

Taxonomic Problems in Cultivated Liriopogons

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Summary. Liriopogons (*Liriope*, *Ophiopogon*) are versatile landscape plants with a complexity of taxonomic problems. A taxonomic revision of liriopogons cultivated in the United States is needed; one that includes an inventory of taxa, quantitative descriptions of species and cultivars, keys and other aids for segregation and identification of taxa, documentation of taxa with vouchers deposited in herbaria, and establishment of a living germplasm collection that can serve as a standard for the nursery/landscape industries.

Bailey (1929) used the term Liriomondos to refer to cultivated members of the genera *Liriope* Lour. and *Mondo* (Kaempf.) Adans. The name *Ophiopogon* Ker-Gawl. has been conserved according to the international rules (Voss 1983), thus reducing the name *Mondo* to synonymy, and recognizing *Ophiopogon* as the correct name for this genus. Accordingly, Bailey's Liriomondos was altered by Skinner (1971) to Liriopogons, a useful name when discussing the complex group because it is difficult in the nursery/landscape industries to identify species and segregate the genera. Bailey (1929) noted "the plants are commonly misnamed in nurseries and the pictures in books are not reliable; specimens are likely to be wrongly determined in herbaria."

The liriopogons are acaulescent plants with grass-like leaves and small, lilac to violet or white flowers clustered in fascicles on scapes among the

foliage. Leaves may be green or variegated with marginal bands, longitudinal stripes, or, occasionally, with transverse bands of creams, yellows, white, or silver.

Liriopogons commonly are known under several vernacular names in the trade, "lilyturfs" (usually applied to *Liriope* spp.), "mondo grass" (usually applied to *Ophiopogon* spp.), and "monkey grass" and "Aztec grass" (both applied across generic lines). They are versatile landscape plants, being used as groundcovers, foundation plants, understory plants for woody crops, edging and massing, and in combination with a wide variety of perennials, shrubs, and trees.

Liriopogons are noted as durable, adaptable low-maintenance evergreens with no serious pest problems. They are moderately drought-resistant and useful in sun or shade (Adams, 1989; Batson, 1984; Dirr, 1983; Flint, 1983; Halfacre and Shawcroft, 1989; Hudak, 1985; Hume and Morrison, 1963; Odenwald and Turner, 1980; Skinner, 1971; Still, 1988; Thomas, 1982; Voigt et al., 1983; Wyman, 1977).

Liriopogons are becoming an increasingly important landscape crop in today's trade. Nurseryworkers, landscapers, and recent authors (Adams, 1989; Batson, 1984; Dirr, 1983; Flint, 1983; Halfacre and Shawcroft, 1989; Hudak, 1985; Hume and Morrison, 1963; Odenwald and Turner, 1980; Skinner, 1971; Still, 1988; Thomas, 1982; Voigt et al., 1983; Wyman, 1977) currently recognize five species in the trade, namely *L. muscari* (Decne.) Bailey, *L. spicata* Lour., *O. jaburan* (Sieb.) Lodd., *O. japonica* (Thunb.) Ker-Gawl, and *O. planiscapus* Nakai. The taxonomic problems of liriopogons have increased in complexity since Bailey, as outlined below.

Taxonomic history

Thunberg (1780) described the species *Convallaria japonica*. This is the origin of plants known today as *O. japonicus*.

Loureiro (1790) proposed the

genus *Liriope* in describing plants from Cochinchina (presently Cambodia, Laos, Vietnam). This is the origin of the plants known presently as *L. spicata*.

Ker-Gawl (1807) proposed the genus *Ophiopogon* based on Thunberg's species that he recognized as misassigned to the genus *Convallaria*. Ker-Gawl (1821) assigned Loureiro's species to *Ophiopogon* as *O. spicata*.

Siebold (1830) described the species *Slateria jaburan* from Japan. Loddiges (1832) assigned Siebold's species to *Ophiopogon*, presently known as *O. jaburan*.

Decaisne (1868) described the species *O. muscari*. This is the origin of the plant currently known in the trade as *L. muscari*.

Nakai (1920) described the species *O. planiscapus* presently known in cultivation. This is the last of the five commonly known cultivated species to be described.

Farwell (1921) reported that the generic name *Mondo* (Adanson 1763) had priority over *Ophiopogon*. Farwell transferred all species to the genus *Mondo*. Lacking common names, this is the probable source of plants in the genus becoming known as "mondo grasses" in cultivation.

Bailey (1929) provided the first major treatment of this cultivated group of plants, referring to them as liriomondos or lilyturfs. He summarized their cultural uses and nomenclatural history.

Bailey noted that several authors combined the taxa under one genus, but correctly concluded that there were two differentiated genera named *Mondo* Adans. (syn. *Ophiopogon* Ker-Gawl) and *Liriope* Lour. A key was provided to the seven species of *Mondo* and two species of *Liriope*, along with descriptions. No cultivars were noted. Bailey transferred Decaisne's name to *Liriope* as *L. muscari* and described briefly two varieties as var. *variegata* and var. *exiliflora*.

Bailey's species *M. japonicum* Farw., *M. jaburan* (Sieb.) Bailey, *M. planiscapus* (Nakai) Bailey, *L. spicata* Lour. and *L. muscari* (Decne.) Bailey are commonly known cultivated species in the United States. *Mondo dracaenoides* (Bak.) Farw., *M. intermedium* (D. Don) Bailey, and *M. wallichianum* (Kunth) Bailey are not currently reported to be in cultivation as liriopogons.

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Congress met in Amsterdam in 1935. A number of generic names were conserved over synonyms and earlier published generic names. These are included in Appendix III of the "International Code of Botanic Nomenclature," the international rules governing plant names. The generic name *Ophiopogon* was conserved over the generic name *Mondo* as the correct name for the genus. Rickett and Stafleu (1959) began publishing a list of conserved and rejected names in *Taxon*, the journal of the International Assn. for Plant Taxonomy.

Hume (1961) provided a revised treatment of the lilyturfs. He reported that the generic name *Mondo* must be abandoned in favor of the conserved generic name *Ophiopogon*, following the adoption by the International Botanic Congress of Amsterdam in 1935. He recognized three species—*O. jaburan*, *O. japonicus*, and *O. arabicus* [= *O. planiscapus*]—the latter name found without a published description. These are the same commonly cultivated species of mondo grasses recognized by Bailey (1929).

Hume (1961) also provided several changes in his treatment of *Liriope*. He recognized five species—*L. muscari*, *L. spicata*, *L. graminifolia* (L.) Bak., *L. exiliflora* (Bailey) Hume, and *L. gigantea* Hume—the latter pair newly described. He also described cultivars for the first time, including 'Vittata' of *O. jaburan* and 11 cultivars of *L. muscari*: 'Big Blue', 'Blue Spire', 'Christmas Tree', 'Curly Twist', 'Eleven-O-Three', 'Gold-banded', 'Lilac Beauty', 'Majestic', 'Monroes White', 'Silver Banded', and 'Variegata'. No key was provided to taxa.

Hume and Morrison (1963) provided cultural uses of lilyturfs and a brief inventory of additional new cultivars, including *L. muscari*: 'Border Gem', 'Cockscomb', 'Grandiflora', 'New Wonder', 'Silver Midget', and 'Silver Sunproof'.

Wang and Tang (1951) rejected Bailey's transfer of Decaisne's basionym *muscari* and proposed a new name, *L. platyphylla*, for the commonly cultivated species. Meyer and Walker (1965) published an English translation of Ohwi's *Flora of Japan*, accepting the name *L. muscari* (Descn.) Bailey in synonymy of *L. platyphylla* Wang & Tang. However, Makino (1961) cited *L. platyphylla* Wang & Tang as a synonym of *L. graminifolia* Baker. Jessop

(1983) cited *L. muscari* auth. (non Bailey) as a synonym of *L. graminifolia* Baker. Hara (1984) recognized Bailey's transfer as legitimate and cited *L. platyphylla* Wang & Tang as a synonym of *L. muscari* Bailey, as did Huxley (1992).

Skinner (1971) proposed the vernacular name "liriopogon" for this cultivated group. His inventory of taxa included brief descriptions of taxa. He adopted the name *L. platyphylla* based upon Meyer and Walker (1965) transferring 15 cultivar names to this species from *L. muscari*. He noted the name *O. arabicus* as synonymous with *O. planiscapus*, and noted *O. intermedius* as apparently not cultivated in America.

Taxonomic problems

First, there is presently no thorough inventory of the cultivated liriopogons. The major contributions include Bailey (1929) and the more-modern revisions by Hume (1961), Hume and Morrison (1963), and Skinner (1971). These modern inventories are incomplete and out-of-date; they recognize five species and nearly 20 cultivars. If one begins to assemble names of available liriopogons cultivated in the United States based on literature and catalogues, one can find more than 20 named species (Table 1) and more than 100 named cultivars (Table 2), even after elimination of similar names.

Second, detailed descriptions of taxa are lacking, both at the level of species and cultivars. Descriptions typi-

cally are brief. They often use characteristics that could apply to several selections and relative terms that are open to misinterpretation. Good quantitative descriptions are needed for comparison and delimitation of taxa.

Third, identification aids are scarce. Illustrated identification guides are limited. Taxonomists use keys—dichotomous statements that present contrasting morphological characteristics—to segregate taxa. Similar keys are needed for liriopogons.

Fourth, there is a lack of representative specimens of species and cultivars deposited in herbaria. Vouchers of identified liriopogons can be used for morphological comparison and aiding identification of unknowns. Liriopogon specimens are rare to nonexistent in some major herbaria in the United States. Larger herbarium collections of liriopogons need critical examination as surveys of species reveal mixed material filed under each name. This makes it difficult for one to ascertain the boundaries of the species and identify unknown cultivated species. Botanical gardens and arboreta are important repositories for living germplasm collections. Unfortunately, liriopogons are represented poorly in these collections, and they frequently contain mixed material filed under one name.

Fifth, there is no revision geographically or monograph of liriopogons worldwide. Liriopogons are native to Asia, introduced into the United States via cultivation; however, most Asian countries lack floras. This lack of key literature references is a major obstacle in being able to identify accurately those species that are found in cultivation in the United States.

Sixth, a number of nomenclatural questions need to be resolved, from the family level downwards. An ordering of the nomenclature is needed to provide the correct name for the taxon plus the available synonyms.

Family. The familial relationship of liriopogons is unclear among modern botanists. Traditionally, liriopogons were included within the family Liliaceae, a family whose delimitation is much disputed because of a number of aberrant members, such as the liriopogons. This has lead botanists to assign liriopogons to the Convallariaceae, Haemodoraceae, or Ophiopogonaceae. Dahlgren et al.

Table 1. A checklist of names of cultivated liriopogon species.

| <i>Liriope</i> sp. | <i>Ophiopogon</i> sp. ² |
|--------------------------|------------------------------------|
| <i>L. exiliflora</i> | <i>O. arabicum</i> |
| <i>L. gigantea</i> | <i>O. chekangensis</i> |
| <i>L. graminifolia</i> | <i>O. clarkei</i> |
| <i>L. grandiflora</i> | <i>O. graminifolia</i> |
| <i>L. hyacinthiflora</i> | <i>O. intermedia</i> |
| <i>L. japonica</i> | <i>O. intermedius</i> |
| <i>L. kansuensis</i> | <i>O. jaburan</i> |
| <i>L. minor</i> | <i>O. japonicus</i> |
| <i>L. muscari</i> | <i>O. nana</i> |
| <i>L. platyphylla</i> | <i>O. ohwii</i> |
| <i>L. spicata</i> | <i>O. planiscapus</i> |
| | <i>O. nigra</i> |
| | <i>O. nigrescens</i> |
| | <i>O. spicatus</i> |
| | <i>O. wallichianus</i> |

²Listed also as *Otheopogon*.

Table 2. A checklist of names of cultivated *liriopogon* cultivars.

| | | | |
|---------------------|-----------------------|---------------------|----------------------------|
| Alba | Fedwell Big Blue | Majestic | Silver Banded |
| Angustifolia | Folius Albostriatius | Majestic Blue | Silver Dragon |
| Arabicus | Folius Aureopunctatus | Majestic Variegated | Silver Mist |
| Argenteo-variegatus | Franklin Mint | Miniature | Silver Showers |
| Argenteo-vittatus | Gilner White | Minor | Silvery Dragon |
| Ariake Janshige | Gold Banded | Monroe | Silvery Midget |
| Aritaki | Grandiflora | Monroe no. 1 | Silvery Sunproof |
| Aureus | Grandiflora White | Monroe no. 2 | Striatius |
| Aztec | Green Midget | Monroe White | Sunproof |
| Big Blue | Gyoko-Ryu | Monroes White | Superba |
| Big Blue Regal | Gyoku-Ryu | Moores White | Tamaryu Nishiki |
| Big Green | Hakuryu | Monroei White | Tidewell's Big Blue |
| Black Dragon | Hakuryu Dwarf | Monroi White | Tidwells Big Blue |
| Blue Cushion | Hakuryu Ko | Munroe White | Tokai-rinpa |
| Blue Spire | Hawks Feather | Nana | Torafu |
| Border Gem | Improved Muscari | Nanus | Traebert White |
| Caeruleus | Ingwersen | New Orleans | Variegata |
| C.T. Tanner | Intermedia | New Wonder | Variegata Alba |
| CT Tanner | Javanensis | Nigrescens | Variegata White |
| Christmas Tree | Jeanerette | Nippon | Variegated |
| Cockscomb | John Burch | Nuscari | Variegated Evergreen Giant |
| Compact Blue | Kigimafukiduma | Original Big Blue | Variegated White |
| Compactus | Kioto | Peedee Ingot | Flowered |
| Crows White | Kiyoto | Purple Boquet | Variegated |
| Crested White | Korean Variegated | Regal | Webber |
| Curly Twist | Kyoto Dwarf | Rocket | Webster Wideleaf |
| Densiflora | Leucanthus | Royal Purple | White on White |
| Ebony | Lilac Beauty | Samantha | Wonder Evergreen |
| Ebony Knight | Magestic | Sheffield | Xmas |
| Eleven-O-Three | Majestic | Shiro Tama Hime | Xmas Tree |
| Evergreen Giant | | Shiroshima Ryu | |

(1985) used anatomical, chemical, cytological, developmental, embryological, morphological, and palynological studies to revise the monocot families. They assigned liriopogons to the order Asparagales, family Convallariaceae, tribe Ophiopogoneae, well-segregated from the traditional order Liliales, family Liliaceae. Cronquist (1988), the recognized American authority, maintained the traditional view of assigning liriopogons to the Liliaceae.

Genus. Genera are defined poorly in the landscape/nursery trade. Nurseryworkers/landscapers appear to rely on growth habit, leafwidth, and flower color as the main characters for segregation. Therefore, plants frequently are misidentified to genus. Adams (1989) reemphasized, and several earlier authors found, that flower position was "the best characteristic for identifying the genus," with flowers of *Ophiopogon* hanging down and flowers of *Liriope* being erect.

Species. Delimitation of species is poorly understood in the trade. Nurseryworkers/landscapers identify *Ophiopogon planiscapus* by its purplish-black

foliage. *Ophiopogon japonicus* identified by its narrow leaves, creeping mat-forming habit, short height, and blue fruit hidden among the foliage. *Liriope spicata* is identified as a creeper with tall, narrow leaves and scapes within the leaves. *Liriope muscari* is identified as a clumper with broad leaves and scapes above the leaves. Nurseryworkers have more difficulty identifying *Liriope* sp. than *Ophiopogon* sp. due to their greater variability in growth habit, leaf size, variegation, and flower color.

There are impostors masquerading under several species names. For example, Hume's (1961) *L. exiliflora* and *L. gigantea* are found within *L. muscari*. Nearly all nurseryworkers/landscapers are unaware of these two names proposed by Hume. Plants sold under the name *O. japonicus* includes four species. *Ophiopogon jaburan* is a mystery to many in the trade who are unfamiliar with the plant. Those familiar with "Aztec grass" regard it as a mutated *Liriope* because of its size, yet these plants actually belong to the genus *Ophiopogon*.

Wang and Tang (1951) of China

proposed the name of *L. platyphylla* as correct for plants bearing the name *L. muscari*. This is the one species presently cultivated in the United States with the largest number of named cultivars. Nurseryworkers appear to be unaware of this name change, despite Meyer and Walker (1965) and Skinner (1971) adopting this name and transferring cultivars to the newer name. Some botanical gardens (e.g., United States National Arboretum; Royal Botanic Gardens, Kew) now bear this newer name on their labels. However, plants of *L. platyphylla* obtained from China by the North Carolina State Univ. Arboretum are not equivalent to our cultivated plants labeled as *L. muscari*. This is a complex nomenclatural problem that needs to be resolved.

Cultivars. Differentiation of cultivars is particularly difficult. There are several complexes of closely related names, yet nurseryworkers recognize different selections. 'Variegata' is a common name applied to selections in several species, as is 'Alba', 'Big Blue', and 'Majestic'. Nurseryworkers segregate cultivars according to leaf morphology, floral color, inflorescence apex, and habit. Mularoni and Anderson (1987) studied the influence of environmental factors, including temperature, photoperiod, and fertility on the growth of one unnamed cultivar of *L. muscari*. They concluded that variability associated with leaf morphology and flower color could be environmentally induced; thus, these were not appropriate taxonomic characters. Additional morphological characters with quantitative components are needed for delimitation of cultivars and their segregation.

Cultural practices. Nurseryworkers use several cultural practices that degrade cultivar integrity (Fantz 1991a-c), and create nomenclatural problems in liriopogons. Sexual reproduction, for instance, is a leading cause of taxonomic problems. Nurseryworkers obtain more propagules by harvesting and growing seeds from cultivars than by divisions. Seedlings are assigned the same cultivar name as the parent plant from which seeds were obtained, but the seedlings also contain genetic information from an unknown parent. This practice results in modification of morphological expression, and cultivar degradation over time.

A second practice that causes cultivar degradation is plant substitution. Some nurseryworkers substitute cultivars when filling an order without informing the customer of the substitution or cultivar switch.

A third cultural problem that leads to cultivar confusion is seedling invasion. Liriopogons are both field- and container-grown. Seedling invasion can occur in field-grown crops by seed germination within a cultivar bed or by invasion of a neighboring cultivar that is stoloniferous and produces daughter plantlets. Yet, all plants harvested from a bed are sold under the same cultivar name. Seedling invasion also occurs when seeds from adjacent selections germinate in another cultivar's bed or pot.

A fourth cultural practice causing cultivar identification problems is labeling. Some nurseryworkers label beds instead of individual plants. This results in cultivars being identified by location, not by morphology. When windstorms, animals, customers, or workers remove labels, they often are replaced by the "guesstimate" method, leading to potential misidentification. Furthermore, workers copying plant labels can make spelling errors, such as observed in the names 'Monroe', 'Monroe White', 'Munroe White', 'Monroi White', 'Mooroe White', and 'Moore White'. Sometimes names are changed inadvertently, such as 'Xmas Tree' or 'Xmas', as a shortened form of 'Christmas Tree'.

Landscapers and nurseryworkers are being held increasingly more accountable for correct plant names. Taxonomic problems create disputes between some nurseryworkers, landscapers, and their customers that may have to be resolved by litigation.

Conclusions

Liriopogons are versatile landscape plants that are increasing in importance and use in today's landscapes. There are several available species and a multitude of cultivars being selected and named. Species are often intermixed, with impostors and sold under the same name.

Taxonomically, liriopogons present a complexity of problems that need to be resolved. A taxonomic revision of cultivated liriopogons grown in the United States is needed; one that includes an inventory of taxa, quantitative descriptions of all taxa, includ-

ing cultivars, keys, and other aids for segregation and identification of liriopogons. The revision should also include an ordering of the nomenclature, documentation of taxa with specimens deposited in herbaria, and establishment of a living collection that can serve as a standard for the nursery—landscape industry. Germplasm accumulation of liriopogons was begun in 1987 under the North Carolina Agricultural Research Service project NC03867 and continues as project NC06104 in order to resolve these problems.

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