New Taxa of *Cimicifuga* (Ranunculaceae) from Korea and the United States

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ABSTRACT. A new species and a new variety of *Cimicifuga* (Ranunculaceae) are described and illustrated. *Cimicifuga austrokoreana,* restricted to south-central Korea, is distinguished from the other species of the genus by its strongly arcuate inflorescence axis, much shorter pedicels, and three bracteoles, one at the base and the other two at the middle of the pedicel. *Cimicifuga elata* var. *alpestris,* found in southern Oregon in the United States, is distinguished from variety *elata* and the other members of the genus by its sheathing scales surrounding the lower nodes of the stem.

Key words: *Cimicifuga,* Korea, Ranunculaceae, United States.

The genus *Cimicifuga* Wernischeck (Ranunculaceae) comprises as many as 22 species that are widely distributed in temperate regions of the Northern Hemisphere, including Europe, Asia, and North America; the center of diversity is in eastern Asia (Tamura, 1966, 1990, 1995; Ramsey, 1965, 1997; Compton et al., 1998). The plants of *Cimicifuga* are erect rhizomatous herbs with long-petioled, ternately compound leaves, racemose or paniculate inflorescences bearing many small flowers, and follicular fruits (Tamura, 1966, 1990, 1995; Park & Lee, 1995, 1996; Ramsey, 1965, 1997).

Classification of *Cimicifuga* and its related genera has been controversial. Compton et al. (1998) merged *Cimicifuga* and *Souliea* Franchet with *Actaea* L. mainly on the basis of the analyses of ITS and *trn*L-F sequences. However, Wang et al. (1999, 2001) argued that they are independent genera based on characters from morphology, palynology, and cytology. *Cimicifuga* is distinguished from *Actaea* in having three (rarely one) bracteoles, five sepals, staminode-like petals, one to eight pistils, follicular fruits, seeds with membranous scales on the surface, and more symmetric karyotypes without telocentric chromosomes. *Cimicifuga* is also distinguished from *Souliea* in having inflorescences with numerous flowers, caducous sepals, oblong to ovoid follicles, seeds with membranous scales on the surface, and mostly tricolpate pollen grains. In this study we follow the generic concept and delimitation of Tamura (1995) and Wang et al. (1999, 2001), in which *Cimicifuga* was recognized as a distinct genus.

During the course of a comprehensive systematic study on the genus *Cimicifuga,* a new species and a new variety were discovered from Korea and the United States, respectively. We describe these new taxa herein to make their names available for the *Flora of Korea* and other works in progress.

1. Cimicifuga austrokoreana H.-W. Lee & C.-W. Park, sp. nov. TYPE: Korea. Chungbuk: Youngdong-gun, Mt. Minjuji-san, Samdo-bong, Minimigol, 700 m, 19 Sep. 2000, *H.-W. Lee 1542* (holotype, SNU; isotypes, MO, SNU, TI). Figure 1.

Differt a *C. simplici* inflorescentiis axibus arcuatis, pedicellis multo brevibus et unibracteolatis basi.

Herbs perennial, hermaphroditic, 40–80 cm tall; rhizomes thick, 5–8 cm long, knotted, bearing fibrous roots; stem simple, erect, 1.5–4 mm thick, glabrous to sparsely pubescent with filiform unicellular trichomes. Leaves cauline, usually 3, alternate, 1- to 3-ternately compound, long-petioled; terminal leaflet broadly elliptic, 7.0–10.2 × 5.4–7.1 cm, 3-lobed, acuminate to cuspidate at tip, cuneate at base; both surfaces moderately to densely pubescent along major veins with filiform unicellular trichomes ca. 0.2 mm long; petiolules 1.5–2.5 cm long, grooved, sparsely to moderately pubescent with filiform unicellular trichomes; lateral leaflets similar to terminal one, but slightly smaller and inequilateral; petiole 10–20 cm long, grooved, sparsely to moderately pubescent with filiform unicellular trichomes. Inflorescence a terminal raceme, 10–20 cm long, often bearing 1 or 2 short

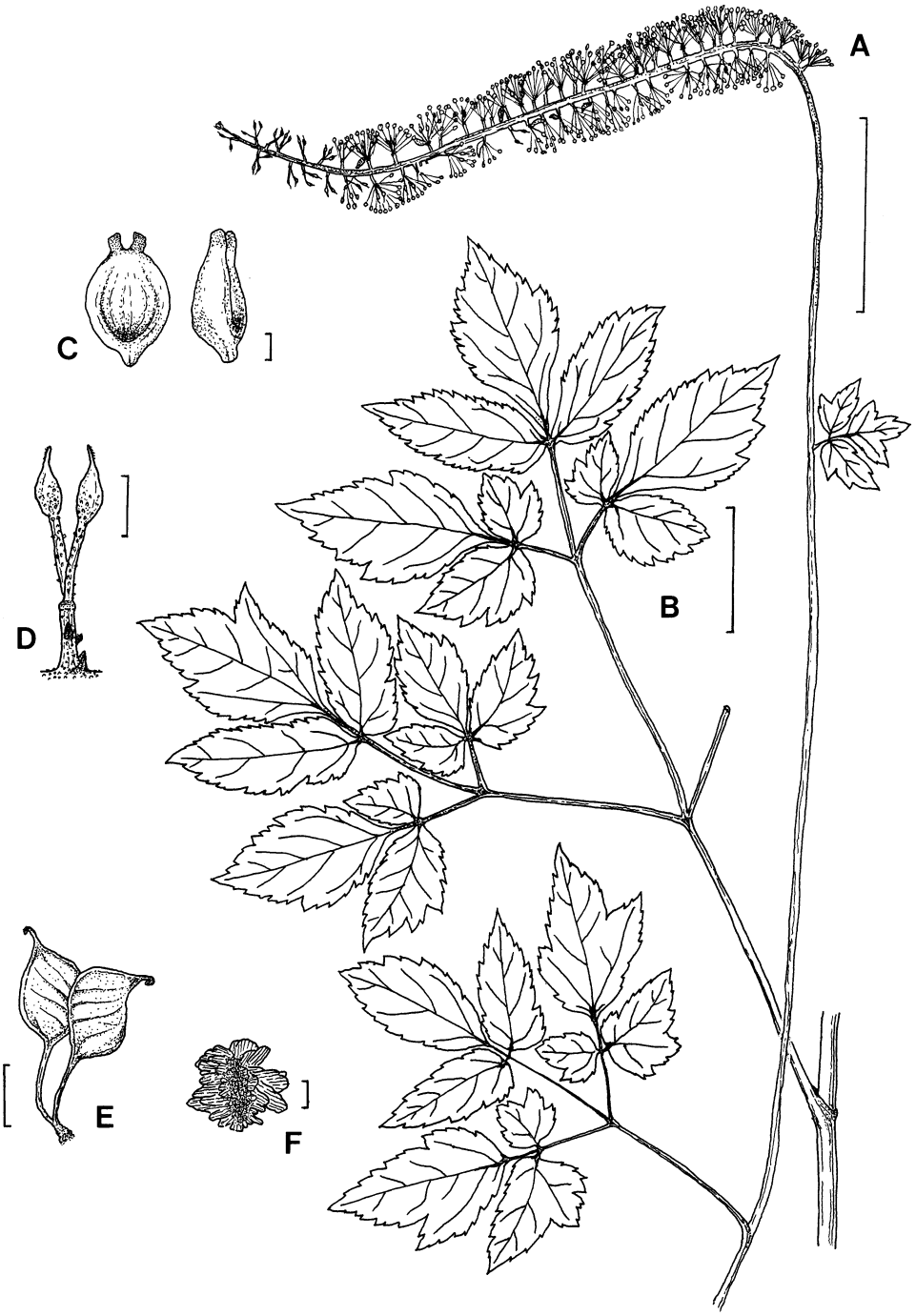

Figure 1. *Cimicifuga austrokoreana* H.-W. Lee & C.-W. Park. —A. Inflorescence and upper leaf. —B. Stem with lower leaf. —C. Petals. —D. Pistils and a pedicel with bracteoles. —E. Follicles. —F. Seed. Scale bars 5 cm (A, B), 5 mm (E), 2 mm (D), 1 mm (C, F). A–D, drawn from the holotype (*Lee 1542*, SNU), and E, F from the paratype (*Oh 1355*, SNU), by H.-W. Lee.

lateral branches near base, densely pubescent with saccate unicellular trichomes 0.1–0.2 mm long; inflorescence axis distinctly arcuate; pedicels very short, 1.0–2.5 mm long; bracteoles 3, 1 at base and 2 at middle of pedicel, triangular, 0.4–0.7 × 0.3–0.5 mm. Flowers bisexual, actinomorphic, small; sepals 5, petaloid, pale brown, broadly elliptic, concave, 3.5–4.8 × 2.8–3.5 mm; petal 1, broadly elliptic, 2.0–4.6 × 1.4–3.3 mm, bearing 2 small white appendages at tip, short-stipitate, nectariferous at base; stamens 18 to 27; filaments filiform, 5–8 mm long, slightly dilated upward; anthers bilocular, broadly oblong, 0.6 × 0.5 mm, basifixed, latrorsely dehiscent; pistils usually 2, rarely 1 or 3, elliptic to broadly elliptic, 1–3 × 0.7–2 mm, stipitate, sparsely pubescent with saccate unicellular trichomes ca. 0.1 mm long; style 1, slender, uncinate when mature, 0.8–1.7 mm long; stigma 1, minute, appressed to style. Follicles oblong, 5.5–9 × 4–6 mm, chartaceous, glabrous or sparsely pubescent with saccate unicellular trichomes; stipe 4–6 mm long; seeds 1 to 5 per follicle, elliptic, 2.2–2.6 × 1 mm, winged; wings ca. 1 mm long, chaffy, crenate.

Distribution. Restricted to high mountains of south-central Korea; moist, shady places along streamsides and mountain slopes of mixed deciduous forests, alt. 500 to 1000 m.

Phenology. Flowering mid-September to October (pers. obs.).

Cimicifuga austrokoreana is closely related to *C. simplex* (DC.) Turczaninow, but it clearly differs from the latter species by its strongly arcuate inflorescence axis, much shorter pedicels ca. 1.0–2.5 mm long, and three bracteoles, one at base and the other two at middle of pedicel (Fig. 1); in particular, the inflorescence axis is distinctly and consistently bent downward from the early stage of its development. *Cimicifuga simplex* has an erect, straight inflorescence axis, relatively long pedicels ca. 4–8 mm long, and bracteoles borne at the base of the pedicel.

In addition, the karyotypic study and allozyme analysis showed that *Cimicifuga austrokoreana* is genetically distinct from *C. simplex* (Lee & Park, 1998; Lee et al., 2000). Their karyotypes differ in the position of a secondary constriction on a pair of submetacentric chromosomes (Lee & Park, 1998), and populations of *C. austrokoreana* are distinguished from those of *C. simplex* by their allelic compositions at four loci (*Fe-3*, *Gdh*, *Lap*, and *Pgi-2*) and significantly low genetic identity values (mean = 0.688) (Lee et al., 2000).

Paratypes. KOREA. **Chunbuk:** Muju-gun, Mt. Dukyu-san, Baekryundam, 19 Sep. 1996, *Lee 771* (SNU). **Chungbuk:** Youngdong-gun, Mt. Minjuji-san, Samdobong, 29 Sep. 1995, *Lee 747, 748* (SNU), 8 Oct. 1995, *Lee 775, 776* (SNU). **Chunnam:** Gurye-gun, Mt. Chiri, Piagol, Sunyugyo, under deciduous forest, 24 Sep. 1990, *Hyun 5012* (SNU); Jilmaejae, 6 July 1995, *Lee 566, 567* (SNU), 18 Sep. 2000, *Lee 1541* (SNU), 30 Sep. 2000, *Lee 1543* (SNU); Simwon, ca. 4 km N of Nogodan, 19 Nov. 1995, *Lee 789, 790* (SNU); betw. Yuam waterfall & Jangteomok, 3 Oct. 1991, *Ryu s.n.* (SNU). **Kyungbuk:** Mt. Chiri, Cheonwang-bong, 5 Aug. 1939, *Col.? 14610* (SNU); Mt. Chiri, without specific locality, Aug. 1912, *Mori 161* (TI); Geumreung-gun, Mt. Hwanghak, near Jikji Temple, 19 Oct. 1993, *Oh 1355* (SNU [2]).

2. Cimicifuga elata Nuttall var. **alpestris** H.-W. Lee & C.-W. Park, var. nov. TYPE: U.S.A. Oregon: Jackson Co., Grizzly Peak, ca. 7 km NE of Ashland, partial shade under *Abies concolor*, 1 Sep. 1999, *H.-W. Lee 1516* (holotype, SNU; isotypes, DAV, OSU). Figure 2.

Affinis varietatis *elatae* et specierum affinium sed caulibus prope basin vaginatis ad nodos, foliolis supra pubescentibus in venis et pistillis numero 1–5 variantibus distincta.

Herbs perennial, hermaphroditic, robust, 1.0–1.6 m tall; rhizomes thick, 5–10 cm long, knotted, bearing fibrous roots; stem simple, erect, 1–1.5 cm thick, pubescent with 2- to 5-celled uniseriate trichomes 0.5–1 mm long, with scales near base; scales sheathing, usually 2, surrounding lower nodes of stem, lance-subulate, 4–6 × 1.5–2.5 cm. Leaves cauline, 3 to 5, alternate, 1- or 2-ternately compound, long-petioled; terminal leaflet broadly ovate to orbicular, 14–27 × 11–26 cm, palmately 5-lobed, acute to acuminate at tip, cordate at base; upper surfaces sparsely pubescent along major veins with multicellular uniseriate trichomes; lower surfaces densely pubescent with multicellular uniseriate trichomes; petiolules 7–14 cm long, grooved, densely pubescent with multicellular uniseriate trichomes; lateral leaflets similar to terminal one, but slightly smaller and inequilateral; petiole 10–17 cm long, grooved, densely pubescent with multicellular uniseriate trichomes. Inflorescence a few-branched terminal panicle, densely pubescent with 1- or 2-celled uniseriate trichomes 0.2–0.4 mm long; inflorescence axis erect; pedicels short, 1–4 mm long; bracteoles 3, at base of pedicel, middle one subulate, 1.5–4 × 0.5–1 mm, 2 lateral ones triangular and smaller. Flowers bisexual, actinomorphic, small; sepals 5, petaloid, pale brown, broadly elliptic, concave, ca. 3.5 × 2.5 mm; petal usually absent, rarely 1, elliptic, ca. 1 × 0.5 mm, bearing small white antheroid appendages at tip, long-stipitate, not nectariferous; stamens 20 to 30; filaments filiform, 3–5 mm long, slightly dilated

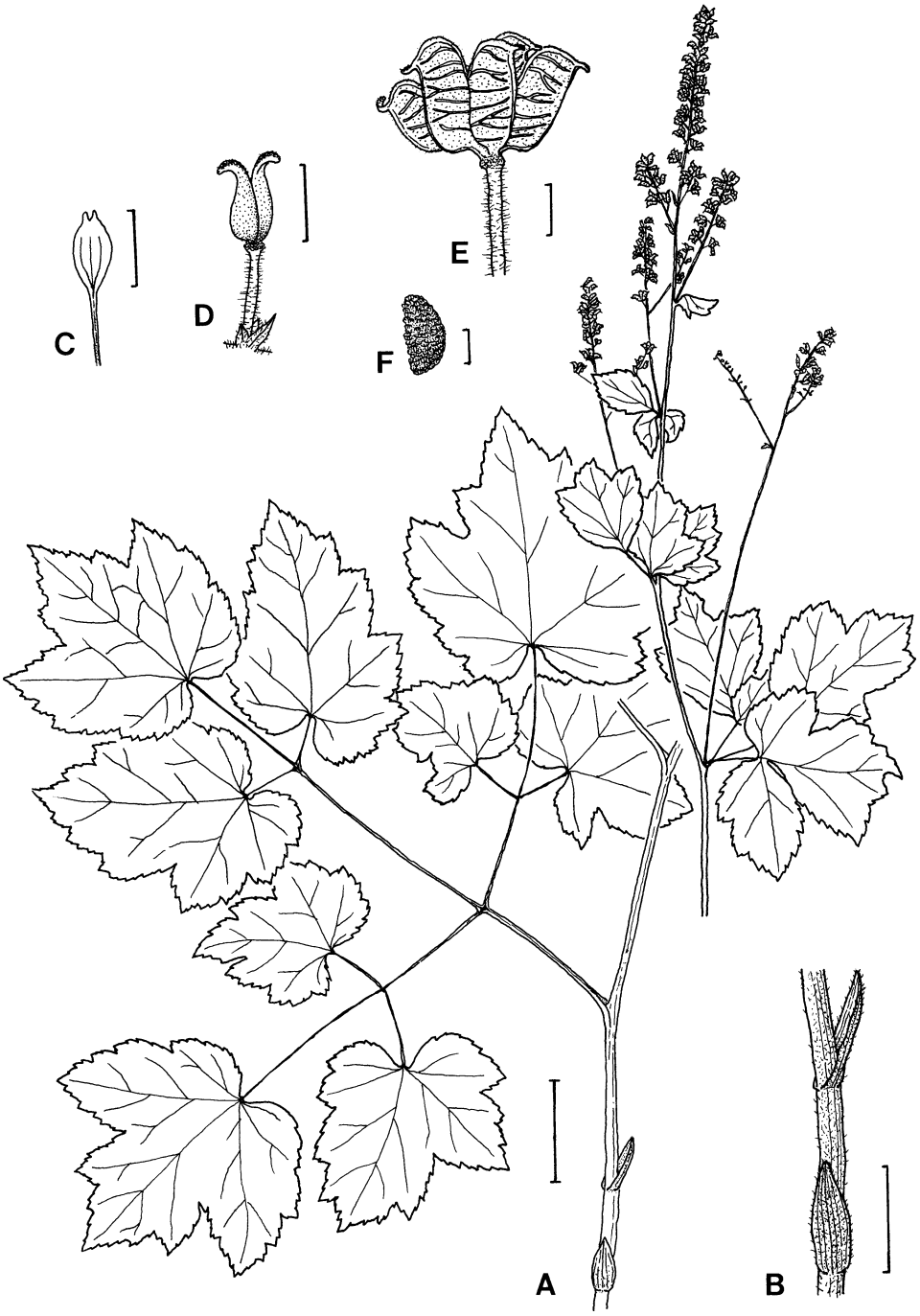

Figure 2. *Cimicifuga elata* var. *alpestris* H.-W. Lee & C.-W. Park. —A. Habit. —B. Stem with sheathing scales. —C. Petal. —D. Pistils and a pedicel with bracteoles. —E. Follicles. —F. Seed. Scale bars 10 cm (A), 5 cm (B), 5 mm (E), 2 mm (D), 1 mm (C, F). A, B, E, F drawn from the holotype (*Lee 1516*, SNU), and C, D from an isotype, by H.-W. Lee.

upward; anthers bilocular, broadly oblong, ca. 0.5 × 0.4 mm, basifixed, latrorsely dehiscent; pistils 1 to 5, elliptic to narrowly elliptic, 2.0–2.5 × 0.7–1.3 mm, sessile, densely pubescent with pyriform unicellular trichomes; style 1, short, stout, ca. 0.4 mm long; stigma 1, slightly expanded and recurved. Follicles elliptic, 7–11 × 4–5 mm, sessile, chartaceous, pubescent with pyriform unicellular trichomes; seeds 8 to 12 per follicle, triangular and lunate in outline, ca. 2.5 × 1.2 mm, transversely wrinkled.

Distribution. Restricted to southern Oregon of the United States; north- to northeast-facing mountain slopes, forest margins and trails in open or partially shaded places under *Abies concolor* (white fir), alt. 1300 to 1600 m.

Phenology. Flowering August to early September (pers. obs.).

Cimicifuga elata var. *alpestris* differs from variety *elata* as well as the other members of *Cimicifuga* in having sheathing scales surrounding the lower stem node. In addition, upper surfaces of the major leaf veins are pubescent with multicellular uniseriate trichomes in variety *alpestris,* and the new variety often has more pistils (one to five) as compared to variety *elata* (one or two).

Allozyme analysis indicated that populations of *Cimicifuga elata* var. *alpestris* have genetically diverged from those of variety *elata* (Lee & Park, in prep.). In addition, variety *alpestris* differs from variety *elata* in habitat preference; the latter usually grows in forests dominated by *Pseudotsuga menziesii* (Mirbel) Franco (douglas fir) and *Acer macrophyllum* Pursh at lower elevations (alt. 100 to 700 m).

Paratypes. U.S.A. **Oregon:** Jackson Co., 3 km E of Grizzly Peak, ca. 10 km NE of Ashland, N-facing slope along Shale City Road, open thickets, 1 Sep. 1999, *Lee 1519, 1520* (SNU).

Acknowledgments. This research was supported by a grant (BSRI-97-4416) from the Ministry of Education, Korea, to C.-W. Park. We thank Aaron I. Liston and Thomas Kaye of Oregon State University at Corvallis and B. Eugene Wofford and Q. Victor Ma of the University of Tennessee at Knoxville for assisting H.-W. Lee with fieldwork in the United States.

Literature Cited

Compton, J. A., A. Culham & S. L. Jury. 1998. Reclassification of *Actaea* to include *Cimicifuga* and *Souliea* (Ranunculaceae): Phylogeny inferred from morphology, nrDNA ITS, and cpDNA *trn*L-F sequence variation. Taxon 47: 593–634.

Lee, H.-W. & C.-W. Park. 1998. A karyotypic study on Korean taxa of *Cimicifuga* (Ranunculaceae). Korean J. Pl. Taxon. 28: 385–398.

———, M. G. Chung, Y. Suh & C.-W. Park. 2000. Allozyme variation and genetic relationships among species of *Cimicifuga* (Ranunculaceae) from Korea. Int. J. Pl. Sci. 161: 413–423.

Park, C.-W. & H.-W. Lee. 1995. Trichome morphology of *Cimicifuga* (Ranunculaceae) and its taxonomic significance. J. Pl. Biol. 38: 289–295.

——— & ———. 1996. Taxonomic notes on *Cimicifuga purpurea,* stat. nov. (Ranunculaceae). Novon 6: 93–95.

Ramsey, G. 1965. A Biosystematic Study of the Genus *Cimicifuga* (Ranunculaceae). Ph.D. Dissertation, University of Tennessee, Knoxville.

———. 1997. *Cimicifuga.* Pp. 177–181 *in* Flora of North America Editorial Committee (editors), Flora of North America, North of Mexico, Vol. 3. Oxford Univ. Press, New York.

Tamura, M. 1966. Morphology, ecology and phylogeny of the Ranunculaceae VI. Sci. Rep. S. Coll. N. Coll. Osaka Univ. 15: 13–35.

———. 1990. A new classification of the family Ranunculaceae 1. Acta Phytotax. Geobot. 41: 93–101.

———. 1995. *Cimicifuga.* Pp. 259–264 *in* P. Hiepko (editor), Die natürlichen Pflanzenfamilien nebst ihren Gattungen und wichtigsten Arten, insbesondere den Nutspflanzen, Band 17 a IV, Angiospermae: Ordnung Ranunculales, Fam. Ranunculaceae. Duncker & Humblot Verlag, Berlin.

Wang, W. T., L.-Q. Li & Z. Wang. 1999. Notulae de Ranunculaceis Sinensibus XXIII. Acta Phytotax. Sin. 37: 209–219.

———, D. Fu, L. Li, B. Bartholomew, A. R. Brach, B. E. Dutton, M. G. Gilbert, Y. Kadota, O. R. Robinson, M. Tamura, M. J. Warnock, Z. Guanghua & S. N. Ziman. 2001. Ranunculaceae. Pp. 133–438 *in* Z. Wu, P. H. Raven & D. Hong (editors), Flora of China, Vol. 6. Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis.