

OVERVIEW OF *LIRIOPE* AND *OPHIPOGON* (RUSCACEAE) NATURALIZED AND COMMONLY CULTIVATED IN THE USA

GUY L. NESOM

2925 Hartwood Drive
Fort Worth, TX 76109, USA
www.guynesom.com

ABSTRACT

The Asian natives *Liriope spicata*, *L. muscari*, *Ophiopogon jaburan*, and *O. japonicus* have been reported to be naturalized at various localities in the USA; reports of *O. jaburan* have been based on misidentifications. The naturalized occurrence of two *Liriope* species in Texas is documented here: (1) *L. spicata* occurs abundantly in large colonies along a forested creek within a city park in Fort Worth (Tarrant Co.) and it has been collected from a bottomland hardwood forest in the Big Thicket National Preserve; (2) a large plant of *L. graminifolia* is growing in low woods in a city park in Euless (Tarrant Co.). A key, brief descriptions, and basic synonymy are provided for the naturalized species as well as for *L. gigantea*, *O. intermedius*, *O. jaburan*, and *O. planiscapus*, which also are sold and commonly cultivated in the USA. An [Online Appendix](#) provides representative photos of the species in cultivation and in naturalized habitats. *Liriope gigantea* sensu stricto (colonial from stolons) differs in habit from the species now generally sold as *L. gigantea* (caespitose) — no species identified as *L. gigantea* has been recognized to occur natively in Asia. The name *Liriope exiliflora* is treated as a synonym of *L. muscari*; plants abundantly cultivated in the USA and often identified as *L. exiliflora* are instead *L. graminifolia*.

KEY WORDS: *Liriope*, *Ophiopogon*, cultivars, Ruscaceae, Liliaceae, naturalized, Texas, USA

Species of *Liriope* Lour. and *Ophiopogon* Ker Gawl. are commonly and abundantly planted in the southeastern and southcentral USA in various ways in landscapes, particularly as ground cover and border plants. All are characterized by basally tufted, linear, evergreen leaves and often are known as “lilyturf,” “mondo grass,” “Aztec grass,” or “border grass,” or sometimes as “monkey grass.” At least one of them has been called “table grass,” alluding to its graceful appearance in a pot placed on a table or desk. As a group, species of both genera are sometimes referred to as “liriopogons,” a term introduced by Skinner (1971), generally supplanting the earlier “liriomondos” suggested by Bailey (1929).

Four species of liriopogons have been reported as naturalized in the USA: *Liriope muscari* (Dcne.) L.H. Bailey, *L. spicata* Lour., *Ophiopogon jaburan* (Sieb.) Lodd., and *O. japonicus* (Thunb.) Ker Gawl. (USDA, NRCS 2010; Kartesz 2010). *Liriope graminifolia* (L.) Baker is added to this list in the current report and *O. jaburan* is removed, as reports of the latter have been based on misidentifications. Of these species, apparently only *O. japonicus* has been reported to grow outside of cultivation anywhere else in the world — from one locality in Brazil (GCW 2010; Instituto Hórus 2010). For the treatment of Liliaceae in Flora of North America North of Mexico (FNANM), Utech (2002) noted that *Liriope muscari*, *L. spicata*, and *Ophiopogon jaburan* “have been reported as escaped in the flora ... but “are not clearly naturalized” and he did not provide a treatment for either of the genera.

In addition to the species reported as naturalized in the USA, the present account includes *Liriope gigantea* H. Hume, *Ophiopogon intermedius* D. Don, and *O. planiscapus* Nakai, which also are sold and cultivated in the southeastern USA. An overview by Hume (1961) of liriopogons cultivated in the USA included *O. “arabicus”* as distinct, but this is a horticultural name for a cultivar

of *O. planiscapus*. Hume and Morrison (1967) included *O. jaburan*, *O. japonicus*, *O. planiscapus*, *L. exiliflora* (here regarded as a synonym of *L. muscari*), *L. gigantea*, *L. graminifolia* (tenuously distinguished by Hume and Morrison from *L. exiliflora*), *L. muscari*, and *L. spicata* in their account of commonly cultivated lilyturfs. Broussard (2007) studied 19 cultivars of *Liriope* and *Ophiopogon* and identified seven species among them — all of them are included in the present manuscript. A brief note on the remaining three or four species of *Liriope*, to complete the genus, also is included.

Fantz (1993) observed that “names of available liriopogons cultivated in the United States based on literature and catalogues [total] more than 20 named species and more than 100 named cultivars, even after elimination of similar names” — he listed 26 species. In a follow-up publication (Fantz 1994), he listed 22 species and 88 cultivars and noted (Fantz 1995) that “a minimum of fourteen morphologically defined species are in cultivation in the United States” — 6 of *Liriope* and 8 of *Ophiopogon*. In his last two most recent publications, Fantz has provided a key and descriptions for 6 species of *Liriope* (2008b) and for 14 of *Ophiopogon* (2009), documenting all as cultivated in the southeastern USA or at least for sale in the regional horticultural trade. Fantz’s studies (at North Carolina State University in Raleigh) were supported by observations on plants of many or most of the species and horticultural forms that he cultivated over 15 years.

Species of *Liriope* and *Ophiopogon* are native to southeastern Asia and the most comprehensive accounts of both genera are in the Flora of China (Chen & Tamura 2000a, 2000b) and the Flora of Japan (Tamura in press). Studies of species groups have been published by Hasegawa (1968), Hara (1984), Tamura (1990), Yang and Li (1990a, 1990b), Yamashita and Tamura (2001), and Tanaka (1998–2000, 2001). Except for the recent reports by Fantz, most accounts of liriopogons in the USA have included only a few species (e.g., Bailey Hortorium Staff 1976; Walters et al. 1984; Adams 1989; Deputy 1999). Regarding potentially naturalized species, beyond a specimen citation or simply the inclusion of the listed name in a floristic account, there appears to be little or no commentary on any of these in North American taxonomic literature.

The present report documents Texas occurrences of *Liriope spicata* and *L. graminifolia* outside of cultivation and provides a taxonomic and photographic overview of commonly cultivated liriopogon species in order to provide a readily available source for their identification in the USA. A detailed account of liriopogons naturalized in Alabama is provided by Spaulding et al. (2010). For critical studies, botanists should have primary Asian literature, especially from the Flora of China and the Flora of Japan, and the recent assessments by Fantz. The treatment here of *Liriope* is parallel to that of Fantz (2008b) except for the name of one species, but Fantz (2009) has treated 14 cultivated species of *Ophiopogon* compared to the four included here. The article by Hume and Morrison (1967) also is useful for its descriptions of common cultivars.

Methods.

For the present review, I have seen many plantings of *Liriope gigantea*, *L. graminifolia*, *L. muscari*, *L. spicata*, *Ophiopogon japonicus*, *O. intermedius*, and *O. planiscapus*. The account here of *O. jaburan* is from published sources. Unless otherwise specified, state records given here for putatively naturalized populations are from summaries by Kartesz (2010) and the PLANTS Database (USDA, NRCS 2010).

Using various sources (literature, internet, nurseries), I have attempted to align names of common cultivars with species, but this should be taken only as a best approximation. Some cultivar names apparently have been duplicated (e.g., a “Variegata” has been developed in more than one species) and inconsistencies are widespread in identification of species and cultivars (see details and examples by Fantz 1993, 1994), even as distributed by growers. Even patent applications for new cultivars are apparently not required to document the parentage (e.g., see applications shown at

internet sites “PatentStorm,” “PatentGenius,” “FreePatentsOnline,” etc. — or search the US Patent Office Collection <<http://patft.uspto.gov/netahtml/PTO/search-adv.htm>>).

Synonymies of scientific names are derived from primary literature and floristic treatments of Chinese and Japanese species (as cited below). The provenance is indicated for types of all of the names included here and I have examined types where photographs or digital images are available (as indicated in the typification summaries; images via website of individual herbaria and JSTOR). Hires images of the holotype of *Convallaria spicata* Thunb. were made available by staff at UPS and those photos are included in the manuscript as Figures 1 and 2.

A set of photos taken mostly by the author is included in the present report (see <[Online Appendix](#)>). Photos identified by cultivar name can be found on a number of commercial internet sites, e.g., “acemondo.co.nz,” “davesgarden.com,” “gogardennow,” “groundcoverto go.com,” and “liriope.com.” A good site for a diversity of high-quality photos of *Liriope* and *Ophiopogon*, with interesting notes by J.C. Raulston, is at <www.cultivar.org>. The dissertation by Broussard (2007; online) also has a series of good photos of cultivars in situ and of representative herbarium specimens.

***Liriope* and *Ophiopogon* at generic rank.**

Liriope includes about eight species distributed in Pakistan, China (including Taiwan), Korea, and Japan to Indochina (Vietnam, Laos, Cambodia) and the Philippines. *Ophiopogon* includes about 54 species (fide Conran & Tamura 1998) or 65 species (fide Chen & Tamura 2000b) in essentially the same area as *Liriope* but definitely known from other Himalayan countries and most of Indochina (see distribution of *O. intermedius*, below) as well as Malesia. The two genera are closely related and vegetatively similar — the most significant differences are in floral morphology (see key below). Both are now placed in the Ruscaceae (Rudall et al. 2000; Nyffeler & Eggli 2010).

A dendrogram of 18 popular cultivars studied by Mcharo et al. (2003) — based on AFLP markers — diverges somewhat from expected groupings according to the putative name assignments here, which lead the authors to suspect that *Liriope* and *Ophiopogon* might be conspecific. Differences in floral morphology, however, appear to be consistent and floristic treatments and other Asian studies have not found placement of species to genus problematic.

The genera *Liriope*, *Ophiopogon*, and *Peliosanthes* Andrews (ca. 11 species, south China to Indochina, Malesia, and India; or 1 species, fide Jessop 1976; also see Yamashita et al. 2002) have been considered to comprise the tribe *Ophiopogoneae* Endl. (e.g., Cutler 1992; Conran & Tamura 1998) or even a separate family, the Ophiopogonaceae Meisn. (Conran 1989), defined by tufted clusters of grasslike leaves, a spikelike inflorescence, irregularly and early dehiscent, 1-seeded fruits, and sarcotestal seeds. It is clear that *Liriope* and *Ophiopogon* are sister taxa, but the relationship of *Peliosanthes* has been shown to lie elsewhere (Rudall et al. 2000), reducing the Ophiopogoneae to only the two genera.

Notes on species biology.

a. Chromosome number.

At least some of the widespread species of *Liriope* and *Ophiopogon* are variable in ploidy level (e.g., see *L. graminifolia*, *L. muscari*, *L. spicata*, *O. intermedius*, *O. japonicus*; chromosome number summaries at the end of morphological descriptions are from Zhang 1998). This at least suggests that the morphological variation may be partitioned to a greater extent than currently recognized. If allopolyploidy has been involved in the formation of supra-diploid levels, attempts to understand relationships among species may be minimally meaningful without a detailed knowledge of genomic constitution of the plants under investigation. Chromosome number variation appears to

have originated in natural populations; I have not encountered any discussion or indication of hybridization involved in the production of cultivars.

Fukai et al. (2008) estimated ploidy levels (using flow cytometry) of cultivars they identified among six species of *Liriope* and *Ophiopogon*: *L. minor* (2x), *L. spicata* (6x), *O. jaburan* (2x), *O. japonicus* (4x), *O. planiscapus* (2x), and *O. platyphylla* (4x). Apart from this report, I have not encountered information regarding ploidy levels of cultivars.

b. Flowers.

The occurrence of inferior to semi-inferior ovaries in *Ophiopogon* is viewed by Rudall (2002) as one among numerous multiple and independent origins of epigyny within monocots in general and Asparagales in particular, probably linked with the evolution of different pollination syndromes. As in *Liriope*, flowers of most taxa of Asparagales are hypogynous, the primitive condition; the predominantly epigynous to perigynous flowers of *Ophiopogon* are specialized. Zhang (1998) has noted, however, that the position of the ovary is variable in both *Liriope* and *Ophiopogon*, sometimes even within a single species, and thus is not a consistently diagnostic feature.

Pedicels of these plants in early development are similar in color and texture to the corolla and floral tube (in *Ophiopogon*) and corolla (in *Liriope*). In *Liriope*, where a floral tube is essentially absent, the “pedicel” has been described in some literature as articulated distally, i.e., directly beneath the corolla. In *Ophiopogon*, the “pedicel” has been described as articulated medially, indicating the point of division between the slender floral tube (the “perigone,” fide Fantz 2008a), and the actual pedicel. During fruit development or after abscission of the corolla, the persistent pedicel in both genera becomes more clearly differentiated, appearing stramineous and somewhat sclerified. At least in *O. jaburan* and *O. japonicus*, and presumably other species of *Ophiopogon* with semi-inferior ovaries, the pedicel and perigone may remain connected and persistent as a unit subtending the fruit until after it is released.

In some of cultivars of *Liriope*, flowers apparently never open and eventually are deciduous still in the form of buds. Hume and Morrison (1967) specifically noted that this is true of *L. muscari* “Christmas Tree.” The observation by Hume (1961) and Hume and Morrison (1967) — and corroborated here at least for some cultivars of *L. muscari* and *L. graminifolia* — that the sequence of flower development is irregular over the inflorescence was questioned by Zhang (1998), who noted that opening of flowers is generally acropetal. An acropetal sequence can be seen in some young inflorescences (see photos of *L. muscari* in the Online Appendix).

c. Stolons and roots.

Some of the species in the present account reproduce clonally by shallow, laterally spreading stolons. These are slender and whitish underground stems with narrowly triangular scale leaves at the relatively widely spaced nodes, usually unbranched, sometimes producing adventitious roots, and producing a new leafy plant at each stolon apex. One or more stolons may be produced from a single leafy plant. Fantz (2008a) termed these structures rhizomes, restricting the use of stolon to creeping, above-ground stems. In the *liriopogons*, these might be termed stolon-like rhizomes, but they are closest to what are generally identified as stolons in plants over a wide range of taxonomically diverse species (see excellent summary and discussion of stolons and rhizomes in Wikipedia). Stolons and rhizomes are not completely dichotomous in distinction, and the term rhizome might be appropriately applied to very short stolons sometimes produced in *Liriope muscari* (see comments below). Representative stolons are shown in the Online Appendix.

Elongating stolons usually are not formed in *Liriope muscari* and *Ophiopogon jaburan*, which are “caespitose” forms that increase and slowly spread by production of new shoots from

lateral buds in the caudex crown. Hume and Morrison (1967) noted that “an old clump of *L. muscari* eighteen inches in diameter may give as many as one hundred and fifty separate pieces” (“bibs,” daughter plants with few leaves, fide Fantz 2008a), presumably from crown buds, but the manner of reproduction was not specified.

Some forms of cultivated *Liriope muscari*, however, do produce short stolons (see comments below under *L. muscari* and photos in the Online Appendix), and stolon production also appears to be variable in *L. gigantea* (see comments under *L. gigantea*). The same may be true in other primarily caespitose, “clumping” species (e.g., perhaps cultivars of *Ophiopogon intermedius*). Fantz (2008a, p. 335) noted that “weakly rhizomatous plants” [of liriopogons] have short stolons, “with daughter plants borne close to the mother plant and their roots intertwining. This growth pattern will form a dense carpet or mound over the ground with age, with original planting sites merging together, providing an attractive ornamental appearance.”

Liriopogons are generally described as “clumping” or “spreading” in horticultural information but below-ground parts are almost never described. Unequivocally “spreading” or “colonial” forms, which sometimes are also termed “invasive,” are *L. spicata*, *L. graminifolia*, and *Ophiopogon japonicus*. Caespitose or primarily caespitose forms are used for borders and for plantings where a certain persistent geometry is desired.

Most of the liriopogon species in cultivation in the USA produce tuber-like ellipsoid swellings, sometimes in tandem, usually at or near the distal ends of the fibrous root system (photos in Online Appendix). Steroidal saponins, steroidal glycosides, and sesquiterpene glycosides have been isolated from tuberous swellings of *Liriope muscari*, *L. spicata*, *O. japonicus*, and others (e.g., Ahmad & Basha 2006; Cheng et al. 2004, 2006; Yu et al. 1996). The root “tubers” of *L. spicata* are used medicinally in China and the species is widely cultivated there for that reason. These organs have not been observed to have a reproductive function.

KEY TO THE COMMONLY CULTIVATED SPECIES

1. Flowers erect, terminal at the tip of a strict pedicel, corollas cupulate to rotate; ovaries superior (flowers hypogynous); anthers free, oblong in outline, apically obtuse, dehiscing apically and appearing poricidal, filaments longer than or as long as anthers; stigmas entire; fruits blackish
..... **LIRIOPE**
2. Plants caespitose, without stolons or weakly stoloniferous or rhizomatous; leaves (5–)8–16(–23) mm wide, (15–)30–70 cm long.
 3. Leaves mostly 24–55 cm long, relatively thin, flexuous and arching 45° to 140° or more; scapes usually equal or longer than the leaves, sometimes shorter 1. **Liriope muscari**
 3. Leaves mostly 50–80 cm long, relatively thick, usually relatively stiff, slightly arching 45° to 90°; scapes usually distinctly shorter than the leaves 3. **Liriope gigantea**
2. Plants colonial, from slender stolons; leaves (2–)3–8(–10) mm wide, (14–)18–60 cm long.
 4. Scapes (15–)20–44(–53) cm long, mostly equal or longer than the leaves and the inflorescences conspicuous; corollas purple to lavender; inflorescence rachis (4–)5–13 cm long, (20–)45–160-flowered 2. **Liriope graminifolia**
 4. Scapes 12–29 cm long, mostly much shorter than the leaves and the inflorescences mostly obscured; corollas mostly white; inflorescence rachis 2–5(–8) cm long, (20–)45–72-flowered
..... 4. **Liriope spicata**

1. Flowers nodding, on a recurving pedicel/floral tube, corollas mostly campanulate; ovaries inferior to semi-inferior (flowers epigynous to perigynous); anthers more or less connate in a column, narrowly lanceolate in outline, apically narrowly attenuate-acute, dehiscing longitudinally, filaments much shorter than the anthers (anthers subsessile); stigmas 3-lobed; fruits commonly blue, sometimes blackish **OPHIOPOGON**

5. Leaves 2–4 mm wide; scapes 6–12 cm long, much shorter than the leaves; inflorescence rachis 2–5 cm long, 5–10+-flowered; plants colonial 1. **Ophiopogon japonicus**

5. Leaves 4–15 mm wide; scapes (12–)15–50 cm long, shorter or longer than the leaves; inflorescence rachis (2.5–)4–16 cm long, 10–32-flowered or 45–250-flowered; plants colonial to weakly colonial.

6. Leaves blackish purple to black in popular horticultural forms, 4–9(–12) mm wide, (10–)25–36 cm long; 10–32-flowered; plants strongly colonial 2. **Ophiopogon planiscapus**

6. Leaves green or variegated, 7–15 mm wide, (20–)25–60 cm long; 45–250 flowered; plants weakly colonial.

7. Rachis 6–10.5 cm long, fascicles 12–20; flowers 3–7 per fascicle calyx tube (perigone) 6–8 mm long; pedicels (in flower) 9–11 mm long; leaves green or variegated

..... 3. **Ophiopogon jaburan**

7. Rachis (8–)17–21 cm long, fascicles (30–)45–55; flowers (1–)3–6 per fascicle; calyx tube (perigone) 1–2 mm long; pedicels (in flower) 2–5 mm long; leaves variegated

..... 4. **Ophiopogon intermedius**

1. LIRIOPE MUSCARI (Dcne.) L.H. Bailey, Gentes Herb. 2: 35. 1929. *Ophiopogon muscari* Dcne., Fl. Serres Jard. Eur. 17: 181. 1867–1868. **TYPE:** China (“Habitat in insula Hong Kong?”).

Convallaria spicata Thunb. in Murray, Syst. Veg., ed. 14, 334. 1784 [also in Fl. Jap. 141. 1784]. *Ophiopogon spicatus* (Thunb.?) Ker Gawl., Bot. Reg. 7: pl. 593. 1821 [nom. invalid.] [non Hook. 1862]. *Liriope muscari* (Decne.) L.H. Bailey var. *exiliflora* L.H. Bailey [nom. nov.], Gentes Herb. 2: 37. 1929. *Liriope exiliflora* (L.H. Bailey) H. Hume, Bailey 9: 144. 1961. *Liriope muscari* forma *exiliflora* (L.H. Bailey) H. Hara, J. Jap. Bot. 59: 37. 1984. **TYPE:** Japan. “Crescit prope Nagasaki” (fide Flora Japonica, p. 141), *C.P. Thunberg s.n.* (holotype: UPS digital image!, Figs. 1 and 2 of present account, photograph in Bailey 1929 as Fig. 7); probable isotypes: BM digital images!, the plants represented only by scapes).

Wang and Tang (1951) proposed the combination *Liriope platyphylla* var. *exiliflora* (Bailey) Wang & Tang, but they did not provide the basionym and the name is invalid. See further comments below, under “The status of the name *Liriope exiliflora*.”

Liriope graminifolia (L.) Baker var. *densifolia* Maxim. ex Baker, J. Linn. Soc., Bot. 17: 500. 1879. *Liriope spicata* (Thunb.) Lour. var. *densifolia* (Maxim. ex Baker) C.H. Wright, J. Linn. Soc., Bot. 36: 79. 1903. **TYPE:** “Japonia, Formosa, China borealis, et insulae Loo Choo.” As synonym fide Chen and Tamura (2000b), Tamura (in press).

Ophiopogon spicatus (Thunb.) Ker Gawl. var. *communis* Maxim., Bull. Acad. Imp. Sci. Saint-Petersbourg 15: 85. 1871. *Liriope muscari* var. *communis* (Maxim.) Nakai, Bot. Mag. (Tokyo) 43: 776. 1934. *Liriope muscari* var. *communis* (Maxim.) P.S. Hsu & L.C. Li, Acta Phytotax. Sin. 19: 460. 1981. **TYPE:** Japan. Possible isotype: Prov. Senano et Nambu, 1864, 1865, and 1866, *S. Tschonoski s.n.* (NY digital image!); a probable duplicate of this, but giving the date as 1864 and the collection number as *Tschonoski 1874*, is at P, digital image!. Basal parts not collected. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope yingdeensis R.H. Miao, Acta Sci. Nat. Univ. Sunyatseni 1982: 75. 1982. **TYPE:** China, Guangdong Province. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Stolons usually absent, short if present. **Roots** with tuberous swellings but usually few, sometimes absent. **Leaves** (15–)24–55(–65) cm long, 6–12(–23) mm wide, stiff and erect to flexuous and arching, (5–)12–25-nerved, margins minutely serrate distally, apices acute to obtuse or rounded. **Scapes** erect, 24–60(–70) cm long, at least some distinctly longer than the leaves, others often shorter, sometimes all about the same height as the leaves, subterete to slightly flattened, especially distally, or distinctly flattened proximally and distally, green to purple. **Inflorescence** (50–)100–220(–300) flowered, rachis 6–20 cm long, narrowly columnar to broadly cylindric with loosely to densely arranged fascicles; bracts lanceolate to triangular, proximal 3–6 mm long. **Flowers** mostly in fascicles of (1 or 2–)3–?, usually reduced to (1–)2–5 distally; pedicels (2–)3–5 mm long; tepals purple, lilac-purple, or lavender, elliptic-oblong to oblong, 3–4 mm long; floral tube 0.2–0.6 mm long, less commonly essentially absent. **Fruits** globose, 4–8(–9) mm in diam., blue-black to dark or blackish purple to nearly black at maturity. **Seeds** blackish purple at maturity, subglobose, 4–7 mm in diam. $2n = 36, 72, 108, 112$.

Native to China, Taiwan, Japan (including Ryukyu Islands). Native habitats include forests, bamboo forests, scrub, shady and moist places in ravines and on slopes; 100–1400(–2000) meters elevation. **Common names:** BIG BLUE LIRIOPE, BLUE LILYTURF, BLUE-FLOWERED SNAKESBEARD (fide Ker Gawler 1821). **Representative cultivars:** Big Blue (later known as Riegel Big Blue and Original Big Blue), Bigun, Blue Spire, Border Gem, California Hybrid, Christmas Tree (sometimes known Monroe No. 2), Cleopatra, C.T. Tanner, Curly Twist, Densiflora, Eleven-O-Three, Gold Banded (v), Grandiflora, Green Midget, Hawk’s Feather (v), Ingwersen, Isabelle, Jeanette, John Burch (v), Just Right, King Felix, Lilac Beauty, Majestic, Marant, Marc Anthony, Mayan Blue, MoneyMaker, Monroe White (sometimes known as Monroe No. 1), New Blue, New Wonder, Okina, Paul Alden (v), Peedee Ingot, Purple Bouquet, Royal Purple, Silver Banded (v), Silver Dragon (v), Silver Ribbon (v), Silvery Midget (v), Silvery Sunproof (v; see comment under *L. graminifolia*), Sno Cone, Summer Beauty, Superba, Tidwell’s Big Blue (now marketed as Tidwell’s True Blue), Traebert White, Variegata (v), Webster Wideleaf. Flowering (Jun–)Jul–Aug. “(v)” = variegated.

Naturalized distribution in the USA. **Alabama, Georgia, Kansas, Louisiana** (Lincoln Par., Thomas & Allen 1993), **Maryland, Mississippi, South Carolina**. A report of *Liriope muscari* from Louisiana (MacRoberts et al. 2008); proved to be *L. spicata*, and it seems likely that at least some others also are misidentifications of stoloniferous species. For example, images of ‘infestations’ of monkeygrass identified as *L. muscari* (Forestry Images 2010; no indication of provenance except “United States”) probably are *L. spicata*. On the other hand, at least one Florida collection (Wunderlin & Hansen 2008) identified as *L. spicata* apparently is *L. muscari* — Jackson Co.: *Burks 1125*, USF; the identification of *Wilhelm 10159* —from Okaloosa Co., USF — as *L. spicata* probably is correct. Diggs et al. (1999) noted that *L. muscari* in north central Texas is widely cultivated and persists and spreads vegetatively in flower beds — the characterization of its vegetative spread suggests that a stoloniferous species (e.g., *L. spicata* or *L. graminifolia* vs. the primarily caespitose *L. muscari*) was included in the concept.

Deputy (1999) noted that Tidwell’s Big Blue is a “spreading form ... not to be confused with the clumping type Big Blue.” Paul Fantz (pers. comm. 2010) also observed that two plants of Tidwell’s Big Blue, obtained from Tidwell’s Nursery in 1987 and grown in research plots, proved to be stoloniferous. Tidwell’s Nursery (pers. comm. 2010, fide “Bo” Tidwell) affirms that at least Tidwell’s True Blue as now marketed is a ‘clumping’ form. See other comments on variability in stolon production — under “Notes on species biology” and with photos in the Online Appendix. It even seems a distinct possibility that some cultivars currently marketed as *L. muscari* may have been derived from forms of *L. graminifolia* in which stolon production has been repressed or restrained. Evidence for this might be sought through molecular studies.

The wide variation in cultivars in habit and other features at least suggests that the genetic pool of *Liriope muscari* may be greater than in other *liriope*s. As noted by Fantz (2008b, p. 347), “This is the only species with inflorescence variations that have lead to distinct cultivar selections.” Consideration of *L. platyphylla* as a species distinct from *L. muscari* (see below) also emphasizes the taxonomic complexity of the latter, and it seems likely that critical study may bring to light additional taxa that can be justifiably recognized.

Status of the name *Liriope exiliflora*.

Bailey (1929) explicitly noted that his *Liriope muscari* var. *exiliflora* was intended as a nomen novum (a replacement name at different rank) for *Convallaria spicata* Thunb. In Hume’s recognition of the taxon at species rank, the prior publication of *Liriope spicata* Lour. (1790) blocked usage of Thunberg’s epithet in the genus *Liriope*.

Chen and Tamura (2000a) interpreted the name *Liriope spicata* Lour. as a combination by Loureiro based on *C. spicata* Thunb. As observed by Bailey (1929), however, *Convallaria spicata* Thunb. (the type from Japan) and *Liriope spicata* Lour. (the type probably from China) are heterotypic and represent different species.

The application of the name *Liriope exiliflora* to the plants commonly cultivated in the USA stems from the interpretation by Hume (1961). From a photo of the UPS type of *Convallaria spicata* Thunb., which Bailey had renamed as *L. muscari* var. *exiliflora*, Hume was convinced that the plant shows “a piece of rhizome attached to the base of the segment” and thus would be a match for the colonial species that he saw in cultivation. Dr. Mats Hjertson, UPS Curator, has sent high resolution images of the UPS specimen (Figs. 1 and 2 in the present account) — the thickened axis from the base interpreted by Hume as a rhizome is instead a cord-like fibrous root, probably contractile in function. The type specimen of *Convallaria spicata* can be matched in aspect to many plants of *L. muscari* seen in cultivation.

Reservations earlier expressed by Skinner (1971, p. 348) about the recognition of *Liriope exiliflora* can now be seen as well-founded: “Its origin is obscure. H.H. Hume has accorded it species rank, but a cultivar designation would have seemed more logical, pending assignment to a known existing species.”

In raising *Liriope exiliflora* to specific rank, Hume contrasted it in tabular form with *L. muscari*. Another stoloniferous species, *L. graminifolia* was also included in Hume’s overview, and a comparison of his description of *L. graminifolia* -vs.- *L. exiliflora* shows this: leaves 35–40 cm long, 3–5 mm wide, 9–11-nerved -vs.- “to 43 cm” long, 9–12 mm wide, 9–13-nerved; rachis 3.5–6.2 cm long -vs.- 8–16.5 cm long; fascicles ?, mostly 3-flowered -vs.- 3–5, mostly 5-flowered. The leaf width described by Hume for *L. exiliflora* matches the leaves of the type specimen (= *Convallaria spicata*, Thunb.) but is considerably broader than the dimensions recorded by Fantz (2008b) and those here for the cultivated stoloniferous species identified as *L. exiliflora*. Thus even the identity of the American plants regarded by Hume as *L. exiliflora* is not perfectly clear in his concept, and a distinct species identified as *L. exiliflora* has never been recognized in Japan, even a half century after its taxonomic uplift by Hume. As concluded here, the plants identified by Hume as *L. exiliflora* are forms of *L. graminifolia* (see discussion below), the type of which is from somewhere in Asia outside of Japan, since *L. graminifolia* does not occur in Japan.

In both the original and revised edition of his Manual of Cultivated Plants, Bailey included only two species, *Liriope spicata* and *L. muscari*, treating var. *exiliflora* within the latter (Bailey 1924, 1949) as a form with leaves “often only 6 mm broad but sometimes nearly twice as broad.”

Both *L. exiliflora* and *L. graminifolia* are listed in Hortus Third (Bailey Hortorium Staff 1976), the latter noted as “probably not in cultivation” (perhaps just repeating earlier comments).

Placement of *Liriope exiliflora* as a synonym of *L. muscari* accounts for several previous discrepancies: (1) the morphological discordance between the type specimen of *Convallaria spicata* Thunb. and plants identified as *L. exiliflora* in the American horticultural trade, (2) the absence of plants identified as *L. graminifolia* in the American horticultural trade, and (3) the absence of a distinctive species identified as *L. exiliflora* in Japan, where the type specimen was collected. For the Flora of Japan, Tamura (in press) has treated *Liriope muscari* var. *exiliflora* L.H. Bailey as a synonym of *L. muscari* sensu stricto, and the present study is in agreement.

Status of *Liriope platyphylla*.

Liriope platyphylla was proposed as a new species in 1951 and the name has engendered taxonomic confusion, especially after being used by Ohwi (1953) for all of the *L. muscari*-like plants of Japan. Recent Asian floras (Chen & Tamura 2000a; Tamura in press) have placed *L. platyphylla* in synonymy under *L. muscari*, but it has been maintained as a species distinct from *L. muscari* by Fantz (2008b), who observed that “Plants bearing the name *L. platyphylla* originating from China or European nurseries (who obtained them from China) are very distinct from cultivated selections of U.S. plants known as *L. muscari*” (p. 345). And (p. 348) “The inflorescences overtop the leaves much higher than *L. muscari*, bearing more fascicles of flowers than any other species. However, fruiting pedicels will bear dried, persistent perianth members, which is less desirable as an ornamental trait when fruit typically abort. Rabbits continually ate the leaves of this species in research beds, ignoring *L. muscari* and other species, which exhibited infrequent feeding.”

Liriope platyphylla F.T. Wang & T. Tang, Acta Phytotax. Sin. 1: 332. 1951. **SYNTYPES**: China: Anhwei, T.N. Liou & P.C. Tsoong 2077; Kiangsu, Y.L. Keng 2749 — cited by Wang and Tang as “Type specimens.” The herbarium of deposition was not specified for either, but the authors were working from “Academia Sinica” and presumably the specimens are at PE in Beijing. Fantz (2008b) noted that he had not been able to obtain type material for study

Liriope spicata var. *latifolia* Franch., Pl. David. 296. 1884. **TYPE**: China. Kiangsi, Kiukiang Mountains, A. David 854 (P). As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope muscari forma *latifolia* (Makino) H. Hara, J. Jap. Bot. 59: 37. 1984. *Liriope graminifolia* var. *latifolia* Makino, Yagaihakubutsu 3: 165. 1933. **TYPE**: Japan.

In synonymy of *Liriope platyphylla*, Wang and Tang cited “*Liriope muscari* Bailey [1929] non *Ophiopogon muscari* Decne. [1868],” but Bailey’s name as a new combination was clearly based on Decaisne’s basionym and thus is homotypic with it. The authors described their new species as “rhizomatosa,” and it is possible that they conceived of it as distinct in growth habit from “*Liriope muscari* sensu Bailey.” They also cited in synonymy “*Ophiopogon spicatus* Hook. [1862] non *Liriope spicata* Lour.” (thus referring to *Convallaria spicata* Thunb. = *Liriope exiliflora*, see comments below — which is stoloniferous). Even if they were proposing *L. platyphylla* as a replacement name for *Convallaria spicata*, Bailey had already provided that in 1929 as *L. exiliflora*. In any case, citation of *L. muscari*, a valid species heterotypic with *L. platyphylla*, in synonymy of *L. platyphylla* appears to render the latter invalid. (617) 495-0794

Among collections from the Harvard Herbaria, I have seen duplicates of several cited by Wang and Tang as paratypes of *Liriope platyphylla*: [China]. Chekiang, Cheo & Wilson 2805 (GH); Hunan, Fan & Li 565 (GH); Kweichow, Steward, Chiao, & Cheo 77 (A, GH). From these, and from the illustration in Wang and Tang (1978), the description in the protologue, and the implication of the epithet, it appears that *L. platyphylla* refers a relatively broad-leaved variant that is treated by current floristicians in China and Japan as a synonym of *L. muscari* — representative collections of this form

are shown in Figs. 5 and 6, compared to collections of typical *L. muscari* in Figs. 3 and 4. I have seen collections generally matching the *L. platyphylla* variant from Japan and Taiwan and a cluster of provinces of southeastern China (Jiangsu, Anhui, Zhejiang, Jiangxi, Hunan, and Guangxi). Typical *L. muscari* appears to be restricted to eastern provinces of China (Shandong, Jiangsu, Anhui, Jiangxi, Zhejiang, Jiangxi, Fujian, Guangdong, and Hainan) and it also occurs in Japan and Taiwan. I am not able to adequately assess whether or not intergradation indicates that *L. platyphylla* and *L. muscari* are conspecific.

The original description of *Liriope platyphylla* noted that it is rhizomatous, but none of the plants I have seen that otherwise match *L. platyphylla*, either cultivated or from the native range, have been rhizomatous. Fantz (2008b) characterized the species as caespitose and forming tufted clumps.

Some variants in the USA horticultural trade match the leaf morphology of *Liriope platyphylla*. Fantz's key (2008b) key does not directly compare *L. platyphylla* and *L. muscari*, but the couplet below is derived from his key and descriptions.

1. Scapes 55–60 cm long; rachis 18–24 cm long, crowded, ca. 3/4–4/5 as long as the peduncle; fascicles 60–80; perianth tube prominent, 1–1.2 mm long; corollas lavender; anthers 1.6–1.8 mm long; outer bracts obovate-elliptic, hyaline wings to near apex **Liriope platyphylla**
1. Scapes 20–30 cm long; rachis 6–12 cm long, loose, ca. 1/3 as long as the peduncle; fascicles 35–50; perianth tube inconspicuous, 0.1–0.4 mm long; corollas violet to purple or white; anthers 1.5 mm long; outer bracts linear with abrupt, ovate, hyaline wings basally **Liriope muscari**

It may be possible to recognize another broad-leaved variant of *Liriope muscari* sensu lato. Plants with exceptionally long, thick leaves and long scapes (see representatives in Figs. 7 and 8) occur in provinces mostly west of the “*platyphylla*” variants (Sichuan, Yunnan, and Guizhou, and overlapping or parapatric with “*platyphylla*” in Hunan). The leaves are relatively even in width rather than prominently broadening distally as in the “*platyphylla*” form. More detailed study would be necessary to accurately portray the variation.

2. **LIRIOPE GRAMINIFOLIA** (L.) Baker, J. Linn. Soc., Bot. 14: 538. 1875. *Asparagus graminifolius* L., Sp. Pl., ed. 2, 1: 450. 1762. *Dracaena graminifolia* (L.) L., Syst. Nat. (ed. 12) 2: 246. 1767. *Mondo graminifolium* (L.) Koidz., Bot. Mag. (Tokyo) 40: 333. 1926. *Ophiopogon graminifolius* (L.) H.R. Wehrh., Gartenstauden 1: 187. 1929. **TYPE**: “Habitat in Asia.”

A type has not been designated for *Asparagus graminifolia* (fide Jarvis 2007), but original material is in herbarium LINN (Savage No. 435.5 digital image!; <<http://www.linnean-online.org/5244/>>). The plant is in flower, clearly *Liriope*, and has narrow leaves (2–2.5 mm wide) and 11–25 cm long. The inflorescence overtops the leaves — the scape (peduncle plus rachis) is 27 cm long and the rachis is 11 cm long. The fascicles are well-separated and each is composed of (1–)2–4 flowers with ovate floral bracts; the flowers total about 85. The basal parts of the plant, critical in its identification, were not collected but the narrowly linear leaves and overtopping inflorescence give some confidence that it represents the species currently identified in Asia as *L. graminifolia*.

Liriope crassiuscula Ohwi, Acta Phytotax. Geobot. 12: 108. 1943. **TYPE**: China. As synonym fide Chen and Tamura (2008a).

Stolons creeping, slender (fide protologue and observation). **Roots** with tuberous swellings. **Leaves** (14–)18–54 cm long, (2–)3–8(–10, –12 fide Fantz) mm wide, flexuous and arching, (6–)8–15-nerved, margins minutely serrulate distally, apices acute to obtuse to rounded. **Scapes** erect, (15–)20–44(–53) cm long, usually longer than the leaves, sometimes subequal to slightly shorter, subterete to

strongly flattened, especially distally. **Inflorescence** (20–)45–160-flowered, rachis (4–)5–13 cm long, narrowly columnar with distinctly separated fascicles; bracts ovate, proximal 4–5 mm long. **Flowers** in fascicles of (1–)2–7, usually 1–3 distally; pedicels 2–5 mm long; tepals light purple to lavender, oblong to oblong-elliptic, 3–4 mm long; floral tube 0.5–1 mm long. **Fruits** globose, 4–5 mm in diam., blackish at maturity. $2n = 72, 108$.

Native to Pakistan and northwestern Himalayas, Vietnam, and China (incl. Taiwan). Native habitats include forests, thickets, shady places along ravines, grassy and rocky places; ca. 10–2300 meters elevation. **Common names:** GRASS LILYTURF, CREEPING LILYTURF. **Representative cultivars:** *Angustifolia*, *Ariaka-janshige* (v = Silvery Sunproof?), *Samantha* (“pink liriope”). Some commercial websites equate the names *Ariaka-janshige* and *Silvery Sunproof*; a few describe it as “spreading” but photos mostly show caespitose plants. Flowering (Jul–)Aug–Sep.

Reported here for the first time (see below) as outside of cultivation in the USA. Hume (1961, p. 147) noted that “In the Lower South it [*Liriope exiliflora* sensu Hume = *L. graminifolia*] is commoner than any other species of *Liriope*.” Fantz (2008) also noted that it is very common in the landscape, and the present study confirms its abundance in cultivation, at least in Texas, Louisiana, and Arkansas.

In a taxonomic account of the Asparagaceae, Baker (1875) disposed of various names outside of his concept of *Dracaena*. His entry for the liriope was this: “D. GRAMINIFOLIA, *L.* = *Liriope graminifolia*, Baker. = *Ophiopogon spicatus*, Gawl.” Fantz (2008b) treated *Liriope graminifolia* as a synonym of *L. spicata* Lour., acceding to a precedent that he cited from the 2007 International Plant Names Index (IPNI), but Baker’s citation of “*Ophiopogon spicatus* Gawl.” would have been in reference to the basionym *Convallaria spicata* Thunb., which is regarded here as a synonym of *L. muscari*.

Examination of the types of *Liriope graminifolia* (L.) Baker and *L. spicata* Lour. (see references above to the images) indicates that they are not the same species (and, of course, the Linnaean name is the earlier). *Liriope spicata* is distinguished by its longer and narrower leaves, shorter scapes (relative to the leaves), much shorter and fewer-flowered rachises, and white flowers. The description of *L. graminifolia* formulated here from first-hand observations of cultivated plants in the USA is remarkably similar to the description of *L. graminifolia* in the Flora of China (Chen & Tamura 2000a), presumably based on a wide geographic sample of native plants.

Liriope graminifolia and *L. muscari*, as identified here, are similar in aspect and can easily be confused in identification, especially if the stolons of *L. graminifolia* are restrained by a barrier from spreading — in both species the scapes characteristically overtop the leaves and the flowers are purplish. The only consistent diagnostic feature is the growth habit, stoloniferous in *L. graminifolia*, caespitose in *L. muscari*. Fantz (2008, p. 346) described a useful technique for observing the difference without digging: “A good field observation is to use your hands to separate the leaves in a *Liriope* patch from above. It will be easy to observe patches of bare soil between bibs within the clump of [*L. graminifolia*] because of its rhizomatous [stoloniferous] habit. The bibs will be close together in caespitose *L. muscari*, making patches of bare soil more obscured or hidden.”

Fantz also noted that “abundant fruit set also indicates *Liriope* [*graminifolia*], as fruit commonly abort in *L. muscari*, leaving pedicellate racemes lacking or bearing very few fruit.”

***Liriope graminifolia* naturalized in Texas.**

The account here is the first report of *Liriope graminifolia* naturalized in the USA.

Texas. Tarrant Co.: city of Euless, Bob Eden Park along S side of West Mid Cities Blvd., low woods of *Ulmus americana*, *Carya illinoensis*, *Quercus shumardii*, *Fraxinus pennsylvanica*, and *Morus rubra*, along slough immediately tributary to large creek, producing abundant fruit, 10 Oct 2010, Nesom FW10-25 with Robert George (BRIT).

A single large plant with stoloniferous offsets was encountered (see photos in Online Appendix). There is no obvious source for the species in the immediate vicinity but large amounts of water move through the habitat in heavy rains and it is possible that a plant fragment was washed into the site from a neighborhood outside the park. *Liriope graminifolia* was observed in cultivation in a nearby neighborhood. Reproduction through seed is possible, especially in view of the abundant fruit production — but then one might expect that escapes would be more commonly reported, since the species is so commonly cultivated in the Southeast. Fruits of the isolated plant in Bob Eden Park perhaps were developed apomictically.

3. LIRIOPE GIGANTEA H.H. Hume, *Baileya* 9: 148. 1961. **TYPE:** Presumably Asia, but provenance otherwise unknown. “The source from which it came originally is obscure. It was found growing in a small area near the house at Millpond Plantation, Thomasville, Georgia. Mr. A.F. Wilkinson, who was superintendent of Millpond Plantation for 40 years, says in a letter dated October 21, 1960, that ‘The original Ophiopogons, I believe, came from France when the gardens were first landscaped some 54 years ago.’ This would place the planting at Millpond in 1906 or thereabouts” (Hume 1961, p. 150). The holotype is housed at FLAS and a digital image! can be seen on the FLAS herbarium website.

Stolons creeping, slender (fide protologue), but apparently without stolons in at least most horticultural forms. **Roots** with or without tuberous swellings. **Leaves** (17– fide Fantz, 30–)50–80 cm long, (5–)8–12(–16 fide Fantz) mm wide, thicker and less arching than in other *liriope*s, 7–13(–17 fide Fantz)-nerved, margins minutely serrulate distally, apices acute to obtuse to rounded. **Scapes** erect, 20–42 cm long, mostly shorter than the leaves, subterete to slightly flattened, especially distally, purplish. **Inflorescence** ca. 40–180-flowered, rachis 6–17 cm long, narrowly columnar with distinctly separated fascicles; bracts lanceolate to linear, proximal 4–5 mm long. **Flowers** mostly in fascicles of (2–)4–8; pedicels 3–5 mm long; tepals light to dark violet, oblong-ovate, 4–6 mm long; floral tube 0.3–1 mm long or less commonly essentially absent. **Fruits** subglobose, 5–8 mm in diam., blue-black to dark or blackish purple at maturity. **Seeds** subglobose, 4–6 mm in diam. $2n$ = unknown.

Native distribution unknown (see comments below and those regarding the **TYPE**). **Common names:** GIANT LILYTURF, GIANT LIRIOPE. **Representative cultivars:** Aztec Grass, Emerald Goddess, Evergreen Giant, Love Potion No. 13, Merton Jacobs, Supergreen Giant. Fantz (2008b) notes that “Variegated Giant,” sometimes claimed to be a horticultural variant of *L. gigantea*, is actually an *Ophiopogon* (*O. jaburan*). Flowering Jun–Oct. As noted by Hume (1961, p. 150): “flowers produced earlier in the season than those of any other species growing under same conditions; fruit also ripening ahead of that of *L. muscari*, *L. spicata*, *L. graminifolia*, and [*L. graminifolia*].” Broussard (2007), however, noted that it flowers June through September; cultivars in Texas were flowering through September, essentially contemporary with *L. graminifolia*, mostly later than *L. spicata*.

The description above of *Liriope gigantea* is drawn mostly from plants seen by the author sold and cultivated as ‘giant liriope’ (and usually identified as “*Liriope gigantea*”), augmented mostly

for fruits from the description by Fantz (2008b). Comments by Fantz (2008b, p. 346) are useful: “The leaves are stiff, mostly erect with some spreading apically, but not becoming arched back and pointed downward toward the ground as observed in most species of *liriopogons*. The leaves are the longest and the most elegant green of *liriopogons* used in the landscape.” I find that *L. gigantea* is easily distinguished from *L. muscari*, but the distinction is subtle and relies mostly on leaf length and thickness.

In the protologue of *Liriope gigantea* (Hume 1961) it was described as a “rhizomatous plant with stout, widely spreading rhizomes, in time forming a dense matted turf.” The type specimen at FLAS (cited above), as well as the photo in the protologue (Hume 1961, Fig. 55, p. 147) clearly show slender, creeping rhizomes. Broussard (2007) studied samples of *Liriope gigantea* and also described the root system as “rhizomatous with stout, widely spreading rhizomes.” Photos of her vouchers (“Evergreen Giant” Fig. 4.7; Merton Jacobs “Supergreen” Fig. 4.19) show rhizomatous (= stoloniferous) plants. The patent application for “Merton Jacobs” (Jacobs 2001) notes that it grows “by adding bibe or small clumps of leaves on short rhizomes on the side of the existing clump. ... The rhizomes are 1/2 to 3/4 inches long, 1/4 to 1/2 inches wide. ... [The original of the new cultivar was] “found as an openly pollinated seedling of *Liriope gigantea* maintained by Flowerwood Nursery, Inc. in Bushnell, Fla.” (Jacobs 2001).

In contrast, Fantz’s description noted that “rhizomatous stems lacking” is characteristic of the growth habit of *Liriope gigantea*, and commercial information generally describes plants with a clumping habit, sometimes reaching three feet in width from lateral growth. All of those I have seen also appear to be distinctly caespitose, without rhizomes (see photos in Online Appendix). Thus it appears that the spreading growth habit is variable in derivatives of typical *L. gigantea*. See comments under *L. muscari*, in which similar variation perhaps occurs.

The lack of correspondence of *Liriope gigantea* with any known Asian species is peculiar. Comments by Skinner (1971, p. 348–349) are pertinent: “This, the largest-leaved of all known wild or cultivated *liriopogons*, is an oddity which may possibly have reached a Georgia plantation from France early in the century. Yet it seems not to have been reported from France. ... It may well be of garden origin.” With Fantz and others, however, the present study confirms that *L. gigantea* is a distinctive entity not clearly associated with any other species cultivated in the USA and apparently not matching any recognized species of the Chinese or Japanese flora.

If *Liriope gigantea* indeed is of garden origin, it seems reasonable to speculate that it has arisen from *L. muscari*. Plants of *L. gigantea* are generally larger than those of *L. muscari*, usually considerably so, but large-leaved plants of *L. muscari* sensu lato may be similar in aspect to *L. gigantea*, overlapping in leaf length and width (e.g., see the variant from south-central China in Figs. 7 and 8). Leaves of *L. gigantea* are thicker and more rigid (also as noted by Fantz 2008b) and the flowers are larger. This set of “gigas” features could be associated with an elevated ploidy level. Variation in habit (stolons present or absent) suggests the possibility that distinct cultivars may have arisen independently. Hybrid origin is not implausible — all plantings I have seen (Texas and Arkansas) have been completely sterile, with no fruit production.

4. LIRIOPE SPICATA Lour., Fl. Cochinch. 1: 201. 1790 (non *Convallaria spicata* Thunb. 1784, based on a type from Japan; see comments under *L. exiliflora*). **TYPE:** probably China. “Habitat frequenter culta, incultaque in Cochinchinâ, & Chinâ” (holotype: P, photograph in Bailey 1929, Figure 6).

Ophiopogon gracilis Kunth, Enum. Pl. 5: 298. 1850. **TYPE:** Vietnam and China. As synonym fide Tamura (in press).

Ophiopogon fauriei H. Lév. & Vaniot, Repert. Spec. Nov. Regni Veg. 5: 283. 1908. *Mondo fauriei* (H. Lév. & Vaniot) Farwell, Amer. Midl. Naturalist 7: 43. 1921. **TYPE:** Korea. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope spicata var. *prolifera* Y.T. Ma, J. Wuhan Bot. Res. 3: 27. 1985. **TYPE:** China. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Liriope spicata var. *humilis* F.Z. Li, Bull. Bot. Res., Harbin 6: 170. 1986. **TYPE:** China. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Stolons creeping, slender. **Roots** with tuberous swellings. **Leaves** (15–)25–60 cm long, 3–6(–8) mm wide, flexuous and arching, 5–11-nerved, margins serrulate, apices acute. **Scapes** erect, 12–29 cm long, shorter than the leaves, terete to slightly flattened, especially distally. **Inflorescence** 45–72-flowered, rachis 2–5(–8) cm long, narrowly columnar with distinctly separated fascicles; bracts lanceolate to linear, 4–6 mm long. **Flowers** in fascicles of (1–)2–4(–6); pedicels ca. 2 mm long; tepals white to very pale violet, oblong-elliptic to oblong, 4.5–5 mm long; floral tube 0.5 mm long. **Fruits** globose, 7–9 mm in diam., blue-black to dark or blackish purple at maturity. **Seeds** subglobose, 5–6 mm in diam. $2n = 36, 72, 88, 90, 108$.

Native to China, Taiwan, Japan, Korea, and Vietnam. Native habitats include forests, grassy slopes, hillsides, moist places; ca. 10–1800 meters elevation. **Common names:** CREEPING LIRIOPE, CREEPING LILYTURF, TABLE GRASS. **Representative cultivars:** Cassidy, Ever Blue, Franklin Mint (or =*L. muscari*?), Small Dragon, Silver Dragon (= Gin Ryu) (v), Small Green. Flowering (Jul–)Aug–Sep(–Oct).

Naturalized distribution in the USA. **Alabama** (Spaulding et al. 2010). **Arkansas** (reported by Smith 1988 as *Ophiopogon jaburan*, but ID'ed here as *L. spicata*. Jefferson Co.: Pine Bluff, invading vigorously in a yard, 16 Aug 1983, Locke 5235, UARK digital image!). **Florida** (Wunderlin & Hansen 2008; voucher for occurrence in Wakulla Co., Anderson 24303, VDB). **Louisiana** (Caddo Par.; MacRoberts et al. 2008, identified in the original report as *L. muscari*). **Maryland** (Calvert Co.: Scientists Cliffs, Port Republic, occasional escape along Steve Easter Trail, E of picnic table, colonial herb, 12 Oct 1986, Hill 17478 (GH). **Mississippi, Illinois, Texas** (see notes below for Texas).

Liriope spicata is a distinctive species identified with certainty by its rhizomatous habit, narrow, arching leaves, and short scapes bearing inconspicuous inflorescences usually about mid-level among the leaves. The flowers are white to very pale violet and relatively few per rachis.

Comments on the name *Liriope spicata*.

In making the nomenclatural combination *Ophiopogon spicatus*, Ker Gawler (1821) listed both *Liriope spicata* Lour. and *Convallaria spicata* Thunb. as synonyms, thus the name is invalid and the basionym for his combination is ambiguous — the listing here with Thunberg's basionym is arbitrary. He noted that “The synonym from the ‘Flora Cochinchinensis’ was kindly communicated by Mr. Brown, who has ascertained it from the original sample in the Herbarium of the Museum of Natural History at Paris; where a portion of Loureiro's Botanical Collection had found its way from Lisbon during the pillage of the late wars.” The illustrated plant (plate 593), however, clearly is not *L. spicata* Lour. It probably represents *L. muscari* or *L. graminifolia* — although the description notes “radice repente,” the basal parts are not illustrated, thus its identity is unambiguous. The illustrated leaves are broader than characteristic of *L. graminifolia* but no measurements are given in the description. Ker Gawler cited “Nepal, Cochinchina, China, and Japan” as the native range of the species, apparently incorporating elements from the protologues of both Loureiro and Thunberg. He noted that the illustrated plant was introduced in 1820 by the Horticultural Society of London and grown in their conservatory — with only the generalized statement as an indication of its native provenance.

Hooker (Bot. Mag. 88: t. 5348. 1862) provided an illustration and commentary associated with the name *Ophiopogon spicatus*, and the name sometimes has been cited as “*O. spicatus* (Thunb.) Hook. 1862.” Hooker, however, clearly did not intend to provide a new name, as he cited *O. spicatus* “Gawl.” The illustration in Hooker’s contribution probably is of *L. muscari* (the basal parts are not shown or described), and regarding the previous illustration in Ker Gawler’s article, Hooker noted that “Gawler’s artist has not done justice to the plant in his figure” (which also does not illustrate basal parts).

***Liriope spicata* naturalized in Texas.**

The occurrence of *Liriope spicata* has been attributed to Texas (Kartesz 2010; USDA, NRCS 2010) on the basis of a report by Neill and Wilson (2001). This Texas report, however (p. 1093), described the species as one of several “found in varying stages of persistence at an old abandoned home sites and cemeteries ... and not appearing to be adventive;” the label explicitly notes that the specimen was collected from an “Abandoned old home site ... persisting after cultivation, rhizomatous-spreading” (Madison Co., 15 Jun 1997 [no flowers or fruits], Neill 672, TAMU digital image!). The plants are clearly stoloniferous, with stiffly arching leaves 10–19 cm long and 2–3 mm wide—a collection of *Ophiopogon japonicus* rather than *L. spicata*.

Liriope spicata is unequivocally documented here as outside of cultivation and naturalized in two distantly removed localities in Texas.

1. Texas. Tarrant Co.: city of Fort Worth, Overton Park between the TCU campus and Hulen Street, Overton Creek parallel to Shady Creek Drive, immediately adjacent to the creek on the sandy terrace, 10 Oct 2010, Nesom FW10-21 (BRIT, MO, NCU, TAMU, TEX, USF).

The plants occur in at least eight large, dense, rhizomatous, well-separated colonies over a stretch of about 200 meters (see photos in Online Appendix) along Overton Creek in Overton Park, near the center of the city of Fort Worth. The creek at this point runs through a broad and wooded but relatively steep-sided ravine and is about three miles above confluence with the Trinity River. The *liriope* colonies are on the first terrace of the creek.

It is possible that the first plants of *Liriope spicata* along Overton Creek were from a local homeowner who dumped lawn refuse down the steep banks. The creek commonly rises beyond its banks in heavy rain and, once established in the lower terrace, a colony could be fragmented in fast water and parts of it carried downstream.

2. Texas. Hardin Co.: Big Thicket National Preserve, Lance Rosier Unit, on the long east fork of Rosier Park Road (Cotton Road) at the turnaround at the road end near Little Island Bayou, bottomland hardwoods, 21 Aug 2004, Brown 30092 (SBSC, photocopy!).

Another collection from Hardin County was reported by Brown et al. (2005) as *Ophiopogon jaburan*—the voucher for this collection is presently unavailable for study, but it is very likely to be *Liriope spicata* (in the Big Thicket National Preserve, along the Kirby Nature Trail near Turkey Creek “far from any house or farm land,” Johnson 1797, RICE transferred to TAES). Diggs et al. (2006) included *O. jaburan* as a member of the East Texas flora on the basis of the report by Brown et al.

Liriope spicata is described on some internet sites as forming an “outstanding weed-suppressing mat,” an accurate description also reflective of its behavior in the Fort Worth creekside habitat. Fruits in *L. spicata* are produced at a very low frequency (pers. observ.), however, which probably limits its wider dispersal and invasive potential.

Other species of *Liriope*.

Liriope includes a total of 6–10 species, depending on the taxonomic interpretations of *L. gigantea*, *L. platyphylla*, and *L. koreana*, and *L. tawadae*. Brief notes on remaining taxa are provided here.

Liriope minor (Maxim.) Makino, Bot. Mag. Tokyo 7: 323 1893. *Ophiopogon spicatus* (Thunb.) Ker Gawl. var. *minor* Maxim., Bull. Acad. Imp. Sci. Saint-Petersbourg 15: 85. 1870. *Liriope graminifolia* (L.) Baker var. *minor* (Maxim.) Baker, J. Linn. Soc., Bot. 17: 500. 1879. *Liriope spicata* Lour. var. *minor* (Maxim.) C.H. Wright, J. Linn. Soc., Bot. 36: 80 1903. *Ophiopogon minor* (Maxim.) Masam., Sci. Rep. Kanazawa Univ., Biol. 5: 111. 1957. **TYPE:** Japan. Kanagawa Prefecture. Yokohama, 1862, C.J. Maximowicz (probable isotypes: GH!, without collection number, NY digital image!; with the same locality and date but labeled Maximowicz 1874 (P digital image!)).

Liriope cernua (Koidz.) Masam., Mem. Fac. Sci. Taihoku Imp. Univ. 11: 559. 1934. *Mondo cernuum* Koidz., Bot. Mag. Tokyo 40: 332. 1926. **TYPE:** Japan. As synonym of *L. minor* fide Tamura (in press).

Mondo tokyoense Nakai, J. Jap. Bot. 19: 314. 1943. **TYPE:** Japan. As synonym of *L. minor* fide Tamura (in press).

Liriope angustissima Ohwi, Acta Phytotax. Geobot. 3: 201. 1934. *Liriope minor* (Maxim.) Makino var. *angustissima* (Ohwi) S.S.Ying, Fl. Taiwan ed. 2, 5: 53. 2000. **TYPE:** Taiwan. As conspecific with *L. minor* fide Ying (2000); as synonym of *L. graminifolia* fide Chen and Tamura (2008a).

Liriope minor was included in the overview by Fantz (2008b, p. 347), who noted that it is “a rare species in the green industry, found in limited botanic gardens labeled as a cultivar of *Liriope* or *Ophiopogon japonicus*.” It is stoloniferous-colonial and further unequivocally characterized by its short and narrow leaves and especially by its scapes shorter than the leaves and with short, very few-flowered rachises. The native range of *L. minor* is China, Japan, Korea, and the Philippines. Chinese plants of the species are described with leaves 2–3(–4) mm wide and 7–20 cm long, scapes 6–7(–15) cm long with rachises 1–3(–5) cm long and 5–12 flowers (Chen & Tamura 2000a); in Japan, the leaves are 8–42 cm long, 2–3 mm wide, scapes 3.5–12(–16) cm long with rachises 0.5–5(–9) cm long and 3–17 flowers (Tamura in press). Analogous measurements for *L. minor* by Fantz indicate that his concept of the species is similar: leaves 2–4 mm wide, (5.5–)7.5–15 cm long, scapes 5–8.5 cm long, and rachises 1–2.5 cm long with ca. 3–18 flowers.

Liriope koreana (Palib.) Nakai, Bot. Mag. Tokyo 48: 777. 1934. *Ophiopogon spicatus* var. *koreanus* Palib., Trudy Imp. S.-Peterburgsk. Bot. Sada 19: 106. 1901. *Liriope graminifolia* (L.) Baker var. *koreana* (Palib.) Nakai, Fl. Kor. 2: 239. 1911. *Mondo koreanum* (Palib.) Hatus., Bull. Kyushu Imp. Univ. Forests no. 5: 231. 1934. *Liriope spicata* Lour. forma *koreana* (Palib.) H. Hara, J. Jap. Bot. 59: 38. 1984. **TYPE:** Korea.

Liriope koreana has been treated as a synonym of *L. spicata* by Chen and Tamura (2000b) and Tamura (in press), but in the limited material I have seen (GH: Japan, Shinsyu; Korea, Sorai Beach, Whanghai), plants identified as *L. koreana* do not appear to be the same species as *L. spicata*. The scapes are equal to or longer than the leaves and produce more and smaller flowers than in *L. spicata*, and the leaves are 10–20 cm long and 2–4 mm wide.

Liriope kansuensis (Batalin) C.H. Wright, J. Linn. Soc., Bot. 36: 79. 1903. *Ophiopogon kansuensis* Batalin, Trudy Imp. S.-Peterburgsk. Bot. Sada 13: 103. 1893. *Mondo kansuense* (Batalin) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE:** China.

Liriope kansuensis is endemic to a relatively small region of central China, in northern Sichuan Province and adjacent Gansu Province. It is distinctive in its stoloniferous habit, short linear leaves, and few-flowered scapes longer than the leaves.

Liriope pedicellata Wang & Tang, Fl. Reipubl. Popularis Sin. 15: 251. 1978. **TYPE:** China.

Liriope pedicellata occurs only at moderate elevations in northeastern Sichuan Province. The plants are characterized by their caespitose habit, long, linear leaves, and as the epithet implies, the distinctively long pedicels.

Liriope tawadae Ohwi, Acta Phytotax. Geobot. 5: 55. 1936. *Ophiopogon tawadae* (Ohwi) Masam., Sci. Rep. Kanazawa Univ. 5(a): 111. 1957. **TYPE:** Ryukyu Islands (Japan, Okinawa).

Tamura (in press) characterizes *Liriope tawadae* as an endemic of the Ryukyu Islands and differentiates it from *L. muscari* by its angled scape and longer pedicels articulated near the apex — but entering the caveat “Further studies are needed in order to clarify whether *Liriope tawadae* is really distinguished from *L. muscari* or not.”

5. OPHIOPOGON JAPONICUS (Thunb.) Ker Gawl., Bot. Mag. 27, plate 1063. 1807. *Convallaria japonica* Thunb., Nova Acta Regiae Soc. Sci. Upsal. 3 [Kaempferus Illustratus I]: 208. 1780 [also Fl. Jap., 140. 1784]. *Flueggea japonica* (Thunb.) Rich., Neues J. Bot. (Schrader) 2: 9. 1807. *Slateria japonica* (Thunb.) Desv., Verh. Batav. Genootsch. Kunsten 12: 15. 1830. *Mondo japonicum* (Thunb.) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE:** Japan, [*C.P. Thunberg* 8491] (holotype: UPS, photo in Bailey 1929 as Fig. 5).

Authorship of *Convallaria japonica* is sometimes attributed to L. f. (Suppl. Pl., 204. 1782), but Thunberg first published the name. Ker Gawler cited Thunberg’s publication in Flora Japonica, but the description in Kaempferus Illustratus was two years earlier. Linnaeus cited “Habitat in Japonia. Thunberg.” Ker Gawler augmented his description of the species with information from Kaempfer’s *Amoenitatum Exoticarum* of 1712.

Convallaria japonica var. *minor* Thunb., Fl. Jap. 139. 1784. **TYPE:** Japan. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Ophiopogon stolonifer H. Lév. & Vaniot, Mem. Accad. Pontif. Nuovi Lincei 23: 344. 1905 [Liliac. etc. Chine, 16. 1905]. *Mondo stolonifer* (H. Lév. & Vaniot) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE:** China. As synonym fide Chen and Tamura (2000b), Tamura (in press).

Stolons creeping, slender. **Roots** with tuberous swellings. **Leaves** (5–)12–35(–40) cm long, 2–4 mm wide, 3–5(–7)-nerved, margins serrulate, apices acute to obtuse or rounded. **Scapes** erect, 6–15(–27) cm, much shorter than leaves, slightly flattened. **Inflorescence** ca. 5–10+-flowered, rachis 2–5 cm; bracts lanceolate, proximal 7–8 mm long. **Flowers** usually nodding, in fascicles of 1–2(–3); pedicels 2–2.5 mm, articulate near middle; tepals white to light lilac or pale purple, lanceolate, 3.5–4.5 mm long; floral tube 1–2 mm long. **Fruits** subglobose to ellipsoid-globose, ca. 7–9 mm in diam., blue to blue-violet at maturity. **Seeds** globose, 6–8 mm in diam., blue at maturity (photos in the Online Appendix). $2n = 34, 36, 67, 68, 72, 108$.

Native to China (incl. Taiwan), Japan, and Korea. Native habitats include forests, dense scrub in ravines, and moist and shady places on slopes and along streams, cliffs; 200–2800 meters elevation. Widely cultivated in China for its tuberous roots, which are used medicinally. **Common names:** MONDO GRASS, MINI MONDO, DWARF MONDO, SUPER DWARF MONDO, ENGLISH MONKEYGRASS. **Representative cultivars:** Albus, Bluebird, Caeruleus, Comet (v), Compactus, Gyoko Ryu, Jade Dragon, Kijimafukiduma (v), Kyoto Dwarf, Minor, Nanus, Nippon, Silver Mist (v, = Kijimafukiduma?), Silver Showers (v), Shiroshima Ryu, Striatus, Super Dwarf, Tears of Gold, Torafu. Several of the cultivar names refer to plants with extremely abbreviated leaves (e.g., Compactus, Gyoko Ryu = Super Dwarf, Kyoto Dwarf, Nanus = Dwarf). Flowering May–Jun; flowers apparently produced uncommonly.

Naturalized distribution in the USA: **Alabama** (fide Kartesz 2010). Diggs et al. (1999) noted that *Ophiopogon japonicus* in north central Texas is widely cultivated and persists and spreads

vegetatively. A photo on the Bayou Preservation Association website <<http://www.bayoupreservation.org/>> shows fruits of *O. japonicus* and the species is included among "The Invasive Exotic "Dirty Dozens" — presumably the photograph was taken of a naturalized plant somewhere in the bayou area around Houston in southeastern Texas but no documentation is provided. See Spaulding et al. (2010) for another photo of a fruiting plant of *O. japonicus* in a naturalized population. I have rarely seen fruits in cultivated plants.

Differences can be striking between longer-leaved horticultural forms and the dwarf, highly compact forms with leaves as short as 5 centimeters. The smaller plants and dwarfs are derived from the longer-leaved wild type.

Tamura (in press) recognizes three varieties within *Ophiopogon japonicus*. Var. *caespitosus* Okuyama (endemic to Japan) and var. *umbrosus* Maxim. (Japan, Korea, and China) both are characterized by stolons much reduced in length (compared to var. *japonicus*) and more vigorously branching rhizomes. Presumably the forms seen in USA horticulture all are var. *japonicus*, since all appear to produce creeping stolons and are strongly colonial.

6. OPHIOPOGON PLANISCAPUS Nakai, Cat. Sem. Hort. Tokyo 20. 1919; 33. 1920. *Mondo planiscapum* (Nakai) L.H. Bailey, Gentes Herb. 2: 25. 1929. **TYPE:** Japan.

Stolons usually creeping, slender, sometimes shorter. **Roots** with tuberous swellings. **Leaves** 15–30(–50) cm long (fide Tamura in press; apparently mostly less than 25 cm in popular cultivars), 4–6(–7) mm wide, 7–11-nerved, margins serrulate distally, apices obtuse. **Scapes** erect or arching, ca. 10–20 cm long, shorter than the leaves, flattened, winged, sometimes weakly 3-angled near the base. **Inflorescence** 10–32-flowered, rachis 4–8 cm long, often 1-sided; fascicles (5–)12–18; bracts lanceolate, proximal 8–18 mm long. **Flowers** pendulous, in fascicles of 1–3; pedicels 2–6 mm long; tepals pale purple to pinkish or white, 4.5–5.5 mm long; floral tube 2–4 mm long. **Fruits** ellipsoid-globose, 5–6 mm in diam., dark blue to blue-black or purple-gray at maturity. **Seeds** globose, 8–9 mm in diam., dark blue to purplish black or black at maturity. $2n = 36$.

Native and endemic to Japan. Native habitats are forest floors and forest margins; ca. 50–1000 meters elevation. **Common names:** BLACK MONDO GRASS, BLACK MONDO, BLACK LILYTURF. **Representative cultivars:** Arabicus, Black Dragon, Dark Beauty, Ebony Knight, Leucanthus, Little Tabby (v), Minimus, Nigrescens, Silver Ribbon (v), Silver Shine (v). Flowering (Jun–)Jul–Aug.

Not reported in the USA outside of cultivation.

Ophiopogon planiscapus is recognized by its large, white to lilac-tinged, campanulate flowers in fascicles of 1–3 and especially by its relatively narrow leaves that become (in the popular horticultural forms) dark purple to black (Howe 2004). Wild type leaves apparently are dark green (see photos in Online Appendix).

7. OPHIOPOGON JABURAN (Sieb.) Loddiges, Bot. Cab. 19, plate 1876. 1832. *Slateria jaburan* Sieb., Verh. Batav. Genootsch. Kunsten 12: 15. 1830. *Flueggea jaburan* (Sieb.) Kunth, Enum. Pl. 5: 303. 1850. *Mondo jaburan* (Sieb.) L.H. Bailey, Gentes Herb. 2: 27. 1929. **TYPE:** Japan. Nagasaki: Nomo-Saki, 1863, C.J. Maximowicz s.n. (holotype: presumably LE; probable isotype: P digital image!, with cited collection information).

A photo of a UPS Thunberg specimen in Bailey (1929, Fig. 3; Japan, "*Convallaria japonica* α") was noted by him as representative of *Ophiopogon jaburan*.

Convallaria japonica L. f. var. *major* Thunb., Fl. Jap., 139. 1784. *Flueggea japonica* (L. f.) Rich. var. *major* (Thunb.) Schult. & Schult. f. in Roemer & Schultes, Syst. Veg. 7: 309. 1829. **TYPE:** Japan. As synonym fide Tamura (in press).
Ophiopogon taquetii H. Lév., Repert. Spec. Nov. Regni Veg. 8: 171. 1910. *Mondo taquetii* (H. Lév.) Farwell, Amer. Midl. Naturalist 7: 43. 1921. **TYPE:** Korea. As synonym fide Tamura (in press).

Stolons absent or very short and vertically oriented. **Roots** with tuberous swellings. **Leaves** linear, 30–85(–130) cm long, (7–)10–18 mm wide, 9–13(–17)-nerved, upper margins minutely serrulate, apices acute. **Scapes** arching, 24–40(–75) cm long, shorter to longer than the leaves, strongly flattened, winged at margins. **Inflorescence** 45–120-flowered, rachis 6–10(–15) cm long, often 1-sided; fascicles 12–20; bracts narrowly lanceolate to lanceolate, proximal 15–85(–180) mm long. **Flowers** in fascicles of 3–8(–10); pedicels 4–6(–8) mm long; tepals usually white, rarely purplish, ovate-oblong, 5–7 mm long, slightly recurved; floral tube 3–6(–8) mm long. **Fruits** oblong, 10–15 mm long, violet-blue to dark violet at maturity. **Seeds** ellipsoid to oblong, (5–)8–14 mm long, white to deep blue at maturity. $2n = 36$.

Native to Japan, Korea, and Taiwan. Native habitats are primarily forests in coastal localities; ca. 5–50 meters elevation. **Common names:** GIANT LILYTURF, WHITE LILYTURF, AZTEC GRASS, SNAKEBEARD, JAPANESE HYACINTH, JABURAN LILY. **Representative cultivars:** Argenteo-variegatus (v), Aureo-variegatus (v), Caeruleus, Crow's White, Javanensis, Variegatus (v), Vittatus (v), White Dragon (v). Flowering Jun–Aug.

Probably not naturalized in the USA; see comments under *Liriope spicata*.

According to Fantz (2009, p. 390), “variegated selections [of *Ophiopogon jaburan*] are most commonly used in interior landscapes and conservatories. Outside [in North Carolina], the variegated selections usually did not survive into the second season.”

8. OPHIOPOGON INTERMEDIUS D. Don, Prodr. Fl. Nepal. 48. 1825. *Flueggea japonica* var. *intermedia* (D. Don) Schultes, Syst. Veg. 7: 310. 1829. *Ophiopogon japonicus* var. *intermedius* (D. Don) Maxim., Mélanges Biol. Bull. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 7: 327. 1870. *Mondo japonicum* var. *intermedium* (D. Don) Farwell, Amer. Midl. Naturalist 7: 42. 1921. *Mondo intermedium* (D. Don) L.H. Bailey, Gentes Herb. 2: 25. 1929. **TYPE:** Nepal.

Flueggea wallichiana Kunth, Enum. Pl. 5: 303. 1850. *Ophiopogon wallichianus* (Kunth) J.D. Hook., Fl. Brit. India 6(18): 268. 1892. *Mondo japonicum* var. *wallichianum* (Kunth) Farwell, Amer. Midl. Naturalist 7: 42. 1921. *Mondo wallichianum* (Kunth) L.H. Bailey, Gentes Herb. 2: 21. 1929. **TYPE:** India (Silbet). Possible type: without collection data, *N. Wallich 5139* (PH digital image!). As synonym fide Chen and Tamura (2000b).

Flueggea jacquemontiana Kunth, Enum. Pl. 5: 304. 1850. **TYPE:** “India orientalis.” As synonym fide Chen and Tamura (2000b).

Flueggea dubia Kunth, Enum. Pl. 5: 305. 1850. **TYPE:** “India orientalis.” As synonym fide Chen and Tamura (2000b).

Flueggea griffithii Baker, J. Linn. Soc., Bot. 17: 502. 1879. *Ophiopogon griffithii* (Baker) J.D. Hook., Fl. Brit. India 6(18): 270. 1892. *Mondo japonicum* var. *griffithii* (Baker) Farwell, Amer. Midl. Naturalist 7: 42. 1921. **TYPE:** India (“Himalaya orientalis in sylvis ad Patkaye”). As synonym fide Chen and Tamura (2000b).

Stolons creeping, long or short. **Roots** with tuberous swellings. **Leaves** 15–55(–70) cm long, 3–15 mm wide, 5–9-nerved [13–23-nerved fide Fantz 2009], margins usually serrulate, apices

acute. **Scapes** projecting outward, (12–)20–50 cm long, shorter than or equalling the leaves, 3-angled to sometimes flattened and narrowly 2-winged. **Inflorescence** ca. (100–)200–300-flowered, rachis (2.5–)5–16 cm long [(8–)17–21 cm long fide Fantz]; fascicles (30–)45–55; bracts subulate, linear, or lanceolate, proximal 15–40 mm long. **Flowers** spreading, in fascicles of (1–)2–3(–6); pedicels 2–3 mm; tepals white to light purplish, oblong, ovate, or ovate-lanceolate, 4–7(–9) mm long; floral tube 2.5–3 mm long. **Fruits** oblong to ovoid to ellipsoid-globose, 8–11 mm long, 7–8 mm in diam, blackish purple to blue at maturity. **Seeds** ellipsoid, ca. 4 mm in diam., blue. $2n = 36, 54, 68, 72, 108, 112$.

As measured from plants cultivated at the University of Texas (see photos in Online Appendix). **Leaves** 23–40 cm long, 4–7 mm wide, 10–13-nerved, upper margins minutely serrulate, apices acute. **Scapes** arching-spreading, 8–14 cm long, shorter than the leaves, strongly flattened. **Inflorescence** 50–75 flowered, rachis 8–10 cm long; bracts ovate-lanceolate, proximal 4–5 mm long. **Flowers** in fascicles of 2–4(–6); pedicels 2.5–4 mm long; tepals white, oblong to oblong-lanceolate, 4–6 mm long; floral tube 1.5–2 mm long.

Native to the Himalayan region (India, Nepal, Bhutan, southwestern China) and Sri Lanka, to Bangladesh, Myanmar, Thailand, Vietnam, and Taiwan. Native habitats include evergreen broad-leaved forests, mixed forests, pine forests, bamboo forests, scrub, moist and shady places along streams, grassy slopes; 700–3000 meters elevation. **Common names:** HIMALAYAN LILY TURF, WHITE MONDO GRASS, AZTEC GRASS. **Representative cultivars:** Argenteomarginatus (v), Compactus, Stripey White. Flowering Jun–Oct.

Not reported in the USA outside of cultivation.

Ophiopogon intermedius has one of the most widespread native geographic ranges in the genus and shows high levels of genetic diversity (allozymes) as well as morphological and chromosomal variation (He et al. 2000). Within the genus, *O. intermedius* and *O. planiscapus* apparently are closely related (Tanaka 2001-III).

According to Fantz (2009, p. 390), *Ophiopogon intermedius* is “marketed commonly under *Liriope muscari* ‘Variegated Evergreen Giant’ or ‘Grandiflora White.’ Also, this species is confused with variegated selections of *O. jaburan*.” The species is described by Chen and Tamura (2000b) as producing short, thick rhizomes; Fantz (2009) observed that it produces rhizomes (stolons) 7–28 cm long and forms dense tufted mounds with age. Fantz also noted that dwarf nursery selections of *O. intermedius* are 12–18 cm tall.

ACKNOWLEDGEMENTS

I am grateful for the arrangement of a loan of *Liriope* from GH to TEX, to David Boufford (Harvard Herbaria) for information on Japanese species, Amber Schoneman (at TEX) for providing digital images of the GH specimens included in the manuscript as Figs. 3-8, Monique Reed (TAMU) for sending an image and observations on the collection from Madison Co., Texas (see comments under *L. spicata*), Larry Brown (SBSC) for sending a photocopy of his *liriopegon* collection (see *L. spicata*) from the Big Thicket National Preserve, Michael and Barbara MacRoberts (LSUS) for information and images of Louisiana plants, Johnnie Gentry and Brent Baker for sending an image of the collection of *L. spicata* naturalized in Arkansas, to Lowell Urbatsch (LSU Botany), John Pruski (MO), Marie Long (NYBG Library), and Mary Stiffler (MBG Library) for sending pertinent literature, to Nancy Elder (University of Texas Life Sciences Library) for on-site help with literature, and to Paul Fantz for a *liriopegon* discussion and for sending his publications on these plants. Many thanks to Dr. Mats Hjertson, UPS Curator, for sending digital images of the type specimen of *Convallaria spicata* Thunb.; Peter Nielson, owner of Ace Mondo Ltd., for images of *Ophiopogon*

planiscapus and permission to use other photos posted on his website; Glenn Kopp, Horticultural Information Manager at the Missouri Botanical Garden, for permission to use a photo; Catherine Broussard to permission to use photos and for comments on the manuscript; Michael Charters of Calflora for permission to use photos; and Robert George (BRIT), who discovered the naturalized plant of *L. graminifolia* in Euless, Texas, and took me to see it.

LITERATURE CITED

- Adams, G. 1989. Great ground covers. *Amer. Nurseryman* 170: 83–91.
- Ahmad, V.U. and A. Basha (eds.). 2006. *Spectroscopic Data of Steroid Glycosides*. Vol. 2. Springer, New York.
- Bailey, L.H. 1924. *Manual of Cultivated Plants*. Macmillan Co., New York.
- Bailey, L.H. 1929. The case of *Ophiopogon* and *Liriope*. *Gentes Herb.* 2: 1–37.
- Bailey, L.H. 1949. *Manual of Cultivated Plants* (rev. ed.). Macmillan Co., New York.
- Bailey Hortorium Staff. 1976. *Hortus Third: A Concise Dictionary of Plants Cultivated in the United States and Canada*. Liberty Hyde Bailey Hortorium, Cornell Univ., Ithaca, New York.
- Baker, J.G. 1875. Revision of the genera and species of Asparagaceae. *J. Linn. Soc., Bot.* 14: 508–632.
- Broussard, M.C. 2007. A horticultural study of *Liriope* and *Ophiopogon*: Nomenclature, morphology, and culture. Ph.D. dissertation, Louisiana State Univ., Baton Rouge.
- Brown, L.E., B.R. MacRoberts, M.H. MacRoberts, P. Harcombe, W.W. Pruess, S. Elsik, and D. Johnson. 2005. Annotated checklist of the vascular flora of the Turkey Creek Unit of the Big Thicket National Preserve, Tyler and Hardin counties, Texas. *Sida* 21: 1807–1827.
- Chen, S.C. and M.N. Tamura. 2000a. *Liriope*. In: Z.Y. Wu and P.H. Raven (eds.). *Flora of China* 24: 250–251. Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis.
- Chen, S.C. and M.N. Tamura. 2000b. *Ophiopogon*. In: Z.Y. Wu and P.H. Raven (eds.). *Flora of China* 24: 252–261. Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis.
- Cheng, Z.-H., T. Wu, S.W. Bligh, A. Bashall, and B.-Y. Yu. 2004. *Cis-eudesmane sesquiterpene glycosides* from *Liriope muscari* and *Ophiopogon japonicus*. *J. Nat. Prod.* 67: 1761–1763.
- Cheng, Z.-H., T. Wu, Y.-L. Guo, B.Y. Yu, and L.-S. Xu. 2006. Two new steroidal glycosides from *Liriope muscari*. *Chinese Chem. Letters* 17: 31–34.
- Conran, J.G. 1989. Cladistic analyses of some net-veined Liliiflorae. *Plant Syst. Evol.* 168: 123–141.
- Conran, J.G. and M.N. Tamura. 1998. Convallariaceae. In K. Kubitzki (ed.). *The Families and Genera of Vascular Plants* 3: 186–198. Springer, Berlin.
- Cutler, D.F. 1992. Vegetative anatomy of Ophiopogoneae (Convallariaceae). *Bot. J. Linnean Soc.* 110: 385–419.
- Deputy, J. 1999. *Liriope*, the “other” mondo grass. Coop. Ext. Service, College of Tropical Agric. and Human Resources, Univ. of Hawaii at Manoa. <<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/liriope.pdf>>
- Diggs, G.M., Jr., B.L. Lipscomb, and R.J. O’Kennon. 1999. Shinnery and Mahler’s Illustrated Flora of North Central Texas. *Sida, Bot. Misc.* 16.
- Diggs, G.M., Jr., B.L. Lipscomb, M.D. Reed, and R.J. O’Kennon. 2006. Illustrated Flora of East Texas, Vol.1. *Sida, Bot. Misc.* 26.
- Fantz, P.R. 1993. Taxonomic problems in cultivated Liriopogons. *HortTechnology* 3: 146–149.
- Fantz, P.R. 1994. A taxonomic research update of cultivated liriopogons. *HortTechnology* 4: 46–48.
- Fantz, P.R. 1995. Taxonomic problems of cultivated liriopogons. *Acta Hort.* 213: 153–156.
- Fantz, P.R. 2008a. Macrophytography of cultivated liriopogons and genera delimitation. *HortTechnology* 18: 334–342.
- Fantz, P.R. 2008b. Species of *Liriope* cultivated in the southeastern United States. *HortTechnology* 18: 33–348.

- Fantz, P.R. 2009. Names and species of *Ophiopogon* cultivated in the southeastern United States. *HortTechnology* 19: 385–394.
- Forestry Images. 2010. Bugwood Image Database System, Univ. of Georgia, Athens. <http://www.forestryimages.org/>
- Fukai, S., T. Shimomura, and T. Kondo. 2006. Convallariaceae ground cover plants native to Asia. *ISHS Acta Horticulturae* 769: XXVII International Horticultural Congress — IHC2006: International Symposium on Asian plants with unique horticultural potential.
- GCW. 2010. Global Compendium of Weeds, website <http://www.hear.org/gcw/>
- Hara, H. 1984. Comments on the East Asiatic plants (13). *J. Jap. Bot.* 59: 33–41 (in Japanese).
- Hasegawa, K.M. 1968. Cytotaxonomic studies on the genera *Liriope* and *Ophiopogon*. *Japan. J. Jap. Bot.* 43: 141–155, plates 7–15.
- He, T., G. Rao, R. You, S. Ge, and D. Zhang. 2000. Genetic diversity of widespread *Ophiopogon intermedius* (Liliaceae s.l.): A comparison with endangered *O. xylorrhizus*. *Biol. Conserv.* 96: 253–257.
- Howe, C. 2004. *Ophiopogon planiscapus* ‘Nigrescens.’ *American Nurseryman* [15 April] (4): 86.
- Hume, H.H. 1961. The *Ophiopogon-Liriope* complex. *Baileya* 9: 135–158.
- Hume, H.H. and B.Y. Morrison. 1963. The lilyturfs in gardens. *Amer. Hort. Mag.* 46: 1–11.
- Instituto Hórus. 2010. Invasive Species. Instituto Hórus de Desenvolvimento e Conservacao Ambiental. <http://www.institutohorus.org.br/index.php>
- Jacobs, R.M. 2001. *Liriope gigantea* plant named “Merton Jacobs,” PP12068. PatentGenius <http://www.patentgenius.com/patent/PP12068.html>
- Jarvis, C. 2007. Order Out of Chaos: Linnean Plant Names and their Types. Linnean Society of London in association with the Natural History Museum, London.
- Jessop, J.P. 1976. A revision of *Peliosanthes* (Liliaceae). *Blumea* 23: 141–59.
- Kartesz, J.T. 2010. Floristic synthesis of North America, Version 2.0 (beta version). June 2010.
- Ker Gawler, J.B. 1821. *Ophiopogon spicatus*. Blue-flowered snakesbeard. *Edward’s Bot. Reg.* 7: 593–594, plate 593. <http://www.biodiversitylibrary.org/item/9043>
- MacRoberts, M.H., B.R. MacRoberts, and G.M. Hanson. 2008. Vascular flora of C. Bickham-Dickson/Red River Education and Research Park, Caddo Parish, Louisiana: An oxbow lake community, with comments on exotic/native species ratios. *J. Bot. Res. Inst. Texas* 2: 1389–1406.
- Mcharo, M., E. Bush, D. LaBonte, C. Broussard, and L. Urbatsch. 2003. Molecular and morphological investigation of ornamental liriopogons. *J. Amer. Soc. Hort. Sci.* 128: 575–577.
- Neill, A.K. and H.D. Wilson. 2001. The vascular flora of Madison County, Texas. *Sida* 19: 1083–1121.
- Nyffeler, R. and U. Eggli. 2010. An up-to-date familial and suprafamilial classification of succulent plants. *Bradleya* 28: 125–144.
- Ohwi, J. 1953 [1965]. *Flora of Japan* (English translation of original 1953 publication. F.G. Meyer and E.H. Walker, eds.). Smithsonian Institution, Washington, D.C.
- Rudall, P.J. 2002. Homologies of inferior ovaries and septal nectaries in Monocotyledons. *Internatl. J. Plant Sci.* 163: 261–276.
- Rudall, P.J., J.G. Conran, and M.W. Chase. 2000. Systematics of Ruscaceae (formerly Convallariaceae sensu lato): A combined morphological and molecular investigation. *Bot. J. Linn. Soc.* 134: 73–92.
- Skinner, H.T. 1971. Some liriopogon comments. *J. Royal Hortic. Soc.* 96: 345–350.
- Smith, E. B. 1988. An atlas and annotated list of the vascular plants of Arkansas (ed. 2). Published by the author. Fayetteville, Arkansas.
- Spaulding, D., W. Barger, and G.L. Nesom. 2010. *Liriope* and *Ophiopogon* (Ruscaceae) naturalized in Alabama. *Phytoneuron* 2010-55: 1–10.

- Tamura, M.N. 1990. Studies on the genus *Ophiopogon* (Liliaceae) of Phu Kradung in Thailand. *Acta Phytotax. Geobot.* 41: 1–6.
- Tamura, M.N. In press. *Liriope*, *Ophiopogon*. In K. Iwatsuke, D.E. Boufford, & H. Ohba (eds.). *Flora of Japan*. Vol. 4a - Monocotyledoneae. A. Kodansha, Tokyo.
- Tanaka, N. 1998–2000. Taxonomic notes on *Ophiopogon* of South Asia. I. 73: 301–313. 1998; II. 74: 25–33. 1999; III. 74: 261–267. 1999; IV. 74: 321–328. 1999; V. 75: 69–79. 2000; VI. 75: 127–136. 2000; VII. *J. Jap. Bot.* 75: 191–212. 2000; VIII. 75: 265–269. 2000; IX. 75: 360–367. 2000.
- Tanaka, N.Y. 2001. Taxonomic notes on *Ophiopogon* (Convallariaceae) of East Asia. I. *J. Jap. Bot.* 76: 59–76; II. 76: 151–165; III. 76: 205–218.
- Thomas, R.D. and C.M. Allen. 1993. *Atlas of the Vascular Flora of Louisiana*. Vol. I: Ferns & Fern Allies, Conifers, & Monocotyledons. Moran Colorgraphic Printing, Baton Rouge, La.
- USDA, NRCS. 2010. The PLANTS Database. National Plant Data Center, Baton Rouge, Louisiana. <<http://plants.usda.gov>>
- Utech, F.H. 2002. Liliaceae (introduction). *Flora of North America North of Mexico* 26: 50–54.
- Walters, S.M., A. Brady, C.D. Brickell, J. Cullen, P.S. Green, J. Lewis, V.A. Mathews, D.A. Webb, P.F. Yeo, and J.C.M. Alexander (eds.). 1984. *The European Garden Flora: A Manual for the Identification of Plants Cultivated in Europe, Both Out-of-Doors and Under Glass*. Volume 2, Monocotyledons (part 2). Cambridge Univ. Press, Cambridge, England.
- Wang, F.T. and T. Tang. 1951. A new *Liriope* in cultivation but hitherto confused, with a key to species of the genus. *Acta Phytotax. Sinica* 1: 331–334.
- Wang, F.T. and T. Tang. 1978. *Liriope*. Pp. 123–130, in *Flora Republicae Popularis Sinicae*, Vol. 15.
- Weakley, A.S. 2010. *Flora of the Southern and Mid-Atlantic States*, working draft of March 2010. Univ. of North Carolina Herbarium, Chapel Hill, NC.
- Wunderlin, R.P., and B.F. Hansen. 2008. *Atlas of Florida Vascular Plants*. [S.M. Landry and K.N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, Univ. of South Florida, Tampa. <<http://www.plantatlas.usf.edu/>>
- Yamashita, J. and M.N. Tamura. 2001. Karyotype analysis of six species of the genus *Ophiopogon* (Convallariaceae-Ophiopogoneae). *J. Jap. Bot.* 76: 100–119.
- Yamashita, J., A. Vogel, and M.N. Tamura. 2002. Molecular phylogeny and taxonomic reconsideration of the genus *Peliosanthes* (Convallariaceae). Abstract, 12th Flora of Thailand Meeting. Forest Herbarium, Wildlife and Plant Conservation Department, Bangkok. <http://web3.dnp.go.th/botany/Botany_Eng/FloraofThailand/FloraMeeting_Eng/flora_Eng_meeting12_paper.html>
- Yang, Y.P. and H. Li. 1990a. Study on the taxonomic systems of *Ophiopogon*. *Acta Bot. Yunnan.* (Suppl. 3): 70–89.
- Yang, Y.P. and H. Li. 1990b. New taxa of *Ophiopogon* from Yunnan. *Acta Bot. Yunnan.* (Suppl. 3): 91–93.
- Ying, S.S. 2000. *Liriope*. Pp. 52–54. *Flora of Taiwan* (ed. 2). Vol. 5, Angiosperms, Monocotyledons [Alismataceae-Triuridaceae]. Tapei.
- Yu, B.-Y., S.-X. Qiu, K. Zaw, G.-J. Xu, Y. Hirai, J. Shoji, H.S. Fong, and A. Douglas. 1996. Steroidal glycosides from the subterranean parts of *Liriope spicata* var. *prolifera*. *Phytochem.* 43: 201–206.
- Zhang, D.M. 1998. Systematics of the tribe Ophiopogoneae (Liliaceae s. l.) with special reference to karyotypes and chromosomal evolution. *Cathaya* 10: 1–154.



Figure 1. Holotype of *Convallaria spicata* Thunb. at UPS. Identified here as *Liriope muscari* (Dcne.) L.H. Bailey.



Figure 2. Detail from holotype of *Convallaria spicata* Thunb. at UPS. Structures at the base are fibrous roots, the thicker ones contractile.



Figure 3. *Liriope muscari*, typical expression. Note the short, thickened rhizome, apparently more commonly characteristic of this species in Japan than elsewhere.



Figure 4. *Liriope muscari*, typical expression. Base apparently strictly caespitose.



Figure 5. *Liriope muscari* sensu lato, “platyphylla” expression (see comments in text).



Figure 6. *Liriope muscari* sensu lato, “*platyphylla*” expression (see comments in text).



Figure 7. *Liriope muscari* sensu lato, variant of “*platyphylla*” expression (see comments in text).

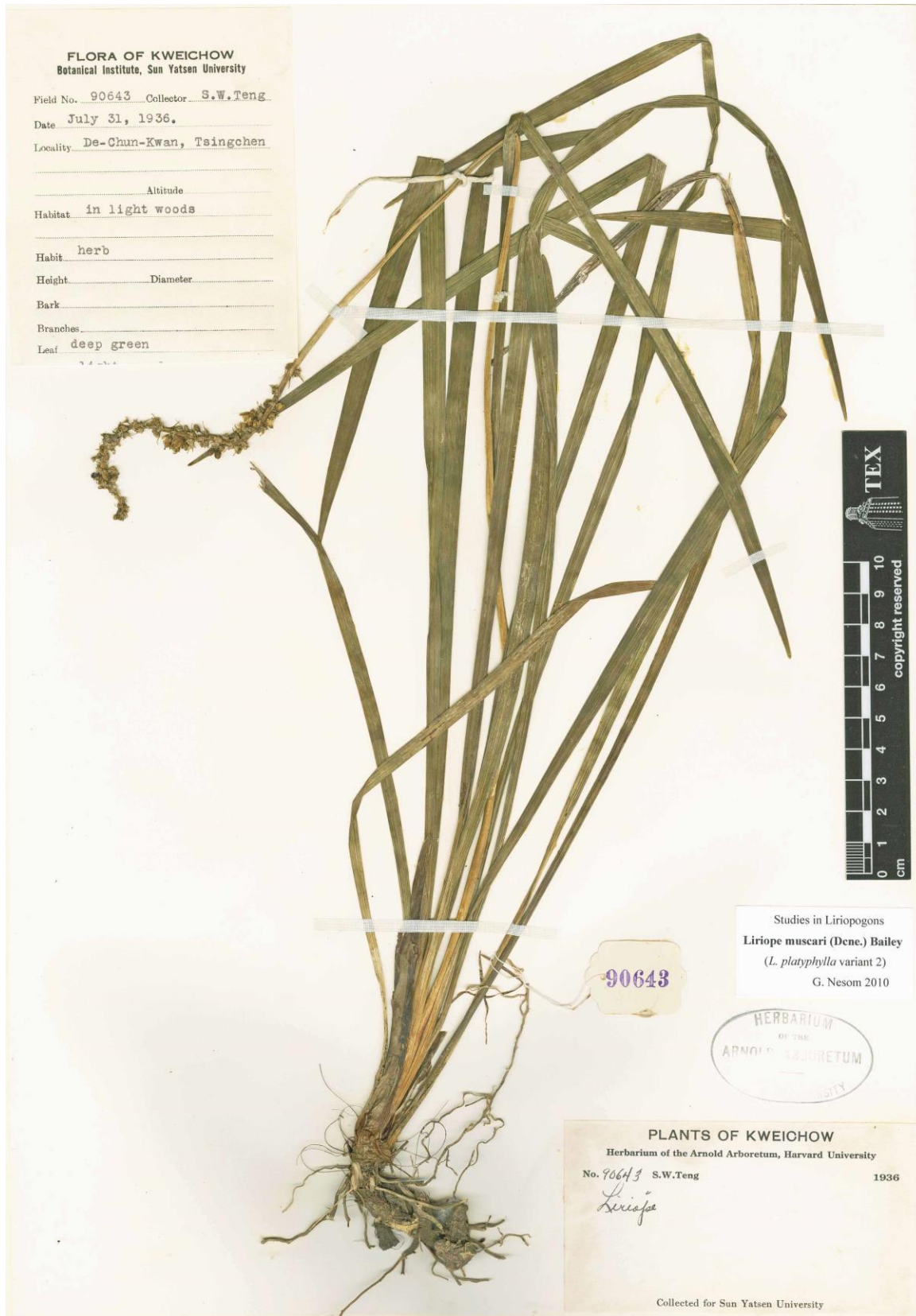


Figure 8. *Liriope muscari* sensu lato, variant of “platyphylla” expression (see comments in text).

Addendum, May 2011

* Limited observations in Fort Worth suggest that leaves of *Liriope* species are annual, completely senescing and replaced by a new set in the spring. Leaves of *Ophiopogon* persist into the next season, being joined by a new set added in the spring.

* All species of *Liriope* appear to be cold hardy in Fort Worth, even after the particularly cold weather of 2010. *Ophiopogon intermedius* was winter-killed in Fort Worth and in Austin. *Ophiopogon japonicus* and *Oph. planiscapus* are cold hardy.

* Contrary to my observation (2010, p. 13) that *Liriope gigantea* appeared to be completely sterile, some plants observed on the UT-Austin campus (early spring 2011) did produce a small number of fruits.