

A NEW SPECIES OF *STENANTHIUM* (MELANTHIACEAE) FROM TENNESSEE, U.S.A.

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ABSTRACT

Stenanthium diffusum Wofford, sp. nov., is described as a new species from Fentress, Morgan, Pickett, and Scott counties on the northern Cumberland Plateau of Tennessee. It is most closely related to *S. gramineum* but differs in having (1) a more diffuse inflorescence, (2) flowers on the mid-portion of lateral panicle branches spaced ≥ 8 mm apart and with distinct pedicels (1.6–4 mm long), and (3) the uppermost non-bracteal stem leaf less than 15 cm above ground level. It also flowers later and has ecological requirements differing significantly from *S. gramineum*. *Stenanthium diffusum* is an extremely rare rockhouse endemic in need of consideration for state and federal endangered species status.

RESUMEN

Se describe una nueva especie *Stenanthium diffusum* Wofford, sp. nov., de los condados de Fentress, Morgan, Pickett, y Scott del norte del Cumberland Plateau de Tennessee. Está estrechamente relacionada con *S. gramineum* pero difiere por tener (1) una inflorescencia más difusa, (2) flores en la parte media lateral de las ramas del panículo espaciadas ≥ 8 mm y con pedicelos diferenciados (1.6–4 mm de longitud), y (3) la hoja superior del tallo no bracteal a menos de 15 cm sobre el nivel del suelo. También florece más tarde y tiene requerimientos ecológicos que difieren bastante de *S. gramineum*. *Stenanthium diffusum* es un endemismo extremadamente raro de roquedos que requiere el estatus de especie amenazada estatal y federalmente.

TAXONOMIC/NOMENCLATURAL PERSPECTIVE

In the traditional sense, the genus *Stenanthium* (Liliaceae s.l.) is represented by one species in Asia, *S. sachalinensis* F. Schmidt, and from two to four taxa in North America. *Stenanthium occidentale* A. Gray, western featherbell, occurs in California, Oregon, Washington, Idaho, Montana, British Columbia, and Alberta (USDA, NRCS). In the eastern United States, depending upon taxonomic interpretation, *Stenanthium* may be composed of the typical variety, *S. gramineum* (Ker Gawler) Morong var. *gramineum* (eastern featherbell), and two additional varieties, *S. gramineum* var. *micranthum* Fernald and *S. gramineum* var. *robustum* (S. Watson) Fernald. *Stenanthium gramineum* s.l. ranges from Florida to Texas and northward to Indiana and Pennsylvania. Local established waifs are known from upper Michigan (Voss 1972).

Fernald (1946) provided a treatment of the *Stenanthium gramineum* complex in the eastern United States and concluded that there is a confluent series

of variation and that ... "As the best I can now do I propose the following definition of the three varieties." Although it is my impression that he had little faith in their distinctiveness, he did provide the following key for others to compare with their collections:

- a. Stem (dry) 4–10 mm thick at lowest exposed internode; leaves rather crowded below, rapidly diminishing below panicle, firm to coriaceous, mostly opaque, the larger ones 4–15 mm wide, their prominently raised ribs producing a corrugated surface; panicle lax, the branches distant, the flowers mostly subremote along the often flexuous branches; perianth 3–8(–10) mm long; capsules ovoid-urceolate, 6–9 mm long, on spreading to reflexed pedicels; seeds 5–5.5 mm long.
 Stem 0.5–1.9 m high, 4–10 mm thick at base; perianth 5–10 mm long _____ *S. gramineum*
var. *typicum* (= var. *gramineum*)
 Stem 0.25–1 m high, 1.5–5 mm. thick at the base; perianth 3–4(–5) mm long
_____ var. *micranthum*
- a. Stem (dry) 7–15 mm thick at lowest exposed internode, up to 1.8 m high; leaves crowded and numerous nearly up to panicle, thin and membranaceous, translucent, the larger ones 1–3 cm wide, their ribs mostly immersed in the tissue; panicle usually dense, with flowers crowded along the stiffly ascending branches; perianth 5–10 mm long; capsules oblong-subcylindric, 9–10 mm long, crowded and ascending to horizontally spreading; seeds 5–8 mm long _____ var. *robustum*

Since Fernald's (1946) assessment, the two varieties of typical *S. gramineum* have been largely unrecognized as distinct taxa in local and regional floras of the eastern United States as well as in the recent Flora of North America treatment by Utech (2002). Utech also cited and agreed with Gates (1918) and Johnson (1969) that the varieties of *S. gramineum* are indistinct and sympatric. I agree that significant morphological variation and overlap of characters exist but the extremes, however, are strikingly distinct and warrant consideration for additional study.

Recently, Zomlefer and Judd (2002) made the following significant new combinations in the tribe Melanthieae based on parsimony analysis of ITS and *trnL*-F DNA sequence data, distributions, chromosome numbers, and morphological data: *Stenanthium sachalinensis* = *Anticlea sachalinensis* (F. Schmidt) Zomlefer & Judd, *Stenanthium occidentale* = *Anticlea occidentalis* (A. Gray) Zomlefer & Judd, *Zigadenus densus* (Desr.) Fernald = *Stenanthium densum* (Desr.) Zomlefer & Judd, and *Zigadenus leimanthoides* A. Gray = *Stenanthium leimanthoides* (A. Gray) Zomlefer & Judd. These former *Zigadenus* taxa share significant morphological and geographical distinctions from the *S. gramineum* complex and their transfer to *Stenanthium* may be subject to debate by botanists emphasizing morphology and biogeography. Both *Zigadenus densus* and the poorly defined and taxonomically ambiguous *Z. leimanthoides* have a small gland at the base of the obovate, round-tipped tepals. They are primarily restricted to the southeastern U. S. Coastal Plain with the exception of a few outliers in the mountains of West Virginia, Virginia, and North Carolina, and on the Eastern Highland Rim of Tennessee. *Stenanthium gramineum* and *S.*

diffusum lack a gland at the base of the lanceolate, tortuose-tipped tepals. *Stenanthium gramineum* is widespread throughout most of the eastern U.S. while *S. diffusum* is restricted to the northern Cumberland Plateau of Tennessee. Conversely, adoption of the new combinations of Zomlefer and Judd would leave the genus *Stenanthium* s.s. restricted to the eastern United States.

BIOLOGICAL/ECOLOGICAL/FLORISTIC RELATIONSHIPS

The Cumberland Plateau is perhaps the most floristically diverse physiographic province in Tennessee, as shown in a recent treatment of the woody plants of Tennessee (Wofford & Chester 2002). This treatment exemplifies that the Cumberland Plateau has both more native genera and native species (and lesser taxa) than any other physiographic province in the state and surprisingly a few more than the Blue Ridge which includes the Tennessee portion of the Great Smoky Mountains National Park and numerous other high mountain peaks.

The highly dissected northern portion of the Cumberland Plateau in Tennessee (Fentress, Morgan, Scott, and Pickett counties) and Kentucky (McCreary Co.) has a unique habitat commonly referred to as rockhouses. These are amphitheater-like semicircular recessions under overhangs and ledges of Pennsylvanian sandstone. In addition to providing moist, sandy soil, other physical features unique to this habitat include lower light quality, lower summer and higher winter temperatures, higher relative humidity, and lower evaporation rates. Rare and/or unique taxa occur here at or behind the drip line and are only rarely in direct sunlight or rainfall. The flowering plant taxa of interest often have paler, more delicate leaves that probably would not withstand direct sunlight or heavy rainfall [see Walck et al. (1986) for an excellent review of sandstone rockhouses with emphasis on ecology and evolution of endemic taxa].

Several taxa closely related (with an asterisk) to Tennessee rockhouse endemics are often common in adjacent forests or outcrops. Examples of these sister species pairs are: *Thalictrum clavatum* DC.* and *T. mirabile* Small, *Arenaria glabra* Michx.* and *A. cumberlandensis* Wofford & Kral, *Ageratina altissima* (L.) King & H.E. Robins.* and *A. luciae-brauniae* (Fern.) King & H.E. Robins., *Silene virginica* L.* and *S. rotundifolia* Nutt., and *Heuchera villosa* Michx.* and *H. parviflora* Bartl. In addition, three pteridophyte taxa endemic to sandstone rockhouses in the eastern U. S. occur on both the Cumberland Plateau and Blue Ridge provinces of Tennessee (Walck 1986); these are: *Vittaria appalachiana* Mickel & Farrar, *Trichomanes intricatum* Farrar, and *Trichomanes boschianum* Sturm. The only rockhouse endemic that is also a Tennessee endemic is the herein described new species of *Stenanthium*.

SPECIES DESCRIPTION

Field observations for numerous seasons from Cumberland Plateau rockhouses have resulted in the discovery of yet another undescribed rockhouse endemic.

This new taxon is most closely related to *S. gramineum* but the distinct differences in morphology, restricted distribution, phenology, associated taxa, and habitat requirements warrant recognition and description of a new species of *Stenanthium*, to wit:

Stenanthium diffusum Wofford, sp. nov. (**Figs. 1, 2, 4**). TYPE: TENNESSEE. Pickett Co.: Pickett State Park, beneath and at the margin of rockhouse ledges and overhangs on Ladder Trail at crossing of Thompson's Creek, 36°33'18"N, 84°47'55"W, elev. 1597 ft, 23 Sep 2005, B.E. Wofford 20051, with D.K. Smith, G. Bresowar, & S. Huskins (HOLOTYPE: TENN; ISOTYPES: BRIT, GH, MO, NCU, NY, US).

Stenanthiogramineo arcte affinis sed differt inflorescentia magis diffusa, floribus midportione ramis lateralibus panicula ca. 1 cm separatim dispositis ac in pedicellis distinctis 3–4 mm longis portatis, et folio caulino nonbracteali summo minus quam 15 cm supra planitiem.

Plants glabrous perennial herbs with a single stem up to 1 m tall, mostly shorter, arising from a shallow seated tunicate bulb 2–8 cm deep; the bulb 2 cm high, 1 cm wide on reproductive individuals and surrounded by a dark, fibrous network of remains of previous years' leaf bases. **Roots** fibrous, numerous, up to 1 mm wide. **Leaves** 7–10, linear, entire, up to 3 dm long, 1–3(–4) cm wide, apex acute to slightly rounded, sheathing, predominately basal, only 1 or 2 above the basal rosette, conduplicate basally, reflexed and flattened distally, lowermost leaves often reclining; basal and cauline leaves (non-bracteal leaves) 15 cm or less above ground level, bracteal leaves becoming progressively reduced toward the inflorescence axes. **Inflorescence** a terminal, bracteate, diffuse panicle up to 3 dm wide of nodding, simple or compound racemes, the terminal portion racemose, erect, and up to 1.5 dm long or mostly shorter or absent, at least not longer than the lateral racemes; lateral branches 6–10, up to 15 in larger plants, each subtended by a bracteal leaf that becomes smaller toward the stem apex, axis of lateral branches up to 1.5 dm long. **Flowers** numerous, mostly bisexual or with the lowermost functionally staminate and the uppermost functionally pistillate, distinctly pedicellate, those on the mid-portion of panicle branches (5–)8–15(–18) mm apart and on slender pedicels (1–)1.6–4(–5) mm long, those of the terminal raceme, if present, of similar length; ultimate pedicel bracts 1.3 mm long, pale margined, clasping at the base. Tepals 6, spreading to slightly campanulate, scarcely connate basally, imbricate, narrowly lanceolate, apex acute to acuminate, tortuous, white at anthesis with a pale green midrib, becoming green and white margined with fruit development, persistent; sepals 4.5 mm long, 1.2 mm wide; petals 5 mm long, 1 mm wide, slightly narrower and longer than the sepals, scarcely tumid along the basal margins but not glandular or nectariferous. Stamens 6, in two series, antitepalous, scarcely epitepalous; filaments white, 0.7 mm long, recurved; anthers 1-locular, yellow, 0.4 mm long and wide, reniform, basifixed, extrorse; dehiscing into a peltate, dumbbell shaped disc; pollen yellow, ellipsoid. Gynoecium 3-carpellate, syncarpous, placentation axile; ovary about one-third inferior, white, 1 mm long, becoming green and glaucous



FIG. 1. Holotype of *Stenanthium diffusum* (Wofford 20051, TENN).

with fruit development, ovules up to 12, most aborting; styles 3, recurved, 0.4 mm long, persistent. **Fruit** a glaucous capsule 7–9 mm long, 3–4 mm wide; styles persistent and recurved; dehiscence septicial; seeds fusiform, sometimes flattened on one side due to compression, 1–6/locule, 3–3.5 mm long, 1 mm wide, brown, with irregular wrinkles, flattened and slightly arcuate at the tip.

Habitat, distribution, and phenology.—*Stenanthium diffusum* is restricted to sandy, moist soil on ledges and below rockhouse overhangs on the northern Cumberland Plateau of Tennessee (Fig. 5). It is presently documented from only five populations in Morgan, Fentress, Pickett, and Scott counties (Fig. 6). The largest are found in Pickett State Park where they are associated with rockhouse endemics *Silene rotundifolia*, *Heuchera parviflora*, *Vittaria appalachiana* and the federally endangered *Arenaria cumberlandensis*. It flowers from mid-September to early October with fruits maturing in mid-November.

Additional collections examined. **TENNESSEE. Fentress Co.:** ca. 6 mi S Pickett Park, shaded rockhouse ledges, sandstone, 6 Sep 1978, R. Kral 62661 (MO & VDB, as photocopy!); Twin Arches, 13 Oct 1978, D. Eagar s.n. (VDB, as photocopy!)*. **Morgan Co.:** beneath sandstone ledges at crossing of Tennessee Valley Authority transmission line above tributary to Clear Fork River, 36°18'59"N, 84°46'46"W, elev. ca. 1300 ft, 3 Oct 2005, B.E. Wofford 20053, with D.K. Smith & G. Sexton (TENN). **Pickett Co.:** acid sandy oak-pine woods above Thompsons Creek ca. 1 mi N Park Headquarters, 7 Jul 1973, R. Kral 50563; in sand of rockhouse, Hidden Passage, Pickett State Park, 13 Aug 1973, A.J. Sharp s.n. (TENN); Sharp Place Quad., Pickett State Park, Ladder Trail, series of sandstone rockhouses near Hwy. 154, in damp soil of sandstone rockhouse overhangs, with hemlock, near *Arenaria cumberlandensis*, 07 Aug 1993, Milo Pyne 93-204 (TENN, VDB, as photocopy!); moist sandstone ledges in hemlock-white pine forest above Ladders Trail, Pickett Park, 22 Sep 1974, R. Kral 54288 (MO & VDB, as photocopy!); Pickett State Park, rockhouse on Hidden Passage Trail, ca. 100 yards E of its jct. with Group Camp Trail, 36°33'35"N, 84°47'26"W, elev. 1538 ft, 26 Oct 2005, B.E. Wofford 20054, with G. Sexton, D. Estes, & J. Beck (TENN). **Scott Co.:** in moist, sandy soil at base of sandstone bluffs at Twin Arches, ca. 0.2 mi. w of Charit Creek, 36°32'30"N, 84°44'09"W, 26 Oct 2005, B.E. Wofford 20052, with D.K. Smith, G. Bresowar, & S. Huskins (TENN). *The correct county for this specimen is Scott Co.

DISCUSSION

Stenanthium diffusum is easily distinguished from *S. gramineum* by morphology, geography, phenology, and habitat (Table 1). Morphologically, the most apparent difference between these two taxa is the nature of the inflorescence. The inflorescence of *S. diffusum* is broader, up to 3 dm wide, more diffuse, and the terminal, wand-like raceme is absent or nearly absent (Fig. 2). The diffuse nature of the inflorescence of *S. diffusum* is due to the more numerous and longer secondary panicle branches that usually exceed 3 cm in length. In *S. gramineum* the inflorescence is less diffuse and rarely exceeds 1.5 dm in width except in some individuals perhaps referable to var. *robustum*; in addition, the terminal raceme is always present and may comprise up to 20–70% of the total inflorescence length (Fig. 3). Furthermore, in *S. gramineum*, secondary branches are infrequent and generally less than 2 cm long.



FIG. 2. *Stenanthium diffusum* habit at anthesis. Image taken at type locality, Ladder Trail, Pickett State Park, Pickett County, Tennessee.

TABLE 1. Morphological and other comparisons of *Stenanthium diffusum* and *S. gramineum*. Quantitative values are based on measurements from specimens deposited in the University of Tennessee Herbarium (TENN).

	<i>S. diffusum</i>	<i>S. gramineum</i>
Pedicle length at mid-portion of lateral inflorescence branches (mm)	(1–)1.6–4(–5)	(0–)0.3–1.1(–1.7)
Distance between pedicels at mid-portion of lateral inflorescence branches (mm)	(5–)8–15(–18)	(1–)3–7(–8.5)
Distance from ground to uppermost cauline leaf (cm)	(3–)4–14(–15)	(15–)22–66(–76)
Distribution	northern Cumberland Plateau of TN	FL to TX, n to IN and PA
Flowering period (at ca. same latitude)	mid-Sep to mid-Oct	May to late Aug
Habitat	moist, shady, sandstone rockhouses	dry to mesic woodlands and open areas

Stenanthium diffusum and *S. gramineum* also may be separated by quantitative morphology, phenology, distribution, and habitat (Table 1). The flowers of the mid-portion of the lateral inflorescence branches of *S. diffusum* are separated from each other by ≥ 8 mm and are borne on distinct pedicels (≥ 1.6 mm long) that often equal or exceed the subtending bracts. In comparison, the flowers of the lateral inflorescence branches of *S. gramineum* are sessile or subsessile on pedicels (≤ 1.1 mm long) that are equal to or shorter than the subtending bracts and are separated from each other by ≤ 7 mm, giving the inflorescence a less diffuse appearance. Interestingly, although the pedicels on the lateral branches are sessile or subsessile, those of the terminal wand-like raceme are distinctly pedicellate and may be up to 5 mm long. Another reliable characteristic that readily separates *S. diffusum* and *S. gramineum* is the distance from the ground to the node of the uppermost cauline leaf (not bracteal inflorescence leaf). The distal-most cauline leaf of *S. diffusum* is ≤ 14 cm above ground level whereas the distal-most cauline leaf of *S. gramineum* is ≥ 22 cm above ground level. Although somewhat difficult to quantify from herbarium material, there also appears to be a difference in leaf length/width ratio between these taxa, with the tendency toward a lower leaf length/width ratio in *S. diffusum*.

Other non-morphological differences include: (1) phenological differences, i.e., *S. diffusum* flowers from mid-September to mid-October and *S. gramineum*, at this approximate latitude, flowers from May to late August, (2) *S. diffusum* is a narrow endemic to the northern Cumberland Plateau of Tennessee in sandstone rockhouse habitats characterized by siliceous soils, low light intensity, high relative humidity, lower evaporation rates, and lower summer and higher winter temperatures than the surrounding forests. The more widespread *S.*



FIG. 3. *Stenanthium gramineum* habit at anthesis.



FIG. 4. *Stenanthium diffusum*, image of flowers at mid-portion of lateral inflorescence branch, from holotype.



FIG. 5. Habitat of *Stenanthium diffusum*. Sandstone rockhouse formations at type locality, Ladder Trail, Pickett State Park, Pickett County, Tennessee.

gramineum occurs in a much broader range of ecological conditions in numerous habitats including rich woods, moist to dry woods, meadows, flood plains, prairies, and grassy balds. The following key is provided for ease of identification:

1. Inflorescence a diffuse panicle up to 3 dm wide, the terminal racemose portion reduced or absent; flowers on mid-portion of lateral branches with distinct pedicels 1.6–4 mm long and 8–15 mm apart; uppermost non-bracteal stem leaf 4–14 cm above ground level _____ ***S. diffusum***
1. Inflorescence not diffuse, typically up to 1.5 dm wide, the terminal racemose portion present and up to 3 dm long; flowers on mid-portion of lateral branches with pedicels 0.3–1.1 mm long and averaging 3–7 mm apart; uppermost non-bracteal stem leaf 22–66 cm above ground level _____ ***S. gramineum*** (including *var. micranthum* and *var. robustum*)

CONSERVATION CONCERNS

The northern Cumberland Plateau of Tennessee and adjacent Kentucky harbors a suite of species commonly referred to as rockhouse plants. This unique flora is restricted to sandstone floors, ledges, and overhangs. There are several

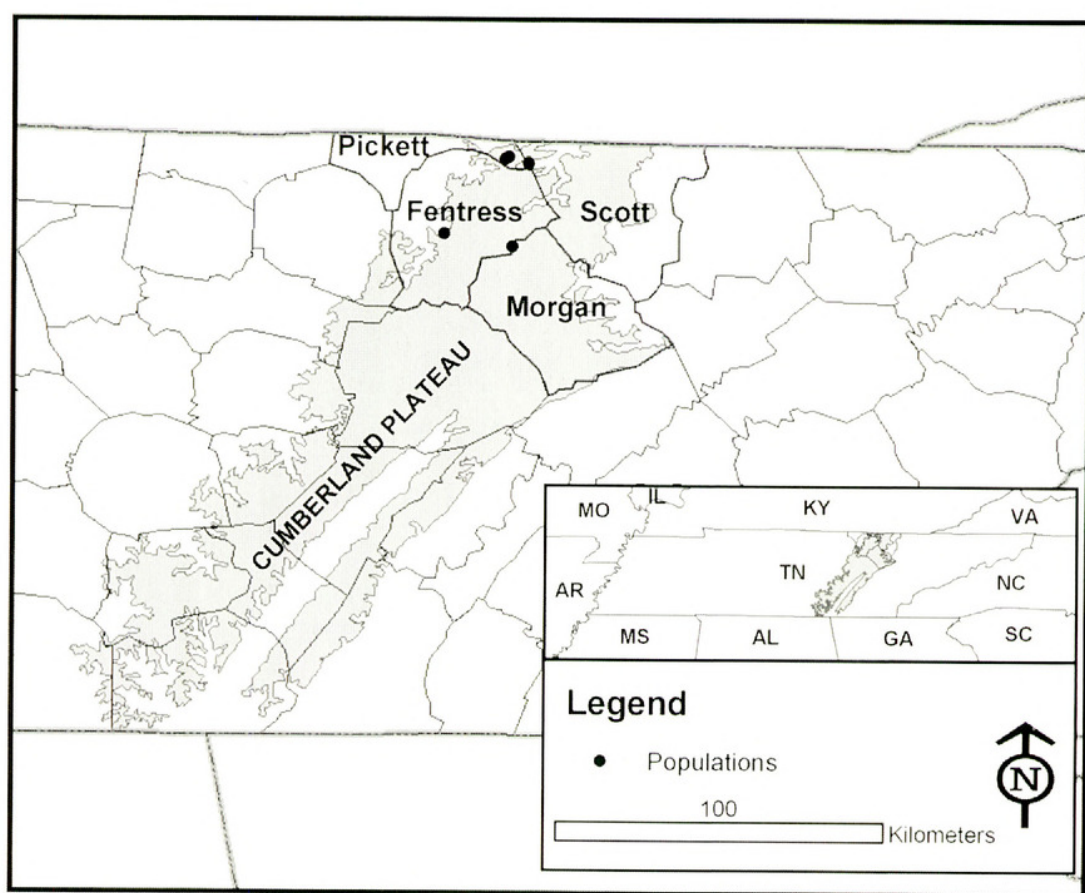


FIG. 6. County and within county distribution of *Stenanthium diffusum*.

critical factors required, in concert, to maintain these unique habitats: moist sandy soil, low light intensity, high relative humidity, low evaporation rate, and lower summer and higher winter temperatures than adjacent forests (Wofford & Smith 1980).

The environmental factor most likely to have an immediate and negative impact would be removal or severe thinning of adjacent woodlands. This would increase light intensity and temperature while reducing relative humidity and moisture. An aggressive management plan should be placed into motion on public lands (especially at Pickett State Park and Forest and the Big South Fork National River and Recreation Area) aimed at protecting a part of this critical habitat and its associated flora. In addition to protecting a unique part of Tennessee's natural heritage, protection would provide opportunity for study of biological/evolutionary problems yet to be resolved, i. e., speciation and sister pair relationships, micro and macroclimates, endemism, rarity, etc. Therefore, it is highly recommended that the Tennessee Department of Environment and Conservation and the U. S. Fish and Wildlife Service, in coordination with public land managers, conservation groups, and interested individuals, propose

both state and federal endangered status for *Stenanthium diffusum*. Hopefully, these efforts can, in concert, accomplish the necessary management and mission plans to preserve this unique habitat and flora.

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