

LIRIOPE AND OPHIOPOGON: OVERVIEW OF TWO GENERA OF RUSCACEAE NATURALIZED IN THE ARKANSAS FLORA

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ABSTRACT

Liriope muscari (Dcne.) L.H. Bailey and *Ophiopogon japonicus* (Thunb.) Ker-Gawl. are first reported here as naturalized in the Arkansas flora, with *Liriope graminifolia* (L.) Baker documented in multiple instances as aggressively spreading from cultivated plants via stoloniferous offsets. The *O. japonicus* record represents the first documented occurrence of the genus *Ophiopogon* in the state outside of cultivation and naturalized. Seven distinct populations of *O. japonicus*, ranging from about 10 plants to 100s of individuals and/or ramets, were discovered along a ca. 3/10 of a mile (530 m) stretch of a small, intermittent stream in a disturbed riparian habitat in Clark County, Arkansas. An additional small population of *O. japonicus* was documented along a second, distinct riparian zone, which is separated from the preceding by over 2 km. One naturalized population of *O. japonicus* also was documented from Pulaski County. Naturalized plants of *Liriope muscari* are documented from Clark, Garland, and Pulaski counties. Naturalized plants and populations of *L. spicata* Lour. are documented from several locations in Clark, Garland, Hot Spring, and Pulaski counties. Based on these observations, it is reasonable to surmise that species of *Liriope* and *Ophiopogon* are considerably more widespread in the state than current records indicate. Keys for identification of Arkansas species of *Liriope* and *Ophiopogon*, photographs of plants in habitat, and notes on both genera in Arkansas are provided.

The Ruscaceae or ruscus family consists of about 28 genera and 500 species of mostly herbaceous monocots distributed over Africa, Asia, Europe, and North America (Weakley 2015). The Arkansas flora boasts 5 genera and 8 species; three genera: *Convallaria*, *Liriope*, and *Ophiopogon* are non-native and of Asiatic origin. A number of *Liriope* and *Ophiopogon* species have become naturalized to various degrees in the USA, although they have received only minimal attention in floristic studies and often are not well-represented in herbaria (Utech 2002; Nesom 2010; Spaulding et al. 2010). For a comprehensive treatment of the species in both genera that are cultivated and naturalized in the USA, see Nesom (2010).

Several species of *Liriope* and *Ophiopogon* are important ornamentals in warm-temperate climates, and frequently are used as ground covers or for borders because of their high shade tolerance, ease of propagation, and hardy, vigorous, and evergreen habit (Bailey & Bailey 1976; Fantz 2008b, 2009). Species in both genera are sometimes collectively referred to as “liriopogons” (Skinner 1971; Fantz 2008b).

Ophiopogon contains about 65 species of herbaceous perennials native to Asia (Chen & Tamura 2000b). *Ophiopogon* species are caespitose or stoloniferous/rhizometous, tightly-leaved, and grass-like in appearance. The flowers are purple, lavender, pink, or white, with six tepals and stamens and a single pistil. The fruit is a small, leathery capsule that dehisces early in development to expose young seeds. At maturity, the seeds are berry-like, with blue or black sarcotestas (Cutler 1992; Chen & Tamura 2000a, 2000b; Fantz 2008a). *Ophiopogon japonicus* (Thunb.) Ker-Gawl. is regularly cultivated in Arkansas; naturalized plants are documented here from two counties.

Liriope, also Asiatic in origin, is closely related and morphologically similar to *Ophiopogon* and includes about 8–12 species (Chen & Tamura 2000a; Nesom 2010). More than one-half of the species from both genera are native to China (Chen & Tamura 2000a, 2000b; Nesom 2010). *Liriope muscari* (Dcne.) L.H. Bailey and *L. spicata* Lour. are frequently cultivated and well-naturalized in the state, with *L. spicata* the most frequently encountered species outside of cultivation. *Liriope graminifolia* (L.) Baker, while not currently documented as a component of the naturalized flora, is regularly cultivated and has high potential for naturalization.

Escaped or naturalized plants regularly are encountered spreading directly from cultivated individuals or in the vicinity of areas where plants of the same species occur in cultivation. It is important to note, however, that many of our records are of plants that, although present in urban environments, are clearly naturalized without direct (obvious) connection to cultivated plants. Naturalized species of *Liriope* and *Ophiopogon* appear to favor disturbed, urban woods or green belts and riparian zones that offer some amount of disturbance, moist soils, and at least partial shade. In this report, we newly document the presence of naturalized plants in both genera from multiple Arkansas counties. Based on our observations, species of *Liriope* and *Ophiopogon* are stable components of the state’s flora. This paper is a floristic overview of two non-native genera of Ruscaceae in the Arkansas flora.

Liriope and *Ophiopogon* establish in the Arkansas flora via asexual reproduction (Fig. 1). With age, stolons bearing offsets deteriorate and separate from the originating genet (Fantz 2008a). Over time, spread and subsequent establishment via stoloniferous offsets occurs, giving rise to escaped individuals and naturalized colonies. Fruit and seed production also occur with both genera, and some establishment of *Liriope* (and probably also *Ophiopogon*) in Arkansas occurs from fruits and seeds (Fig. 2). Spaulding et al. (2010) noted that spread and establishment of *Liriope* and *Ophiopogon* in the Alabama flora occurs through fragmentation of stoloniferous offsets and water-mediated dispersal of seeds. Larger populations or colonies of these species present in the Arkansas

flora may represent a single clone and/or a mixture of multiple plants derived from a combination of asexual and sexual reproduction.



Figure 1. Asexual reproduction in *Liriopogon spicatus*. (A) Stoloniferous offsets produced from a large, naturalized colony of *L. spicatus* along a riparian zone in Clark County. (B) Stolons/rhizomes and tuberous roots.



Figure 2. Sexual reproduction in *Liriopogon muscari*. (A–B) Spontaneous seedlings and juvenile plants from Clark County; a close-up of two seedlings may be seen in Fig. A, as indicated by the yellow-colored arrows. Seventeen additional juvenile plants from the same location in various stages of development are shown in Fig. 2B (photo credit: Renn Tumblison); additional spontaneous plants were present at this location. (C) Seeds with sarcotestas removed.

Arkansas species of *Liriope* and *Ophiopogon* are morphologically similar and easily confused, especially in regard to sterile or vegetative material. Reproductive structures (inflorescences, flowers, and fruits/seeds) are best used for species separation (Nesom 2010). Escaped or naturalized species that may currently be encountered in the Arkansas flora are distinguished using the following key (modified from Nesom 2010).

1. Pedicels of flowers recurved (flowers drooping); flowers perigynous or epigynous; anthers connate; fruits (seeds) blue **Ophiopogon japonicus**
1. Pedicels of flowers straight (flowers held erect); flowers hypogynous; anthers free; fruits (seeds) black or dark blackish–blue.
 2. Plants caespitose to occasionally weakly stoloniferous, clump–forming and not spreading aggressively via stoloniferous offsets **Liriope muscari**
 2. Plants highly stoloniferous, clearly forming large, extensive colonies via stoloniferous offsets.
 3. Inflorescences usually as tall or taller than the leaves, rachis of inflorescence (4–)5–13 cm long, flowers purple, lilac, or lavender **Liriope graminifolia**
 3. Inflorescences clearly shorter than the leaves and often obscured by them, rachis of inflorescence 2–5(–8) cm long, flowers white to pale pink or pale violet **Liriope spicata**

CATALOG OF *LIRIOPE* AND *OPHIOPOGON* SPECIES

1. *Liriope graminifolia* (L.) Baker – GRASS LILYTURF, CREEPING LILYTURF (Fig. 3).

Liriope graminifolia, is a stoloniferous perennial that is native to China, Pakistan, Taiwan, and Vietnam (Chen & Tamura 2000a; Nesom 2010). In the USA, it previously only has been documented outside of cultivation in Texas (Nesom 2010). It is regularly cultivated in Arkansas and also much of the Southeast (Hume 1961; Fantz 2008a, 2009; Nesom 2010). Plants in cultivation typically produce extensive colonies via stoloniferous offsets. This tendency of *L. graminifolia* to aggressively spread from source plants provides legitimate potential for escape and naturalization into areas adjacent to where plants of the species are cultivated (Fig. 4). Case–in–point—about a decade ago, *L. graminifolia* was planted extensively on the Henderson State University campus as a border in a series of raised–bed planters. Currently, the planters are well–colonized with *L. graminifolia*, and plants continue to spread despite periodic mulching and mowing. A similar pattern of asexual spread by cultivated *L. graminifolia* was documented by Nesom (2010) on the Hendrix campus in Conway (Faulkner County). Based on its regular occurrence in cultivation and aggressive stoloniferous habit, *L. graminifolia* should be expected in the Arkansas flora, particularly in the vicinity of where it is cultivated.

In most characteristics, *Liriope graminifolia* overlaps with *L. muscari*, with the exception of its highly stoloniferous habit (Nesom 2010)—see discussion under *L. muscari* for additional information. In the field, extensive colonies of plants indicate *L. graminifolia* (or the similar *L. spicata*), whereas caespitose plants are *L. muscari*. Some forms of *L. muscari* are weakly stoloniferous but still produce a more or less caespitose growth form, rather than extensive colonies of plants. Young plants of *L. graminifolia* and *L. spicata* may sometimes initially appear caespitose but later will typically bear elongate stolons.

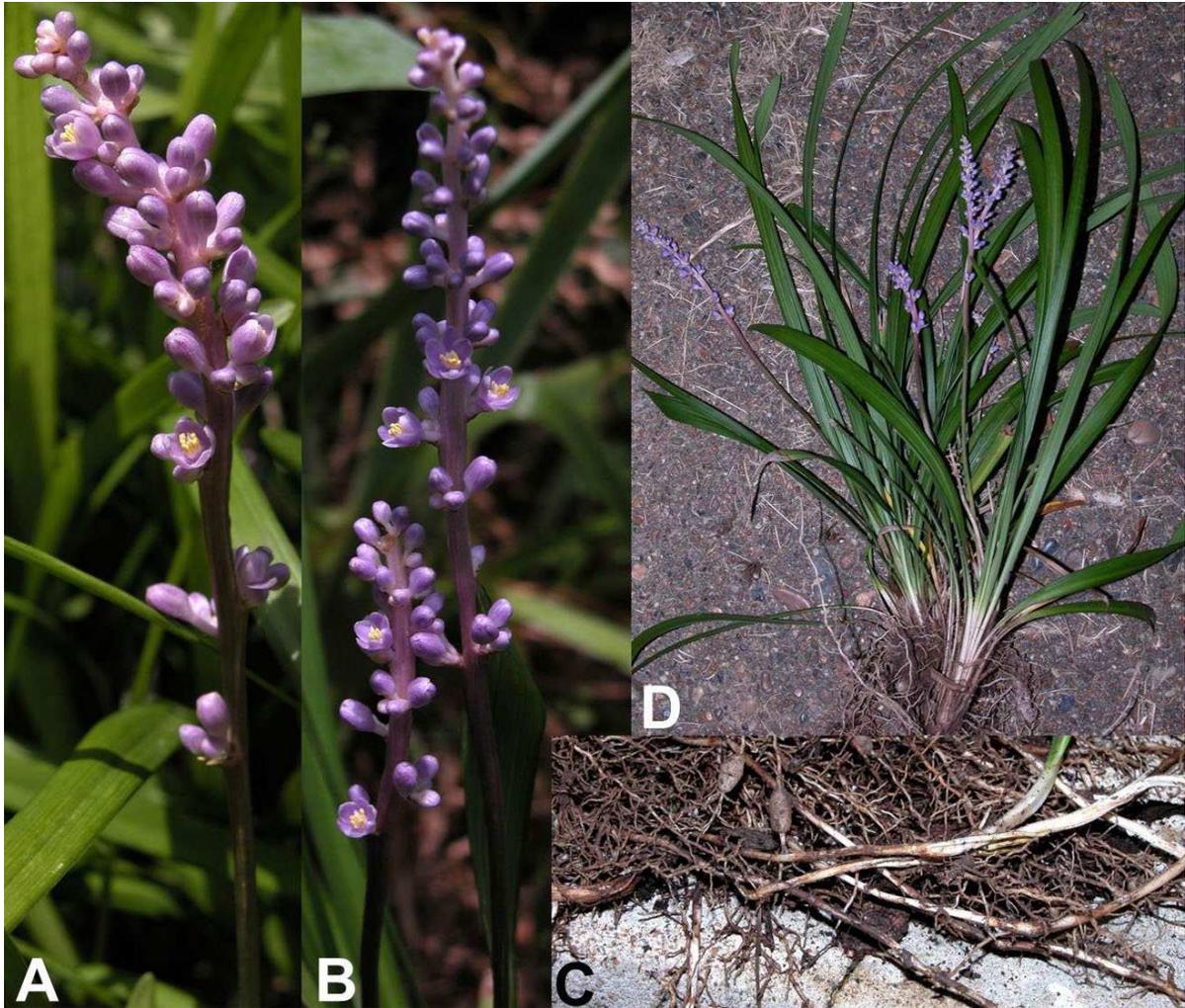


Figure 3. *Liriope graminifolia* plant and habit. (A–B) Inflorescences and flowers. (C) Stolons and roots. (D) Plant.



Figure 5. Comparison of sterile material of *Liriope graminifolia* and *L. spicata*; notice the close similarity in growth form and habit. (A) *Liriope graminifolia*. (B) *Liriope spicata*.

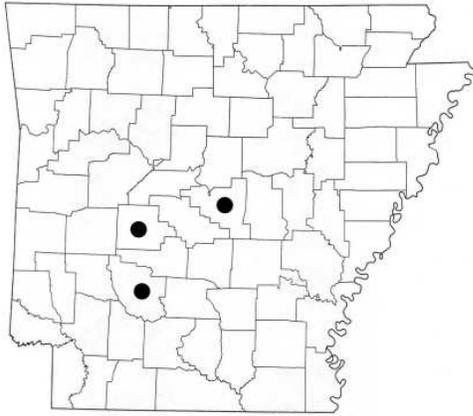
With regard to sterile material, *Liriope graminifolia* is easily confused with the widespread *L. spicata*, as both species produce expansive colonies via stoloniferous offsets and possess similar growth forms (Fig. 5). When reproductive, however, the two species easily are distinguished by flower color and height of inflorescence/infructescence in relation to leaf height. The flowers of *L. graminifolia* are lilac, pinkish–purple, or purple and the inflorescences are generally as tall or taller than the leaves. In contrast, the flowers of *L. spicata* are white or pale lilac and typically much shorter than the leaves, often partially obscured by them.



Figure 4. Plants of *Liriope graminifolia* spreading asexually via stoloniferous offsets in a raised–bed planter on the Henderson State University campus. The plants in the foreground (bottom of picture) were planted; however, every offset in the upper three–fourths of the photograph has spread from the originally cultivated plants. Several such plantings of *L. graminifolia* are present on the campus, with the plants showing similar patterns of spread.

Voucher specimens: **ARKANSAS**. Clark Co.: Hundreds of offsets/ramets present throughout raised–bed shrub planter (several similar planters with *L. graminifolia* are present on the HSU campus), plants have been present and have continued to aggressively spread for over a decade, 3 Jul 2016, *Serviss* 8357 (HEND); numerous plants spreading aggressively (from stoloniferous offsets) from originally cultivated plants in shrub planting, HSU campus, Arkadelphia, 5 Aug 2005, *Serviss* 6993 (HEND).

2. *Liriope muscari* (Dcne.) L.H. Bailey – BLUE LILYTURF, BIG BLUE LIRIOPE, MONKEY GRASS (Fig. 6).



Liriope muscari is a caespitose (clump-forming), sometimes weakly stoloniferous perennial that is native to China, Japan, and Taiwan (Chen & Tamura 2000a; Nesom 2010). It has previously been documented from Alabama, Georgia, Kansas, Louisiana, Maryland, Mississippi, Missouri, North Carolina, South Carolina, and Tennessee (Thomas & Allen 1993; Nesom 2010; Kartesz 2015; Weakley 2015). It is frequently cultivated in Arkansas, but until 2016 has not been documented outside of cultivation in the state. Our records of *L. muscari* from Clark, Garland, and Pulaski counties represent the first documented occurrences of this species in the state outside of cultivation (Fig. 7).

Both non-stoloniferous and weakly stoloniferous forms occur in the flora (Fig. 8). Based on our observations, the stoloniferous form produces a few, relatively short stolons but remains essentially caespitose, even over an extended period of many years. As Nesom (2010) noted, *L. muscari* and *L. graminifolia* are similar in nearly all characteristics, with the exception of the highly stoloniferous habit of *L. graminifolia*. Nesom speculated that some stoloniferous *L. muscari* could plausibly be forms of *L. graminifolia*, where the stoloniferous habit has been suppressed or restrained,

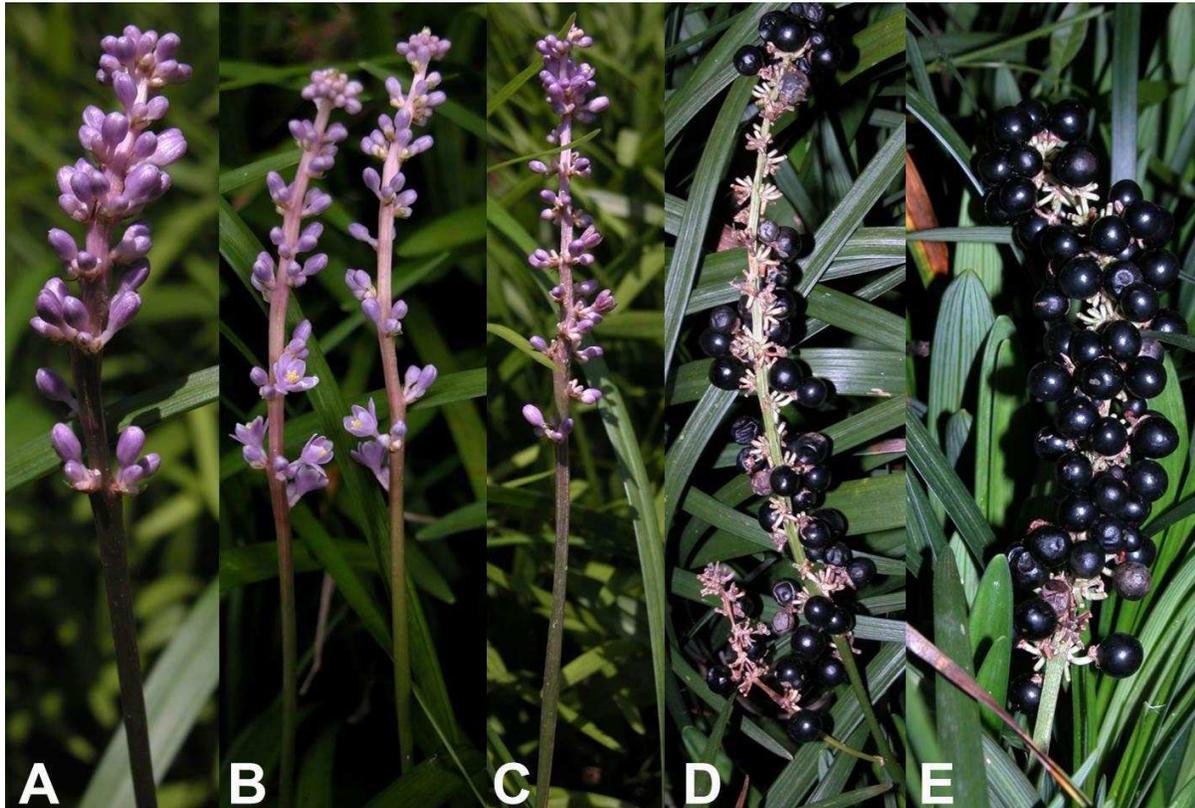


Figure 6. *Liriope muscari* reproductive structures. (A–C) Inflorescences and flowers (Fig. 6A shows a close-up view of the inflorescence). (D–E) Infructescences and mature fruits/seeds—the plants shown in Figs. 6B, D–E are the weakly stoloniferous form.



Figure 7. Escaped/naturalized plants of *Liriope muscari* from Clark and Pulaski counties. (A) Plant along a disturbed, semi-wooded roadside in Clark County. (B) Plant in disturbed, urban woods/green belt in Clark County; several naturalized plants of *L. muscari* were present at this location. (C) Possibly escaped individual from a residence in Arkadelphia. (D) Plant growing in a low area of disturbed, urban woods in Pulaski County; three plants of *L. muscari* were present at this location.

and suggested that evidence for this might be clarified through molecular studies. In Arkansas, the weakly stoloniferous form of *L. muscari* produces fruit, sometimes heavily so, and spontaneous seedlings sometimes are observed in the vicinity of where fruiting plants occur (Fig. 2). Fantz (2008b) noted that abundant fruit set is a trait of *L. graminifolia*, rather than *L. muscari*.

Escaped plants of *Liriope muscari* were observed in lawns, flower beds, shrub plantings, and along walkways. Naturalized plants of *L. muscari* also were regularly observed in urban woods and green belts that occur in proximity to areas where *L. muscari* was cultivated. Presumably seeds are dispersed to these areas by birds and/or water.

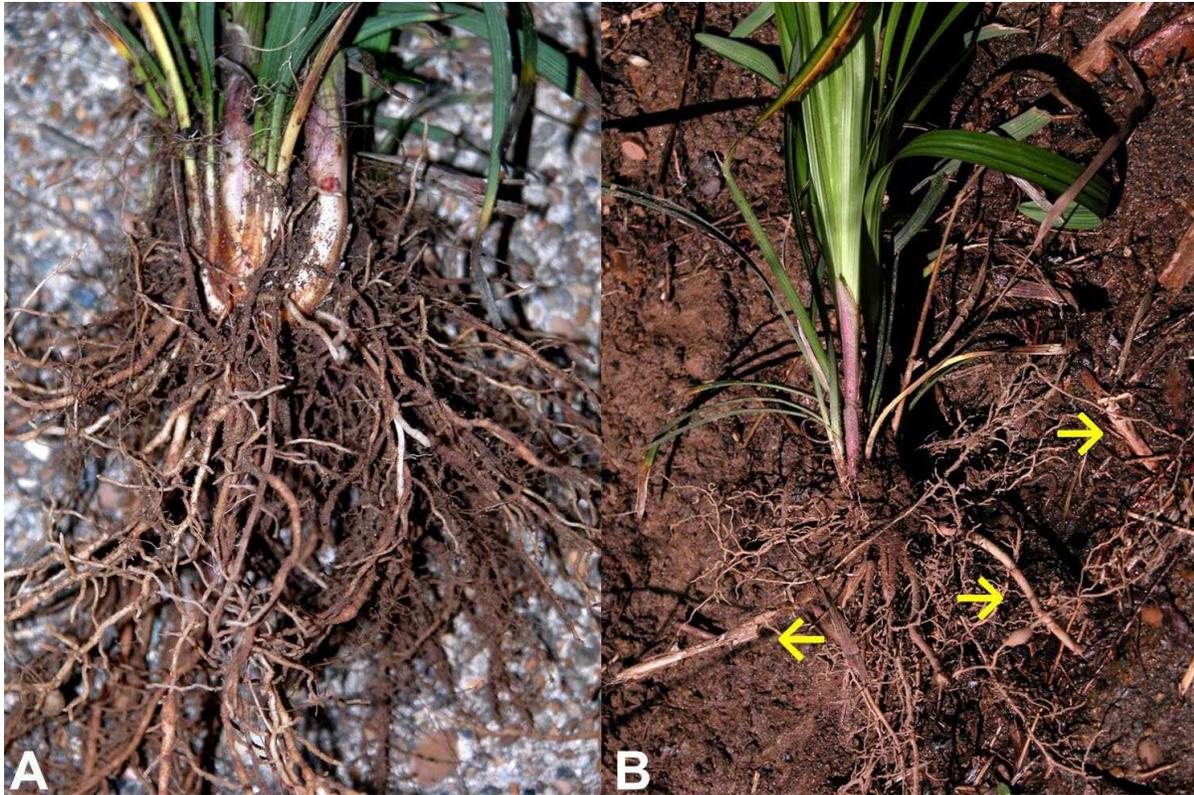
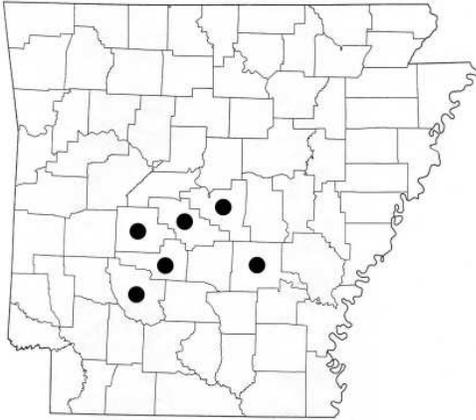


Figure 8. *Liriopogon muscari*: comparison of stoloniferous and non-stoloniferous forms. (A) Plant without stolons (the white-colored structures that are reminiscent of such are actually roots). (B) Plant with short but well-developed stolons—stolons are indicated by the yellow-colored arrows. This plant is an escaped individual from Clark County. Based on our observations of Arkansas plants of *L. muscari*, stoloniferous plants produce only a relatively few number of short stolons and maintain an overall caespitose growth form, even over many years.

Voucher specimens: **ARKANSAS. Clark Co.:** One possibly spontaneous (escaped) plant at base of tree in sandy, rocky soil, residence at 1318 O’Connell St., N34.11561, E-93.063618, Arkadelphia, 22 Jun 2016, *Stone 2016-2* (HEND); several (ca. 8) spontaneous plants in disturbed, semi-unkept area next to church building, many cultivated plants of the species in the vicinity, off Country Club Rd. at the intersection of Country Club Rd. and W.P. Malone Dr., Arkadelphia, 4 Jun 2016, *Serviss 8343* (HEND); one naturalized plant on roadside, non-stoloniferous form, semi-wooded with high disturbance, Clinton St. adjacent to the intersection of Clinton St. and 26th St., Arkadelphia, 28 May 2016, *Serviss 8342* (HEND); five scattered, naturalized plants—plants stoloniferous but caespitose, in highly disturbed urban woods/green belt and riparian zone, off O’Connell St. adjacent to the intersection of O’Connell St. and 18th St., Arkadelphia, 14 May 2016, *Serviss 8336* (HEND); nearly two dozen escaped/spontaneous, juvenile plants (from seeds) in lawn and highly disturbed areas around walkway, numerous cultivated plants of the species in the immediate vicinity, residence, 1900 block of Sylvia St. Arkadelphia, 3 May 2016, *Serviss 8232* (HEND). **Garland Co.:** One naturalized clump of plants in flower, plant with short stolons, about 4 feet from creek in moist, rocky soil, numerous plants of the species also cultivated in the area, Hot Springs Creek at Hollywood Park off Hollywood Ave., Hot Springs, N34.29127, E-93.02815, 26 Jun 2016, *Olsen 2*; a few plants along a wooded stream with many exotics, off Carpenter Dam Road, Cherokee Beach development, SW Hot Springs, 22 Jul 2006, *Peck 06-033* (HEND). **Pulaski Co.:** Three widely separated naturalized plants, non-stoloniferous form, in low area with moist soils in semi-disturbed, urban woods adjacent to the intersection of Boyle Park Rd. and Archwood Dr., Little Rock, 11 May 2016, *Serviss 8234* (HEND).

3. *Liriope spicata* Lour. – CREEPING LILYTURF, CREEPING LIRIOPE, MONKEY GRASS
(Figs. 9–10)



Liriope spicata Lour. is a stoloniferous perennial that is native to China, Japan, Korea, Taiwan, and Vietnam (Chen & Tamura 2000a; Nesom 2010). It previously has been documented from Alabama, Arkansas, Florida, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Illinois, and Texas (Nesom 2010; Wunderlin & Hansen 2011; Gentry et al. 2013; Kartesz 2015; Weakley 2015). In Arkansas, *L. spicata* has previously been documented from three counties in central Arkansas: Jefferson, Pulaski, and Saline (Gentry et al. 2013). We add three new county records to its distribution: Clark, Garland, and Hot Spring. Based on

our observations, however, *L. spicata* is likely more widespread in the state than its current known distribution.

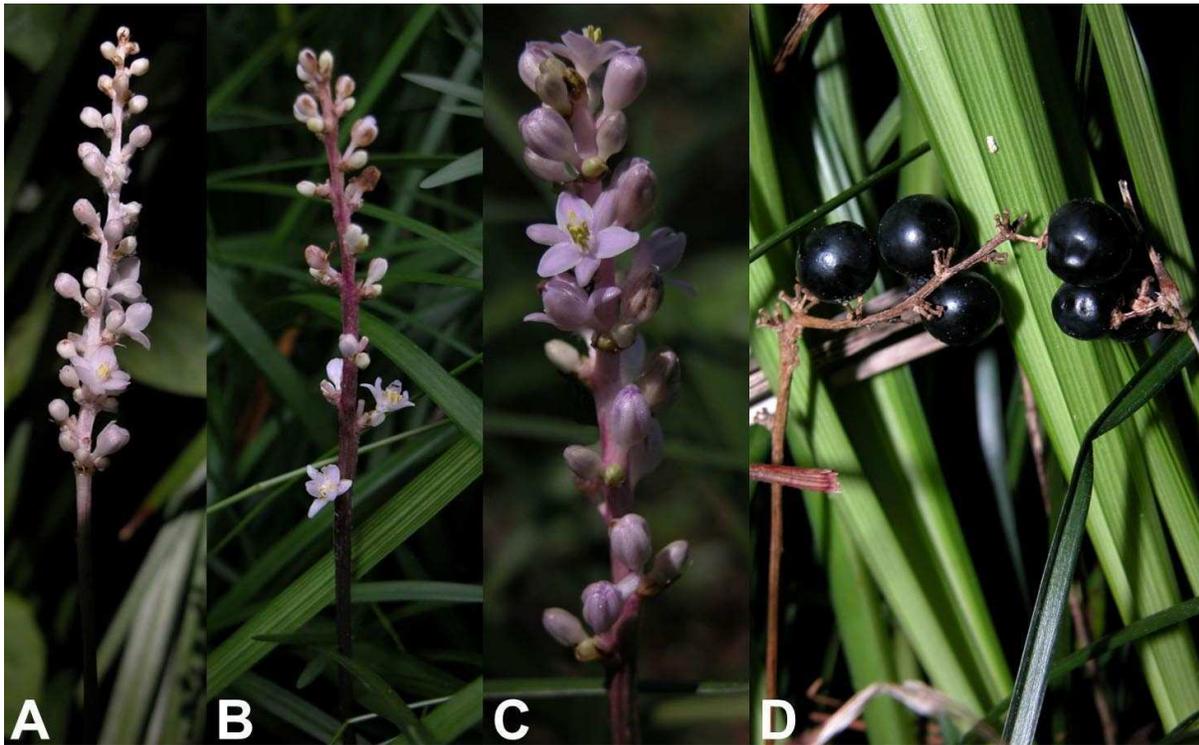


Figure 9. *Liriope spicata* reproductive structures. (A–C) Inflorescences and flowers showing some of the variation in flower color that may be encountered — flowers of *L. spicata* may range in color from white to pale lilac (Fig. 9C shows a close-up view of the inflorescence). (D) Infructescence and mature fruits/seeds.

In the flora, *Liriope spicata* was observed at several locations in large numbers, with plants clearly spreading vegetatively via stoloniferous offsets (Figs. 11–12). In regard to these large populations or colonies that consist predominately of ramets, it was outside the scope of this study to determine whether these populations might represent a single clone, combinations of multiple clones, or some mixture of both sexually and asexually derived plants. Fruiting plants and putative seedlings also were observed in some locations; hence, some establishment also probably occurs via seeds (Fig. 13). Naturalized *L. spicata* is regularly encountered in disturbed urban woods, green belts, and

riparian zones. In these habitats, *L. spicata* should be considered invasive. It also is long-persistent subsequent to cultivation practices and often observed spreading vegetatively from cultivated plants.



Figure 10. *Liriope spicata* showing well-developed stolon/rhizome, tuberous roots, and fibrous root system.



Figure 11. Naturalized plants of *Liriope spicata* from Clark County. This population extends beyond what is shown in the photograph and consists of hundreds of (or possibly more) offsets (ramets). The principal means of spread appears to be via stoloniferous offsets, but some establishment also may be occurring via seeds, as plants with spent infructescences were present. Several similar populations occur along Mill Creek and elsewhere in Arkadelphia.



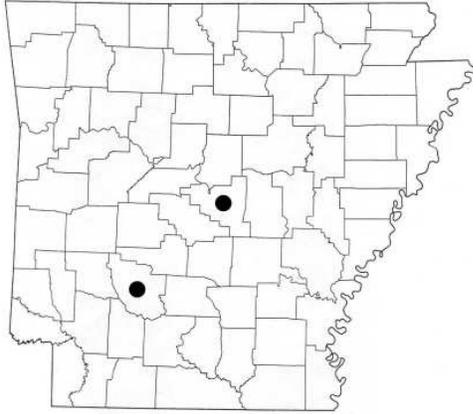
Figure 12. Naturalized plants of *Liriopogon spicata* from Clark County. This large population occurs at the top of a slope at the edge of a wooded ravine in Arkadelphia, and extends much beyond what is shown in the photograph. Similar to that shown in Fig. 11, most of the establishment appears to be asexual. It consists of possibly thousands of ramets. This location is densely shaded.



Figure 13. Possible sexual reproduction in *Liriopogon spicata*. (A) Naturalized plants growing in a wash on a steep slope in an urban greenbelt. (B) Several, small juvenile individuals produced presumably from seeds generated by the plants shown in Fig. 13A. These juveniles occur in a mostly flat area a few dm down slope at a nearly vertical drop from the mature plants shown in Fig. 13A. Direct production from stoloniferous offsets was not likely the source of the juvenile plants. However, even though seeds are the presumed propagule, asexual spread via stolons cannot completely be excluded, because fragmentation and subsequent dispersal of stoloniferous offsets can occur.

Voucher specimens: **ARKANSAS. Clark Co.:** Large colony of naturalized plants growing in low, wet depression and drainage, highly disturbed, open woods, off of Pinewood Dr., SE of intersection of Pinewood Dr. and 10th St, 3 Jul 2016, *Serviss 8356* (HEND); extensive, naturalized population consisting of numerous colonies and individual plants along embankment and overflow area, with many plants also extending to near edge of stream, disturbed, semi-wooded riparian zone adjacent to HSU campus, directly S of Mill Creek Dr. and Feaster Trail between 12th St. and 15th St., Arkadelphia, 3 Jul 2016, *Serviss 8353* (HEND); a few large colonies of plants in and at edge of highly disturbed, urban woods, NW of Reddie Athletic Center, HSU campus, Arkadelphia, 17 Jun 2016, *Serviss 8357* (HEND); one large colony of naturalized plants and a few additional isolated individuals, disturbed, urban woods and riparian zone, off University Ave. adjacent to the intersection of University Ave. and 10th St., Arkadelphia, 17 Jun 2016, *Serviss 8348* (HEND); a few naturalized colonies and isolated plants on and below wash and slope in disturbed, urban woods/green belt and riparian zone, HSU/OBU Ravine, off 8th St. adjacent to the intersection of 8th St. and McNutt St., Arkadelphia, 16 Jun 2016, *Serviss 8347* (HEND); three colonies of naturalized plants at edge and within disturbed, urban woods/green belt, directly NE of Arkadelphia Medical Clinic, off Pine St., Arkadelphia, 15 Jun 2016, *Serviss 8345* (HEND); several large and small colonies of naturalized plants in highly disturbed, urban woods adjacent to residential area, Feaster Trail area, off 15th St. adjacent to the intersection of 15th St. and Mill Creek Dr., Arkadelphia, 26 May 2016, *Serviss 8341* (HEND); several naturalized plants in semi-unkept lawn area and under shrubs, many of the plants juveniles apparently from seeds, NW side of the Reynolds Science Building, HSU campus, Arkadelphia, 18 May 2016, *Serviss 8338* (HEND); several large, naturalized colonies of plants along highly disturbed riparian zone, plants with fruits, Mill Creek, Feaster Trail area E of 26th St., Arkadelphia, 15 Oct 2015, *Serviss 8199* (HEND); small colony of plants naturalized in disturbed, urban woods, adjacent to the intersection of 12th St. and Huddleston St., Arkadelphia, 28 Aug 2014, *Serviss 8174* (HEND); numerous plants naturalized on wooded slope along Mill Creek, adjacent to the intersection of Twin Rivers Dr. and Cypress Rd., Arkadelphia, 4 Sep 2014, *Serviss 8178* (HEND); large colony of many plants growing on disturbed, semi-wooded bank of stream, spreading vegetatively via stolons, Mill Creek, Feaster Trail area off 15th St. and Mill Creek Dr., Arkadelphia, 8 Oct 2013, *Serviss 8075* (HEND). **Garland Co.:** Small colony of naturalized plants at edge of creek, with some plants growing over concrete rubbish, Hot Springs Creek at Olive St. and Transportation Depot, N34.30390, W-93.03100, 8 May 2016, *Olsen 1* (HEND); numerous escaped plants in woods and ditches, Brecklins' Corner, Golf Links Rd. and Shady Grove Rd., SE Hot Springs, 2 Sep 2006, *Peck 06-278* (HEND). **Hot Spring Co.:** Extensive colony of naturalized plants along open roadside and adjacent ditch, plants apparently spreading and escaped from cultivated plants in the vicinity, Smoke Ridge Rd., coming from Hwy. 51, N34.454176, E-92.851663, Jun 22 2016, *Stone 2016-2* (HEND). **Pulaski Co.:** Two small colonies of naturalized plants in semi-disturbed, urban woods, adjacent to the intersection of Boyle Park Rd. and Archwood Dr., Little Rock, 11 May 2016, *Serviss 8235* (HEND); naturalized plants in floodplain woods, Arkansas River floodplain, Two Rivers Park, W of Little Rock, sandy soils, 5 Aug 2007, *Peck 07-1799* (HEND); naturalized plants in waste areas, ditches, and wooded drainage areas, Coleman Creek, Little Rock, 10 Sep 2006, *Peck 06-278* (HEND).

4. *Ophiopogon japonicus* (Thunb.) Ker–Gawl. – JAPANESE MONDO GRASS, DWARF MONDO GRASS (Figs. 14–15).



Ophiopogon japonicus is a stoloniferous perennial that is native to China, Japan, Korea, and Taiwan (Chen & Tamura 2000b; Nesom 2010). It previously only has been documented outside of cultivation in four states: Alabama, Mississippi, North Carolina, and Texas (Diggs et al. 1999; Nesom 2010; Spaulding et al. 2010; Roling et al. 2011; Weakley 2015). The genus previously was attributed to Arkansas (Smith 1988; Arkansas Vascular Flora Committee 2006); however, it was based on misidentified material of *L. spicata* (Nesom 2010; Gentry et al. 2013). Hence, our records of *O. japonicus* from Clark and Pulaski counties represent the first

documented occurrences of the genus *Ophiopogon* in the state outside of cultivation and apparently only the fifth state-level occurrence in the USA.

In 2014 and 2016, a total of seven, distinct populations of naturalized *Ophiopogon japonicus* were documented in a highly disturbed, urban woods and riparian zone along a ca. 530 m stretch of a small, intermittent stream in Clark County (Figs. 16–18). The populations ranged in size from about 10 plants to hundreds of plants/ramets in the largest. Plants occurred along the stream edge, embankment, and the overflow areas above. Plants were observed spreading via stoloniferous offsets; however, some plants had mature fruits, indicating that some establishment also may have occurred via seeds (Fig. 14). All plants were one of the dwarf forms of *O. japonicus*, which only reach a height of ca. 5–10 cm. The dwarf forms are derived from larger, wild-type plants (Nesom 2010).

It is important to note that three of the seven *Ophiopogon japonicus* populations occur upstream and are somewhat separated from the other four. These populations occurred in large, expansive colonies directly above the bank in the overflow area and may possibly have been long-persistent from cultivation practices, as the entire site is surrounded by residential areas. The location of these populations may have been an old home site, although no obvious evidence of such is currently present and the area is subject to periodic flooding and remains wet for long periods of time. One possible explanation as to the origin of the four downstream populations is that propagules, such as seeds, stolon segments or offsets, or whole plants were transported downstream by birds (seeds) and/or water, allowing establishment of the naturalized populations.

In 2016, an additional small population of a few-dozen naturalized plants was discovered along a second, distinct riparian zone. This location is separated from the preceding by more than 2 km, but is similar in regard to level of disturbance. Plants were present along the base of the streambank, with some individuals occurring almost within the streambed. Plants were spreading via stoloniferous offsets and also possibly by seeds, as a number of plants occurred as isolates or small, widely-separated clusters. Some plants were reproductive with spent inflorescences.

In 2015, a single naturalized population of *Ophiopogon japonicus* was discovered in Pulaski County growing along a natural seep in semi-disturbed, urban woods (Fig. 19). Again, as observed typically with *L. spicata* (and the Clark County populations of *O. japonicus*), the Pulaski County population consisted largely or wholly of stoloniferous offsets, and most establishment appeared to be asexual. The Pulaski County plants were not the dwarf form. In Arkansas, *O. japonicus* occurs in disturbed, urban woods and greenbelts, woodland edges, and riparian zones, particularly in moist to wet soils.

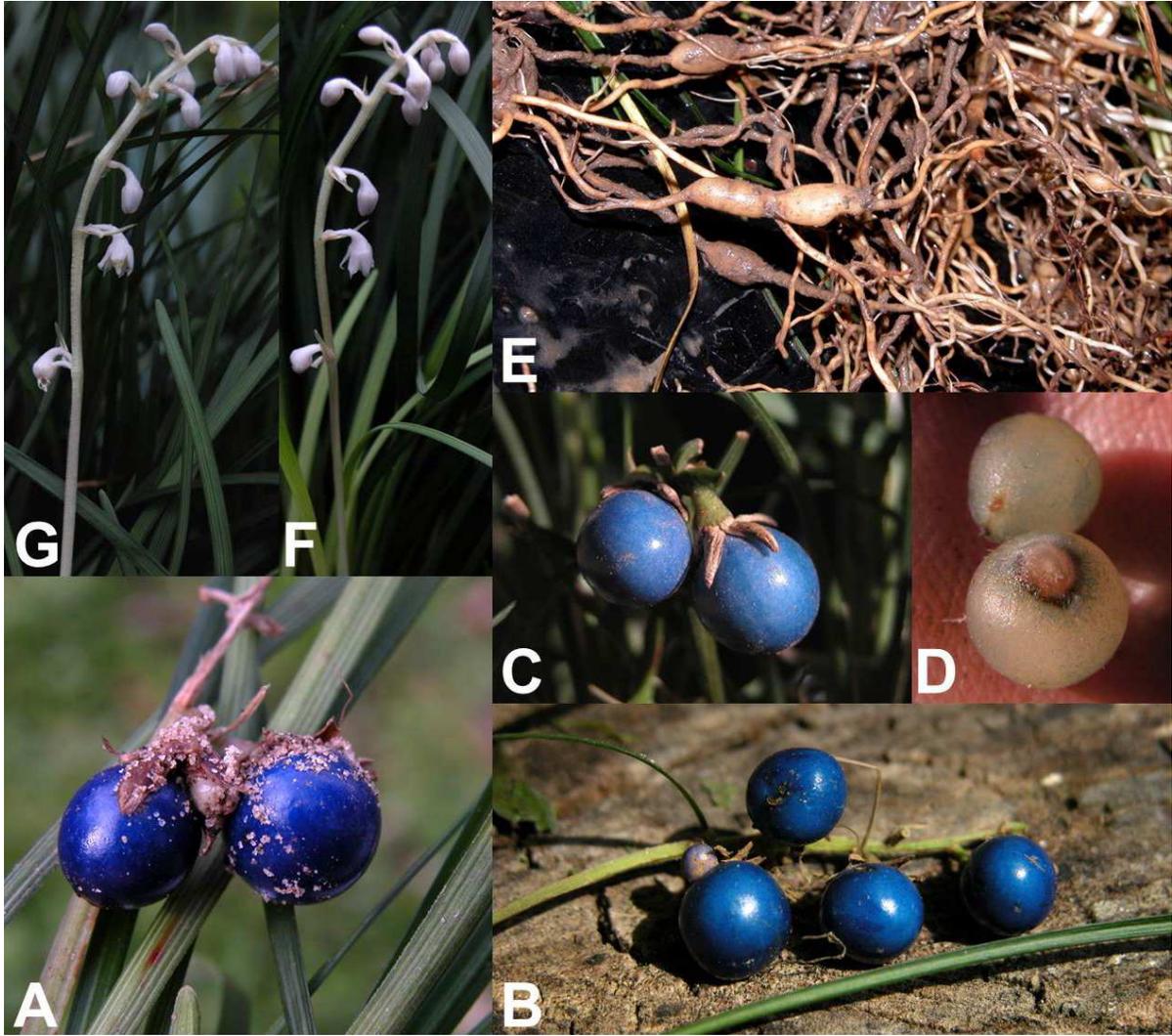


Figure 14. *Ophiopogon japonicus* reproductive structures and tuberous roots. (A–C) Mature infructescences and mature fruits/seeds; the seeds in Fig. 14C are lighter in color than those in in Figs. 14A–B. (D) Seeds with sarcotestas removed. (E) Tuberous roots. (F–G) Inflorescences and flowers—notice the downward oriented and curved pedicels of the flowers (the flowers of *O. japonicus* sometimes have more pink coloration than what is shown in Figs. 14F–G).



Figure 15. *Ophiopogon japonicus* plants, stolons/rhizomes, and tuberous roots (from cultivated plants).



Figure 16. Naturalized, fruit/seed-bearing plants of *Ophiopogon japonicus* from Clark County. (A) Individual from one of the smaller naturalized populations; a few plants from this population were reproductive with mature fruits/seeds. (B) Larger individual (from a different population than the plant shown in Fig. 16A). These plants are one of the dwarf forms of the species.



Figure 17. Small population of naturalized individuals of *Ophiopogon japonicus* from Clark County. The lowermost plants in the photograph are just above the waterline of a small stream in a disturbed riparian zone, and would be temporarily inundated during periods of high water flow.



Figure 18. Largest of the four downstream naturalized populations of *Ophiopogon japonicus* from Clark County. Several large clusters of dark green-colored plants may be seen, both directly above the water line and higher up on the streambank. As previously mentioned with *Liriope spicata*, it is unknown whether or not the ramets making up much or all of this population represent a single clone or were generated from multiple, distinct individuals. Numerous ramets produced from stoloniferous offsets even extend above the bank into the taller vegetation at the top of the photograph.



Figure 19. Naturalized plants of *Ophiopogon japonicus* from Pulaski County. The boundaries of this population extend much beyond what is shown in the photograph. This population was present growing along a seep in very moist soil in semi-disturbed, urban woods in Little Rock (Pulaski County). These plants are not one of the dwarf forms.

Voucher specimens: **ARKANSAS**. Clark Co.: Small population of a few dozen plants and offsets at edge of stream in disturbed, semi-wooded riparian zone, some plants growing almost in streambed, plants with spent flowers present, adjacent to HSU campus, directly S of Mill Creek Dr. and Feaster Trail between 12th St. and 15th St., Arkadelphia, 3 Jul 2016, *Serviss 8355* (HEND); four naturalized colonies of plants along a ca. 0.2 mi stretch of a highly disturbed woods and riparian zone, some plants with fruits, distributed between 19th St. and 23rd St. about 1 block N of Crawford St., 18 Apr 2016, *Serviss 8227* (HEND); small colony of a few dozen plants growing at edge and along bank of small stream in a disturbed, semi-wooded riparian zone, plants with fruits, off 23rd Street, ca. 1 block N of the intersection of 23rd St. and Crawford St., 22 Feb 2016, *Serviss 8210* (HEND); three large colonies of plants along highly disturbed, open and semi-wooded right-of-way adjacent to small stream, off 23rd St., ca. 1 block N of the intersection of 23rd St. and Crawford St., 14 Feb 2014, *Serviss 8103* (HEND). Pulaski Co.: Large colony of probably 100s of plants at edge and along seep in semi-disturbed, urban woods, very moist soil, adjacent to intersection of Boyle Park Rd. and Archwood Dr., Little Rock, 11 May 2016, *Serviss 8233* (HEND).

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