept (1943) of subg. *Hopea* sect. *Palaeosymplocos*, but she reduced *S. sinuata* and *S. acutangula* to synonyms of *S. setchuensis*, and treated *S. ernestii* and *S. discolor* as synonyms of *S. phyllocalyx*. These are distinguished only by the small differences between leaf shape and size. But later when she co-operated with Nooteboom in *Flora of China* (Wu & Nooteboom, 1996), she totally accepted Nooteboom's opinion (1975) and reduced the seven species described in *Flora Reipublicae Popularis Sinicae* to synonyms of the Japanese endemic species *S. lucida* (Thunb.) Siebold & Zucc.: *S. crassifolia*; *S. henryi*; *S. multipes*; *S. tetragona*; *S. setchuensis*; *S. theifolia*; and *S. phyllocalyx* (five species endemic to China, the other two endemic to East Asia) (Wu, 1987). Nagamasu (1993, 2006) carried out a comprehensive research program. He recognized six species of this complex in Japan according to leaf size, fruit shape, and number of flowers on each inflorescence and gave a new nomination, *S. kuroki* Nagam., for *S. lucida* (Thunb.) Siebold & Zucc. due to the heterogeneity of two earlier homonyms, *S. lucida* Wall. ex G. Don (1837) and *S. lucida* (Thunb.) Siebold & Zucc (1838). He recognized three species of this complex in Taiwan, China, *S. setchuensis* and two new species, *S. migoi* Nagam. and *S. shilanensis* Y. C. Liu & F. Y. Lu. They all belong to subg. *Hopea* sect. *Palaeosymplocos* Brand. Wang (2000) disagreed with Nagamasu's conclusions in *Flora of Taiwan*. He recognized two species and one subspecies and reduced *S. setchuensis* and *S. migoi* to synonyms of *S. kuroki* and also accepted *S. shilanensis* and *S. japonica* A. DC. var. *nakaharae* Hayata in Taiwan, China. Nooteboom (2005) made a supplement to his previous work and completed his worldwide revision of Symplocaceae. He recognized only two species in the complex, *S. boninensis* and *S. lucida* (Thunb.) Siebold & Zucc., as he did in 1975. He also expressed his views in other floras and books related to the complex, such as Symplocaceae in *Flora of Taiwan* (Nooteboom, 1976) and *Flora Malesiana* (Nooteboom, 1977).

In general, the specimens in the complex are superficially vegetatively similar when they are mounted for herbaria. Previous workers, such as Ying (1975), Wu (1987), Nagamasu (1987, 1993, 1998), Wang & Ou (1999), Wang (2000), and Zhou et al. (2006), paid attention only to local taxa without a comprehensive worldwide revision. The worldwide revision made by Nooteboom (1975, 2005) holds a totally different view of the definition of "species" compared with previous workers, and his species concept was so broad that his classification has not been accepted by other taxonomists. Ying (1975, 1987), Nagamasu (1998), and Wang & Ou (1999) all expressed disagreement in their articles with the assessment of Symplocaceae as proposed by Nooteboom (1975).

In the monograph by Nooteboom (1975), the fruit characters and their variation in many species from Southeast Asia were not described in sufficient detail (Mai & Martinetto, 2006) and the great morphological variation of different taxa within this complex was not fully considered. This all leads to confusion for anybody

who tries to identify taxa in the *S. nakaharae* complex. All previous work has made the delimitation of the *S. nakaharae* complex controversial, and several new taxa have been described for only few morphological variations from the typical forms. Many morphological characters have no taxonomic significance and the use of these characters can lead to uncertainty in plant identification. The identity of the *S. nakaharae* complex is important because it and related species are significant constituents of subtropical forest in Asia, so further investigation and revision of the *S. nakaharae* complex is required.

Is the *S. nakaharae* complex composed of two polymorphic species, or can more than two taxa within the complex be recognized? To answer these questions and to seek support for a taxonomic revision of the group, a comprehensive study of the group is needed throughout its distribution area. The aims of the present study are to gather comprehensive information to reveal the variation patterns of morphological characters, to make a revaluation of micro- and macromorphological characters, and to complete a taxonomic rearrangement of this complicated group.

1 Material and methods

We studied the morphology, distribution, and habitats of the *Symplocos nakaharae* complex in the field between 2007 and 2010 at ca. 30 sites throughout the entire known distribution range. We observed the plants of the complex in the field in China at Chongqing, Fujian, Guangxi, Guizhou, Hubei, Hunan, Jiangsu, Jiangxi, Shannxi, Sichuan, Yunnan, and Zhejiang. Several colleagues helped us to collect plant materials and supplied us with photographs of living plants from eight sites in Taiwan (China) and six sites in Japan in 2010.

We also carried out comprehensive bibliographic research on the taxonomy of this complex. We studied more than 800 specimens from the following 37 herbaria, A, B, BM, CDBI, CGE, CQBG, E, G, GH, HAST, HHBG, HIB, HWA, I, IBSC, K, KUN, KYO, L, LBG, N, NAS, NY, PE, SAUF, SING, SM, SWAU, SZ, TI, TNS, TOFO, UC, UPM, W, WH, and YL. Herbarium abbreviations follow *Index Herbariorum* (Holmgren & Holmgren, 1998).

A subset of 80 specimens was selected to serve as operational taxonomic units for fruit anatomy experiments. Fruits were selected from mature and complete specimens of living or herbarium specimens in a good state of conservation, later observed under an SMZ1000 stereo microscope and photographed with a DXM1200F digital camera (both Nikon, Yokohama, Japan). A list of voucher specimens and localities is given in Table 2. The mature fruits were examined with a dissecting microscope. At least five fruit samples for each taxon were chosen to cover the range of variation (except for *S. henryi*, with only three fruit specimens known).

For scanning electron microscope pollen observations, pollens of the 14 taxa were collected from dry specimens and some from liquid-preserved specimens. At least three flowering specimens for each taxon were chosen to carry out the experiment. The pollen grains were dehydrated through an ethanol series and treated with critical point drying by solvent-substituted liquid CO_2. After being coated with gold, they were observed with an S4800 scanning electron microscope (Hitachi, Naka, Japan). The terminology follows Erdtman (1952), van der Meijden (1970), Barth (1979, 1982), Liang (1986), and Nagamasu (1989b).

2 Results

We present a taxonomic revision of the *Symplocos nakaharae* complex, including a key to species, description, and representative specimens. The new morphological characters are added in the taxonomic descriptions, including the numbers of locules, the texture and thickness of the mesocarp, and the surface morphology and texture of the endocarp.

2.1 Infructescence characters

The infructescences of the *S. nakaharae* complex are axillary, simple, or sometimes branched at the base. There are a bract and two bracteoles at the base of the flower. Bracts and bracteoles are often keeled and caducous. Morphological characters of infructescence are lised in Table 3.

2.1.1 Type of infructescences

2.1.1.1 Raceme (Fig. 4: A) Infructescences are simple or branched from the middle of the main axis and bear 2–8 pedicellate fruits on each infructescence, pedicel 3–6 mm long.

Symplocos lucida Wall. ex G. Don subsp. *lucida*, *S. lucida* subsp. *howii* (Merr. & Chun ex L. H. Li) Bo Liu & H. N. Qin, *S. henryi* and *S. multipes* are included.

2.1.1.2 Spike (Fig. 4: B, C) Infructescences are contracted, branched or not. The axes of branches are visible, often 0.6–3 cm (but 4–8 cm in *S. tetragona*) long. There are often 1–8 (but 10–40 in *S. tetragona*, the largest number in the complex) non-pedicellate fruits on each infructescence.

S. pergracilis (Nakai) T. Yamaz., *S. boninensis*, *S. kawakamii* Hayata, *S. theifolia*, *S. migoi*, *S. shilanensis*,

Table 2 Voucher specimens of fruit material from *Symplocos nakaharae* complex studied in lateral view and transverse section

Taxon	Figure	Voucher	Locality
S. boninensis Rehder & E. H. Wilson	1: J and 2: A	H. Tabata & Y. Shimizu 79–51 (TI)	Bonin Islands, Japan
S. henryi Brand	1: N and 2: G	K. M. Feng 4637 (KUN)	Pingbian, Yunnan, China
S. kawakamii Hayata	1: L and 2: C	G. Murata et al. 110 (TI)	Chichijima Island, Bonin Islands, Japan
S. lucida Wall. ex G. Don subsp. *lucida*	1: G and 2: D	Y. Tsiang 233 (PE)	Guangdong, China
S. lucida Wall. ex G. Don subsp. *howii* (Merr. & Chun ex L. H. Li) Bo Liu & H. N. Qin	1: H and 2: E	Anonymous s.n. (PE)	Hainan, China
S. nakaharae (Hayata) Masam.	1: C and 2: F	M. Togasi 1800 (PE)	Hikarishi in Suwo, Honshu, Japan
S. migoi Nagam.	1: A and 2: J	J. C. Wang et al. 8611 (TAI)	Hualian, Taiwan, China
S. multipes Brand	1: F and 2: I	Anonymous s.n. (SZ)	Sichuan, China
S. pergracilis (Nakai) T. Yamaz.	1: I and 2: B	F. Miyoshi 11306 (PE)	Bonin Islands, Japan
S. setchuensis Brand ex Diels	1: D and 2: K	B. Liu 255 (PE)	Jiujiang, Jiangxi, China
S. shilanensis Y. C. Liu & F. Y. Lu	1: B and 2: O	S. M. Liu 271 (TAI)	Manchou, Taiwan, China
S. tanakae Matsum.	1: M and 2: H	S. Amino et al. 260 (TI)	Kagoshima, Kyushu, Japan
S. tetragona F. H. Chen ex Y. F. Wu	1: K and 2: N	B. Liu 5 (PE)	Hangzhou, Zhejiang, China
S. theifolia G. Don	1: E and 2: L, M	B. Liu 180 (PE)	Jianwei, Sichuan, China

Herbarium abbreviations follow *Index Herbariorum* (Holmgren & Holmgren, 1998).

S. tanakae Matsum., and *S. nakaharae* (shown in Fig. 4: B, and *S. tetragona* shown in Fig. 4: C) are included.

2.1.1.3 Glomerule (Fig. 4: D) Infructescences are condensed, without axis. Each infructescence bears 3–8 fruits.

Symplocos setchuensis is included.

2.1.2 Length of infructescences The length of infructescences varied greatly from 0.6 to 3(–8) cm long. The infructescences axis is extremely short, even invisible, in *S. setchuensis* and it is the longest in *S. tetragona*, ca. 4–8 cm long. The axes of other species of the complex are in the range 0.6–3 cm long.

2.2 Morphological characters of fruits

The mature fruit is a monopyrenous drupe (Fig. 1: A–N), with blue, bluish black to dark blue color in most species, but purple in *S. shilanensis*. The fruits are similar in size in many species, generally 8–15 × 4–8 mm. The largest fruits were observed in *S. henryi*, 35–45 × 16–25 mm (Fig. 1: O), with the second largest in *S. boninensis*, 20–25 × 8–13 mm (Fig. 1: J) and the narrowly ellipsoidal fruits in *S. pergracilis*, 20–25 × 7–12 mm (Fig. 1: I).

The shapes of the fruits are ellipsoid to obovoid in most species, but globular in *S. tanakae* (Fig. 1: M) and *S. kawakamii* (Fig. 1: L). Five calyx lobes are persistent on the fruit, erect or spreading, with the exception of *S. boninensis* (Fig. 1: J) in which the calyx bends inwards.

The transverse sections of the fruit are round in most species, but the fruits of *S. boninensis* (Fig. 2: A) have 3 ridges in polar view and are triangular in equatorial view.

A thin epicarp and fleshy mesocarp surround a pit of hardened endocarp with seeds inside. The monopyrenous fruits develop from 2 to 3 syncarpous carpels and the placentation is axil.

The morphological and anatomical characters of fruits are listed in Table 3 and Table 4, respectively.

2.2.1 Locules In the genus *Symplocos*, the number of carpels is stable. Three equal or unequal locules occur in all the species, except for 2-loculed in *S. nakaharae* (Fig. 2: F). The locules of the ovary at anthesis sometimes do not all develop well and one or two carpels may abort in some species. The development of the locules can be divided into four types:

1. With 3 subequal locules and all developed, for example, *S. setchuensis* (Fig. 2: K), *S. tetragona* (Fig. 2: N), *S. lucida* subsp. *lucida* (Fig. 2: D), *S. lucida* subsp. *howii* (Fig. 2: E), *S. shilanensis* (Fig. 2: O), *S. pergracilis* (Fig. 2: B), *S. tanakae* (Fig. 2: H), and *S. kawakamii* (Fig. 2: C).
2. With 3 unequal locules and all developed, for example, *S. boninensis* (Fig. 2: A), *S. henryi* (Fig. 2: G), *S. multipes* (Fig. 2: I), and *S. migoi* (Fig. 2: J).
3. With 3 unequal locules with 1 or 2 degenerated, for example, *S. theifolia* (Fig. 2: L, M).
4. With 2 equal locules and all developed, for example, *S. nakaharae* (Fig. 2: F).

2.2.2 Surface of endocarp Three types of surface of the endocarp can be recognized in the complex:

2.2.2.1 Smooth *Symplocos theifolia* (Fig. 2: L, M), *S. multipes* (Fig. 2: I), *S. shilanensis* (Fig. 2: O), *S. migoi* (Fig. 2: J), and *S. nakaharae* (Fig. 2: F) are included.

2.2.2.2 Slightly rugose to striate *Symplocos lucida* subsp. *howii* (Fig. 2: E), *S. tetragona* (Fig. 2: N), *S. boninensis* (Fig. 2: A), *S. kawakamii* (Fig. 2: C), and *S. henryi* (Fig. 2: G) are included.

2.2.2.3 Deeply longitudinally grooved, edged, or winged *Symplocos lucida* subsp. *lucida*

Table 3 Morphological characters of infructescence and fruit in *Symplocos nakaharae* complex

Taxon	Figure	Infructescence	Infructescence length (cm)	Fruit shape	Fruit length × width (mm)	No. of fruits/ infructescences	Color of mature fruit	Calyx lobe
S. boninensis Rehder & E. H. Wilson	1: J	Axillary contracted spikes, branched from base	Less than 1	Narrowly obovoid	20–25 × 8–13	1–3	Blue	Bending inwards
S. henryi Brand	1: N	Axillary racemes, single	0.6–2	Broadly obovoid	35–45 × 16–25	1–5	Blue	Erect or spread
S. kawakamii Hayata	1: L	Axillary contracted spikes, branched	0.5–2.5	Globose or broadly obovoid	12–20 × 8–12	1–5	Blue	Erect or spread
S. lucida Wall. ex G. Don subsp. *lucida*	1: G	Axillary racemes, branched	1–2	Broadly obovoid	10–13 × 6–8	2–5	Blue	Erect or spread
S. lucida Wall. ex G. Don subsp. *howii* (Merr. & Chun ex L. H. Li) Bo Liu & H. N. Qin	1: H	Axillary racemes, branched	1–2	Broadly obovoid	10–13 × 6–8	2–5	Blue	Erect or spread
S. nakaharae (Hayata) Masam.	1: C	Axillary contracted spikes, basally branched	Less than 1	Ellipsoidal	9–13 × 5–8	3–8	Blue	Erect or spread
S. migoi Nagam.	1: A	Axillary contracted spikes, simple or branched	Less than 1	Ellipsoidal	8–13 × 5–7	1–3	Blue	Erect or spread
S. multipes Brand	1: F	Axillary racemes, branched	1–3	Ellipsoidal	5–7 × 4–6	2–8	Blue	Erect or spread
S. pergracilis (Nakai) T. Yamaz.	1: I	Axillary reduced contracted spikes, simple	Less than 0.5	Narrowly obovoid or narrowly ellipsoidal	20–25 × 7–12	1(–2)	Blue	Erect or spread
S. setchuensis Brand ex Diels	1: D	Axillary glomerules	0	Ellipsoidal	8–12 × 5–7	3–8	Blue	Erect or spread
S. shilanensis Y. C. Liu & F. Y. Lu	1: B	Axillary contracted spikes, simple or paniculately branched	Less than 1	Narrowly ellipsoidal	8–10 × 4–6	1–3	Purple	Erect or spread
S. tanakae Matsum.	1: M	Axillary contracted spikes, branched	Less than 1	Globose to obovoid	18–25 × 15–20	1–5	Blue	Erect or spread
S. tetragona F. H. Chen ex Y. F. Wu	1: K	Axillary elongated spikes, usually basally 3-branched	4–8	Broadly obovoid	14–18 × 8–10	10–40	Blue	Erect or spread
S. theifolia G. Don	1: E	Axillary spikes, simple or basally branched	0.8–2.5	Ellipsoidal	6–15 × 4–7	3–8	Blue	Erect or spread

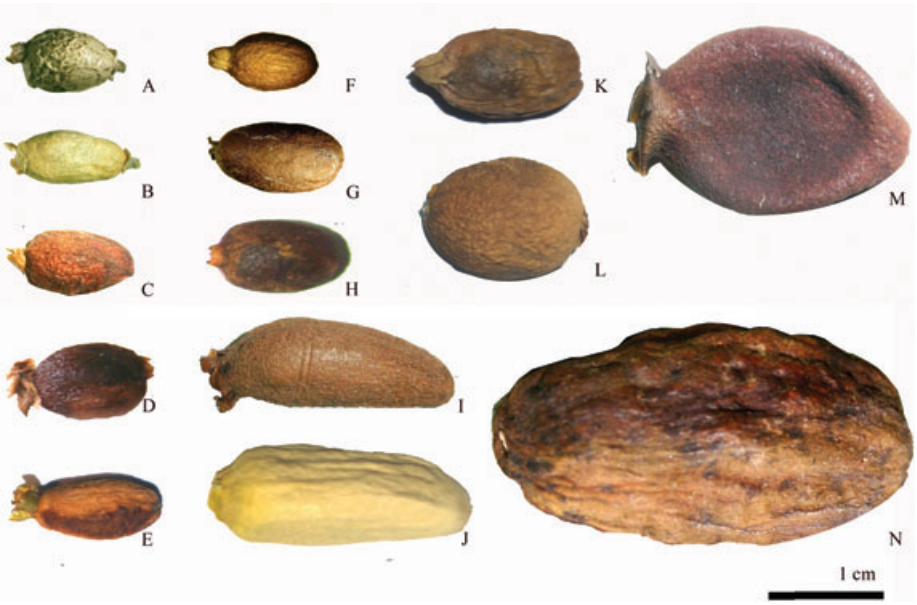

Fig. 1. Fruits of *Symplocos nakaharae* complex. **A,** *Symplocos migoi*. **B,** *S. shilanensis*. **C,** *S. nakaharae*. **D,** *S. setchuensis*. **E,** *S. theifolia*. **F,** *S. multipes*. **G,** *S. lucida* subsp. *lucida*. **H,** *S. lucida* subsp. *howii*. **I,** *S. pergracilis*. **J,** *S. boninensis*. **K,** *S. tetragona*. **L,** *S. kawakamii*. **M,** *S. tanakae*. **N,** *S. henryi*.

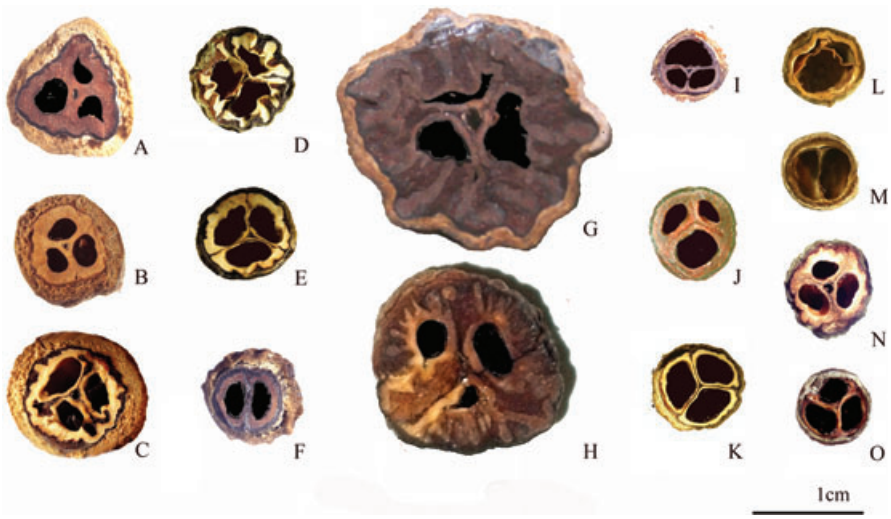

Fig. 2. Transverse sections of fruits of *Symplocos nakaharae* complex. **A,** *Symplocos boninensis*. **B,** *S. pergracilis*. **C,** *S. kawakamii*. **D,** *S. lucida* subsp. *lucida*. **E,** *S. lucida* subsp. *howii*. **F,** *S. nakaharae*. **G,** *S. henryi*. **H,** *S. tanakae*. **I,** *S. multipes*. **J,** *S. migoi*. **K,** *S. setchuensis*. **L, M,** *S. theifolia*. **N,** *S. tetragona*. **O,** *S. shilanensis*.

(Fig. 2: D) and *S. tanakae* (Fig. 2: H) are included.

2.2.3 Texture of endocarp The texture of the endocarp differs in various species, for example: chartaceous, thin, and fragile in *S. theifolia* (Fig. 2: L, M); woody in *S. nakaharae* (Fig. 2: F), *S. migoi* (Fig. 2: J), *S. multipes* (Fig. 2: I), and *S. setchuensis* (Fig. 2: K), 1 mm thick; thick woody in *S. boninensis* (Fig. 2: A), *S. pergracilis* (Fig. 2: B), and *S. tanakae* (Fig. 2: H), ca. 2 mm thick, and *S. henryi* (Fig. 2: G) ca. 5–8 mm thick; and stony in *S. lucida* subsp. *lucida* (Fig. 2: D), *S. lucida* subsp. *howii* (Fig. 2: E), *S. kawakamii* (Fig. 2: C), *S. tetragona* (Fig. 2: N), and *S. shilanensis* (Fig. 2: O), 2–4 mm thick.

2.2.4 Fusion of carpels The carpels arise on a ring meristem. With development these carpels fuse in different degrees. According to the degree of carpel fusion, three types of mature fruit can be distinguished (Fig. 5).

Type I. Carpel fusion of minimal degree occurs and the gap between carpels are obvious (Fig. 5: A). This

Table 4 Anatomical characters of fruit in *Symplocos nakaharae* complex

Taxon	Figure	Shapes of transverse section	No. of locules	Locule development	Degrees of fusion carpels	Surface of endocarp	Texture of endocarp
S. boninensis Rehder & E. H. Wilson	2: A	Triangle	3	1 locule slightly bigger, all fertile	Entirely fused, septa disappeared	Smooth	Thick woody, 2–4 mm thick
S. henryi Brand	2: G	Round	3	1 locule degenerated, others fertile	Entirely fused, septa disappeared	Longitudinally ridged	Thick woody, 5–8 mm thick
S. kawakamii Hayata	2: C	Round	3	Equal, fertile	Partly fused, septa reduced	Slightly striate	Stony
S. lucida Wall. ex G. Don subsp. *lucida*	2: D	Round	3	Equal, fertile	Partly fused, septa obvious	With 8–12 longitudinal ridges	Stony
S. lucida subsp. *howii*	2: E	Round	3	Equal, fertile	Partly fused, septa obvious	Longitudinally striate	Stony
S. nakaharae (Hayata) Masam.	2: F	Round	2	Equal, fertile	Partly fused, septa obvious	Smooth	Woody
S. migoi Nagam.	2: J	Round	3	1 locule slightly bigger, all fertile	Partly fused, septa reduced	Smooth	Woody
S. multipes Brand	2: I	Round	3	1 locule much bigger, all fertile	Partly fused, septa reduced	Smooth	Woody
S. pergracilis (Nakai) T. Yamaz.	2: B	Round	3	Equal, fertile	Entirely coalescent, septa disappeared	Smooth	Thick woody, 2–4 mm thick
S. setchuensis Brand ex Diels	2: K	Round	3	Equal, fertile	Partly fused, septa obvious	Slightly striate	Stony
S. shilanensis Y. C. Liu & F. Y. Lu	2: O	Round	3	Equal, fertile	Partly fused, septa reduced	Smooth	Woody
S. tanakae Matsum.	2: H	Round	3	Almost equal, fertile	Entirely coalescent, septa disappeared	More than 10 longitudinal wings	Thick woody, 4–6 mm thick
S. tetragona F. H. Chen ex Y. F. Wu	2: N	Round	3	Equal, fertile	Partly fused, septa reduced	Smooth or slightly striate	Thick stony, 2–4 mm thick
S. theifolia G. Don	2: L, M	Round	3	1 or 2 locules degenerated, others fertile	Partly fused, septa reduced	Smooth	Chartaceous

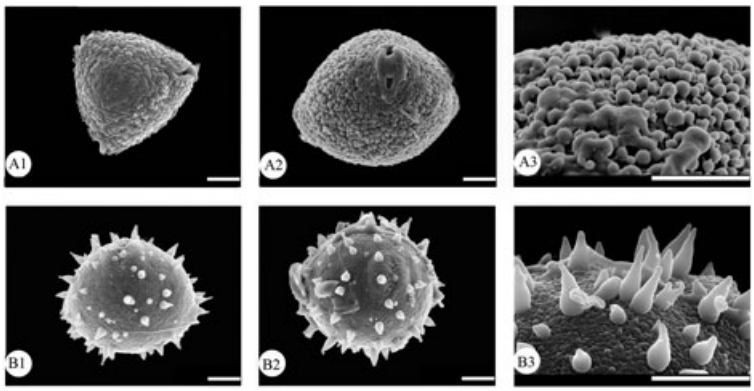

Fig. 3. Pollen exine sculpture types in *Symplocos nakaharae* complex. **A,** Type I: Verrucate pollen of *S*. *tetragona* (B. Liu 256, PE). **B,** Type II: Echinate pollen of *S*. *theifolia* (B. Liu 2, PE). **1.** Pollen grains in long equatorial view. **2.** Pollen grains in polar view. **3.** Pollen grains in detail. †Only two species are shown here, as the pollen grains of the other species have nearly the same shape, size, and ornamentation as *S*. *tetragona*. Bar = 5 μm.

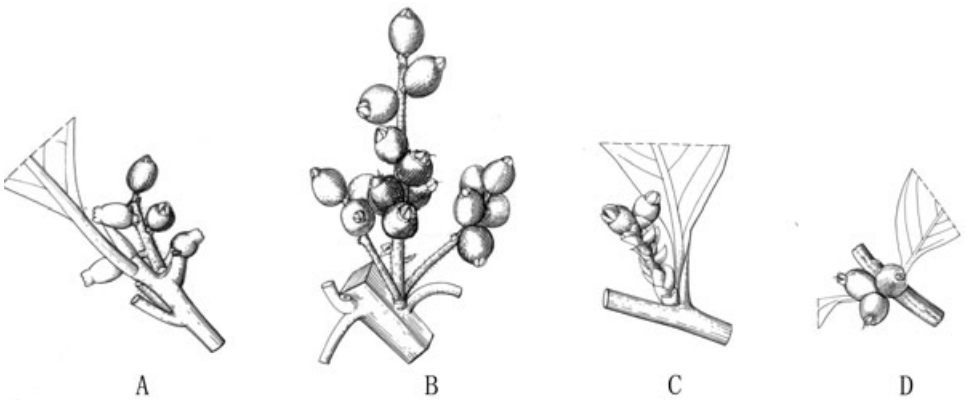

Fig. 4. Types of infructescences in *Symplocos nakaharae* complex. **A,** Raceme. **B, C,** Spike. **D**, Glomerule.

type of fruit was observed in *S*. *setchuensis* (Fig. 2: K), *S*. *lucida* subsp. *lucida* (Fig. 2: D), *S*. *lucida* subsp. *howii* (Fig. 2: E), and *S. nakaharae* (Fig. 2: F).

Type II. Carpel fusion occurs to some degree and the gap between carpels is very small (Fig. 5: B). This type of fruit was found in *S*. *kawakamii* (Fig. 2: C), *S. migoi* (Fig. 2: J), *S*. *multipes* (Fig. 2: I), *S. shilanensis* (Fig. 2: O), *S*. *tetragona* (Fig. 2: N), and *S*. *theifolia* (Fig. 2: L, M).

Type III. Carpels fuse well, but the gap between carpels can be still observed in some local sites (Fig. 5: C). This type of fruit occurs in *S*. *henryi* (Fig. 2: G), *S*. *tanakae* (Fig. 2: H), *S*. *pergracilis* (Fig. 2: B), and *S*. *boninensis* (Fig. 2: A).

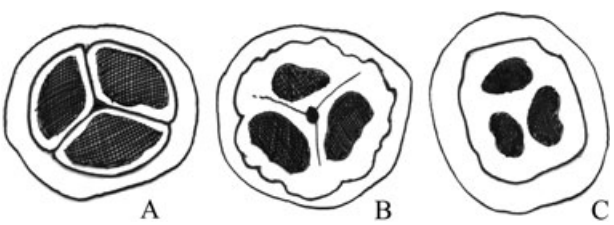

Fig. 5. Different degrees of fusion of carpels in *Symplocos nakaharae* complex.

2.3 Pollen morphology

Pollen grains of the *S. nakaharae* complex are simple, oblate in equatorial view, mostly semi-angular in polar view. They have 3- or rarely 2- or 4-aperturate, isopolar. The size of pollen varies between 20–70 μm long, 30 μm long in average (Erdtman, 1952; van der Meijden, 1970; Barth, 1979, 1982; Liang, 1986; Nagamasu, 1989a; Wang & Ou, 2000).

The pollen grains can be divided into two distinctive types (Fig. 3).

Type I: Verrucate pollen

Three-colporate pollen grains are suboblate in equatorial view and semi-angular to angular in polar view. Supratectal ornamentation of pollens is densely

and finely verrucate. The pollen have a distinct columella layer, an obviously thickened tectum, obvious outline of ektoaperture.

Symplocos tetragona (Fig. 3: A1–A3), *S. boninensis*, *S. lucida* subsp. *lucida*, *S. lucida* subsp. *howii*, *S. henryi*, *S. kawakamii*, *S. nakaharae*, *S. migoi*, *S. multipes*, *S. pergracilis*, *S. setchuensis*, *S. shilanensis*, and *S. tanakae* are included.

Type II: Echinate pollen

Pollen grains are 3-porate, circular in equatorial view and semi-angular in polar view. Supratectal ornamentation of the pollen surface is characterized by spinules. Columella layer is reduced, invisible or nearly so. Tectum is not thicked and the outline of ektoaperture is vague. *Symplocos theifolia* (Fig. 3: B1–B3) is included.

3 Discussion

The present study sought to provide useful information to analyze the *Symplocos nakaharae* complex by applying the morphological approach with special reference to fruit morphology and pollen morphology.

Data on features of fruit morphology have been reported to be useful for taxonomy in numerous groups of angiosperms with the aim of elucidating problems involving species complex (Juan et al., 2000; Chiarini & Barboza, 2009; Magee et al., 2009; Abdel Khalik, 2010; Le et al., 2011). For Symplocaceae, these data were used to circumscribe species in Mai & Martinetto (2006).

However, the fruit characters and their variation in many species of the *S. nakaharae* complex have not been described in sufficient detail. Previous studies of this complex often concentrated mainly on the size, shape of leaves, and number of stamens (Brand, 1901; Handel-Mazzetti & Peter-Stibal, 1943; Nooteboom, 1975; Wu, 1987; Nagamasu, 1993; Nagamasu, 1998; Zhou et al., 2006), whereas the fruit morphology and anatomy in the complex were often neglected or imperfectly studied. Nagamasu (1987, 1993) believed that shapes of seed, and mesocarp and endocarp characters are valuable in recognizing species groups of Symplocaceae in Japan. Nooteboom (1975) observed the fruit morphology of some represented species of Symplocaceae and considered the fruit morphology of the family as useful characters in taxonomy.

Nooteboom (1975, 2005) recognized three different types of inflorescences (glomerule, spike, and raceme) and the length of inflorescence as just continuously variable characters, thus believed they were not of taxonomic value. However, based on examination of a large number of specimens and living plants in some field populations and cultivated species, we found that all materials show the stability of the inflorescences type and length in a specific species.

We observed and recorded the phenology of three species, *S. setchuensis* (three individuals, glomerule), *S. tetragona* (three individuals, spike), and *S. theifolia* (two individuals, spike), cultivated in Hangzhou Botanic Garden (Zhejiang Province, China). We found that individuals of *S. theifolia* have simple unbranched spikes and their inflorescences were never longer than 1 cm, nor condensed to a glomerule without pedicels or peduncles as in *S. setchuensis* during the whole period of flowering and fruiting. The spikes of *S. tetragona* are much longer (4–8 cm long) and many-branched compared to that of *S. theifolia* (2.5 cm long). *Symplocos setchuensis* blossoms at the beginning of February, 10 days earlier than *S. tetragona* and 20 days earlier than *S. theifolia*. These three species can also be readily recognized. *Symplocos theifolia* has a papery endocarp, with 1 or 2 locules degenerated, the other two species have stony endocarps; *S. tetragona* has much bigger leaves (12–20 × 4–8 cm long vs. 8–12 × 2–3 cm long).

The anthesis is also a useful character in recognizing species. Five species endemic to Japan all have contracted spikes to 1 cm long. *Symplocos boninensis*, *S. pergracilis*, and *S. kawakamii* are endemic to the Bonin Islands and they flower October–December. *Symplocos tanakae* and *S. nakaharae* flower October–November and December–February, respectively. Two species endemic to Taiwan, *S. migoi* and *S. shilanensis*, flower December–February and August–October, respectively, and have contracted spikes. Four species endemic to mainland China, *S. setchuensis* with glomerules, *S. tetragona* with spikes, *S. multipes* with racemes, and *S. henryi* with racemes, flower February–April, February–April, March–April, and September–October, respectively. Two widespread species in South Asia, *S. theifolia* and *S. lucida* Wall. ex G. Gon, are quite different in inflorescence type (spikes vs. racemes) and flowering time (March–May vs. June–November).

Our studies suggest that the type and length of inflorescences are taxonomically important and they can be added to other combined characters to distinguish species within the complex.

Based on observations of the flower and fruit materials from many dry specimens and living plants, we studied the development of the ovary in the complex. The results showed that the numbers of locules were stable within species and the degenerated locules in some species are formed after anthesis. These features can be used for identification and delimitation of the taxa.

The species in the Symplocaceae have a 2–5-locular ovary. Most species in Europe have a 4-locular ovary, whereas only three species, *S. paniculata* Wall. ex D. Don, *S. chinensis* (Lour.) Druce, and *S. nakaharae*, in Asia have a 2-locular ovary (Fig. 2: F) and all others have 3-locular ovaries. The species with 2-locular ovaries form two equally developed locules and have no reduced locule. *Symplocos paniculata* and *S. chinensis* are the only two deciduous species and probably represent the most advanced taxa in Symplocaceae according to the life form, the morphology, and the fossil records (Kirchheimer, 1949).

In the complex, *S. nakaharae* is the only species that has a 2-locular ovary. *Symplocos boninensis* (Fig. 2: A) and *S. multiples* (Fig. 2: I) have unequal locules. Other species have equal locules.

For the pollen studies of the complex, previous researchers made some wrong identifications. Erdtman (1952) reported that *S. setchuensis* has echinate pollen type. We examined the specimen that he used for the experiment "China. Guizhou: Mt. Fanjing, 1930-07-20, *Y. Tsiang 7746* (NAS!)". We found that the specimen was *S. theifolia* rather than *S. setchuensis*.

Van der Meijden (1970) carried out pollen research in Symplocaceae based on the species concept of Nooteboom (1975). He only reported verrucate pollen in the complex, so they made the wrong conclusion that: "It is curious that the occurrence of echinate pollen is restricted to East Malaysia, the New Hebrides, and Fiji".

We re-examined pollen from the 14 taxa in the complex and found that within the complex a peculiar pattern of variation occurred in *S. theifolia*. The pollen morphology in this species is different from the other species of the *S. nakaharae* complex in its supratectal spinule ornamentation (2–3 μm) and reduced columella layer and thin tectum.

With the speculation that the spinule ornamentation might come from further development of verrucate ornamentation, the authors examined pollen grains of various development stages in *S. theifolia*. The results showed that the number and length of the spinules have been formed before maturity of the anthers. The ornamentation of the pollen surface could be a stable character for identification.

Echinate pollen occurs in *S. cochinchinensis* (Lour.) S. Moore var. *leptophylla* (Brand) Noot. and others, and verrucate pollen occurs in *S. racemosa* Roxb., *S. sumuntia* Buch.-Ham. ex D. Don and others. Species with the same pollen type can be dissimilar in other morphological features. The pollen has taxonomic value for the recognition of species, but it can not be applied to express the affiliation of species in the complex.

4 Taxonomic treatment

Key to *Symplocos nakaharae* complex based primarily on flower characters

1a. Inflorescences racemes 2
1b. Inflorescences spikes or glomerules 5
2a. Leaf blades 15–20 cm long, 5.5–8 cm wide; petiole 1.6–2.2 cm long . . . . . 4. **S. henryi**
2b. Leaf blades shorter than 15 cm, narrower than 4 cm; petiole 0.4–0.8 cm long 3
3a. Stamens 20–25 in number; leaves sharply serrated . . . . . 3. **S. multipes**
3b. Stamens 30–80 in number; leaves crenate-serrated 4
4a. Leaf blades thick, leathery; stamens 60–80; mesocarp angulated consciously, 8–12 ribbed . . . . . 2a. **S. lucida** subsp. **lucida**
4b. Leaf blades thin, papery; stamens 30–60; mesocarp slightly undulate . . . . . 2b. **S. lucida** subsp. **howii**
5a. Flowers 1–3 from a leaf axil 6
5b. Flowers in more than 3-flowered inflorescences 8
6a. Stamens 35–50; leaf margins recurved . . . . . 7. **S. shilanensis**
6b. Stamens 60–120; leaf margins flat 7
7a. Twigs slender, often zigzag; stamens 100–120; leaf blades 3–6 cm long . . . . . 10. **S. pergracilis**
7b. Twigs thick, not zigzag; stamens 60–100; leaf blades 6–9 cm long, lateral and reticulate veins prominent adaxially . . . . . 11. **S. boninensis**
8a. Inflorescences sessile, condensed to glomerules . . . . . 6. **S. setchuensis**
8b. Inflorescences branched spikes 9
9a. Leaf blades 13–20 cm long, 4.5–8 cm wide; inflorescences 4–8 cm long, with 15–25 fruits on each inflorescence . . . . . 5. **S. tetragona**
9b. Leaf blades 3–12 cm long, 1.5–4 cm wide; inflorescences 0.5–2 cm long, with 1–6 fruits on each inflorescence 10
10a. Stamens 60–90 in number 11
10b. Stamens 15–60 in number 12
11a. Twigs conspicuously ridged, nearly winged; leaves revolute, upper surface rugose, lateral and reticulate veins impressed adaxially . . . . . 12. **S. kawakamii**
11b. Twigs slightly terete or ridged; leaves not revolute, upper surface flat, lateral and reticulate veins prominent adaxially . . . . . 13. **S. tanakae**
12a. Ovary 2-locular . . . . . 9. **S. nakaharae**
12b. Ovary 3-locular 13
13a. Stamens 15–50, lateral veins 6–8 per side . . . . . 1. **S. theifolia**

13b. Stamens 50–60, lateral veins 8–12 per side . . . . . 8. **S. migoi**

Key to *Symplocos nakaharae* complex based primarily on fruit characters

1a. Infructescence racemes 2
1b. Infructescence spikes or glomerules 5
2a. Leaf blade 15–20 cm long, petiole ca. 2 cm long; fruit 3–4 cm long, 1.8–2.5 cm diam., endocarp ca. 5 mm thick . . . . . 4. **S. henryi**
2b. Leaf blade 4–12 cm long, petiole 0.3–0.8 cm long, fruit 0.4–1.2 cm long, 0.6–0.8 cm diam., endocarp ca. 1 mm thick 3
3a. Leaf margin sharp serrated, stones smooth, endocarp woody . . . . . 3. **S. multipes**
3b. Leaf margin often entire, stones have longitudinally grooves, endocarp stony 4
4a. Leaf blades thick, leathery; mesocarp angulated consciously, 8–12 ribbed . . . . . 2a. **S. lucida** subsp. **lucida**
4b. Leaf blades thin, papery; mesocarp slightly undulate . . . . . 2b. **S. lucida** subsp. **howii**
5a. Infructescence glomerules . . . . . 6. **S. setchuensis**
5b. Infructescence spikes 6
6a. Fruit 2-locular . . . . . 9. **S. nakaharae**
6b. Fruit 3-locular 7
7a. One or two locules of fruits often smaller or even degenerate, endocarp chartaceous . . . . . 1. **S. theifolia**
7b. All locules develop almost at the same size, endocarp woody or stony 8
8a. Infructescence a long spike, 4–8 cm long, with 15–25 fruits on each infructescence . . . . . 5. **S. tetragona**
8b. Infructescence a contracted spike, 1–2 cm long, with 1–6 fruits on each infructescence 12
9a. Fruit 2–3 cm long, 0.8–2 cm in diam 10
9b. Fruit 0.5–1.5 cm long, 0.4–0.7 cm in diam 13
10a. Twigs slender often zigzag; fruit length/fruit diam. >2 . . . . . 10. **S. pergracilis**
10b. Twigs thick, not zigzag; fruit length/fruit diam. <2 11
11a. Leaf blades 2–5 × 0.7–2 cm, margin revolute, upper surface rugose, lateral and reticulate veins impressed adaxially; twigs conspicuous ridged, nearly winged . . . . . 12. **S. kawakamii**
11b. Leaf blades 6–9 × 2–2.5 cm, margin not revolute, upper surface flat, lateral and reticulate veins prominent adaxially; twigs slightly terete or ridged 12
12a. Fruit cross-section triangle, stone surface slight striate . . . . . 11. **S. boninensis**
12b. Fruit cross-section round, stone surface with more than 10 longitudinally deep grooves . . . . . 13. **S. tanakae**
13a. Leaves entire or with 2–3 pairs of teeth; nerves 4–5 pairs; stamens 35–50 . . . . . 7. **S. shilanensis**
13b. Leaves crenate-serrate; nerves 6–9 pairs; stamens 50–60 . . . . . 8. **S. migoi**

1. Symplocos theifolia D. Don in Prodr. Fl. Nepal. 145. 1825. non Hayata. 1916. ut 'theaefolium'. —*Eugeniodes theifolium* O. K. in Revis. Gen. Pl. 2: 409. 1891. ut 'theaefolium'. —*Symplocos racemosa* DC. in Prodr. 8: 255. 1844. non Roxb. 1832. nec Wight ex C. B. Clarke. 1882. Type: Nepal. Narainhetty, *Hamilton s.n.* (holotype, BM!, photo).

Symplocos phyllocalyx C. B. Clarke in Fl. Brit. India 3: 575. 1882. Type: India. Sikkim, 8–12 000 ft., *J. D. Hooker & c. s.n.* (lectoholotype, K!; isolectotypes, M!, photo, W!, photo).

Symplocos warburgii Brand in Pflanzenr. (Engler) Symploc. 6: 66. 1901. Type: India. Nilgiri, *Warburg 560* (holotype, B, destroyed).

Symplocos discolor Brand in Repert. Spec. Nov. Regni Veg. 3: 216. 1906. Type: China. Yunnan, 1888-06-07, *Delavay 4331* (holotype, P!, photo; isotypes, K!, P!, photo).

Symplocos wilsonii Brand in Repert. Spec. Nov. Regni Veg. 3: 216. Dec. 1906. non Hemsl. (July 1906). —*Symplocos ernestii* Dunn in J. Linn. Soc., Bot. 34: 499. 1911. ut 'ernesti'. —*Dicalix ernestii* (Dunn) Migo in Bull. Shanghai Sci. Inst. 13 (3): 201. 1943. Type: China. W Hupei, 1900-04-24, *Wilson 58* (lectoholotype, E!; lectoisotypes, A!, E!, K!, NY!, photo, P!, photo, US!, photo); Sutchuen oriental, District de Tchen-Kéou-Tin, *R. P. Farges 796* (lectoparatype, US!, photo).

Symplocos loheri Brand in Philipp. J. Sci. 7: 32. 1912. Type: Philippines. 1906-03-06, *A. Loher 6192* (holotype, SING!, photo; isotype, M!, photo).

Symplocos xanthoxantha H. Lév. in Bull. Géogr. Bot. 24: 283. 1914. Type: China. Tibet: Mo-Tsou, 3000 m, 1913-04, *E. E. Maire 648* (holotype, E!).

Symplocos coronigera H. Lév. in Repert. Spec. Nov. Regni Veg. 10: 431. 1912. Type: China. Kweichou: Majo, 1907-07-24, *Cavalerie 3106* (holotype, E!; isotype, P!, photo).

Symplocos potaninii Gontsch. in Not. Syst. Herb. Hort. Petrop. 5: 100. 1924. Type: China. Szechwan: Mt. Omei, *Potanin*, *2-4-1893* (holotype & isotype, LE).

Symplocos elephantis Guillaumin in Bull. Soc. Bot. France 71: 279. 1924; Fl. Gén. IndoChine 3: 998. 1933. Type: Cambodia. Kampot, Mts. de l'Eléphant, 1000 m, 1919-09-07, *Poilane 239* (syntypes, P!, photo, US!, photo); 900 m, 1919-08-15, *Poilane 341* (syntypes, A!, BM!, photo, CAS!, photo, NY!, photo, US!, photo).

Dicalix shinodanus Migo in Bull. Shanghai Sci. Inst. 13 (3): 205. 1943. Type: China. Yunnan: *C. W. Wang 68262* (isotypes, LBG!, NAS!).

Symplocos ernestii Dunn var. *pubicalyx* C. Chen syn. nov. in Fl. Yunnan 16: 807 (304–305). 2006. Type: China. Yunnan: Jingdong, *M. K. Li 1209* (holotype, KUN!); 1963-06-08, *Z. H. Yang et al. s.n.* (paratype, KUN!).

茶叶山矾 (Fig. 1: E; Fig. 2: L, M; Fig. 3: B)

Small evergreen trees or shrubs, to 15 m high. Twigs green, glabrous, ridged. Petioles 6–12(–16) mm long; leaf blades leathery, 8–12 × 2–3 cm long, glabrous on both sides, base cuneate, margin subentire or serrated, apex long acuminate; midvein adaxially prominent, lateral veins 8–12 per side. Inflorescences simple or basally branched, axillary spikes, 0.8–2.5 cm long, axis puberulent; bracts and bracteoles persistent, broadly obovate, 1–3 mm long, often glabrous. Calyx glabrous or puberulent, margin ciliolate, lobes orbicular. Corolla white, 3–5 mm long, deeply 5-lobed. Stamens 15–50, pentadelphous or inconspicuous pentadelphous. Disc soft pilose. Drupes ellipsoidal, 6–15 × 4–7 mm, apex with erect or spread persistent calyx lobes, 3-loculed, 1 or 2 locules often fertile, mesocarp woody, endocarp surface smooth, chartaceous.

Distribution and habitat: Bhutan, Cambodia, China (south of the Yangtze River), India, Indonesia, Malaysia, Myanmar, Nepal, and Philippines occurring in mixed forests on slopes below 2600 m.

Phenology: Fl. Mar.–May, fr. Jun.–Aug.

Note: *Symplocos theifolia* own has echinate pollen, adding to its chartaceous endocarp and fertile locules (Fig. 2: L, M). It should be easily separated from other species in the complex.

Wu (1987) considered it different from *S. phyllocalyx* mainly because "the stones are not divided into 3 pyrenes and the stamens are not obviously pentadelphous". We checked many specimens and found that the two characters are not consistent among individuals. Apart from that, the two species are indistinguishable, so they should be conspecific. *Symplocos ernestii* var. *pubicalyx* was published based on its pubescence on calyx in *Flora Yunnanica* (Gao, 2006). However, the pubescence should be carefully considered as an identification character in Symplocaceae (Hardin, 1966). After examination of specimens referred in the original description and other specimens in KUN, we found the pubescence on calyx of *S. theifolia* is not an effective taxonomic character. In fact, both glabrous and pubescence on calyx were found in the same inflorescence, therefore, no obvious correlation exists between the pubescent calyx and the environment. As a result, it is treated as a new synonym here.

Additional specimens examined:

Bhutan. Tongsa District, *S. Miehe 00-012-07* (A), *s.n.* (E); Bhutan to Sikkim, *W. Griffith 2275* (K, E), *A. J. C. Grierson & D. G. Long 1190, 1602* (K).

Cambodia. Phnum Bokor National Park, Mts de l'Eléphant, *M. Poilane 239* (K).

China. Anhui: Xiuning, *anonymous 2549* (PE). **Chongqing:** Nanchuan, *B. Liu 168* (PE); Zhong Xian, *W. P. Fang 685* (PE). **Guangxi:** Rongshui, Mt. Damiaoshan, *Q. H. Lv 3295* (PE). **Guizhou:** Tongren, Mt. Fanjingshan, *S. N. Albert*, *C. Y. Chiao & H. C. Cheo 486* (PE), *Y. Tsiang 7746* (PE). **Hubei:** Ichang, *A. Henry 3730* (K); Hefeng, Mulinzi Nature Reserve, *B. Liu 106* (PE); Jianshi, *H. C. Chow 1255, 1754* (PE); Shennongjia, *E–Shennongjia Exped. 22346* (PE). **Hunan:** Xingning, Mt. Ziyun, *Ziyunshan Exped. 764* (PE); Tschangscha, *H. R. E. Handel-Mazzetti*, *11341* (W). **Jiangxi:** Luxi, Mt. Wugong, *Jiangxi Invest. Team 1117* (PE). **Shannxi:** Hanyin, Tiewadian, *B. Z. Guo 2147* (PE). **Sichuan:** Jianwei, *B. Liu 180* (PE); Mt. Emei, *T. N. Liou 12240* (PE), *G. H. Yang 56251* (PE). **Xizang:** Motuo, *W. L. Chen 15128* (PE). **Yunnan:** Lu-djiang (Salween), *P. Genestier & H. R. E. Handel-Mazzetti 9953* (W); Lvchun, Mt. Huanglian, *B. Liu s.n.* (PE); Lijiang, Mt. Yulong, *Z. H. Yang 101829* (PE); Yn Kia Ngan au-dessus de Houan Kia Pin, *J. M. Delavay s.n.* (P).

India. West Bengal, Darjeeling, Sum forests, *anonymous 6622* (RRLH), *C. B. Clarke 27596* (K), *Dawsona 258A* (K), *H. H. Haines 783*, *1130* (K).

Nepal. Central Development Region, Narayani, *Second Darwin Nepal Fieldwork Training Exped. B233* (A); Arun Valley, above Tashigaon, *Edinburgh Makalu Exped. (1991) 19920059* (E); Bikhey Bhanjang, *H. Hara*, *H. Kanai*, *S. Kurosawa*, *M. Togashi & T. Tuyama 6303841* (K).

Philippines. Precise location unknown, *Ingle Nina R. 592* (E, K).

2. Symplocos lucida Wall. ex G. Don in Gen. Hist. 4: 3. 1837. descr. non Siebold & Zucc. 1838. —*Lodhra lucida* Miers in J. Linn. Soc., Bot. 17: 299. 1879. Type: *Wallich 4414* (isotypes, BM!, photo, CGE!, photo).

厚皮灰木 (Fig. 1: G; Fig. 2: D)

Small evergreen trees or shrubs. Twigs stout, yellowish green, glabrous, ridged. Petioles 8–15 mm long; leaf blades thick leathery, ovate-elliptic, elliptic or narrowly elliptic, 6.5–10 × 2.5–4 cm long, glabrous on both sides, base cuneate, margin entire or occasionally with few glandular dentate, apex long acuminate; midvein adaxially prominent, lateral veins 6–10 per side. Inflorescences branched from the middle or from the base, axillary racemes, 1–2 cm long, 4–7-flowered; bracts persistent, oblong-ovate, bracelets persistent, triangle-ovate. Calyx puberulent outside, margin ciliolate, lobes orbicular or broadly ovate. Corolla white, 3–5 mm long, deeply 5-lobed. Stamens (60–80) pentadelphous. Disc soft pilose, 5-glandular. Drupes broadly obovoid, 10–13 × 6–8 mm long, apex with persistent erect calyx lobes, 3-loculed, all developed equally, mesocarp

woody, endocarp stony, surface longitudinally ridged or striate, ca. 2 mm thick.

Distribution and habitat: China, Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam, occurring in broad-leaf forests below 1800 m.

2a. subsp. **lucida**

Symplocos ciliata (Blume) Miq. in Fl. Ned. Ind. 1 (2): 466. 1859. non C. Presl. 1835. nec Benth. 1841. —*Dicalix ciliatus* Blume in Bijdr. Fl. Ned. Ind. 17: 1119. 1826. —*Eugeniodes ciliatum* (Blume) Kuntze in Revis. Gen. Pl. 2: 975. 1891. Type: Indonesia, West Java, Mt. Tjeremai, *Blume 1598* (holotype, L!, photo).

Symplocos crassifolia Benth. in Fl. Hongk. 212. 1861. —*S. japonica* A. DC. var. *crassifolia* Benth. in Hooker's J. Bot. Kew Gard. Misc. 4: 303. 1852. —*Lodhra crassifolia* Miers in J. Linn. Soc., Bot. 17: 302. 1879. —*Dicalix crassifolia* (Benth.) Migo in Bull. Shanghai Sci. Inst. 13: 200. 1943. Type: China. Hong Kong: Mt. Victoria, *Champion 136* (holotype, K!).

Symplocos ridleyi King & Gamble in J. Asiat. Soc. Bengal Pt. 2, Nat. Hist. 74 (1): 239. 1906. Type: Singapore. Kranji, 1894-07, *Ridley 5684* (holotype, K!; isotype, BM!, photo, SING!, photo).

Symplocos laeviramulosa Elmer in Leafl. Philipp. Bot. 7: 2323. 1914. Type: Philippines. Island of Mindanao, Cabadbaran, 1912-10, *Adolph D. E. Elmer 14123* (syntypes, BM!, photo, K!, L!, photo, MO!, photo, NY!, photo, W!, photo).

Distribution and habitat: China (South Hunan, Guangdong, Guangxi, and Hongkong), Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam, occurring in broad-leaf forests below 1800 m.

Phenology: Fl. Jun.–Nov., fr. Jul.–Dec.

Note: The authors checked type specimens of *S. lucida* Wall. ex G. Gon and *S. crassifolia* Benth., and found that they are referring to the same taxon. So *S. crassifolia* is treated as a synonym. *Symplocos lucida* Wall. ex G. Gon is widely distributed in E and SE Asia as *S. theifolia*, the two species are somewhat similar vegetatively, but *S. lucida* Wall. ex G. Gon has much thicker leathery leaves and branched racemes (*S. theifolia* with spikes), and its endocarp conspicuously angular, with 8–12 ribs (Fig. 2: D). The species should be reinstated.

Additional specimens examined:

China. Guangdong: Conghua, *L. Deng 8550* (SZ); Dianbai, *Z. Huang 38705* (PE); Fengkai, *L. Deng 163341* (SWCTU); Huizhou, Mt. Luofu, *N. Q. Chen 41553* (PE, SZ), *N. K. Chun 41553* (SZ); Xinfeng, *L. Deng 8213*; Xinyi, *S. P. KO. 51397* (PE); Sin-fung District, Fuk Lung Monastery, Hau T'ong Shan, *Y. W. Taam 747* (W); Yangshan, *X. G. Li 201225*, *201194* (HHBG); Precise location unknown, *Y. Tsiang 233* (PE). **Guangxi:** Hepu, *CAS Guangdong Hepu Plant Exped. 2002* (PE); Rongshui, *anonymous*, *s.n.* (PE); Rongxian, Mt. Tiantang, *S. Q. Cheng 9745* (PE). **Hunan:** Yizhang, Mt. Mangshan, *D. Z. Lu 284* (N). **Hongkong:** Mt. Lianhua, *C. Wang 3226* (SZ), *N. X. Chen 41777*, *41783* (WH); Mt. Ma On, *S. Y. Hu 11797* (PE); Mt. Victoria, *S. Y. Hu 8853* (PE); Precise location unknown, *E. Faber s.n.* (K).

Indonesia. East Java, Besuki, *C. G. G. J. van Steenis 10895*, *10902* (K); Madioen, *J. Elbert s.n.* (L); Pasoeroean, *Koorders 38237 B* (K); Sulawesi Selatan, Piek van Bonthain, *Teysmann 13986* (K); West Java, Mt. Tjeremai, *C. G. G. J. van Steenis s.n.* (K), *Junghuhn 419* (K), *S. H. Koorders 6184 B*, *6188 B* (K); Tanjung Lesung, *J. J. Afriastini Bl-39* (K); West Nusa Tenggara, Mt. Batulanteh, *Kostermans 18476* (K).

Singapore. Kranji, *Ridley 6755* (K).

Thailand. Chiang Mai, Mt. Doi Inthanon, *H. P. Nooteboom 832* (K).

Vietnam. Dong Nai, *M. E. Poilane 23393*, *21972*, *22692* (K); Tokin, Mt. Sai Wong Mo, *W. T. Tsang 30168* (K).

2b. subsp. **howii** (Merr. & Chun ex H. L. Li) Bo Liu & H. N. Qin, comb. nov.

Symplocos howii Merr. & Chun ex H. L. Li in J. Arnold Arbor. 25 (2): 211. 1944. Type: China. Hainan: Poting, ca. 500 m, 1935-07-23, *F. C. How 73286* (holotype, A!, isotypes, PE!, SING!, photo).

棱核山矾 (Fig. 1: H; Fig. 2: E)

Distribution and habitat: Endemic to China (Hainan: Baoting, Baisha, and Ledong), occurring in broad-leaf forests below 1800 m.

Phenology: Fl. Jun.–Jul., fr. Jul.–Sep.

Additional specimens examined:

China. Hainan: Baisha, *X. Q. Liu 26356* (PE); Baoting, *anonymous*, *73286* (PE), *K. S. Hou 73346* (PE); Lingshui, Mt. Diaoluo, *Diaoluoshan Exped. 2320* (PE); Ledong, Taohuai, *X. Q. Liu 27450* (PE); Qionghai, *Hainan East Exped. 00055* (PE); Qiongdong, *Hainan East Exped. 55* (FUS).

3. Symplocos multipes Brand in Repert. Spec. Nov. Regni Veg. 3: 216. 1906. Type: China. Nanto, 1900-03, *Wilson 4* (syntypes, E!, K!, NY!, photo, W!, photo).

枝穗山矾 (Fig. 1: F; Fig. 2: I)

Small shrubs; twigs yellowish green, glabrous, stout, ridged. Petioles 8–10 mm long; leaf blades leathery, ovate or elliptic, 5–8.5 × 2.5–4.5 cm long, glabrous on both sides, base cuneate, margin sharp serrated, apex long acuminate; midvein adaxially prominent, lateral veins 4–6 per side. Inflorescences basally many-branched, axillary racemes, 1–3 cm long, 3–8-flowered, axis puberulent; bracts and bracteoles persistent, broadly obovate. Calyx margin ciliolate, lobes orbicular. Corolla white, 3.5–4 mm long, deeply 5-lobed. Stamens ca. 25, pentadelphous. Disc soft pilose. Drupes oblong-subglobose to ellipsoidal, 5–7 × 4–6 mm, apex with erect persistent calyx lobes, 3-loculed, all

developed, one bigger, the other 2 equal, smaller, mesocarp woody, endocarp surface smooth, thin woody.

Distribution and habitat: Endemic to China (Chongqing, Hubei, Guangdong, Guangxi, and Sichuan), occurring in scrubs at 500–1500 m.

Phenology: Fl. Mar.–Apr., fr. Aug.

Note: This species resembles *S. lucida* Wall. ex G. Gon, but its leaves are sharply serrated. The stones are also different, those of *S. multipes* have a smooth surface, one locule bigger (Fig. 2: I), whereas in *S. lucida* Wall. ex G. Gon the stones surface sharp-ridged or undulate, 3 locules evenly developed (Fig. 2: D, E). The two species do not overlap in geographical range; furthermore, they have different anthesis.

Additional specimens examined:

China. Chongqing: Hechuan, Mt. Huayun, *T. H. Tu 5055* (PE), *CAS Sichuan Exped. 5055* (SZ). **Guangdong:** Renhua, Mt. Danxia, *W. Y. Chun 5578* (IBSC); Yangshan, *P. X. Tan 60393* (IBSC); Yuebei, *K. W. Liang 230* (IBSC). **Guangxi:** Xiangxian, Mt. Guchenyao, *Kwangsimus 194* (IBSC). **Hubei:** Hefeng, *H. J. Li 8388* (PE); Sangzhi, Mt. Badagong, *H. J. Li 3468* (PE). **Sichuan:** Jiuzhaigou, *J. H. Xiong & Z. L. Zhou 90025* (LBG). **Precise location unknown:** *Anonymous s.n.* (SZ), *R. P. Farges s.n.* (K).

4. Symplocos henryi Brand in Pflanzenr. (Engler) Symploc. 6: 67. 1901. Type: China. Yunnan: Mengzi, ca. 1500 m, 1898, *A. Henry 11415* (lectoholotype, K!; lectoisotypes, CAS!, photo, E!, MO!, photo, NY!, photo, PE!, US!, photo).

蒙自山矾 (Fig. 1: N; Fig. 2: G)

Evergreen trees, to 10 m high. Twigs yellowish brown, glabrous, terete. Petioles 1–2 cm long; leaf blades thick papery, oblong or elliptic-oblong, 15–20 × 5–9 cm long, glabrous on both sides, base cuneate, margin subentire or glandular-serrated, apex short acuminate; midvein adaxially prominent, lateral veins 9–10 per side. Inflorescences simple, axillary racemes, 0.6–2 cm long, 3–5-flowered, axis puberulent; bracts and bracteoles persistent, broadly obovate, often glabrous. Calyx margin ciliolate, lobes orbicular. Corolla white, 3–5 mm long, deeply 5-lobed. Stamens 75–80, pentadelphous. Disc without white pilose. Drupes long ellipsoidal, 30–45 × 16–25 mm, apex with erect or spread persistent calyx lobes, 3-loculed, 1 locule often degenerated, other 2 locules fertile, mesocarp woody, endocarp brown, thick woody, 5–8 mm thick, surface with longitudinally ridges.

Distribution and habitat: Endemic to China (Yunnan: Mengzi and Pingbian), occurring in sparse or dense evergreen broad-leaf forest at 900–1700 m.

Phenology: Fl. Sep.–Oct., fr. Sep. of the following year.

Note: The species is the most remarkable one, and it shows several noteworthy peculiarities. It differs by having the largest papery leaves in the complex (15–20 × 5–9 cm), the biggest fruits (35–45 × 16–25 mm) (Fig. 1: O), and the thickest endocarp (5–8 mm) (Fig. 2: G), so it should be reinstated as a distinct species.

Additional specimens examined:

China. Yunnan: Pingbian, Dudian, *K. M. Feng 5201* (KUN); Pingbian, Aogapotou, *K. M. Feng 4637* (KUN).

5. Symplocos tetragona F. H. Chen ex Y. F. Wu in Acta Phytotax. Sin. 24 (3): 194. 1986. Type: China. Zhejiang: Hangzhou Botanic Garden, cultivated (introduced from Jiangxi: Jiujiang), 1978-04, *Y. Y. Ho 30344* (holotype, IBSC!).

棱角山矾 (Fig. 1: K; Fig. 2: N; Fig. 3: A)

Evergreen trees, to 18 m high. Twigs yellowish green, stout, glabrous, conspicuously 4–5-ridged. Petioles 14–20 mm long; leaf blades thick leathery, 12–20 × 4–8 cm long, glabrous on both sides, base cuneate, margin subentire or serrated, apex long acuminate; midvein adaxially prominent, lateral veins 8–12 per side. Inflorescences usually basally 3-branched, axillary spikes, 4–8 cm long, axis puberulent, 15–30-flowered, several terminal on apex of branchlets; bracts ovate, and bracteoles persistent, elliptic. Calyx glabrous or puberulent, margin ciliolate; lobes orbicular. Corolla white, ca. 6 mm long, deeply 5-lobed. Stamens 20–50 pentadelphous. Disc soft pilose. Drupes broadly obovoid, 14–18 × 8–10 mm, apex with erect persistent calyx lobes, 3-loculed, all developed, equal, mesocarp woody, endocarp stony, 2–4 mm thick, surface smooth or slightly striate.

Distribution and habitat: Endemic to China (Fujian: Yong'an, Shaxian, and Nanping. Hunan: Daoxian. Jiangxi: Lushan, Duchang, Fenyi, and Jiujiang), occurring in mixed forests below 1000 m. Cultivated as ornamental plant in South China.

Phenology: Fl. Feb.–Apr., fr. Aug.–Oct.

Note: Wu & Nooteboom (1996) reduced *S. tetragona* to one synonym of *S. nakaharae s.l.*, their reasons were: "In many collections the petioles in *S. lucida* are decurrent on the twigs, making the latter ridged to slightly winged. The name *S. tetragona* has been applied to the extreme condition, but after careful study it is apparent that, apart from winged branchlets, *S. tetragona* is indistinguishable from *S. lucida* (Thunb.) Siebold & Zucc."

After examination of specimens, and field and nursery observations, the authors found *S. tetragona* to be a distinctive species. It should be reinstated using the following features: the ridged branches and petioles are a stable characteristic; it can be distinguished from

S. nakaharae by the thick leathery leaves 12–20 × 4–8 cm long (*S. nakaharae*: 4–7 × 2–3.5 cm long), 4–8 cm basally branched spikes with 15–30 flowers (inflorescence of *S. nakaharae* to 1 cm long, with 3–8 flowers), buds lilac (*S. nakaharae*: white), several inflorescences terminal on first 3 nodes of branchlets (*S. nakaharae*: regularly arranged on branchlets); ovary 3-locular (*S. nakaharae*: 2-locular), surface of stones slightly striate (Fig. 2: N) (*S. nakaharae*: surface of stones rather smooth (Fig. 2: F)).

The species has been widely cultivated in nurseries in Hubei, Hunan, Fujian, and Zhejiang for ornamental use.

Additional specimens examined:

China. Hubei: Wuchang, Wuhan Botanic Garden cultivated, *B. Liu 94* (PE). **Fujian:** Shaxian, *anonymous*, *s.n.* (KUN). **Hunan:** Nanyue, Nanyue Botanic Garden, cultivated, *B. Liu 259* (PE), *M. H. Li & Y. Q. Kuang 672* (PE). **Jiangxi:** Duchang, *B. Liu 64*, *s.n.* (PE); Fenyi, *X. P. Ding s.n.* (LBG), *X. P. Ding 5* (W); Lushan, Baizhaoan, *M. J. Wang 1208* (LBG, NAS, PE); Lushan Botanical Garden, *R. C. Qin 10854* (LBG); Dongyuguan, *G. Yao 8799* (LBG, NAS); Guishen, *Y. G. Xiong 894* (LBG, NAS, PE); Guizongguan, *M. X. Nie*, *S. L. Chen & W. P. Wang 7502* (LBG); Weizongxiang, *M. J. Wang 143* (NAS, PE); Xiangshansi, *M. J. Wang 724* (NAS, PE); Mt. Lushan, *Y. G. Xiong 7117* (NAS), *anonymous 11824* (LBG); Xingzi, *B. Liu 24*, *39*, *40*, *43*, *44* (PE); Precise location unknown, *anonymous 135*, *12174* (LBG). **Zhejiang:** Xihu, Hangzhou Botanic Garden, cultivated, *anonymous*, *37* (PE), *B. Liu 5* (PE), *Q. G. Zhu & Q. W. Liu 193* (IBSC).

6. Symplocos setchuensis Brand ex Diels in Bot. Jahrb. Syst. 29 (3–4): 528. 1900. —*Dicalix setchuensis* (Brand) Migo in Bull. Shanghai Sci. Inst. 13: 205. 1943. Type: China. Sichuan: Mt. Emei, *E. Faber 209* (syntype, K!); Patung District, *A. Henry 3730* (syntype, K!); Nanchuan, Ku fu tung, 1891-09, *Bock & von A. Rostorn 928* (syntype, GZU!, photo, sterile); Precise location unknown, *Bock & von A. Rostorn 976* (syntype, W!, photo, sterile).

Symplocos acutangula Brand in Pflanzenr. (Engler) Symploc. 6: 65. 1901. Type: China. Futschan, 1887, *Warburg 5855* (lectotype, K!).

Symplocos argyi H. Lévl. in Repert. Spec. Nov. Regni Veg. 10: 431. 1912. Type: China. Kiangsu: Longtze, 1846-06-06, *d'Argy s.n.* (holotype, E!; isotype, A!).

Symplocos ilicifolia Hayata in Icon. Pl. Formosan. 5: 102. t. 29. 1915. —*Bobua ilicifolia* (Hayata) Kaneh. & Sasaki in List Pl. Formosa (Sasaki) 331. 1928. Type: China. Taiwan: Mt. Hakakotaizan, *U. Mori 2688* (holotype, TAIF!, photo).

Symplocos glomeratiflora Hayata in Icon. Pl. Formosan. 5: 100. 1915. —*S. congesta* Benth. var. *glomeratifolia* (Hayata) S. S. Ying in Bull. Exp. Forest Nation. Taiwan Univ. 116: 554. 1975. —*S. glomerata* King ex C. B. Clarke var. *glomeratifolia* (Hayata) S. S. Ying in Coloured Illustr. Fl. Taiwan 2: 578. 1987. Type: China. Formosa: Mt. Arisan, *S. Sasaki 1911* (holotype, TI!, photo).

Symplocos sinuata Brand in Repert. Spec. Nov. Regni Veg. 14: 326. 1916. Type: China. Yunnan, ca. 1500 m, *A. Henry 13401* (lectoholotype, A!, lectoisotypes, K!, photo, NY!, photo).

四川山矾 (Fig. 1: D; Fig. 2: K)

Evergreen trees, to 18 m high. Twigs green, glabrous, ridged. Petioles 5–10 mm long; leaf blades thin leathery, oblong or narrowly elliptic, 6.5–13 × 2–5 cm long, glabrous on both sides, base cuneate, margin serrated, apex long acuminate or acuminate; midvein adaxially prominent, lateral veins 8–12 per side. Inflorescences axillary, glomerule, 3–8-flowered, axis puberulent; bracts and bracteoles persistent, broadly obovate, outside densely pilose. Calyx margin ciliolate, lobes oblong. Corolla white, 3–5 mm long, deeply 5-lobed. Stamens 30–40, pentadelphous. Disc soft pilose. Drupes ellipsoidal or oblong, 8–12 × 5–7 mm long, apex with erect persistent calyx lobes, 3-loculed, all developed, equal, mesocarp woody, endocarp stony, surface rather smooth.

Distribution and habitat: Endemic to China (Anhui, Fujian, Guangxi, Hunan, Jiangsu, Jiangxi, Taiwan, Yunnan, and Zhejiang), occurring in mixed forests or forest edges below 2000 m.

Phenology: Fl. Feb.–Apr., fr. Jun.–Oct.

Note: Ying (1987) and Wang & Ou (1999) merged this species into *S. nakaharae*. Apart from the 3-locular fruits differing from *S. nakaharae* 2-locular fruits, the glomerulate inflorescence without pedicel or peduncle is unique in the *S. nakaharae* complex.

Additional specimens examined:

China. Anhui: Xiuning, *anonymous 3251* (PE); Huangshan, Mt. Huangshan, *M. J. Wang 3545* (PE); Mt. Meimaofeng, *L. G. Fu 0718* (PE). **Chongqing:** Beibei, Mt. Jingyun, *B. Liu 141* (PE), *Chuanqian Exped. 467* (PE), *T. H. Tu 5100* (PE). **Fujian:** Wuyishan, Mt. Wuyi, *C. P. Jian et al. 400548* (PE); Precise location unknown, *O. Warburg 5857* (W). **Guizhou:** Zunyi, Mt. Jinding, *Chuanqian Exped. 1357* (PE). **Guangxi**: Luocheng, *R. C. Qin 6035* (PE). **Hubei:** Hefeng, Mulinzi Nature Reserve, *B. Liu 138* (PE). **Hongkong:** Central Island, *S. Y. Hu 12170* (PE). **Hunan:** Jiangkou, Dengjiachong, *Y. B. Luo 2796* (PE); Xingning, Mt. Wanfeng, *Z. C. Luo 1723* (PE); Precise location unknown, *H. R. E. Handel-Mazzetti 12780* (W). **Jiangsu:** Yixing, Mt. Minling, *F. X. Liu*, *M. J. Wang & Z. Y. Huang 2337* (PE). **Jiangxi:** Chongren, *Y. Jiang 10009* (PE); Lushan, Lushan Botanic Garden, *B. Liu 55* (PE); Shahe, *C. M. Tan 951375* (PE). **Sichuan:** Mt. Emei, *E. Faber s.n.* (K). **Taiwan:** Neihu,

S. Y. Lu 5603 (TAIF); Rengechi, *Keng*, *Liu & Kao s.n.* (TAI). **Yunnan:** Wenshan, Mt. Laojun, *Y. M. Shui 002027* (PE), *H. T. Tsai 51641* (PE). **Zhejiang:** Qingyuan, *H. W. Limpricht. 326* (W), *B. Liu 14* (PE); Tiantai, Mt. Tiantai, *anonymous 0157* (PE).

7. Symplocos migoi Nagam. in Fl. Taiwan ed. 2. 4: 116. 1998. Type: China. Taiwan: Ilan, Mt. Taiping, ca. 2000 m, 1963-06-30, *M. Tamura*, *T. Shimizu & M. T. Kao 21397* (holotype, KYO!, photo).

拟日本灰木 (Fig. 1: A; Fig. 2: J)

Small evergreen trees. Twigs green to grayish dark brown, terete. Petioles 3–10 mm long; leaf blades leathery, 3–9 × 1–3 cm long, glabrous on both sides, base cuneate, margin recurved, crenate-serrated, apex short caudate, obtuse; midvein adaxially prominent, lateral veins 6–8 per side. Inflorescences simple or branched, axillary contracted spikes, axis puberulous, to 1 cm long; bracts persistent, semiorbicular to depressed ovate, bracteoles 2, persistent, ovate, often glabrous. Calyx margin ciliolate, lobes ovate. Corolla white, 4.5–5.5 mm long, deeply 5-lobed. Stamens 50–60, pentadelphous. Disc soft pilose. Drupes ellipsoidal or obovoid, 8–13 × 5–7 mm, apex with erect or spread persistent calyx lobes, 3-loculed, all developed, unequal, mesocarp woody, endocarp woody, surface slightly striate.

Distribution and habitat: Endemic to China (Taiwan), occurring in mountain areas.

Phenology: Fl. Dec.–next Feb., fr. Aug.–Sep.

Note: *Sumplocos nakaharae*, *S. migoi*, and *S. shilanensis* are morphologically similar and closely related taxa. Wang (2000) confused *S. migoi* with *S. nakaharae*; the latter has a 2-locular ovary (Fig. 2: F), whereas *S. migoi* has a 3-locular ovary (Fig. 2: J).

Symplocos shilanensis often has 2–3 pairs of sharp teeth on leaves, and less nerves and stamens than *S. migoi*; these are important characters in delimiting the three taxa.

Additional specimens examined:

China. Taiwan: Hsinchu, by Yuanyanghu lake, *anonymous*, *s.n.* (HAST); Yufeng Village, *C. C. Liao 813* (HAST); Hualian, Hoping logging tract, *J. C. Wang*, *H. W. Lin et al. 8611* (TAI), *W. H. Hu 2201* (HAST); Fong-shan Branch Station, *Liu*, *Chen & Kao 18* (TAI); Ruisui, Yuhli Wildlife Protected Area, *K. Y. Wang 597* (HAST); Ilan, Mt. Taiping, *C. C. Chuang*, *J. M. Chao & M. T. Kao 4725, 4730* (TAI, HAST); Yuen-yana Lake Nature Reserve, *E. W. Wood 3836* (PE), *W. Word 3836* (PE); Jiayi, Mt. Ali, *C. S. Kuo 80309* (TAI); Miaoli, Da-lu West logging tract, *J. C. Wang & Summer collecting team*, *8405* (HAST); Nantou, Mt. Tsuifeng, *S. Y. Lv 13364* (HAST); Yunhai, *S. Y. Lu 4703* (TAIF); Pingtung, Mt. Kaoshifoshan, *T. Y. Liu 1056* (HAST); Mutan Hsiang, *anonmyous s.n.* (HAST), *S. M. Liu 225* (HAST), *S. Z. Yang 27270* (HAST); Yung-hai to Tien-Chih, *S. L. Kelley*, *Y. C. Kao & C. T. Huang 200–98* (HAST); Mt. Gaoshifo, *C. C. Wang s.n.* (PE); *H. Ohashi*, *Y. Tateishi et al. 13503* (PE); Taichung, *Keng*, *Liu & Kao s.n.* (TAIF); Taipei, Sanhsia Town, to Peichatienshan, *K. Y. Wang 452* (HAST); Mt. Chising, *K. C. Yang 1240* (TAI); Mt. Takuanshan, *K. Y. Wang 869* (HAST), *C. F. Hsieh*, *T. S. Hsieh & C. S. Hsiao 674* (TAI).

8. Symplocos shilanensis Y. C. Liu & F. Y. Lu in Quart. J. Chin. Forest 10 (3): 90. 1977. Type: China. Taiwan: Pingtong, Mt. Shilan, 1974-07-17, *C. H. Ou et al. 2730* (holotype, TCF!, photo; isotype, TPCA!, photo).

希兰灰木 (Fig. 1: B; Fig. 2: O)

Small evergreen trees. Twigs grayish dark brown, terete or slightly ridged. Petioles 5–7 mm long; leaf blades leathery, elliptic to ovate, 2.5–5 × 1.5–2.5 cm long, glabrous on both sides, base attenuate, margin recurved, entire or with 2 or 3 pairs of crenate-serrate teeth, apex shortly caudate and obtuse, with apiculate tip; midvein adaxially prominent, lateral veins 4–5 per side. Inflorescences simple or sometimes paniculately branched, axillary short spikes, 0.5–1 cm long, axis puberulent; bracts and bracteoles persistent, minute, and ovate to orbicular. Calyx margin ciliolate, lobes semiorbicular to depress ovate. Corolla white, 3–5 mm long, deeply 5-lobed. Stamens 35–50, pentadelphous. Disc soft pilose. Drupes narrowly ellipsoidal, purple when matured, 8–10 × 4–6 mm, apex with erect or spread persistent calyx lobes, 3-loculed, all developed, equal, mesocarp woody, endocarp thin stony, surface rather smooth.

Distribution and habitat: Endemic to China (Taiwan: Pingtung, Taitung), occurring in evergreen forests.

Phenology: Fl. Aug.–Oct., fr. Jun.–Aug. of the following year.

Additional specimens examined:

China. Taiwan: Pingtung, Lanjenchi, *S. C. Wu & C. Y. Wang 1381* (HAST), *C. M. Wang & C. C. Wang 01233* (HAST); Kenting National Park, *S. M. Liu*, *W. P. Leu*, *W. H. Hu*, *H. F. Yen & C. P. Lu 240*, *271* (HAST); Manchou Hsiang, *S. T. Chiu & H. Y. Lin 04069* (PE); Mt. Nanjen, *C. H. Tsou Tsou-325* (HAST, PE), *M. C. Ho s.n.* (TAIF), *Robert F. Thorne 62735* (PE), *R. T. Li 3143*, *3263* (TAI), *S. Y. Lv 3130*, *4543*, *4542*, *4541* (TAIF), *S. K. Chuang 489* (HAST), *S. Z. Yang 20140* (HAST), *T. C. Huang 8945* (TAI), *Y. B. Chen 1021* (TAI), *Y. C. Ho s.n.* (TAIF), *Y. F. Chen 1763* (TAI); Shizi Hsiang, Shuangliu, *S. M. Ku 1765* (HAST); Shizi Hsiang, Shouka 58–59, *P. F. Lv 12818* (HAST); Taitung, Dawu, *C. C. Wang 302* (NCUF); Shauka, *C. C. Wang 318* (NCUF); Mt. Taihe, Daren Township, *C. C. Wang s.n.* (PE); Tajen Hsiang, along Hsien Road #199, *T. Y. Liu 1081* (HAST).

9. Symplocos nakaharae (Hayata) Masam. in Trans. Nat. Hist. Formosa 30: 62. 1940. ut 'nakaharai'. — *S. japonica* A. DC. var. *nakaharae* Hayata in Icon.

Pl. Formosan. 5: 103. 1915. ut 'nakaharai'. —*S. lucida* (Thunb.) Siebold & Zucc. var. *nakaharae* (Hayata) Makino & Nemoto in Fl. Japan. ed. 2 (Makino & Nemoto). 373. 1925. ut 'nakaharai'. —*Bobua japonica* (A. DC.) Miers var. *nakaharae* (Hayata) Sasaki in Cat. Govt. Herb. 407. 1930. ut 'nakaharai'. —*Dicalix lucida* (Thunb.) Hara var. *nakaharae* (Hayata) Hara in Enum. Spermatophytarum Japon. 1: 106. 1948. ut 'nakaharai'. Type: Japan. Ryukyus: Mt. Nago-take, Okinawa Islands, *G. Nakahara s.n.* (holotype, TI!, photo).

Symplocos lucida (Thunb.) Siebold et Zucc. in Fl. Jap. (Siebold) 1: 55. t. 24. 1838. non Wall. ex G. Don. 1837, excl. syn. *Myrtus laevis* Thunb. —*Laurus lucida* Thunb. in Syst. Veg. ed. 14 (J. A. Murray). 384. May–June 1784; Fl. Jap. (Thunberg) 174. non Laurinea. Aug. 1784. —*Hopea lucida* (Thunb.) Thunb. in Ic. Jap. t. 14. 1800. —*Dicalix lucida* (Thunb.) H. Hara in Enum. Spermatophytarum Japon. 1: 105. 1948. —*Symplocos japonica* A. DC. in Prodr. (A. P. de Candolle) 8: 255. 1844, excl. syn. *Myrtus laevis* Thunb. —*Bobua japonica* (A. DC.) Miers in J. Linn. Soc., Bot. 17: 306. 1879, excl. syn. *Myrtus laevis* Thunb. —*Bobua lucida* (Siebold & Zucc.) Kaneh. & Sasaki in List Pl. Formosa (Sasaki) 331. 1928. non Miers. 1879. —*Symplocos kuroki* Nagam. in Contrib. Biol. Lab. Kyoto Univ. 28 (2): 240. 1993. syn. nov. Type: Japan. *Thunberg s.n.* (holotype, UPS, microfiche!, photo).

中原氏山矾 (Fig. 1: C; Fig. 2: F)

Evergreen trees or shrubs. Twigs gray or dark brown, terete or ridged, glabrous. Petioles 8–15 mm long; leaf blades leathery, elliptic, narrowly elliptic, obovate or narrowly obovate, 4–7 × 2–3.5 cm long, glabrous on both sides, base cuneate, margin recurved, entire or glandular-crenate, apex long acuminate; midvein adaxially prominent, lateral veins 5–9 per side. Inflorescences basally branched, axillary spikes, to 1 cm long, 3–8-flowered; bracts widely ovate to depressed ovate; bracteoles 2, depressed ovate to kidney-shaped, both persistent, outside sparse appressed pubescent and ciliolate. Calyx glabrous or puberulent, margin ciliolate; lobes widely ovate to ovate. Corolla white, 4–5 mm long, deep 5-lobed. Stamens 25–40, pentadelphous. Disc soft pilose. Drupes ellipsoidal, bluish black, 9–13 × 5–8 mm, apex with erect or spread persistent calyx lobes, 2-loculed, all equally developed, mesocarp woody, endocarp woody, surface rather smooth.

Distribution and habitat: Endemic to Japan (Honshu, Shikoku, and Kyushu), occurring in warm temperate evergreen forests.

Phenology: Fl. Dec.–Apr., fr. Aug.–Nov.

Note: *Symplocos lucida* Siebold & Zucc. (1838) was published with two synonyms: *Kuroggi* Kaempfer (1712) and *Myrtus laevis* Thunb. (1784). *Kuroggi* Kaempfer is the Japanese vernacular name for *Symplocos lucida* (Thunb.) Siebold et Zucc.; *Myrtus laevis* Thunb. is a synonym for *Photinia villosa* (Thunb.) Decne. var. *laevis* (Thunb.) Stapf in Rosaceae (Ohwi et al., 1965).

The description and illustration with analysis are both based on *Laurus lucida* Thunb., so according to Art. 33.3 of the *International Code of Botanical Nomenclature* (*Vienna code*) (McNeill et al., 2006), *Symplocos lucida* Siebold & Zucc. should be treated as a combination name based on *Laurus lucida* Thunb.

But the epithet is not applicable because of an earlier homonym *S. lucida* Wall. ex D. Don. (1837), so Nagamasu (1993) proposed a new name: *Symplocos kuroki* Nagam.

Nagamasu (1993) separated *S. nakaharae* from *S. kuroki* by its smaller bracteoles (1.5–2 mm long vs. 3.5–4 mm long) and fruits (6–10 mm long vs. 9–13 mm long). The authors observed many specimens of the two species and found the differences are not sufficient to distinguish the two species. So *S. kuroki* should be a synonym of *S. nakaharae.*

Among evergreen species in Asia, *S. nakaharae* (Hayata) Masam. is the only one with a 2-locular ovary (Fig. 2: F), so undoubtedly it should be given species status. *Symplocos migoi* is quite similar to *S. kuroki* in general morphological features, however, it has a 3-locular ovary, and more stamens.

Additional specimens examined:

Japan. Honshu. Hiroshima: *Anonymous*, *s.n.* (KYO). **Nagano:** Oshika, *J. Murata*, *M. Kata & D. Parnaed 17723* (PE). **Tokyo:** Precise location unknown, *Hwang & Su* (*26)1* (PE). **Yamaguchi:** Hikarishi in Suwo, *M. Togasi 1800* (PE); Kogushi to Kawatana, *N. Kurosake 8994* (KYO); Nagato, *F. Miyoshi 10085* (PE). **Kyushu. Kagoshima:** Amami, *Y. Takasi & Y. Fako 5943* (PE); Akakuebana, *S. Kitamura & G. Murata 2925* (KYO); Kamiyaku-cho, *T. Yahara*, *J. Murata & H. Ohba 9029* (PE); Mt. Jiuwa-dake, Uken-son Island, *F. Miyoshi 7945* (PE); Ohsumi, *F. Miyoshi 8062, 8064, 8418*, *10463*, *12019*, *13235* (PE); Satsuma, *F. Miyoshi 8106, 10300*, *39914*, *42705*, *42706* (PE); Yaku Island, *J. Murata*, *M. Kato & D. Darnaedi 17723* (PE); Precise location unknown, *S. Kitamura & G. Murata 2820* (KYO). **Kumamoto:** Uchinomaki, Higo, *M. togasi 1427* (PE). **Shiga:** Tamanoura, *H. Taoda 3623* (PE). **Ryukyus Islands. Okinawa:** Okinawa Island, Mt. Nago-dake, *H. Nagamasu 1488* (KYO); Ishigaki-jima Isl., Mt. Omoto-dake, *H. Nagamasu 1032* (KYO); Yonakuni, Mt. Urabu, *F. Miyoshi 1343* (PE); Oku, Kunigami-son, *Y. Miyagi 7997* (KYO), *F. Miyoshi 1667, 5578* (PE); Shoshi, Nakijin-son, *Z. Tashiro s.n.* (PE); Yagaji Islet, *Z. Tashiro s.n.* (KYO); Precise location unknown, *F. Miyoshi 4700, 4905, 5136*, *5204*, *5136* (PE). **Shikoku. Kochi:** Hatagun, *G. Murata 17978* (KYO, PE), *T. Yahara*, *J. Murata & H. Ohba 9029* (PE). **Precise location unknown:** *H. Bürger s.n.*, *s.n.*, *s.n.* (M).

10. Symplocos pergracilis (Nakai) T. Yamaz. in J. Jap. Bot. 44: 366. 1969. —*Bobua pergracilis* Nakai in Rigakkai 26 (5): 258. t. 7. 1928. nom. nud.; Bot. Mag. Tokyo 44: 24. 1930. descr. —*Dicalix pergracilis* (Nakai) H. Hara in Enum. Spermatophytarum Japon. 1: 106. 1948. Type: Japan. Bonin Islands: Chichijima Island, *H. Toyoshima s.n.* (holotype, TI!, photo).

细枝山矾 (Fig. 1: I; Fig. 2: B)

Small evergreen trees. Twigs green or brown, zigzag, glabrous, terete, often tinged violet. Petioles 7–15 mm long, narrowly winged, often tinged violet; leaf blades leathery, obovate to narrowly obovate, 3–6 × 1–2.5 cm long, glabrous on both sides, base cuneate, margin recurved, entire or slightly glandular-crenate, apex acute, obtuse or rounded; midvein adaxially prominent, lateral veins 6–8 per side. Inflorescences simple, axillary reduced contracted spikes, to 5 mm long, 1(–2)-flowered, axis puberulent, axis with several persistent sterile bracts; bracts and bracteoles persistent. Calyx margin ciliolate, lobes semi-orbicular to kidney-shaped. Corolla white, 6–7 mm long, deeply 5-lobed. Stamens 100–120, pentadelphous. Disc soft pilose. Drupes narrowly obovoid or narrowly ellipsoidal, 20–25 × 7–12 mm, apex with erect or spread persistent calyx lobes, 3 carpels entirely fused, septa disappeared, all equally developed, mesocarp thick woody, 2–4 mm thick, endocarp thick woody, 2–4 mm thick, surface rather smooth.

Distribution and habitat: Endemic to Japan (Bonin Islands: Chichijima Island), occurring in subtropical dry evergreen forests.

Phenology: Fl. Nov.–next Feb., fr. Jul.–Dec.

Additional specimens examined:

Japan. Honshu. Tokyo: Bonin Islands, Chichijima Island, Chuoosan-higashidaira, *Yoshikazu Shimizu 77–132* (TI); Higashidaira, *H. Hara T51* (TI); Mt. Chuoo-san, *G. Murata*, *H. Tabata*, *K. Tscuchiya & K. Takada 251* (KYO); Mt. Hatsune, *Y. Momiyama*, *S. Kobayashi & M. Ono 126134* (KYO); Mt. Yoake, *Y. Momiyama*, *S. Kobayashi & M. Ono 125983* (KYO); Precise location unknown, *F. Miyoshi 7859, 11306* (PE), *T. Yamazaki & K. Enomoto*, *137* (KYO).

11. Symplocos boninensis Rehder & E. H. Wilson. J. Arnold Arbor. 1: 119. 1919. —*Dicalix boninensis* (Rehder & E. H. Wilson) H. Hara in Enum. Spermatophytarum Japon. 1: 104. 1948. Type: Japan. Bonin Islands: Mukojima Island, 50–100 m, 1917-04-28, *E. H. Wilson 8336* (holotype, A!, photo; isotypes, BM!, photo, E!, photo, K!, photo).

小笠原山矾 (Fig. 1: J; Fig. 2: A)

Small evergreen trees or shrubs. Twigs green, glabrous, terete. Petioles 8–30 mm long, narrowly winged, often tinged violet; leaf blades leathery, elliptic, 6–9 × 2.5–5 cm long, glabrous on both sides, base attenuate, margin recurved, entire or slightly glandular-crenate, apex obtuse to rounded; midvein adaxially prominent, lateral veins 5–8 per side. Inflorescences simple, axillary contracted spikes, branched at base, to 1 cm long, 1–3-flowered, axis with many persistent sterile bracts; bracts and bracelets persistent, broadly ovate, often glabrous. Calyx margin ciliolate, lobes orbicular. Corolla white, 5–6 mm long, deeply 5-lobed. Stamens 60–100, pentadelphous. Disc soft pilose. Drupes obovoid to narrowly obovoid, slightly triangular prism shaped, 20–25 × 8–13 mm long, apex with bending inwards persistent calyx lobes, 3 carpels entirely fused, septa disappeared, all locules developed and fertile, often unequal, transverse section triangle, mesocarp thick woody, 2–4 mm thick, endocarp thick woody, 2–4 mm thick, surface smooth.

Distribution and habitat: Endemic to Japan (Bonin Islands: Chichijima Island, Mukojima Island), occurring in subtropical dry evergreen forests at 50–100 m.

Phenology: Fl. Oct.–Dec., fr. Jul.–Aug.

Note: A well-marked species characterizeed by its leaves and fruits. However, Nooteboom (1975, 2005) considered it to be conspecific with *S. pergracilis*. It can be readily recognized by its non-zigzag branches, elliptic leaves with apex obtuse to rounded, and transverse sections of fruit triangle-shaped (Fig. 2: A), the apex with persistent calyx lobes bending inwards. *Symplocos pergracilis* has zigzag branches, obovate or narrowly obovate leaves with apex acute, transverse sections of fruit round (Fig. 2: B).

It also appears related to *S. nakaharae*, which has smaller serrate leaves, shorter petioles, fascicled flowers, and smaller 2-locular fruit.

Additional specimens examined:

Japan. Honshu. Tokyo: Bonin Islands, Mukoh-jima Island, *H. Kihara s.n.* (KYO), *H. Hara T178b*, *s.n.* (TI), *H. Tabata & Y. Shimizu 79–51* (KYO), *79–55* (KYO, TI); Mt. Ito, *A. Sojima*, *C. Endo & H. Nagamasu 25787* (KYO), *G. Murata*, *H. Tabata*, *K. Tsuchiya & K. Takada 646* (KYO), *T. Tuyama s.n.* (TI).

12. Symplocos kawakamii Hayata in Icon. Pl. Formosan. 5: 104. 1915. —*Bobua kawakamii* (Hayata) Nakai in Rigakkai. 26 (5): 257. t. 7. 1928. nom. nud.; Bot. Mag. Tokyo 44: 24. 1930. —*Dicalix kawakamii* (Hayata) Hara in Enum. Spermatophytarum Japon. 1: 104. 1948. Type: Japan. Bonin Islands: Chichijima Island, *T. Kawakami s.n.* (holotype, TI!, photo).

Symplocos otomoi Rehder & E. H. Wilson in J. Arnold Arbor. 1: 119. 1919. Type: Japan. Bonin Islands: Chichijima Island, 1917, *H. Otomo s.n.* (A!, photo).

川上山矾 (Fig. 1: L; Fig. 2: C)

Evergreen shrubs. Twigs green, glabrous, conspicuously ridged. Petioles winged, 2–8 mm long; leaf blades leathery, obovate, elliptic or ovate, 2–5 × 0.7–2 cm on both sides, glabrous on both sides, base cuneate, margin conspicuously recurved, entire, apex rounded or emarginate; midvein prominent near base adaxially, lateral veins 5–7 per side, prominent on upper surface with reticulation (rugose on upper surface). Inflorescences branched near base, axillary spikes, 0.5–2.5 cm long, 3–10-flowered, axis ridged and puberulent; bracts persistent, narrowly ovate to ovate, bracteoles 2, persistent, ovate to triangular. Calyx margin ciliolate, lobes ovate. Corolla white, ca. 7 mm long, deeply 5-lobed. Stamens 70–90 pentadelphous. Disc soft pilose, with 5 glands. Drupes globose or broadly obovoid, 12–20 × 8–12 mm, persistent calyx lobes forming a blunt beak, 3 carpels ventral sides attached, dorsal sides fused, septa slightly reduced, all locules equally developed, mesocarp woody, endocarp stony, slightly striate.

Distribution and habitat: Endemic to Japan (Bonin Islands: Chichijima Island), occurring in subtropical dry scrubs at 180–210 m.

Phenology: Fl. Nov., fr. May–Oct.

Note: A very distinct species characterized by its small crowded rugose obtuse or emarginate leaves and winged twigs, it seems most closely related to *Symplocos tetragona*. *Symplocos kawakamii* has relatively smaller leaves (2–5 × 0.7–2.2 cm) with margin conspicuously recurved and entire, lateral and reticulate veins prominent on the adxial surface, whereas *S. tetragona* has bigger leaves 12–20 × 4–8 cm, margin flat and serrated, lateral veins and reticulate veins impressed, not rugose on the surface. In addition, the two species do not overlap in geographical range.

Additional specimens examined:

Japan. Honshu. Tokyo: Bonin Islands, Chichijima Island, Mt. Hatsune, *H. Hara T77* (TI), *G. Murata*, *H. Tabata*, *K. Tsuchiya & K. Takada 82* (KYO), *Y. Momiyama*, *M. Ono & S. Kobayashi 126315* (KYO); Hatsuneura, *F. Miyoshi 7544* (PE), *G. Murata*, *H. Tabata*, *K. Tsuchiya & K. Takada 110* (KYO), *T. Yamazaki 34892* (PE), *Y. Shimizu 77–47* (KYO).

13. Symplocos tanakae Matsum. in Bot. Mag. (Tokyo) 15: 79. 1901. —*Bobua tanakae* (Matsumura) Masam. in Prelim. Rep. Veg. Yakus. 110. 1929. —*Dicalix tanakae* (Matsumura) Hara in Enum. Spermatophytarum Japon. 1: 107. 1948. Type: Japan. Tanegashima. *S. Tanaka 436* (holotype, TI!, photo).

Symplocos zentaroana Makino ex Yanagida in J. Jap. Forestry Soc. 20 (3): 115, 532. t. 531. 1938. nom. nud., descr. in jap.

田中山矾 (Fig. 1: M; Fig. 2: H)

Evergreen trees. Twigs green, glabrous, terete. Petioles narrowly winged, 1–2.5 cm long; leaf blades leathery, decurrent, narrowly obovate to narrowly oblong-elliptic, 7–13 × 2–3.5 cm long, glabrous on both sides, base cuneate, margin recurved, glandular-crenated, usually the proximal half entire, apex obtuse, acute or short acuminate; midvein adaxially prominent, lateral veins 8–14 per side. Inflorescences simple, axillary contracted spikes, to 1 cm long, 5 to 8-flowered, axis puberulent; bracts persistent, orbicular to widely ovate, margin ciliolate; bracteoles 2, persistent elliptic to ovate. Calyx margin ciliolate, widely ovate to elliptic. Corolla white, 6–7.5 mm long, deeply 5-lobed, lobes elliptic. Stamens 60–75 pentadelphous. Disc soft pilose, with 5 glands. Drupes globose to ellipsoid, 18–25 × 15–20 mm, apex with bending inwards persistent calyx lobes, 3 carpels entirely fused, septa disappeared, all locules well developed, mesocarp woody, endocarp thick stony, suface rather trigonous, with wings 4–6 mm long.

Distribution and habitat: Endemic to Japan (Shikoku, Kyushu), occurring in warm temperate evergreen forests at 100–500 m.

Phenology: Fl. Oct.–next Jan., fr. Sep.–Dec.

Note: This species has rather large flowers, 6–7.5 mm long, compared to 3–6 mm long in all other species and narrowly lanceolate leaves 7–13 × 2–3.5 cm long, with length/width >2.5 compared to <2 in other species. The fruits are the biggest among Japanese native species (2–2.5 × 1–1.3 cm).

Additional specimens examined:

Japan. Kyushu. Kagoshima: Ohsumi, *F. Miyoshi 10590*, *10860*, *12196*, *12314*, *12915* (PE); Isl. Yakushima, *S. Sako 6484* (KYO); Kumage-gun, *S. Amino*, *M. Okonogi et al. 260* (KYO). **Shikoku. Tokushima:** Sugio-jinja shrine, *H. Nagamasu & A. Soejima 4589* (KYO).

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References

Abdel Khalik KN. 2010. Seed coat morphology and its systematic significance in *Juncus* L. (Juncaceae) in Egypt. Journal of Systematics and Evolution 48: 215–223.

Barth OM. 1979. Pollen morphology of Brazilian *Symplocos* species (Symplocaceae). Grana 18: 99–107.

Barth OM. 1982. The sporoderm of Brazilian *Symplocos* species (Symplocaceae). Grana 21: 65–69.

Brand A. 1901. Symplocaceae. In: Engler A ed. Das Pflanzenreich (Engler). Leipzig: Verlag Von Wilhelm Engelmann. 1–100.

Chiarini FE, Barboza GE. 2009. Fruit anatomy of species of *Solanum* sect. *Acanthophora* (Solanaceae). Flora-Morphology, Distribution, Functional Ecology of Plants 204: 146–156.

Erdtman G. 1952. Pollen morphology and plant taxonomy: Angiosperms (an introduction to palynology). Stockholm: Almqvist & Miksell.

Fritsch PW, Kelly LM, Wang YG, Almeda F, Kriebel R. 2008. Revised infrafamilial classification of Symplocaceae based on phylogenetic data from DNA sequences and morphology. Taxon 57: 823–852.

Gao XF. 2006. Symplocaceae. In: Wu CY ed. Flora Yunnanica (Tomus 6). Beijing: Science Press. 304–305 & Addenda.

Handel-Mazzetti H, Peter-Stibal E. 1943. Eine revision der chinesischen arten der gattung *Symplocos* Jacq. Beihefte zum Botanischen Centralblatt 62-B: 1–42.

Hardin JW. 1966. An analysis of variation in *Symplocos tinctoria*. Journal of the Elisha Mitchell Scientific Society 82: 6–12.

Holmgren PK, Holmgren NH. 1998. Index herbariorum: A global directory of public herbaria and associate staff [online]. Available at http://sweetgum.nybg.org/ih/ [accessed 20 June 2010].

Jacquin NJ. 1760. Enumeratio systematica plantarum, quas in Insulis Caribaeis vicinaque Americes. VI. Leiden: Inter Documentation.

Juan R, Pastor J, Fernandez I. 2000. SEM and light microscope observations on fruit and seeds in Scrophulariaceae from southwest Spain and their systematic significance. Annals of Botany 86: 323–328.

Kirchheimer F. 1949. Die Symplocaceae der erdgeschichtlichen Vergangenheit. Palaeontographica 90B: 1–52.

Le R, Marianne M, Wyk BE. 2011. The systematic significance of morphological and anatomical variation in fruits of *Crotalaria* and related genera of tribe Crotalarieae (Fabaceae). Botanical Journal of the Linnean Society 165: 84–106.

Liang YW. 1986. The pollen morphology of Symplocaceae in China. Acta Botanica Austro Sinica 2: 111–120.

Magee AR, Wyk BE, Tilney PM. 2009. A taxonomic revision of the woody South African genus *Notobubon* (Apiaceae: Apioideae). Systematic Botany 34: 220–242.

Mai DH, Martinetto E. 2006. A reconsideration of the diversity of *Symplocos* in the European Neogene on the basis of fruit morphology. Review of Palaeobotany and Palynology 140: 1–26.

McNeill J, Barrie FR, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiesema JH, Turland NJ. 2006. International code of botanical nomenclature (Vienna code). Ruggell: A. R. G. Gantner Verlag.

Nagamasu H. 1987. Notes on *Symplocos lucida* and related species in Japan. Acta Phytotaxonomica et Geobotanica 38: 283–291.

Nagamasu H. 1989a. Pollen morphology and relationship of *Symplocos tinctoria* (L.) L'Hér. (Symplocaceae). Botanical Gazette 150: 314–318.

Nagamasu H. 1989b. Pollen morphology of Japanese *Symplocos* (Symplocaceae). Botanical Magazine 102: 149–164.

Nagamasu H. 1993. The Symplocaceae of Japan. Contributions from the biological laboratory, Kyoto University 28: 173–260.

Nagamasu H. 1998. Symplocaceae. In: Flora of Taiwan Editorial Committee ed. Flora of Taiwan. Vol. 4. Taipei: Editorial Commiittee of the Flora of Taiwan.

Nagamasu H. 2006. Symplocaceae. In: Iwatsuki K, Yamazaki T, Boufford DE, Ohba H eds. Flora of Japan. Vol. IIIa. Tokyo: Kodansha.

Nooteboom HP. 1975. Revision of the Symplocaceae of the Old World, New Caledonia excepted. Leiden: Universitaire Pers Leiden.

Nooteboom HP. 1976. Symplocos. In: Li HL, Liu TS eds. Flora of Taiwan. Vol. 4. Taipei: Epoch Publishing. 112–132.

Nooteboom HP. 1977. Symplocaceae. In: van Steenis CGGJ ed. Flora Malesiana. Series I. Spermatophyta flowering plants. Vol. 8, part 2. Leiden: Noordhoff International Publishers. 205–274.

Nooteboom HP. 2005. Additions to Symplocaceae of the Old World including New Caledonia. Blumea 50: 407–411.

Ohwi J, Meyer FG, Walker EH. 1965. Flora of Japan. Washington: Smithsonian Institution.

Thunberg CP. 1784. Flora Japonica. Lipsiae: Bibliopolio I. G. Mulieriano.

van der Meijden R. 1970. A survey of the pollen morphology of Indo-Pacific species of *Symplocos* (Symplocaceae). Pollen and Spores 12: 513–551.

Wang CC. 2000. A taxonomic study of the Symplocaceae of Taiwan. PhD thesis. Taichung: National Chung Hsing University.

Wang CC, Ou CH. 1999. The Symplocaceae of Taiwan. Quarterly Journal of Forest Research 21: 37–60.

Wang CC, Ou CH. 2000. Study on the pollen morphology of *Symplocos* (Symplocaceae) from Taiwan. Quarterly Journal of Forest Research 22(2): 21–36.

Wang YG, Fritsch PW, Shi SH, Almeda F, Cruz BC, Kelly LM. 2004. Phylogeny and infrageneric classification of *Symplocos* (Symplocaceae) inferred from DNA sequence data. American Journal of Botany 91(11): 1901–1914.

Wu RF. 1986a. A preliminary study on *Symplocos* of China. Acta Phytotaxonomica Sinica 24(3): 193–202.

Wu RF. 1986b. A preliminary study on *Symplocos* of China (continue). Acta Phytotaxonomica Sinica 24(4): 275–291.

Wu RF. 1987. Symplocaceae. In: Flora Reipublicae Popularis Sinicae. Beijing: Science Press 60(2): 1–77.

Wu RF, Nooteboom HP. 1996. Symplocaceae. In: Wu ZY, Raven PH eds. Flora of China. Beijing: Science Press; St. Louis: Missouri Botanical Garden Press. 15: 235–252.

Ying SS. 1975. The Symplocaceae of Taiwan. Bulletin of the Experimental Forest of National Taiwan University 116: 545–571.

Ying SS. 1987. Symplocaceae. Taipei: National Taiwan University.

Zhou LH, Frisch PW, Bartholomew B. 2006. The Symplocaceae of Gaoligong Shan. Proceedings of the California Academy of Sceinces 57: 387–431.