Missouriensis

Journal of the Missouri Native Plant Society

Volume 34
2017

effectively published online 30 September 2017

Missouriensis, Volume 34 (2017)

Journal of the Missouri Native Plant Society

From the Editor

Welcome to the first online edition of *Missouriensis*. The format has been redesigned to facilitate access and on-screen readability, and articles are freely available online as open source, archival pdfs. These changes will make the journal more widely available and searchable through various online databases. Each article is available as an individual pdf; additionally, a link to a composite pdf of the entire volume is sent to all current members of the Society.

Missouriensis is the official technical publication of the Missouri Native Plant Society, and as such, is focused on articles that increase knowledge related to Missouri plants, vegetation, natural communities, conservation, ecological restoration, and associated topics. In recognition of recent changes in journals and publications, effective 1 January 2012, electronic-only publication of new nomenclatural acts is valid under the *International Code for Botanical Nomenclature*, rendering this new format for *Missouriensis* an effective window for taxonomic publication. As your editor, I welcome inquiries regarding potential articles and suggestions for improving the journal. A revised Instructions for Authors will soon be available on the society's website: https://monativeplants.org/.

Many individuals were critical to production of this issue. Special appreciation is extended to those who generously donated time as reviewers and provided editorial assistance: David Bogler, Missouri Botanical Garden; James Lendemer, New York Botanical Garden; Paul McKenzie, U.S. Fish and Wildlife Service; Caleb Morse, University of Kansas; John Oliver; Cindy Pessoni, The Nature Conservancy; Justin Thomas, NatureCITE; Amy Helper Welch, The Nature Conservancy, Gerould Wilhelm, Conservation Research Institute; George Yatskievych, University of Texas. George Yatskievych was also patient and helpful during the transition from his editorship.

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**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

A naturalized population of *Cenchrus purpurascens* (Poaceae) in Boone County, Missouri

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ABSTRACT. – *Cenchrus purpurascens* is reported new to the Missouri flora in Boone and St. Louis counties; the Boone County population is discussed in detail.

Cenchrus purpurascens Thunb. (Chinese fountain grass or foxtail fountain grass) has been recently treated as *Pennisetum alopecuroides* (L.) Spreng. by various authors (e.g. Yatskievych 1999, Wipff 2003). Verloove (2012) noted that *Pennisetum* and *Cenchrus* were closely related and recommended that further genetic studies be conducted to clarify the taxonomic relationship between the two genera. Chemisquy et al. (2010) unified *Cenchrus* and *Pennisetum* along with *Odontelytrum* Hack., following a detailed nuclear, plastid, and morphological analysis and transferred members of the genus *Pennisetum* into *Cenchrus* as the latter has nomenclatural priority. However, in that publication, the authors listed *Cenchrus compressus* (R. Br.) Morrone as the correct name for *Pennisetum alopecuroides*. Verloove (2012), however, noted that the correct binomial should be *Cenchrus purpurascens* as noted by Alan Weakley in his *Flora of the Southern and Mid-Atlantic States* (2015) and confirmed by him through correspondence with Robert Soreng at the Smithsonian Institution (Weakley, pers. comm. Oct. 2016).

Cenchrus purpurascens is a commonly planted ornamental along with other members of the genus [treated as *Pennisetum* by Yatskievych (1999), Donadío et al. (2009), Chemisquy et al. (2010)]. In Missouri, Yatskievych (1999) noted that this taxon was planted to revegetate mine spoils in Boone County. Outside of garden plantings, the first record of this species escaping from captivity was apparently made by Douglas Ladd in St. Louis County in August 2000 (http://www.tropicos.org/Specimen/2598432). Ladd collected the specimen from along the edge of a small overgrown depression adjacent to Ruth Park. Justin Thomas has also reported this grass escaping from landscape plantings (Thomas, pers. comm. Oct. 2016).

On 24 September 2016, I discovered a naturalized population of *Cenchrus purpurascens* in Boone County near the intersection of Bearfield Rd. and Mace Dr. in southeast Columbia in a vacant lot (38.90138º N, 92.30437º W) (Figure 1). Vouchered specimens (*McKenzie 2610*) will be distributed to the Missouri Botanical Garden (MO) and other cooperating herbaria.

The population at the site is apparently well established as a few hundred inflorescences were estimated. The obvious source population for this escape was surely the ornamental planting

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directly on the opposite side of the street at 4304 S. Bearfield Rd. (Figure 1). When I returned to the site to collect mature seed on 14 October 2016, the field had been mowed.

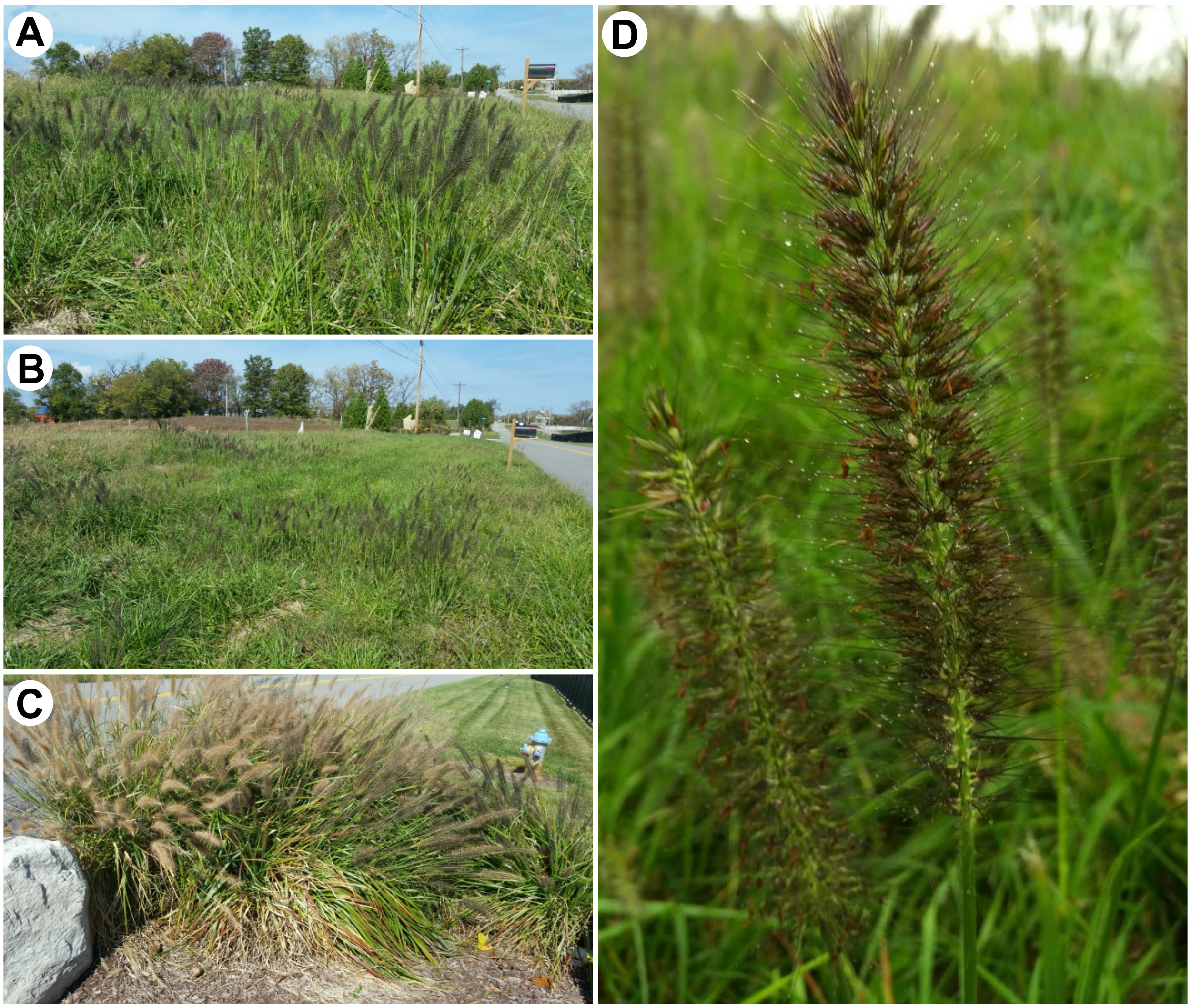

Figure 1. *Cenchrus purpurascens*, Columbia, Boone Co., Missouri. **A-B**: naturalized population, 4304 S. Bearfield Rd.; **C**: presumed source population in planting across street; **D**: close-up of inflorescence. All photos by the author.

It is likely that this species will continue to escape cultivation and undoubtedly additional records for this grass will be recorded. Ironically, a record of *Cenchrus purpurascens* was recently discovered in Tennessee following email correspondence regarding the Boone County discovery (Dwayne Estes, Austin Peay State University, pers. comm. Oct. 2016). However, given the mowed fate of the most recent discovery, one can only wonder what other interesting finds may be missed due to maintenance activities.

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Missouriensis, **34**: 4-19. 3017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

New additions, vouchers of old additions, and a new combination (*Dichanthelium inflatum*) for the Missouri flora

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ABSTRACT. – Thirty taxa are reported or confirmed for Missouri, along with discussions of their biogeography, ecology, taxonomy, and field characters. A new combination, *Dichanthelium inflatum*, is created to accommodate a distinct element in the state.

INTRODUCTION

Over the years, I've documented several species new to Missouri that have long been in need of reporting or vouchering. Yatskievych (2006, 2013) and Ladd and Thomas (2015) include a few of these, but without direct reference to vouchered specimens. Some of these species have clean taxonomic histories, while others have moderately convoluted taxonomic histories. In the latter case, I've provided evidence and justification for my perspective. Additionally, I've encountered a taxon of *Dichanthelium* that needs to be pulled out of *D. sphaerocarpon*. This new combination, *Dichanthelium inflatum*, is discussed and compared to related taxa. All voucher specimens are deposited in the herbarium of the Missouri Botanical Garden (MO).

FLORISTIC ENUMERATION

Agrostis scabra **Willd.**

This species differs from *A. perennans* in that the secondary panicle branches diverge beyond the middle of their length. It differs from *A. hyemalis* in having spikelets well separated in the inflorescence (compared to spike-like at the tips of panicle branches), longer spikelets (> 2 mm), longer pedicles and a later blooming period (mid-summer to fall compared to late spring). This species has a wide geographical range throughout North America. Barkworth et al. (2007) refer to three variants of *A. scabra*. The Missouri specimen fits into the southeastern, weedy variant.

Voucher specimen: **U.S.A. MISSOURI:** BARTON CO.: Shelton Cook Memorial Meadow in open flat along swale, NAD83 coordinates 15 S 399939.0, E 4141666.8, 25 Sept. 2015, *Thomas #15-09-25-1*.

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Andropogon hirsutior **(Hack.) Weakley and LeBlond**

This species was discovered in Missouri in 2015 at Diamond Grove Prairie Natural Area, but the plants did not make adequate herbarium specimens. Since then, the species has been found at several other locations including Cook Meadow (Barton Co.), Prairie State Park (Barton Co.), and Carver Prairie (Newton Co.). At all three localities it was associated with wet soils in relatively intact prairie swales. Additional associated species at these sites included *Tridens strictus*, *Panicum anceps*, and *Andropogon virginicus*. It also has been observed numerous times growing as large colonies in road ditches in the southern half of the Unglaciated Plains Natural Division, suggesting that it does not necessarily exhibit fidelity to sites with high ecological integrity. Andrew Braun has also vouchered it on Crowley's Ridge in southeastern Missouri. It is similar in gross morphology to *A. virginicus* but taller, with thicker stems, slightly scabrous sheaths (Weakley et al. 2011), and more numerous and denser inflorescence branches (Hitchcock and Chase 1951). The clumps of the previous season weather to a pale gray color compared to the yellow-orange color of *A. virginicus*. This is one of several primarily southern coastal plain species that enter southwestern Missouri through the southern Tallgrass Prairie.

Voucher specimen: **U.S.A. MISSOURI:** NEWTON CO.: Carver Prairie, several thousand stems growing throughout large swale, with *Panicum rigidulum*, *Rhynchospora recognita*, *Persicaria hydropiperoides* and *Ludwigia palustris,* NAD83 coordinates 15 S 376258.3, E 4098037.8, 5 Sept. 2016, *Thomas 16-09-05-1*.

Bothriochloa ischaemum **(L.) Keng**

This exotic species was collected or annotated from roadsides in three Missouri counties (Howell, Shannon, and Warren) in 2010 by various collectors. The specimen cited occurs in an area with heavy horse trailer traffic from "trail rides" in the Eminence area. Seed blowing from horse trailers is a likely source for this species as well as *B. bladhii*, which is also increasing in the area.

Voucher specimen: **U.S.A. MISSOURI:** SHANNON CO.: along the margin of state highway 19 at junction with gravel road, extending for about 100 meters, associated with *Bothriochloa bladhii* and *B. saccharoides*, NAD83 coordinates 15 S 643700.9, E 4118580.3, 23 July 2010, *Thomas 2347*.

Carex woodii **Dewey**

The protected, seepy bluffs along Spring Creek harbor many rare and relictual species including *Carex woodii*. Several of these species, such as *Euonymus obovatus*, *Tilia americana*, *Phlox carolina* var. *interior*, and *Cypripedium reginae* are indicative of mesic beech-maple forest communities more common north and east of the Ozarks. This population of *C. woodii* represents a disjunction of nearly 450 miles from the nearest known population in Kankakee County, Illinois (Kartesz 2013). *Carex woodii* forms small to large, rhizomatous colonies in high quality forests and woodlands on rich, mesic to wet mesic soils. Through the efforts of Paul McKenzie, several other populations of *C. woodii* along Spring Creek have been documented.

Voucher specimen: **U.S.A. MISSOURI:** HOWELL CO.: Mark Twain National Forest, on extremely steep slope ca. 60 meters above Spring Creek and below a large dolomite outcrop; dense colony of mostly sterile shoots growing on a sandstone-based shelf below a dolomite shelf, approximately 100 × 10-20 meters, consisting of thousands of stems, associated with *Maianthemum racemosum*, *Desmodium glutinosum*, *Quercus alba*, *Geranium maculatum*, *Carex communis*, *Carex timida*, *Tilia americana*, *Staphylea trifolia*, *Adiantum pedatum*, *Euonymus obovatus*, *Acer saccharum* and *Brachyelytrum erectum*, NAD83 coordinates 15 S 582321.1, E 4085091.3, 26 May 2008, *Thomas 1917*.

Coleataenia longifolia* (Torrey) Soreng ssp. *longifolia

This species was originally reported by Ladd and Thomas (2015) as *Panicum longifolium* Torrey. Recent work by Zuloaga et al. (2010) support the separation of yet another distinct genus out of the traditional concept of *Panicum*, and Soreng (2010) instituted the genus as *Coleataenia*. The population cited here represents the only known location for this species in Missouri. It should be looked for in high quality wetland communities that harbor other taxa more commonly associated with the southern coastal plain. *Coleataenia longifolia* can be differentiated from *C. rigidula* in having a ciliate ligule which is greater than 1.0 mm long, compared with an erose ligule 0.3-1.0 mm long in the latter species.

Voucher specimen: **U.S.A. MISSOURI:** SHANNON CO.: Mark Twain National Forest, Grassy Pond Natural Area, southeast of Winona, on floating sedge mats in sinkhole pond, associated with *Rhynchospora scirpoides*, *Utricularia gibba*, *Brasenia schreberi* and *Triadenum walteri*, NAD83 coordinates 15 S 651246.1, E 4093239.5, 5 Oct. 2012, *Thomas 2607*.

***Dichanthelium columbianum* (Scribn.) Freckmann**

Few remnants remain of the once extensive sand prairie communities in southeastern Missouri. Several of these remnants have large populations of *D. columbianum* which persists as a dominant component in areas with deep, well-drained, sandy soils where little else grows. This species is distinct from other Missouri *Dichanthelium* by having hairs restricted to the marginal areas of the adaxial surfaces of the vernal blades, which are glabrous down the middle (Thomas 2015). It is also unique in the way the vernal leaves curl under, nearly forming circles in late summer through winter. Missouri populations represent the southwestern extent of *D. columbainum*'s range. It is a species of deep sandy soils of dunes and deposits from the coasts of the Northeast, through the Great Lakes and down the Mississippi River with few interior localities (Thomas 2015).

This is the first verified collection of *Dichanthelium columbianum* from Missouri. Steyermark (1963) excluded a single record of *D. columbianum* (then *Panicum columbianum*) based on questionable label data. That specimen has since been determined to belong to the *D. acuminatum* complex; likely *D. lanuginosum*. A Taney County specimen collected in 1987, *Ladd 12337 (MO),* was initially determined as *P. columbianum*. Yatskievych later annotated the specimen as *P. portoricense* and placed *P. columbianum* under synonymy (Yatskievych 1999).

This specimen was subsequently annotated by Freckmann as *D. acuminatum*. Upon review, the specimen better fits what Thomas (2015) calls *D. lanuginosum*.

Voucher specimen: **U.S.A. MISSOURI:** SCOTT CO.: Sand Prairie Conservation Area, in remnant sand prairie north of Highway 77 and east of Road 333, east of Benton, NAD83 coordinates 16 S 277518.3, E 4108619.7, 21 August 2009, *Thomas #09-08-21-1*.

Dichanthelium inflatum **(Scribn. & J.G. Sm.) J.R. Thomas comb. nov.**

Panicum inflatum Scribn. & J.G. Sm. Circular, Division of Agrostology, United States Department of Agriculture 16: 5. 1899. (1 Jul 1899). *Panicum sphaerocarpon* subsp. *inflatum* (Scribn. & J.G. Sm.) Hitchc. Contributions from the United States National Herbarium 15: 253, f. 275. 1910. *Panicum sphaerocarpon* var. *inflatum* (Scribn. & J.G. Sm.) Hitchc. Manual of the Grasses of the United States 643, 913. 1935. **USA**. **Mississippi**. Harrison Co.: Biloxi, 18 Oct 1898, *S.M. Tracy* #4622 (US!; isotype: MO!).

This new combination is necessary to accommodate plants that diverge significantly from the morphology of *D. sphaerocarpon*. Hitchcock and Chase (1951) and Fernald (1950) recognized *inflatum* infraspecifically (subsp. by the former and var. by the latter) as differing from typical *Panicum sphaerocarpon* by being taller, with linear-lanceolate blades that are ≤1 cm wide, with nearly parallel margins. They also noted that *inflatum* differs in having a noticeable ligule to 1 mm long and spikelets 1.3-1.5 mm long (compared to the obsolete ligule and spikelets 1.5-1.8 mm long in *D. sphaerocarpon*). This morphology has a strong geographical component, as specimens are restricted to the southern coastal plain from Maryland to Texas. In preparation for an upcoming treatment for *Dichanthelium* in Arkansas, I conducted a thorough review of numerous specimens from Arkansas and throughout the southeast and was surprised at the consistency of these characters. Additionally, most specimens of *D. inflatum* consistently have few (≤15) ciliate hairs per side at the base of vernal blades, compared to *D. sphaerocarpon*. Given how consistently these characters differentiate the two taxa and given their geographical affinity, the elevation to species seems justifiable and warranted.

The cited voucher of *D. inflatum* was collected in an acidic prairie in southwestern Missouri where it occurred with other species typical of the southern coastal plain and southern Tallgrass Prairie, including *Marshallia caespitosa*, *Rhynchospora recognita*, *Dichanthelium neuranthum*, *Andropogon hirsutior*, and *Ludwigia linearis*. Another population of *D. inflatum* was found several miles away at another prairie remnant with many of the same associates. Both of these sites differ from most prairie remnants in the area in their abundance of *Sporobolus heterolepis* and *Rhynchospora recognita*. Such prairies are colloquially referred to as “dropseed prairies”. Both *D. inflatum* and *D. sphaerocarpon* thrive in seasonally moist and slightly disturbed soils with light to moderate interspecific competition.

Voucher specimen: **U.S.A. MISSOURI:** NEWTON CO.: Diamond Grove Prairie Natural Area, NAD83 coordinates 15 S376816.7, E 4097401.8, 17 July 2014, *Thomas 14-07-17-1*(MO).

***Dichanthelium joorii* (Vasey) Mohlenbr.**

As stated in Ladd and Thomas (2015), this has been a largely overlooked species in Missouri. Because of its intermediate morphology, it initially appears to represent hybridization or introgression between *D. ashei* and *D. commutatum*. However, it forms distinct populations with unique characters throughout eastern, southern, and southeastern North America. It has an erect habit with more evenly distributed leaves than either *D. ashei* or *D. commutatum*. *Dichanthelium joorii* also tends to branch more, is more erect, and has leaves that are nearly symmetrical at the base and taper to nearly acuminate tips, compared to *D. commutatum*. This is contrary to the keys and descriptions in many floras including Hitchcock and Chase (1951), Fernald (1950), and Flora of North America (Barkworth et al. 2007) which, based on a review of the type material, appear to have these characters reversed. One wonders if this reversal has added to the confusion in the group. Plants tend to be lighter green than those of *D. ashei* or *D. commutatum,* and occur in more mesic habitats than those of *D. ashei*. Field familiarity with this species alleviates impressions of morphological intermediacy between *D. ashei* and *D. commutatum*, and brings resolution to the group.

Voucher specimen: **U.S.A. MISSOURI:** CARTER CO.: Chilton Creek Preserve, near western entrance to south side of the property, associated with *Phyrma leptostachya*, *Ageratina altissima*, *Dichanthelium boscii*, *Solidago ulmifolia*, *Ulmus alata*, and *Quercus alba*, NAD83 coordinates 15 S 763005.8, E 4103350.3 8 June 2012, *Thomas 12-06-08-1*.

***Dichanthelium longiligulatum* (Nash) Freckmann**

This species usually occurs along the draw-down zone of ephemeral wetlands, ditches, and pond margins. It appears to have a proclivity for acidic, sandy-clay and clay soils with little competition, where it forms large populations of well-spaced clumps. It is a morphological diminutive within Section Lanuginosa. Thomas (2015) discusses the details of distinction between *D. longiligulatum* and other members of section *Lanuginosa*. This species has recently been documented at numerous locations across the state.

Voucher specimen: **U.S.A. MISSOURI:** HARRISON CO.: Dunn Ranch Prairie, large population on the upstream side of swale feeding into pond, NAD83 coordinates 15 S 406509.8, E 4483757.5, 11 August 2014, *Thomas 2715*.

***Dichanthelium neuranthum* (Griseb.) LeBlond**

Despite being a common and situationally dominant component of prairies in the Osage Plains Natural Division that have southern coastal plain floristic elements, this species was long undetected in Missouri. Specimens collected in the early 2000s were misidentified as *D. portoricense*. Ladd and Thomas (2015) referred to this taxon as *D. angustifolium* in a "broad sense" application of that name. Since then, work throughout the southeastern U.S. combined with herbarium research has demonstrated that the Missouri material clearly represents *D. neuranthum* and that *D. angustifolium*, in the strict sense, although found in nearby Arkansas counties, is yet to be found in Missouri.

This species only occurs in prairie communities in Missouri. I have observed a strong correlation between disturbance (induced by intense fires, grazing or growing season fire) and rampant hybridization between this species and *D. lanuginosum*; "growing season" is defined as any point at which plants have either not entered into or have broken from their winter dormancy. In such situations, it is often difficult to find plants that have not introgressed to some degree. This is a profound phenomenon of some concern witnessed in many species in several genera in prairies and woodlands including *Dichanthelium*, *Desmodium*, *Lespedeza* and *Elymus,* and certainly requires further study.

Voucher specimen: **U.S.A. MISSOURI:** NEWTON CO.: Diamond Grove Prairie Natural Area, associated with *Rhynchospora recognita*, *Andropogon gerardii*, *Viola sagittata*, *Dichanthelium lanuginosum*, *Scleria triglomerata*, and *Elymus jejunus*, NAD83 coordinates 15 S376816.7, E 4097401.8. 17 June 2015, *Thomas 15-06-17-1*.

***Digitaria violascens* Link**

In Missouri, this species superficially resembles *D. ischaemum* but has spikelets <2.0 mm long, often with fewer racemes and is generally smaller in stature. It has since been found at two other locations and is likely more common in southern Missouri than collections currently indicate. It occurs in heavily disturbed areas with fairly open canopy and should especially be looked for along logging roads. *Digitaria violascens* is a non-native species that has become established in the southeastern United States.

Voucher specimen: **U.S.A. MISSOURI:** BUTLER CO.: Mark Twain National Forest. Cane Ridge management area, associated with *Solidago nemoralis*, *Solidago longipetiolata*, *Rubus roribaccus* and *Digitaria ischaemum*, NAD83 coordinates 15 S 715457.9, E 4087804.6, 12 Sept. 2012, *Thomas 2614*.

***Eleocharis acutisquamata* Buckley**

This taxon has consistently been encountered in vegetation sampling projects in glaciated and unglaciated prairies in Missouri. It differs strikingly from *E. compressa*, under which it has been treated as a variety (FNA 2002), by having narrower culms that are less flattened and darker green. Additionally, the scales of the spike have less hyaline tips that are notched instead of the more deeply cut tips typical of *E. compressa*. In Missouri, *E. compressa* appears to be restricted to the high calcium soils of dolomite and limestone glades and fens, whereas *E. acutisquamata* is found in acidic to circumneutral soils of prairies. *Eleocharis acutisquamata* also resembles *E. elliptica*. The two can be difficult to distinguish but *E. elliptica* tends to have blunt-tipped scales that are merely notched, compared to the pointed, deeply bifid scales of *E. acutisquamata* and *E.*

compressa. *Eleocharis acutisquamata* occurs in wet to mesic grasslands, meadows, and open oak woods throughout the Great Plains.

Voucher specimen: **U.S.A. MISSOURI:** BARTON CO.: Golden Prairie, in prairie swale, NAD83 coordinates 15 S 397987.9, E 4135973.2, 9 July 2013, *Thomas 13-07-09-1*.

***Eleocharis bifida* S.G. Smith**

A small population of *Eleocharis bifida* was discovered while visiting a population of *Dalea gattingeri* on a small glade in Howell County. Being intimately familiar with *E. compressa*, which occurs in seasonally wet zones on many calcareous glades in the Ozarks, I immediately realized that these plants were different. Compared to *E. compressa*, *E. bifida* typically has wider stems, a deeper green color, more deeply bifid basal scales and thicker rhizomes. *Eleocharis bifida* and *Dalea gattingeri* also co-occur on limestone glades in the Central Basin of Tennessee and both have restricted geographical ranges.

Voucher specimen: **U.S.A. MISSOURI:** HOWELL CO.: White Ranch Conservation Area, in degraded glade, associated with *Dalea gattingeri*, *Carex crawei*, and *Houstonia nigricans*, NAD83 coordinates 15 S 611457.4, E 4042821.8, 3 June 2017, *Thomas 17-06-03-1*.

***Eupatorium album* L.**

Several stems of *E. album* were found in a fire-scorched area of Mark Twain National Forest in 2012. Given that other species of *Eupatorium* have been spreading their ranges into southeastern Missouri from southeastern states, there is no reason to believe that the intensity of fire is responsible for the occurrence of *E. album*, as has been speculated. Schilling (2011) conducted a molecular investigation into the *E. album* complex which resulted in a nuanced perspective of the underlying systematics and some nomenclatural changes. Considering this treatment, the Missouri material safely fits the morphology of typical *E. album*. Outside of Missouri, *E. album* occurs in central Mississippi, Kentucky, and Tennessee east to the Atlantic and Gulf coasts (Schilling 2011).

Voucher specimen: **U.S.A. MISSOURI:** CARTER CO.: Mark Twain National Forest. South of Fremont, in gravel wash community and uplands of recently severely burned woodland, associated with *Panicum virgatum*, *Andropogon gerardii*, *Brickellia eupatorioides*, *Elymus glabriflorus* and *Physostegia virginiana*, NAD83 coordinates 15 S 662276.1, E 4082931.3, 22 August 2012, *Thomas 2621*.

***Heliopsis gracilis* Nutt.**

Fisher (1957) conducted a thorough investigation into the taxonomy of *Heliopsis,* but left many unanswered questions. Chief among them is the relationship of *H. gracilis* with the *H. helianthoides* complex. By providing no narrative comparison, we are forced to separate them based on the character provided in his key; 6-8 rays for *H. gracilis* and 10-12 rays for *H. helianthoides*. Under *H. gracilis* Fisher states the following:

> "The original description adequately agrees with the specimens examined except for a reference made concerning the indument of the leaves and peduncles which is described as being scabrous or smooth. The description may have been compiled from a single plant specimen. All the herbarium specimens examined are glabrous, or essentially so, certainly not scabrous. The most logical explanation of this discrepancy lies in the fact that the range of the species, as cited in the original description, is Georgia to Louisiana to Arkansas. This range would overlap that of the newly described taxon *H. helianthoides* ssp. *scabra*, which does have scabrous leaves. All specimens from Louisiana to Arkansas have been determined *H. helianthoides* ssp. *scabra*, not *H. gracilis*. Therefore, the original description by Nuttall may have been broadened to include those plants which are now determined *H. helianthoides* ssp. *scabra*."

The problem is that many small statured, small flowered plants with long, narrow leaves occur west to Texas and north into the Ozarks of Arkansas and Missouri. Many of these specimens have 6-8 rays and are identical to Fisher's narrow concept of *H. gracilis* except for their slightly scabrous adaxial leaf surfaces. Fisher reported clinal variation in several characters among his subspecies of *H. helianthoides*, with the typical subspecies in the east being glabrous on the adaxial leaf surfaces, the central range subspecies *scabra* being slightly scabrous, and the northwestern subspecies *occidentalis* being very scabrous. After examining specimens, I concur with this finding in regard to the variation in indument of the adaxial leaf surfaces of *H. helianthoides*, among other characters. However, I believe that affording this same degree of clinal variation to *H. gracilis* serves to confirm Nuttall's original description and geographical range better than Fisher's alternative hypothesis that Nuttall described the species more broadly, morphologically and geographically, than he intended. This broadened concept of *H. gracilis*, which seems more likely to be Nuttall's intent, is certainly more distinct than *H. helianthoides* subsp. *scabra* and subsp. *helianthoides* are from each other. Admittedly, some specimens are difficult to place as *H. gracilis* or *H. helianthoides* subsp. *scabra*, with absolute confidence, but by allowing the leaves of *H. gracilis* to be scabrous or glabrous, as in Nuttall's original description, a cleaner, more satisfying *H. gracilis* emerges. This also lends clarity to *H. helianthoides* subsp. *scabra* which is hereby better united with the typical glabrous subspecies and severed from the many troublesome Interior Highlands populations that, besides having a subtle difference in leaf pubescence, are better considered to be *H. gracilis*.

In Missouri, *H. gracilis* occurs in slightly more mesic and shaded habitats than *H. helianthoides*. It also seems to have an affinity, if not dependence, on calcareous soils. It is especially fond of mesic rocky dolomite outcrops and mesic bottoms. I have annotated specimens of *H. gracilis* from the following Missouri counties: Carter, Crawford, Madison, Oregon, Ozark, St. Louis, Shannon and Taney. It is worth noting that *H. helianthoides* is also common throughout Missouri including the Ozarks.

Voucher specimen: **U.S.A. MISSOURI:** MADISON CO.: Mark Twain National Forest, on floodplain of Peters Creek in disturbed bottomland forest with open canopy, associated with *Coreopsis pubescens*, 37.4248° N, 90.3333° W, 24 July 2014, *Brant 7693* (MO).

***Houstonia canadensis* Willd. ex Roem. and Schult.**

For several years I have encountered an odd *Houstonia* on dolomite glades and glade-like bluffs in the northeastern Ozarks. These plants are all morphologically very similar to *H. canadensis* in that they are short, relatively fewer branched, and have conspicuous basal rosettes and larger flowers compared to *H. longifolia* or *H. tenuifolia*. The large basal rosettes led me to believe that they were *H. canadensis*, but they lacked the ciliate margins that most treatments attribute to *H. canadensis*. Upon review of herbarium specimens, I found that some plants from Missouri populations have very short ciliate margins on some basal leaves and not on others. I also found that a few specimens of *H. canadensis* in the heart of its range (east-central Kentucky to south central Ohio) also lack ciliate hairs. Additionally, although the key in Terrell's (1996) treatment of the group includes ciliate margins for *H. canadensis*, his description admits "or rarely glabrate" margins. Other than *H. nigricans*, which these plants are clearly not, no other *Houstonia* consistently occurs in open calcareous habitats in Missouri. These specimens occur in Cape Girardeau, Franklin, Jefferson, and St. Louis counties. The review also led to a new county record for St. Clair County, Illinois. *Houstonia canadensis* is also known from several Illinois counties just across the Mississippi River from the new Missouri sites, which makes the Missouri plants a slight range extension rather than a disjunction.

Voucher specimen: **U.S.A. MISSOURI:** FRANKLIN CO.: Shaw Nature Reserve, Dana Brown Woods, at edge of glade area, in dry oak/hickory woods, associated with *Plantago pusilla*, *Galium virgatum* and *Arenaria patula,* 38.4703° N, 90.8172° W, 11 May 2004, *Holmberg 468*.

***Hypericum lobocarpum* Gatt. ex. J.M. Coult.**

Both Steyermark (1963) and Yatskievych (2006) attributed *Hypericum lobocarpum* (the former as a variety of *H. densiflorum*) to Missouri based on two specimens (*Bush 282* and *Steyermark 40010*) that Adams, in conjunction with his monograph of section *Myriandra* (Adams 1962), annotated as being most like *H. lobocarpum* but possibly hybridized with *H. prolificum*. Tim Smith (2006) relocated the population of *H. lobocarpum* that Bush collected in Ripley County. These plants also resemble the putative hybrid plants in that they are often tricarpellate and the pistils are more shallowly lobed than the deeply pentacarpellate pistils of typical *H. lobocarpum*. In 2012, Jacob Hadle and I encountered a population of plants that fit the typical morphology of *H. lobocarpum*. Upon review of herbarium specimens at MO, we found other collections of typical *H. lobocarpum* (Butler County: *Summers #8293; Hudson s.n.*; Stoddard County: *Holmes 1005*) that were previously treated as *H. prolificum*. Thus, while *H. lobocarpum* is not necessarily new to Missouri's flora, these more typical populations are noteworthy.

Voucher specimen: **U.S.A. MISSOURI:** BUTLER CO.: Big Cane Conservation Area, numerous plants along forest edge, associated with *Crataegus marshalli*, *Amorpha nitens*, and *Amorpha fruticosa*, NAD83 coordinates 15 S 726048.7, E 4042275.2, 18, July 2012, *Thomas 2617*.

***Juncus filipendulus* Buckley**

This species has an odd distribution. It is found in central Texas, Alabama, and central Tennessee, with a few outliers in surrounding states. It resembles *Juncus marginatus* in silhouette but has fewer heads (1-5) and thicker, more pointed tepals. It typically is found on calcareous substrates. More populations should be looked for in the White River Hills of the western Ozarks.

Voucher specimen: **U.S.A. MISSOURI:** TANEY CO.: Mark Twain National Forest, Hercules Glades Wilderness Area, in expansive glade opening surrounded by high quality native vegetation, approximately 20 plants on wet seepy shelves, especially where puddles have formed, NAD83 coordinates 15 S 510697.3, E 4061368.3, 24 June 2009, *Thomas 2000*.

***Knautia arvensis* (L.) Coult.**

This is a sporadic escapee from gardens into weedy areas throughout North America. It is questionable whether populations persist. From a distance it resembles a slightly off-color and leggy *Cichorium intybus* or *Centaurea maculata*.

Voucher specimen: **U.S.A. MISSOURI:** DADE CO.: In roadside ditches at highway intersection, NAD83 coordinates 15 S 4249828.8, E 4138372.1, 17 July 2014, *Thomas 14-07-17-1*.

Linum floridanum* (Planch.) Trel. var. *floridanum

At Shut-in Mountain Fens in the spring of 2010, Scott Namestnik, Brad Slaughter and I encountered three species new to Missouri. Two of them, *Cladium jamaicense* and *Utricularia minor*, were reported by Namestnik et al. (2012). The third species initially appeared to be a very odd *Linum medium* var. *texanum*. Further investigation resulted in its identification as *L. floridanum* var. *floridanum*; a species of southeastern North America. A subsequent review of Missouri material at MO resulted in the discovery of another record from a calcareous fen in Howell County (*Summers 3388*). Since then, *L. floridanum* has been found at several fens in the Ozarks.

Voucher specimen: **U.S.A. MISSOURI:** SHANNON CO.: Shut-in Mountain Fens Preserve, in small fen with abundant exposed dolomite bedrock, associated with *Andropogon gerardii*, *Sorghastrum nutans*, *Andropogon scoparius*, *Oxypolis rigidior*, *Rudbeckia fulgida*, *Vernonia balwinii* var. *interior*, *Lysimachia quadriflora*, *Helenium autumnale*, *Liatris pycnostachya*, *Furina simplex*, *Eupatorium perfoliatum*, *Symphyotrichum lateriflorum*, *Panicum virgatum*, *Rhynchospora capillacea* and *Pycnathemum virginianum*. NAD83 coordinates 15 S 657489.3, E 4108526.9 28, August 2012, *Thomas #12-08-28-1*.

***Listera australis* Lindl.**

A single stem of *Listera australis* was found on a Missouri Native Plant Society field trip. It is distinct from other species of orchid in Missouri in having two leaves nearly opposite each other on the middle of the stem. *Listera australis* ranges from central Arkansas, south to eastern Texas, east to Florida and north along the Atlantic Coast into New York and Vermont.

Voucher specimen: **U.S.A. MISSOURI:** STODDARD CO.: Holly Ridge Conservation Area, on Crowley's Ridge, in moist sandy soil near acid seep meander, 1 plant at base of oak tree, ca. 30 feet west of *Isotria verticillata* colony, 36.8442° N, 89.9078° W, 19 April 2009, *Yatskievych 09-36*.

Ludwigia linearis* Walter var. *linearis

This species is included for Missouri based on an 1894 collection of *Ludwigia linearis* from Allenton, St. Louis County by George Letterman (Yatskievych 2013). This collection is one of several collections by Letterman of species that have never been relocated in the area and lack detailed location information. Given the uncertainty of these collections, there is no way to be sure if the current discovery of *L. linearis* is new to the state or just a new collection of a locally extirpated species; I suspect the former. *Ludwigia linearis* differs from other species in Missouri (Yatskievych 2013) by having as many stamens as sepals (as opposed to twice as many) and having alternate, linear leaves. Both the Letterman collection and specimens from the new population fit Peng's (1989) "completely glabrous morph" which he interprets as an often-sympatric glabrous expression of his "densely strigillose morph". *Ludwigia linearis* is most commonly associated with the coastal plain, extending north into central Arkansas. At the new Missouri station, it occurs with other coast plain species such as *Andropogon hirsutior*, *Rhynchospora recognita* and *Dichanthelium neuranthum*. This small population occurs in an intact swale community that transects the site.

Voucher specimen: **U.S.A. MISSOURI:** NEWTON CO.: Missouri Prairie Foundation Carver Prairie, in meandering swale community, NAD83 coordinates 15 S 376190.8, E 4098031.1, 28 August 2016, *Thomas 16-08-28-1*.

***Lycopus uniflorus* Michx.**

A few swale communities of Dunn Ranch and Pawnee Prairie Preserves in Harrison County have small populations of *Lycopus uniflorus*, a species commonly encountered in the northern Midwest and northeastern North America. The Missouri populations, discovered during vegetation sampling in 2000, co-occur with *Lythrum alatum*, *Eleocharis wolfii*, *Carex lacustris*, and *Scirpus georgianus*. Several other specimens located in herbarium collections have been determined as *L. uniflorus* by Henderson (1962) and Yatskievych (2013) but are better treated as either *L. virginicus* or *L.* x *sherardii*, the putative hybrid of *L. virginicus* and *L. uniflorus*. These aberrant specimens occur mostly in the Ozarks, south of the range Henderson established for *L. uniflorus*, and well within the range of *L.* x *sherardii*, which Henderson mapped as potentially occurring statewide in Missouri. A more detailed investigation of the extent and overlap of these taxa is needed.

Voucher specimen: **U.S.A. MISSOURI:** HARRISON CO.: Dunn Ranch Prairie, in moist drainage, associated with *Vernonia fasciculata*, *Arnoglossum tuberosum* and *Spartina pectinata,* also occasional in swales throughout area, NAD83 coordinates 15 T 405310.44, E 4480770.5, 11 August 2000, *Thomas 1360*.

***Quercus similis* Ashe**

As reported by Yatskievych (2013), Missouri specimens determined as *Quercus similis* morphologically, ecologically and geographically resemble *Q. similis* occurring farther south into the Mississippi alluvial plain. For these reasons, it is included here as an addition to the Missouri flora. However, the distinctness of *Q. similis* throughout its relatively limited range is unsatisfying. Although it occurs in seasonally wet bottomland habitats, it often occurs with species that also co-occur with *Q. stellata* in dry upland habitats, such as *Ulmus alata* and *Carya texana*. Additionally, some populations of *Q. stellata* in uplands of the Ozarks and beyond lack the classic pronounced perpendicular leaf lobes of *Q. stellata*. Are these ascending-lobed upland plants also *Q. similis*? Until this matter is better resolved, it seems best to maintain *Q. similis* rather than discount it without sufficient evidence.

Voucher specimen: **U.S.A. MISSOURI:** STODDARD CO.: Otter Slough Conservation Area, Bradyville Natural Area, dominant in flatwoods community, associated with *Quercus pagoda*, *Quercus lyrata*, *Ulmus alata*, *Carya texana*, *Carex hyalinolepis*, and *Hymenocallis occidentalis*, NAD83 coordinates 15 S 757798.9, E 4067853.0, 18 July 2012, *Thomas 2603*.

Rhynchospora globularis* (Chapm.) Small var. *globularis

Both Steyermark (1963) and Yatskievych (1999) included *Rhynchospora globularis* var. *recognita* in Missouri's flora. Kral (1999), with good reason, reinstated the species status of *R. recognita*. While investigating the morphological limits of *R. recognita* populations in western Missouri, I ran across two collections of typical *R. globularis* that had been misidentified. Both of these specimens came from the same population at a sinkhole pond in southeast Missouri. Most notably, *R. globularis* differs from *R. recognita* in having a smaller stature and fewer, more conspicuous spikelets arranged in less bristly clusters (Kral 1999). The larger geographical range of Rhynchospora globularis is the southern and southeastern United States.

Voucher specimen: **U.S.A. MISSOURI:** HOWELL CO.: along rocky shores of Myatt Pond, a natural sinkhole pond, T23N R8W S 36, 4 July 1990, *Summers 3421*.

***Rhynchospora scirpoides* (Torr.) Griseb.**

In North America, *Rhynchospora scirpoides* occurs primarily along the southern and eastern coastal plains and south and east of Lake Michigan. The single Missouri population occurred in a sinkhole pond in extensive floating sedge mats, of which it was the primary constituent. It is known from 21 states and listed as a species of conservation concern in 15 of them (Natureserve 2017).

Voucher specimen: **U.S.A. MISSOURI:** SHANNON CO.; Mark Twain National Forest, Grassy Pond Natural Area, abundant on floating sedge mats in the sinkhole pond, associated with *Panicum longifolium*, *Utricularia gibba*, *Brasenia schreberi* and *Triadenum walteri*, NAD83 coordinates 15 S 651246.1, E 4093239.5, 9 Oct. 2012, *Thomas 2604*.

***Rosa foliolosa* Nutt.**

This population of *Rosa foliolosa* comprised thousands of plants in a swale extending a few hundred meters to the margins of a shrubby intermittent waterway. The margins of the population coincided with the margins of the swale. Where these margins came into contact with *R. carolina* there was pronounced introgression. Prior to the discovery of *R. foliolosa*, I had noted occasional populations of *R. carolina* at various location in the Unglaciated Plains Natural Division with morphological tendencies toward *R. foliolosa*. The two species differ in that *R. foliolosa* normally has white petals, is often smaller and has smaller leaves with narrower leaflets. It also has smaller and fewer prickles on the stem. This is one of several species of the southern Tallgrass Prairie that find the northernmost extent of their range in western and southwestern Missouri.

Voucher specimen: **U.S.A. MISSOURI:** ST. CLAIR CO.: Wah'Kon-Tah Prairie, The Nature Conservancy tract, extending through a swale, NAD83 coordinates 15 S 413196.7, E 4197165.9, 8 July 2016, *Thomas 16-07-08-1*.

***Rudbeckia bicolor* Nutt.**

This new *Rudbeckia*, found in profusion at Lichen Glade, is clearly an annual. It has a smaller stature, smaller heads, more ovate-elliptic to oblong leaves and a different pubescence than can be comfortably attributed to the regionally ubiquitous *R. serotina* (used here in the sense of Fernald (1950), which is a synonym for *R. hirta* var. *pulcherrima* - the only member of the *R. hirta* complex attributed to Missouri). These plants also grow in a density that is unlike *R. serotina*, on extremely shallow sandstone glade soils uncharacteristic of *R. serotina* and are at their peak bloom just as *R. serotina* begins blooming in the surrounding landscape. The Lichen Glade plants key to *R. bicolor* in Fernald (1950) and Mohlenbrock (2014), but Nuttall described *R. bicolor* as having bi-colored rays (glossy brown-black in the proximal half). Because there is no designated type with which to compare the Missouri material, this identification is not wholly satisfying. Fernald's (1950) description of *R. bicolor* includes plants with completely yellow rays and bi-color rays. Bi-colored variations are also known from other species of *Rudbeckia* that principally have yellow rays in the wild. The use of the name *R. bicolor* serves as a "best fit" to distinguish this unique entity from the broader *R. hirta* complex until the matter is better investigated.

Voucher specimen: **U.S.A. MISSOURI:** ST. CLAIR CO.: Lichen Glade Conservation Area, seasonally abundant in very shallow soil on sandstone glades, associated with *Phemeranthus calycinus*, *Phemeranthus parviflora*, *Croton wildenowii*, *Allium lavendulare*, *Diodia teres*, and *Oenothera linifolia, NAD83 coordinates 15 S 430394.5, E 4212200.4,* 20 June 2015, *Thomas 15-06-20-1*.

***Styrax grandifolius* Aiton**

Despite the large size of this population and its proximity to a road, *Styrax grandifolius* had not been documented from Missouri. It is found in many counties in Arkansas and west-central Tennessee, as well as throughout the southeastern U.S. It is an arborescent shrub or small tree that forms an umbrella-like canopy (much like *Cornus florida*). It has alternate, elliptic to obovate leaves with occasional teeth along the margins and rounded tips. The flowers are white, fragrant, and occur in racemes. In the vegetative state it can superficially resemble a young Persimmon (*Diospyros virginiana*). It is found in mesic to dry-mesic woodlands.

Voucher specimen: **U.S.A. MISSOURI:** SHANNON CO.: Mark Twain National Forest, southeast of Winona, potentially thousands of plants ranging from seedlings to mature plants scattered across an area approximately 0.5 x 0.5 kilometers, in Shortleaf Pine/mixed oak upland, associated with *Vaccinium pallidum*, *Quercus alba*, *Quercus velutina*, *Crataegus spathulata,* and *Pinus echinata*, NAD83 coordinates 15 S 655602.7, E 4090855.9, 2 Oct. 2012, *Thomas 2611*.

***Urochloa ramosa* (L.) Nguyen**

Both known Missouri populations occurred along highway medians where they were likely seeded as part of soil erosion control efforts. However, each population of this annual grass consists of many thousands of stems that have persisted for more than two years. Subsequent cursory surveys for *U. ramosa* at these locations four years later resulted in very few relocated stems. It is unlikely that the populations will persist. *Urochloa ramosa* superficially resembles a large *Dichanthelium* with large spikelets on raceiform branches.

Voucher specimens: **U.S.A. MISSOURI:** SHANNON CO.: locally dominant in median along U.S. Highway 60 east of Winona; apparently planted for erosion control along construction that took place the previous year; population extending east into Carter Co., [36.949º N, 91.161º W], 15 Sept. 2010, *Thomas 2344*. GREENE CO.: along highway intersection in Springfield, NAD83 coordinates 15 S 477531.1, E 4110153.0, 18 Oct. 2010, *Thomas 2345*.

Acknowledgments

This list covers 17 years of field work in Missouri and involved numerous people along the way. Jacob Hadle was present for many of these discoveries and we spent many a jovial evening keying and pressing plants together. George Yatskievych was instrumental in suggesting literature, critically reviewing identifications and providing insight and advice. I'd also like to thank my staff at the Institute of Botanical Training, Andrew Braun, Brett Budach, Claire Ciafre, Calvin Maginel and Tesa Madsen-McQueen, for their assistance, as well as their eagerness to spontaneously stop by interesting places even after long days in the field. The Missouri Botanical Garden and its staff deserve high praise and hearty thanks as well. Lastly, I would like to thank my most notorious conspirator, my wife Dana Thomas. Without her encouragement, critical eye, understanding, selflessness and behind the scenes support, nothing I have done or will do would be possible.

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Missouriensis, **34**: 20-23. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

The first Missouri occurrences of *Cerastium dubium* (anomalous mouse-eared chickweed)

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ABSTRACT. – *Cerastium dubium* is reported new to the Missouri flora from two counties in eastern Missouri. A detailed description is provided based on local populations.

Cerastium dubium (Bastard) Guépin (= *Cerastium anomalum* Waldst. & Kit. ex Willd.; *Stellaria dubia* Bastard; *Dichodon viscidum* (M. Bieb.) Holub – see Tropicos.org) is a Eurasian member of the Caryophyllaceae. Commonly called anomalous mouse-eared chickweed, three-styled chickweed, or doubtful chickweed, its first reported appearance in North America was in Washington state in 1966 (Hitchcock and Cronquist 1973). Since then, the plant has been discovered in Illinois (Shildneck and Jones 1986), and is now known from scattered populations in several states bordering Missouri: Illinois, Kentucky, Tennessee, Arkansas, and Kansas. Yatskievych (2006) discusses *C. dubium* and mentions that although the species had not been reported in Missouri, its arrival is anticipated. According to Yatskievych, the plant generally resembles *C. nutans* or *C. brachypodum*, but with the unique characters of three styles and a straight capsule with 6 apical teeth at dehiscence.

In March of 2012, while rototilling a garden plot at his residence near Labadie, in Franklin County, Missouri, the first author discovered a small population of plants unfamiliar to him, growing with *Lamium amplexicaule* and *Stellaria media*. The flowers of this plant were somewhat showier than the common *Stellaria*, with wider and less deeply cleft petals. The centers of the flowers were bright yellow due to anthers and profusely shed pollen. The plants appeared to belong to the genus *Cerastium*, having cylindrical fruits which were at that time immature. However, the very narrow leaves of the plants were unlike the more common Missouri species of *Cerastium*. Application of the keys in Mohlenbrock (2002) led to the tentative identification of *Cerastium dubium*. A few days later, mature fruits were found in a dehiscent state, with the capsule opening via 6 apical teeth, and this character, along with the three styles in the flowers, strongly supported the identification. This is the first report for *C. dubium* in Missouri.

The population comprised an estimated 24-48 individuals, and appeared to be persistent, having been observed in most subsequent years through 2017. During this short period the size of the population remained relatively constant. In 2016, the first author discovered much larger populations on private property about 1.3 km east and northeast of the original site. One of these

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populations, comprising thousands of plants, lies in the Labadie Bottoms, which in late December 2015 was inundated with Missouri River floodwaters.

In early March 2016, while driving along some fallow agricultural fields in New Madrid County, Missouri, the second author spotted an unfamiliar plant that was later confirmed to be *C. dubium.* Subsequently, it was collected in similar habitats in Mississippi and Scott counties. *Cerastium dubium* is a winter annual that completes most of its life cycle before fields are worked in the spring. It was very common at all locations and likely to occur in similar habitats (alluvial fields along large rivers) throughout the Bootheel.

Figure 1 provides detailed images of the species. Specimen images are available online through the Missouri Botanical Garden's database at www.tropicos.org. All voucher specimens are deposited at the Missouri Botanical Garden (MO). A detailed species description from *Flora of North America* may be found at http://www.efloras.org/.

Figure 1. *Cerastium dubium*, Franklin County, Missouri. **A**: older plant showing cespitose growth form; **B**: inflorescence branches; **C**: flower and immature capsule; **D**: mature capsule. All photos by Steve Turner.

Specimens cited. **U.S.A. MISSOURI**: CAPE GIRARDEAU CO.: Headwaters Public Access Ramp between I-55 and Old US Hwy 61, shrubby roadside between cultivated fields. 37.2456° N, 89.5644° W, 24 April 2016, *G. Davidse 42840.* FRANKLIN CO.: residence at 125 Skyview Lane, overwintered garden plot, 38.5367° N, 90.8683° W, 21 March 2012, with *Lamium amplexicaule* and *Stellaria media*, *S.R. Turner 12-019;* near Labadie, residential lawn along Maple Hill Lane, 38.5244° N, 90.8611° W, 9 April 2015, with *Stellaria media*, *Taraxacum*, grasses, *S.R. Turner 15-005;* 18 April 2015, *S.R. Turner 15-018;* near Labadie, in small agricultural plot adjacent to Labadie Bottom Road, 38.5934° N, 90.8544° W, 9 April 2016, with *Ranunculus abortivus*, *Thlaspi arvense*, *Capsella bursa-pastoris*, *Lamium amplexicaule*, *Cerastium pumilum*, *S.R.Turner 16-010*. MISSISSIPPI CO.: ca. 1 mile west of intersection of US Hwy 60 and MO Hwy 77, ca. 1 mile west of Wilson City, fallow agricultural field, 36.9214° N, 89.2431° W, 24 April 2016, *G. Davidse 42864*. NEW MADRID CO.: along County Road 404, ca. 2.5 air miles directly E of New Madrid, abundant on roadside, edge of fallow field. 36° 35' 24" N Lat., 089° 29' 13" W Long., elevation 89 m, 21 March 2016, Gerrit Davidse 42774; St. John's Bayou Public Access, ca. 1 air mile E of New Madrid along MO Hwy WW. Fallow field between base of levee and forest edge. 36.5914° N, 89.5114° W, 24 April 2016, *G. Davidse 42847*. SCOTT CO.: intersection of MO Hwy D and MO Hwy N, ca. 9.5 air miles SE of Benton, in fallow cornfield, 37.0406° N, 89.4042° W, 24 April 2016, *G. Davidse 42823*.

A composite description of Franklin County specimens follows: **Stems** to 40 cm, lax to ascending, sometimes numerous from a cespitose base, slightly viscid, densely pubescent with glandular hairs, these sometimes sparser toward the base. **Leaves** progressively smaller toward the top of the plant, opposite, sessile, entire, blades single nerved, linear to narrowly lanceolate, bluntly to sharply pointed, to 3 cm long and 3 mm wide, moderately to densely pubescent with stalked glands. **Nodes** remote, slightly swollen. **Inflorescences** dichasial cymes, with flowers on pedicels to 1 cm and longer than the sepals. **Bracts** reduced in size but otherwise similar to leaves, densely pubescent with stalked glands, margins green and herbaceous. **Sepals** 5, free to base, 5 mm long, lanceolate, light green, with pointed tips, margins often hyaline, densely pubescent with stalked glands. **Petals** 5, white, free to base, 8 mm long with a 1.0-1.3 mm apical notch. **Stamens** 10, filaments 2.0-2.3 mm long, with yellow anthers shedding bright yellow pollen. **Ovary** oblong, 1.3-1.9 mm long, green. **Styles** 3, white. **Fruits** cylindrical, straight (not curved), up to twice the length of the sepals, often with persistent styles, papery, translucent, tan in color, and opening via 6 teeth at the capsule apex. **Seeds** numerous, ovate, 0.7 mm x 0.6 mm, flattened, 0.2-0.3 mm thick, strumose or papillate, brown.

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Missouriensis, **34**: 24-26. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

Vegetative key to *Galium* of Missouri

ANDREW P. BRAUN[1]

ABSTRACT. – A vegetative key is presented for 16 species of *Galium* (Rubiaceae) and one related species. Fifteen species of *Galium* occur in the Missouri flora and one is frequently cultivated and may become established in the state. Eleven of the state's *Galium* taxa are native, including several species widely distributed in various natural communities.

INTRODUCTION

Representatives of the genus *Galium*, commonly called Bedstraws, occur in a variety of community types throughout Missouri, including wetlands, woodlands, forests, cliffs, glades, prairies, and disturbed areas. Many of these species are widespread across Missouri, being found in almost every county, while others are much more restricted in their distribution. The genus is not exceptionally difficult, but a vegetative key could be useful to field botanists and others learning Missouri's flora, especially those needing to identify specimens that are not yet or are past flowering or fruiting.

Galium is relatively easily identified as a genus as low-growing, weak-stemmed, herbaceous plants with whorled leaves at each node. Of the 16 species known from Missouri, 11 are native; nine of these native species are perennial and two are annual. Three of the four adventive taxa are annual. Additionally, *Galium odoratum* is sold as an ornamental perennial under the common name "Sweet Woodruff". Although not currently naturalized in Missouri, it is included here in the event that it escapes cultivation. A distinct and reliable vegetative difference between specimens of *G. anglicum* and *G. divaricatum* examined here could not be found. The following key uses inflorescence characters from Lipscomb and Nesom (2007) to distinguish the species in this complex.

Sherardia arvensis is found in lawns and similar disturbed areas throughout southern Missouri. Those unfamiliar with the species might be forgiven for assuming it is a species of *Galium* due to its scabrous texture, whorled leaves and Rubiaceous flowers, and so it is included here. *Mollugo verticillata* is sometimes mistaken as a species of *Galium*, but unlike species of Missouri *Galium*, it is completely glabrous and forms a prostrate habit.

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Missouriensis, **34**: 24-26. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

VEGETATIVE KEY TO *GALIUM* IN MISSOURI

1. All or almost all leaves ≤ 10 mm long, short-lanceolate or elliptic.
    2. Leaves with long to medium length hairs; leaf tips usually without minute spine-like projections; various habitats.
        3. Upper stems glabrous to sparsely hairy; leaves with medium length, bristly hairs mostly on margins and veins; number of leaves per node often variable, usually 4-6; native species of glades and occasionally other dry, open habitats…...………*G. virgatum*
        3. Upper stems moderately to densely hairy; leaves covered with relatively long, spreading hairs; number of leaves per node usually consistent, either 4 or 6 leaves per node along the whole stem; exotic species of lawns, pastures, and other disturbed areas.
            4. Nodes with 6 leaves……………………………..………*Sherardia arvensis*
            4. Nodes with 4 leaves………………………………..……..*G. pedemontanum*
    2. Leaves with minute hairs (visible with magnification); leaf tips often with small spine-like projections; exotic species of disturbed areas (not reliably distinguished vegetatively).
        5. Terminal flowers and base of inflorescence separated by 2-3 branch points, branches ascending…………………………………………………………*G. anglicum*
        5. Terminal flowers and base of inflorescence separated by 3-6 branch points, branches spreading……………………………………………………………..*G. divaricatum*
1. All or almost all leaves >10 mm long, linear, lanceolate, elliptic, ovate, or oblong-spatulate.
    6. Most nodes with 6-8 leaves.
        7. Leaves linear or nearly so, ≤ 2 mm wide…………………….……………….*G. verum*
        7. Leaves elliptic or oblong-spatulate, ≥ 1.5 mm wide.
            8. Stems with conspicuous spreading, unhooked, usually dense hairs…………...
            ………………………..…………………….……………….*Sherardia arvensis*
            8. Stems glabrous or with hooked hairs.
                9. Plants with many hooked hairs (easily adhering to clothes, etc.); largest leaves oblong-spatulate…………………......……..…..*G. aparine*
                9. Plants glabrous or with a few hooked hairs (not or weakly adhering to clothes, etc.); leaves elliptic.
                    10. Mature leaves 5-15 mm wide; plants often aromatic.
                        11. Stems glabrous to moderately hairy; nodes usually without a ring of dense pubescence (do not confuse with hairs on leaf bases); widespread native species……………………………………*G. triflorum*
                        11. Stems glabrous; nodes usually with a ring of dense pubescence; cultivated perennial not yet found naturalized in Missouri……………………..*G. odoratum*
                    10. Mature leaves 2-7 mm wide; plants not aromatic.
                        12. Leaves 4-7 mm wide, tips pointed; known from one historic collection in DeKalb county(northwest Missouri)..……………………..…………..….*G. asprellum*
                        12. Leaves ≤3 mm wide, tips rounded (but often with a spiny projection); common and widespread in Missouri ……………………………………….…*G. concinnum*

6. Most nodes with 4-6 leaves.

13. Leaf tips tapering to definite points (rhombic-elliptic or lanceolate) but without a spine-like projection at the tip; almost always with 4 leaves per node; leaves with 1-3 lateral veins.

14. Leaves ovate to broadly elliptic, with 3 lateral veins…….…….*G. circaezans*

14. Leaves lanceolate to narrowly elliptic; leaves with 1-3 lateral veins.

15. Largest leaves ≤5 mm wide, often with 3 apparent veins; glacial relict species known from one population on calcareous cliffs in Shannon county (southeast Missouri)……..…………………….………..…*G. boreale*

15. Largest leaves ≥5 mm wide; often with only 1 apparent vein, sometimes with 2 lateral veins weakly apparent; widespread Ozark woodland species…......................………………………*G. arkansanum*

13. Leaf tips mostly rounded (short-ovate or linear), sometimes with a spine-like projection at the tip; 4-6 leaves per node (almost always 4 in *G. pilosum*); leaves with one lateral vein.

16. Leaves broadly elliptic, about 2-3 times longer than wide, mature leaves to 20 mm wide; stems hairy……..*G. pilosum*

16. Leaves more narrowly elliptic, about 3-5 times longer than wide, mature leaves <7 mm wide; stems glabrous or roughened with minute bristles.

17. Bristles on leaf margins and midveins retrosely barbed; stems roughened, especially below the nodes and on younger branches; most plants with at least some main stem nodes with 5-6 leaves…………………...…………..……….…*G. tinctorium*

17. Bristles on leaf margins and midveins directed antrorsely or spreading; stems smooth; most plants with 4 leaves per node (sometimes 5).………………………………….………..*G. obtusum*

Acknowledgements

Thanks to Justin R. Thomas for comments on an earlier version of this key.

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Missouriensis, **34**: 27-33. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

Lysimachia nummularia (Primulaceae): A non-native plant in Ozark springs

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ABSTRACT. – The presence, ecology, and probable physiological mechanisms of *Lysimachia nummularia* populations in Missouri Ozark spring systems is discussed, including the species' ability to function as a submerged aquatic.

INTRODUCTION

Moneywort (Creeping Jenny, *Lysimachia nummularia* L, Primulaceae. is commonly sold as a landscape plant in nurseries, gardening centers, and garden catalogs. This perennial evergreen species and native of Europe was naturalized in the United States by 1900, and it is thought to have originated from nursery stock (Mack 2003). Due to its widespread use in landscaping, it has frequently escaped cultivation and become feral in North America. The specific factors that facilitated the successful escape of Moneywort in North America are unknown, but are likely complex (Theoharides and Dukes 2007). Moneywort occurs throughout most of the eastern United States and Great Plains, as well as west of the Rocky Mountains (USDA, NRCS 2017). The National Park Service has reported Moneywort at 60 service properties in the United States, including the Buffalo National River, Arkansas, and Ozark National Scenic Riverways, Missouri (NPSpecies 2017). It is widely distributed in Missouri (Yatskievych 2013, USDA NRCS 2017).

Previous studies (Ramsey et al. 1993, Fleming and Kanal 1995, Aronson et al. 2004, Blood et al. 2010) found Moneywort to be among the most dominant invasive species in the plant communities they studied. The invasiveness of this species is at least partially related to its physical and environmental plasticity. It readily reproduces through fragmentation, roots at the nodes, and demonstrates an affinity for a wide range of environmental and habitat conditions (Godfrey and Wooten 1981). It predominantly inhabits wet areas along the banks of ponds, streams and springs, which also is the preferred habitat in its native range (Curry and Slater 1986) (Figure 1). Because of its preference for wetland habitats, Moneywort is occasionally sold as a plant for water gardens. Moneywort also can grow in a range of light conditions ranging from heavy shade to full sun (MIPAG 2005). Moneywort is not known to produce seeds in Missouri (Yatskievych 2013), and reproduction is apparently entirely vegetative. Nonetheless, the affinity of this species for wet areas and the abundance of its fragments in floodplain debris likely serves as an effective dispersal mechanism that facilitates its invasiveness (Gleason 1897, Ott 1969, Bell 1974, Carpenter and

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Chester 1987, Ramsey et al. 1993, Fleming and Kanal 1995, Basinger et al. 1997, Hughes and Cass 1997, Kearsley 1999, Taft 2003, Leck and Leck 2005, Van Vechten and Buell 1959, Yatskievych 2013).

Figure 1. *Lysimachia nummularia*, Round Spring, Shannon Co., Missouri. **A**: terrestrial population on bank; **B**: leaf shape and elongated stem of submerged plant; **C**: submerged plants (circled). All photos by the author.

Missouriensis, **34**: 27-33. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

OCCURRENCE IN MISSOURI SPRINGS

Although widely known as a floodplain-inhabiting species, Moneywort is not generally considered to be a submersed aquatic plant, yet it is becoming an increasingly problematic invasive in and around Missouri spring systems. During surveys of aquatic vegetation occurring in Ozark springs, I commonly find Moneywort growing among the vegetation communities on the banks of these aquatic systems, and in many cases I find it growing entirely submersed (Fig. 1) at depths up to 0.5 m. I have found completely submersed and rooted populations of Moneywort at Big Spring (Carter Co.), Patterson Spring (Christian Co.), Maramec Spring (Phelps Co.), Boze Mill Spring (Oregon Co.), Hodgson Mill and Rainbow springs (Double Spring) (Ozark Co.), Cave and Round springs (Shannon Co.), Turner's Mill Spring (Oregon Co.), and Boiling Spring (Texas Co.). I found an additional submersed population growing in the Jacks Fork River approximately 1 km upstream of Bay Creek (Shannon Co.).

TOLERANCE TO SUBMERSION

Thermal and physical consistency associated with springs may be a contributing factor that makes such aquatic habitats favorable for establishment and spread of Moneywort, as has been shown for other invasive plants (Bowles and Bowles 2013, Bowles et al. 2011, Bowles and Dodd 2015). For example, in a survey of large springs at Ozark National Scenic Riverways, Bowles and Dodd (2015) reported submersed populations of Moneywort in addition to several other wetland and terrestrial species that were found growing submersed (i.e., native species—*Glyceria striata*, *Lobelia cardinalis*, *Physostegia virginiana*; introduced species—*Mentha aquatica, Poa annua*, *Rumex obtusifolius*). The physiological mechanism(s) used by these plants to inhabit aquatic environments and photosynthesize while submersed are not entirely understood, but several mechanisms have been identified that are used by terrestrial plants to manage complete submergence during flooding (Mommer et al. 2005, Mommer and Visser 2005, Voesenek et al. 2006, Striker 2012). Some of these same mechanisms, as described below, may be used by Moneywort and other wetland species to inhabit springs.

A critical physiological requirement of submersed plants is assimilation of carbon dioxide (CO_2) for photosynthesis. Although CO_2 often has a higher concentration in water compared to the atmosphere, its availability in water usually is lower because molecular diffusion of dissolved gases is about 10^4 times slower in water than in air (Winkel and Borum, 2009). Because of this limitation, many aquatic plants instead use bicarbonate for photosynthesis, or more rarely crassulacean acid metabolism (CAM) and C4-like metabolism (Keeley 1998). However, Pedersen et al. (2013) found that amphibious aquatic plant species that are only occasionally submersed rely mostly on CO_2 for photosynthesis. In comparison, aquatic systems high in alkalinity typically have a high proportion of aquatic plants that use bicarbonate for photosynthesis (see Pedersen et al. [2013] for review). Because of the carbonate substrates in the Ozarks, the pH of most springs ranges between 7 and 8 (Bowles et al. 2011), which is about the level where the relative distribution of carbon dioxide (CO_2) and bicarbonate (HCO_3^-) in water are at equilibrium (Pederson et al.

2013). Elevated levels of both CO_2 and HCO_3^- in karstic springs also may serve to reduce the respiration rate and requirement for dissolved oxygen in submersed plants (Gonzàles-Meler et al. 1996). Moreover, Mommer et al. (2005) showed that some plant species have higher underwater CO_2 assimilation rates after they become acclimated to submergence. Thus, it appears tolerance of plants to submergence occurs when they can maintain photosynthesis and high stomatal conductance as well as respiratory processes in their tissues (Onoda et al. 2009, Caudle and Maricle 2012). It remains unclear what method of carbon assimilation is being used by Moneywort and other species to tolerate submersion in Ozark springs.

In addition to requirements for dissolved gasses, submersed plants often facilitate increased photosynthesis through production of thinner cuticles and leaves, and increased stem lengths (Mommer et al. 2005, Mommer and Visser 2005, Voesenek et al. 2006, Striker 2012). High concentrations of CO_2 have been shown to result in stem elongation in some plants (Voesenek et al. 2006). Moreover, Bailey-Serres and Voesenek (2008) found that the gaseous plant hormone ethylene increases in tissues when plants becomes covered in water, which subsequently enhances shoot elongation. Although I lack empirical evidence to show that this is occurring in the aquatic populations of Moneywort, it is notable that the submersed forms of this species have longer stems and thinner leaves with a larger surface area compared to emergent plants (Fig. 1).

High CO_2 and HCO_3^- concentrations in karstic groundwater and springs (Knight and Notestein 2008), coupled with water clarity and thermal and physical consistency, likely facilitates the submersed growth of Moneywort and other wetland species in these systems as opposed to other surface waters.

MANAGEMENT CONSIDERATIONS

It remains unknown to what extent Moneywort may be impacting the springs or displacing native species, but Bowles and Bowles (2017) found that many introduced species do not cause discernible impacts to the ecosystems to which they are introduced, and minor impacts may be difficult to measure. Although Moneywort is invasive and readily spreads under favorable conditions, removal by hand pulling has been shown to be effective for controlling small patches of this species (Kennay and Fell 1992, Clark and Wilson 2001), but similar control for large patches has not been demonstrated. Prescribed burning for non-aquatic environments can be effective, but typically several burns are necessary for this treatment to be efficacious (Kennay and Fell 1992), and some areas may be too wet to burn. Such manual effort may not be practical for large populations, but smaller populations should be aggressively controlled when possible. Discouraging planting of Moneywort as an ornamental plant, and education on its invasive tendencies, would be helpful in slowing the spread of this invasive species.

Moneywort presently is not listed as an invasive species of concern for Missouri. Thus, many gardeners are unaware of this specie's tendency to escape. Indeed, one self-described 'native plant nursery' near Springfield Missouri listed this species as native and recommended it for native gardens. Education of vendors, government agencies, and the general public on the invasive tendencies of Moneywort will go far in helping to reduce the spread of this species.

ACKNOWLEDGMENTS

I thank LaToya Kissoon-Charles, Missouri State University, and anonymous reviewers who provided constructive comments on an earlier draft. Beth Davis Bowles kindly assisted with fieldwork.

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Missouriensis, **34**: 34-41. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

Once Upon a Time

BOOK REVIEW

Paradise Found: Nature in America at the Time of Discovery, by Steve Nicholls. 2009. University of Chicago Press, Chicago and London. 524pp.
[ISBN 9780226583419 (paper); ISBN 9780226583402 (cloth); ISBN 9780226583426 (E-book)]

Reviewed by:
PAUL M. MCKENZIE[1]

This captivating book should be read by anyone interested in conservation as well as anyone desiring to learn more about our country's pre-Eurosettlement flora and fauna, how management by Native Americans historically shaped the landscape, and how quickly European and Scandinavian explorers brought once-abundant species to extinction, as well as decimating indigenous peoples.

Entomologist and Emmy-winning wildlife documentary filmmaker Nicholls spent over 20 years traveling across North America researching this book and the quality of the product is reflective of the time the author spent gathering information from an exhaustive literature review as well as interviewing many who provided historical accounts. The book is organized chronologically as well as longitudinally where he covers the North American environment from the Atlantic to the Pacific. The author covers the decimation of native species in gory and nauseating details, including Atlantic and Pacific salmon, cod, seals, whales, Carolina Parakeet, Great Auk, Heath Hen, Passenger Pigeon, freshwater mussels, Gray Wolf, prairie dogs, Eastern Cougar, bison, Blue Pike, beavers, Sea Otter, Stellar Sea Lion, Bighorn Sheep, Pronghorn Antelope, Grizzly Bear, coral reefs, and even the Rocky Mountain Locust.

In addition to the annihilation of North America's species by Europeans, Nicholls covers in well-documented detail the introduction of numerous non-native species, including zebra mussels, quagga mussels, sea lampreys, feral hogs, horses, and a host of diseases that in some cases decimated native wildlife as well as Native Americans who occupied this land long before Scandinavian and European explorations. Throughout the book, the author contrasts greed, wanton waste, and economic incentives with initial conservation efforts that were often initiated only after extinction of many species had occurred or numbers had been reduced to such low levels that recovery was futile.

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On one hand this book will make you sick to your stomach and make you wonder why the title is not "Paradise Lost" rather than "Paradise Found". On the other hand, it will reaffirm that a commitment to conservation is a noble cause and that by learning from the horrid lessons of our past, we may work together to secure and maintain what's left in North America to sustain and benefit future generations.

Missouriensis, **34**: 34-41. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

Looming Evolutionary Apocalypse

BOOK REVIEW

Half-Earth: Our Planet's Fight for Life, by Edward O. Wilson. 2016.
W.W. Norton & Co. (Liveright Publishing): New York. 272 pp.
[ISBN 9781631492525 (paper); ISBN 9781631490828 (cloth)]

Reviewed by:
JOHN C. RICHTER[1]

I volunteered to review E. O. Wilson's latest book. What did I know of E. O. Wilson? Well he studies ants and I knew he also has been a prolific writer, including co-authoring the classic *Theory of Island Biogeography* (1967). I also discovered that he attracted controversy for his book *On Human Nature* (1978). As a humanist, Wilson shares company with other brilliant and influential authors, including Isaac Asimov, Kurt Vonnegut, Jr., and Carl Sagan. The book begins and ends with a fly page, which does not seem congruent with Wilson's view of how we should allocate resources. That aside, there are 21 chapters presented in three parts. These parts are titled "The Problem", "The Real Living World", and "The Solution".

The brevity of the chapters makes the book easy to read, and black and white illustrations preceding each chapter provide interesting fodder for thought. The book begins with a series of chapters introducing the subject of species diversity and how the loss of species represents the termination of a phylogenetic branch which can never be duplicated. This is the section of the book where the Anthropocene worldview is presented as antagonist. There is a glossary that includes definitions for terms such as "Anthropocene worldview".

As I read Part I, I found myself disagreeing with the need to establish an antagonist literary component, so I figure the author has either had success with this approach in previous novels, or bears a personal grievance against this component of society. Wilson was 86 years old when the book was published, and although not a curmudgeon, he has my approval to say it like it is without a sugar coating. One passage I remember from Part I is Wilson stating that if he were to travel back in time to the late Pleistocene, he is confident he could recognize most of the insects, but would be wholly taken aback by the diversity of large mammals that are now extinct due to hunting by Paleoindians. Part 1 effectively introduces the problem, which is an accelerated global extinction rate resulting from the Anthropocene worldview. For Wilson, this extends beyond a moral regression on the part of *Homo sapiens*, to a crime against evolution

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itself. Surely, no single species should have the power to cauterize the tips of phylogenetic branches that are tens of millions of years in the making.

Part II was mesmerizing, and the chapters easily flowed. The antagonist was mostly absent from Part II, and here Wilson's hyper-graphic talents come alive. He describes nature, species, strange habitats, survival mechanisms, and effectively pulls the reader into the bizarre qualities of life that has evolved on land and sea. Chapters 13 and 14 found I could not put the book down, as Wilson provides fascinating examples of life that occurs deep under the sea floor, and deep under the earth. Not afraid of any backlash, he also takes a small jab at The Nature Conservancy, pointing out that the organization falls shy of complete conservation by assimilating humans and their domestic cattle and crops into the ecological web of life on the lands they strive to protect. Part II also offers intellectual thought for botanists, such as noting that the Galapagos Islands has produced, through transmutation, trees derived from a phylogenetic base of herbs in the sunflower family. [For you botanists out there, here is some ambrosia (taxonomically correct pun intended): Perry, Roger. 1974. *Sunflower Trees of the Galapagos*[2].]

Part III is intended to introduce a solution, but these chapters become obtuse and conceptually unraveled. For example, several pages are devoted to artificial intelligence, which can be explained by Wilson's fascination with technology; here I come to complete odds with the solution and moral attributes Mr. Wilson suggests. I found an abundance of inconsistencies, such as the assertion that we need nature to promote a healthy mind, although preservation of the earth may only allow us to view it via a drone flown through the Amazon. Similarly, how we are always going to be tied to the biodiversity of nature and the processes that shaped us, while conceding life may be improved by genetic engineering, or even creating new cells or species in the laboratory? These inconsistencies are perplexing.

The book contains some fascinating information, although in terms of providing a solution to curtailing extinction rates I mainly found Wilson to leave it up to technology in general, which is the largest inconsistency of the book. He stresses the need for thoroughly understanding each of the millions of species occurring in the web of life to the minutest detail, yet has no moral reproach about creating a species in the laboratory and releasing it to the earth for domestic use.

Edward Wilson has a unique perspective on life and generously shares his deep knowledge of the earth, and that comes out in his literature. This is admirable, and here is my interpretation of how Part III, the Solution, could be more relevant: Consider Mr. Wilson himself, at 25 years old, doing fieldwork on ants in a remote jungle forest. The forests so alive

[2] Available online at:
http://www.darwinfoundation.org/datazone/media/pdf/22/NG_22_1974_Perry_Sunflower_trees.pdf

with species that the young naturalist is forever changed, by nature, by the beauty of biodiversity, on a level of respect for what the earth can produce. This was followed by the maturation of that awe into a lifelong philosophy over earth's mechanisms of perpetuating life. I think a lot more people need to take such a journey.

Missouriensis, **34**: 34-41. 2017.
**pdf effectively published online 30 September 2017 via https://monativeplants.org/missouriensis*

Arborescent Anthropomorphisms

BOOK REVIEW

The Hidden Life of Trees, by Peter Wohlleben. 2015.
Greystone Books, Vancouver and Berkeley. xv + 271 pp.
[ISBN 9781771642484 (cloth); ISBN 9781771642491 (E-book)]

Reviewed by:
DOUGLAS LADD[1]

Written by a German forester based on his experiences in managing forests there, this book is a reverential homage to "trees as social beings", and the underappreciated complexities of their interactions and ecological relationships. The subtitle of this small, enjoyable read — "What they feel, how they communicate" — sets the stage for what is to come. The author, a keen observer of the natural world, has obviously spent considerable time studying the forests in his region, with an astute ability to link individual phenomena to their system context.

Through a series of 36 short chapters with titles such as "The Language of Trees" and "Trees Aging Gracefully", the author examines all aspects of trees and their relationships with each other, the physical environment, and other biota. There is a wealth of fascinating information here, including intriguing new information based on recent studies questioning previously accepted tenants such as mechanisms for water transport. The author does a good job of resetting our temporal focus to the perspective of organisms with individual life spans ranging from centuries to millennia. There is useful information about fungal interrelationships, phytochemical communications, reproductive strategies, nutrient cycles, cold adaptations, and other aspects of both tree life history and forest ecosystems. Interspersed through the text are fascinating asides, such as the powerfully lethal properties of conifer needle extracts on microscopic animals.

The style and approach are popular and non-technical. Perhaps to make the topic relevant to the reader, the text attempts to relate functions and traits to their human analogs. This can become a bit contrived, for instance when the development of bark fissures in aging trees is linked with the development of wrinkles in the skin of older humans, or when light overexposure in trees is compared to sleep deprivation in humans.

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A persistent theme throughout the book is the anthropomorphization of virtually every trait and pattern exhibited by trees. Thus, we learn that beeches "harass" oaks, trees do not intrude their crown branches into those of their "friends", but develop stout branches competing with "non-friend" trees. Other examples include statements that trees make soil "even more precious", grasses are "relieved" that young trees are eliminated by browsers, and trees become "exhausted" after a growth spurt. The interpretation of evolutionary adaptations and system response as "tree etiquette" is a bit saccharine and imparts a false sense of near-universal, deliberate collaboration among the biota.

Similarly, in an evolutionary context, it is hard to interpret overarching, undocumented statements such as "an organism that is too greedy or takes too much without giving anything in return destroys what it needs for life and dies out", and that therefore "most species have developed innate behaviors that protect the forest from overexploitation". Imbued with a deep respect for living things, balance, and collaborative interrelationships, the author views everything through a lens of Utopian harmony towards a common goal of an enduring healthy forest.

There are also several questionable 'facts' or erroneous assumptions in the book, including the debatable point that "the root network is in charge of all chemical activity in the tree", or that the lack of coal development in the contemporary era is because "forests are constantly being cleared" (ignoring hypotheses about the post-Carboniferous appearance of lignin decomposers, or major changes in climate). Some assertions in the book are fascinating, although lack of documentation prevents further analysis, such as that silver firs (*Abies alba*) have an evolutionary adaptation to retard competition via their long, pendulous branches acting as wind-driven whips to damage encroaching foliage.

An additional criticism is the implication of universal forest and tree facts based on a near-total focus on northern European forests and a relatively few tree species: most of the examples in the book are based on European beech, fir, pine, spruce, oak, and bird cherry. Additionally, the most valuable ecological condition is always deemed to be old growth, closed canopy forest, as manifested by the above-ground presence of big trees. All human interventions are deemed a deleterious disturbance. Fire is hardly mentioned (and when mentioned, its ecological role is misinterpreted), and the depauperate ground layer of old, closed forests is considered a good thing, as opposed to the manifestation of a degraded system, as is now recognized in much of North America. The possibility of the existing European forests being a product of millennia of anthropogenic interactions is blithely ignored.

Overall, this book is a mixed bag: I enjoyed reading it and appreciated the author's eye for detail, passion for nature, deep love of trees, and concerns for ongoing degradation and threats. For non-specialists, there is a wealth of basic information about tree function and ecology, if sometimes in stiltedly Utopian and anthropomorphic terms. The work often dances on the edge of accepted science, as evidenced by the plethora of web sites, newspaper articles, and non-refereed citations in the 76 footnotes; no other references or bibliography are included. Entertaining, informative, and to be read with a healthy skepticism and wish that the author had the ecological perspective to see the full context of healthy woodland systems through the trees.