STUDIES IN THE VASCULAR FLORA OF THE SOUTHEASTERN UNITED STATES: V

[1]Alan S. Weakley, [2]R. Kevan Schoonover McClelland, [3]Richard J. LeBlond

UNC-CH Herbarium (NCU), North Carolina Botanical Garden,
University of North Carolina at Chapel Hill, Campus Box 3280
Chapel Hill, North Carolina 27599-3280, U.S.A.
weakley@unc.edu, schoonor@live.unc.edu, richardleblond@charter.net

[4]Keith A. Bradley

A.C. Moore Herbarium (USCH)
Department of Biological Sciences
University of South Carolina
Columbia, South Carolina 29208, U.S.A.
linaceae@gmail.com

[5]James F. Matthews

Herbarium (UNCC), Center for Biodiversity Studies
Mecklenburg County Park and Recreation
2900 Rocky River Road
Charlotte, North Carolina 28215, U.S.A.
mr.jimmatthews@gmail.com

[6]Chad Anderson

Florida Natural Areas Inventory
1018 Thomasville Road, Suite 200-C
Tallahassee, Florida 32303, U.S.A.
canderson@fnai.fsu.edu

[7]Alan R. Franck

Department of Biological Sciences
Florida International University
11200 SW 8th St., Miami, Florida 33199, U.S.A.
afranck@fiu.edu

[8]James Lange

Fairchild Tropical Botanic Garden (FTG)
10901 Old Cutler Road, Coral Gables, Florida 33156, U.S.A.
jlange@fairchildgarden.org

ABSTRACT

As part of ongoing efforts to understand and document the flora of the southeastern United States, we propose a number of taxonomic changes. In *Trichostema,* we name a new species, narrowly endemic to maritime grasslands in the Carolinas and warranting formal conservation status and action. In *Dichanthelium* (Poaceae), we continue the reassessment of taxa formerly recognized in *Panicum* and provide new combinations along with a new key to taxa in the *Dichanthelium scabriusculum* complex. In *Paspalum* (Poaceae), we address the controversial taxonomy of *P. arundinaceum* and *P. pleostachyum* and treat the two as conspecific, with *P. arundinaceum* the correct name. In *Portulaca* (Portulacaceae), we report the discovery of the Bahamian *P. minuta* as a native component of the North American flora, occurring in southern Florida.

RESUMEN

Como parte de los esfuerzos en marcha para entender y documentar la flora del sureste de Estados Unidos, proponemos un número de cambios taxonómicos. En *Trichostema,* nombramos una especie nueva, endemismo restringido a las praderas marinas en las Carolinas y que justifica un estatus formal de conservación y acción. En *Dichanthelium* (Poaceae), continuamos la reconsideración de taxa reconocidos previamente en *Panicum* y hacemos combinaciones junto con una nueva clave para los taxa en el complejo *Dichanthelium scabriusculum*. En *Paspalum* (Poaceae), abordamos la taxonomía controvertida de *P. arundinaceum* y *P. pleostachyum* los tratamos como conspecíficos, con *P. arundinaceum* su nombre correcto. In *Portulaca* (Portulacaceae), reportamos el descubrimiento de *P. minuta* de las Bahamas como componente nativo de la flora de Norte América, que está en el sur de Florida.

INTRODUCTION

As part of ongoing work on the *Flora of the Southern and Mid-Atlantic States* (Weakley 2015; Weakley in prep.), as well as for general floristic, conservation, and scientific work in eastern North America, taxonomic and nomenclatural changes and significant distribution records need to be documented. In some cases, new combinations are needed to accurately reflect current taxonomic understanding. Some of these reflect rank

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changes, whereas others are generic transfers to apply new (or old) generic concepts to taxa that do not have corresponding available names at the specific or infraspecific level. We have also addressed various nomenclatural issues and clarified characters and identification of difficult groups in the regional flora.

We here present a fifth volume of such changes, contributed by eight authors. It follows similar conventions and philosophical approaches as the earlier volumes in the series (Weakley et al. 2011, 2017, 2018a, 2018b). Primary authorship of the sections in this paper is as follows (and is also indicated at the beginning of each section): *Trichostema* (RKSM and ASW), *Dichanthelium* (RJL), *Paspalum* (ARF & JL), and *Portulaca* (KAB, JFM, & CA).

LAMIACEAE

Trichostema: A new species of *Trichostema* (Lamiaceae, Ajugoideae) from barrier island systems of North and South Carolina

Primary authors: R. Kevan Schoonover McClelland and Alan S. Weakley

Trichostema L. is a genus in the family Lamiaceae, subfamily Ajugoideae, that is native to North America. It currently has 18 recognized species and one subspecies and has been divided into five sections based on chromosome number and morphology (Lewis 1945; Lewis 1960; Lewis & Rzedowski 1978); a recent study supported this circumscription save for a single species (Huang et al 2008). Four out of the five sections (*Orthopodium, Chromocephalum, Paniculatum,* and *Rhodanthum*) all have western North American (including Mexico) distributions, occurring west of the Great Plains and south into south central Mexico (Lewis 1945; Lewis & Rzedowski 1978; Villaseñor 2016). The eastern part of North America is home to the fifth section, *Trichostema.* This section has usually been treated in recent floras and checklists (e.g., Kartesz 1999) as including three species: *Trichostema dichotomum* L., *T. setaceum* Houtt., and *T. suffrutescens* Kearney. *Trichostema dichotomum* and *T. setaceum* both have wide distributions. *Trichostema dichotomum,* as currently circumscribed, ranges from southern Ontario and Québec south into peninsular Florida, and west into eastern Texas and Oklahoma, southeastern Missouri, and Illinois. *Trichostema setaceum,* as currently circumscribed, ranges from southern Ohio and Pennsylvania south to Florida, and west into eastern Texas and along the Mississippi-Ohio River system. *Trichostema suffrutescens* differs from the other two in both its distribution and its habit. It is restricted to peninsular Florida and is strictly a perennial, whereas the other species (as currently circumscribed) contain both annual and perennial populations.

The perennial habit in section *Trichostema* has been interpreted one of two ways: either all perennial members are *Trichostema suffrutescens* and all annual members are *T. dichotomum* or *T. setaceum* (Small 1913; Lewis 1945, 1960; Long & Lakela 1971), or all perennial and annual entities are either *T. dichotomum* or *T. setaceum* based on leaf size and shape (Wunderlin 1982, 1998; Wunderlin et al. 2018). Wunderlin (1982, 1998) treated *T. suffrutescens* as a synonym of *T. dichotomum* but did not provide a rationale for the decision; Wunderlin et al. (2018) cited an overlap in leaf size as the reason for synonymization. This classification goes against genetic and morphological evidence published in Huang et al. (2008) and a consensus taxonomy based on morphological and ecological evidence developed over the past 100+ years (Small 1903, 1913, 1933; Lewis 1945, 1960; Weakley 2015).

While Small's (1913) treatment of the Southeast was extensive, there were no perennial *Trichostema* documented outside of Florida at the time. This changed in 1939 and 1940 when three Carolinian collectors (B.W. Wells, Lloyd T. Carl, & F.R. Fosberg) discovered perennial forms of *Trichostema* on the barrier islands of North Carolina. Wells collected four plants, three on Smith Island (present day Bald Head Island) and one on Zeke [sic; Zeke's] Island (with Carl); all are apparently short, shrubby, perennial plants. Wells originally identified two of the Smith Island plants (NCSC 08814 and DUKE 71956) and the Zeke's Island plant (NCSC 08815) as *T. suffrutescens*. The other of Wells' collections from Smith Island was originally identified as *T. dichotomum* (NCSC 08811). Fosberg had also collected a perennial plant in 1940, near the Cape Hatteras Lighthouse, identified at the time as *T. dichotomum* (NCSC 47312). These perennial plants were not studied in Lewis' 1945

monograph. It seems that Lewis first saw the Wells collections from Smith Island (NCSC 08814 and DUKE 71956) in 1958, at which time he annotated them as *T. suffrutescens*.

In the 1980s, Steven W. Leonard and Weakley noted low, shrubby, perennial *Trichostema* plants growing at Bald Head Island (Brunswick County) and other cape and barrier island sites in southern North Carolina. The plants had lavender flowers and were quite different from local *T. dichotomum* plants, which were erect, herbaceous annuals with blue flowers. *Trichostema suffrutescens* was the only known shrubby species in the Southeast; however, these North Carolinian plants differed in growth form, leaf shape, and flower color, were disjunct, and occupied a different habitat. Common garden experiments conducted by Weakley in the late 1980s and early 1990s also showed that the plants retained their characteristics when grown in the Piedmont in garden soils and with *T. dichotomum*. These observations led to a strong hypothesis that the coastal Carolinas plants warranted recognition as a species distinct from *T. dichotomum* and *T. suffrutescens*.

Based on additional analysis of all available specimens and further common garden experiments conducted in 2018 by McClelland which support Weakley's earlier work, we conclude that this narrow endemic, which is distinct in morphology, distribution, and habitat, warrants taxonomic recognition. Additionally, it is of conservation concern and is being identified (under the name *Trichostema* sp. 1) as a Federal Species of Concern (Fish and Wildlife Service 1993) and ranked (also as *Trichostema* sp. 1) by the North Carolina Natural Heritage Program as a G2 (imperiled) species (North Carolina Natural Heritage Program 2016; Nature-Serve 2018).

Trichostema nesophilum K.S. McClell. & Weakley, **sp. nov.** (**Figs. 1, 2**). Type: U.S.A. North Carolina. Brunswick Co.: established dune system, Bald Head Island State Natural Area, just inside southern border, 15 Oct 2017, *R. Kevan Schoonover, II 113c* [holotype: NCU; isotypes: *R. Kevan Schoonover II 113a & b* (USCH), *R. Kevan Schoonover II 113d* (NY)].

Note.—Specimens *R. Kevan Schoonover II 113a–d* represent a single gathering in accordance with Article 8.2 of the International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code; Turland et al. 2018).

Diagnosis.—*Trichostema nesophilum* is placed into *Trichostema* sect. *Trichostema* by its *zygomorphic calyces* that recurve in fruit. *Trichostema nesophilum* is distinguished from all members of sect. *Trichostema* by its consistently pink-lavender to nearly white flowers and lemon-yellow anthers. There are occasional albino morphs of *T. dichotomum* that are pink or white, but these can be told apart from *T. nesophilum* by their leaf shape, annual life history, upright growth form, and stem pubescence.

Plant perennial, 10–40(60) cm tall, generally short and shrubby, with shade plants being more upright and diffuse. Roots spreading. Stems erect to spreading, much branched; young stems slightly four sided, becoming maroon with age, covered in short, downwardly curved trichomes 0.1–0.2 mm long, upper portions of stems with spreading and capitate glandular trichomes 0.1–0.2 mm long; older stems terete with tight light brown bark with maroon ridges. Leaves oblong to rhombic to slightly obovate, largest (0.9)1.4–1.9(2.5) cm long × (0.4)0.6–0.8(1.0) cm wide (sun plants; including the indefinite petiole) or (2.8)3.0–3.4(3.8) cm long × (0.9)1.0–1.3 cm wide (shade plants; including the indefinite petiole), with sessile glands and 0.1–0.2 mm long trichomes appressed toward the apex on both surfaces, base acute to acuminate, tapering to an indefinite petiole, apex rounded to obtuse. Inflorescences axillary, cymose, with 3–7(11) flowers, y-shaped as the secondary cymes onward only give rise to one flower, aggregated toward the ends of branches giving a paniculate appearance, highly glandular with capitate glands 0.1–0.2 mm long with sparse short, spreading trichomes of the same length. Bracts subtending individual flowers opposite, elliptic, (3.5)4.5–5.8(6.6) mm long × (0.5)1.2–1.7(2.3) mm wide (sun plants), (6.8)7.3–11.5(15) mm long × 2.2–2.5(2.6) mm wide (shade plants), becoming smaller toward the inflorescence apex. Calyx zygomorphic, connate, glandular punctate with short, upwardly curved trichomes 0.1–0.2 mm long and sessile capitate glands to 0.2 mm long, calyx lobes 5 (three long, two short); in fruit, the calyces recurve and are accrescent to (5.7)6.3–6.8(7.5) cm long (including tube and teeth). Buds light grayish lavender, pubescent, trichomes 0.1–0.2 mm long, curved to appressed towards the apices of the petals, scant sessile capitate glands along the margins of the petals. Corollas zygomorphic, pink-lavender to nearly white, pubescence persistent. Petals 5, connate for ¼–⅓ their length, tube exserted, lobes flaring, posterior four lobes of uniform color, often with a darker margin, apices acute, anterior lobe forming a lip, white with a

Fig. 1. *Trichostema nesophilum* holotype specimen *in situ*. Photo by R. Kevan Schoonover McClelland.

few dark red-violet spots, often with a red-violet fringe at its apex, apex obtuse to emarginate. Stamens 4, all fertile, didynamous, exserted, arched, becoming more curled as the flower ages, filaments typically a darker shade of pink-lavender than the flower, anthers lemon yellow, pollen white. Style two-branched, exserted, arched, becoming more curled as the flower ages. Style branches slightly curved, one branch slightly shorter. Carpels 2, connate at the base, forming four distinct lobes, each lobe containing a single ovary. Fruit a mericarp, fused at the base for (0.25)0.29–0.35(0.4) times the length of the lobes, splitting upon maturity; mericarps reticulate with irregular areolae, (1.5)1.6–1.8 mm long.

Discussion.—*Trichostema nesophilum* is placed into *Trichostema* sect. *Trichostema* by its zygomorphic calyces that recurve in fruit. It is differentiated from *T. dichotomum,* the closest member of the section geographically, by its perennial habit, smaller leaf size (*T. dichotomum* has leaves (1.5)2.9–4.3(6.3) cm. long), smaller leaf dimensions (*T. nesophilum* has leaves (1.6)2.3–2.8(3.3) times longer than wide vs. leaves (2.7)3.6–4.7(6.0) time longer than wide in *T. dichotomum*), leaf shape (*T. dichotomum* has ovate to oblong leaves), smaller mericarps (*T. dichotomum* has mericarps (1.5)1.8–2.1(2.4) mm long), mericarp architecture (the areolae of *T. nesophilum* are shallower, giving them a smoother appearance), and stem pubescence (short, downwardly curved trichomes vs. short and long spreading trichomes; nodes not bearded vs. nodes bearded) (Figs. 3, 4, 5). The pubescence is of particular importance, as it has been shown to be a strong indicator of species in other mint genera (Salmaki, et al. 2009; Xiang, et al. 2010; Seyedi and Salmaki 2015; Atalay et al. 2016). Even when the shade morphs of *T. nesophilum* approach *T. dichotomum* in leaf size and shape, the perennial habit, leaf length/width ratio, and pubescence distinguish the taxa. Furthermore, even when growing in similar environments, *T. dichotomum*

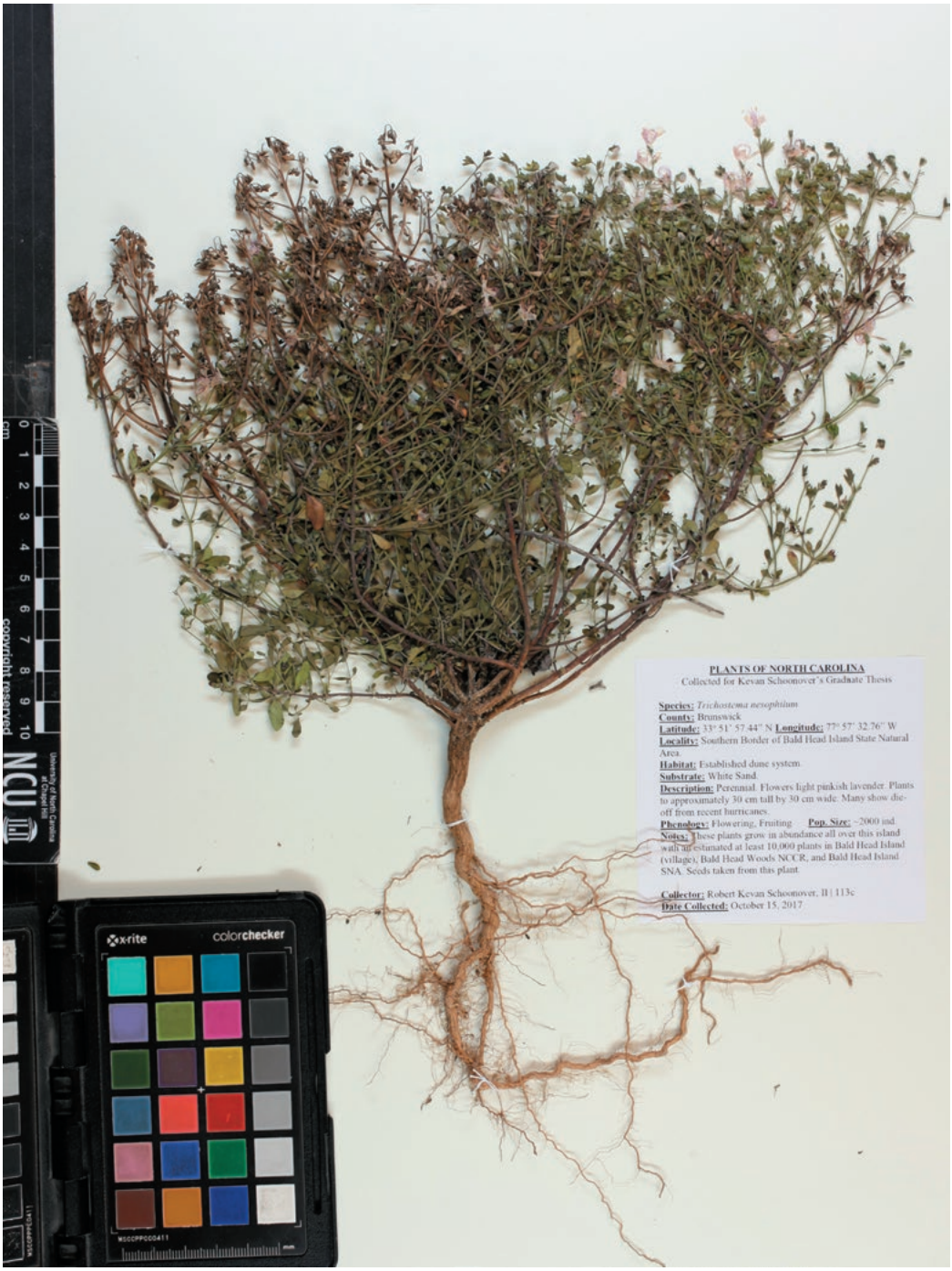

Fig. 2. *Trichostema nesophilum* holotype herbarium specimen. Photo by G. Sollom.

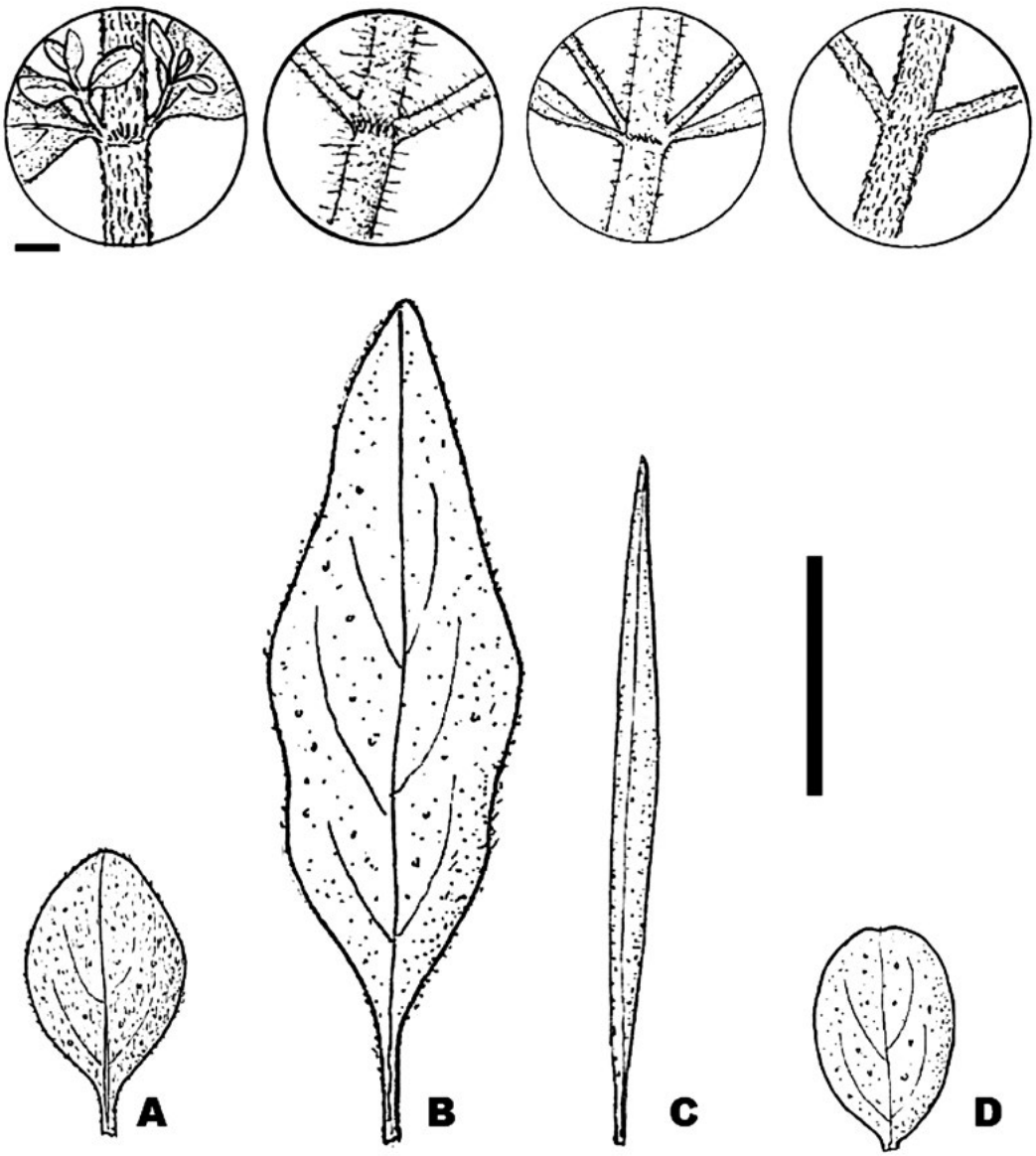

Fig. 3. Stem pubescence and leaf sketches of: A) *Trichostema nesophilum*, B) *T. dichotomum*, C) *T. setaceum*, and D) *T. suffrutescens*. Scale bar for stem pubescence is 1 mm; scale bar for leaves is 1 cm. Sketches by Julia Larke.

retains its annual habit, overall architecture, leaf shape, and stem pubescence (e.g., WILLI 58852 and *Schoonover II 116*). *Trichostema nesophilum* is distinguished from *T. setaceum* by its perennial habit, smaller leaf size (*T. setaceum* has leaves (1.6)2.9–3.8(5.1) cm long), leaf dimensions (*T. setaceum* has leaves (4.8)9.9–13.4(18.1) times longer than wide), leaf shape (*T. setaceum* has narrowly lanceolate to nearly linear leaves), and mericarp shape (*T. setaceum* has mericarps that are concave near the fusion area) (Figs. 3–5).

Trichostema nesophilum is distinguished from *T. suffrutescens* by its branching pattern (*T. suffrutescens* branches almost exclusively near the bottom of the plant, creating a leggy appearance with several ascending virgate branches, whereas *T. nesophilum* freely branches throughout the plant, from at or near ground level

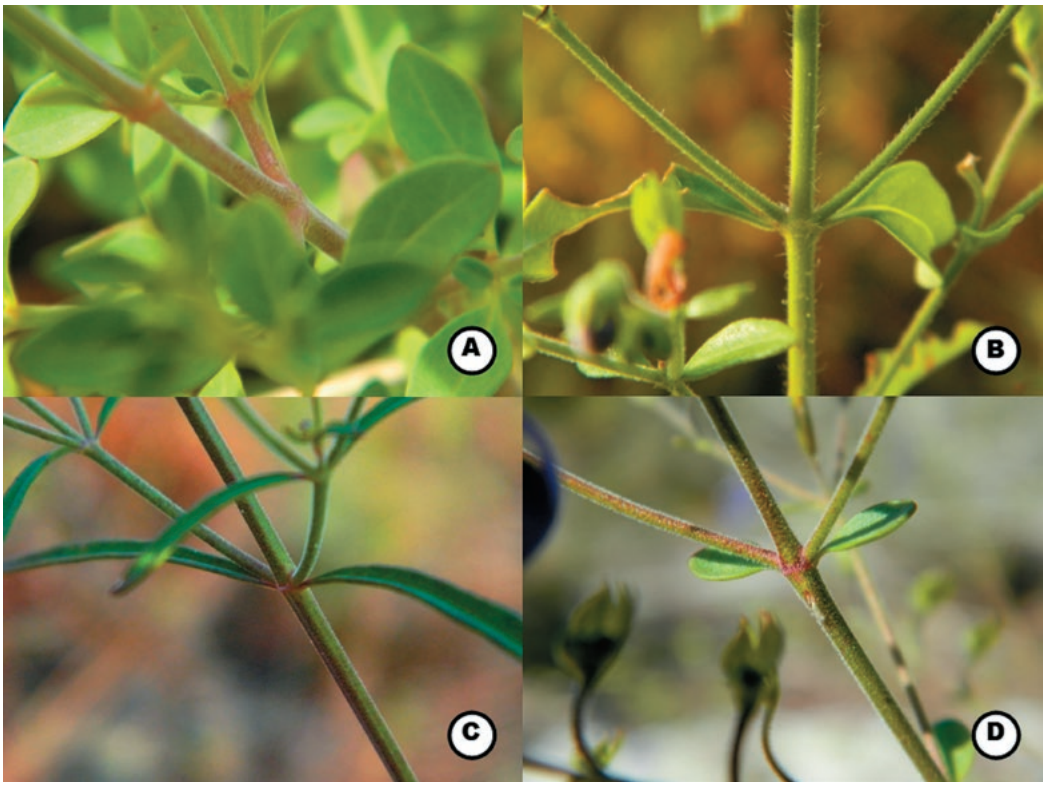

Fig. 4. Stem and node pubescence of: A) *Trichostema nesophilum*, B) *T. dichotomum*, C) *T. setaceum*, and D) *T. suffrutescens*. Photos by R. Kevan Schoonover McClelland.

upwards, creating a small, intricately branched subshrub), leaf shape (*T. suffrutescens* has oblong-obovate leaves), bract shape (*T. suffrutescens* has oblong-obovate bracts), smaller mature calyces (*T. suffrutescens* has mature calyces (4.6)5.3–5.9(6.5) mm long), and mericarp shape and architecture (*T. suffrutescens* has mericarps that are concave near the fusion area and have smaller, rounder, and more regular areolae) (Figs. 3, 4, 5).

Etymology.—The name *nesophilum* (island loving) [*nesos*: Greek, island; *philos*: Greek, loving] is given to this species because of its restricted range and unusual habitat: it occurs almost exclusively in established dune fields and openings in maritime forest on barrier islands along the coast of North and South Carolina (Fig. 6).

Habitat and distribution.—*Trichostema nesophilum* grows in a variety of habitats along the barrier islands of North and South Carolina, from just south of New Inlet in Pea Island National Wildlife Refuge, NC, to the northern part of Cape Island, Cape Romaine National Wildlife Refuge, SC (Fig. 6). It primarily grows in established dune grasslands dominated by *Uniola paniculata* and *Hydrocotyle bonariensis* [Dune Grass Southern Subtype Maritime Grassland (Schafale 2012); CEGL004040], and Stable Dune Barrens, Southern Subtype (Schafale 2012; CEGL004234) (Fig. 7), where it commonly occurs with *Opuntia pusilla* (personal observation). In a couple of sites in Fort Macon State Park, this species also occurs in shaded openings in maritime forest dominated by *Quercus virginiana, Juniperus virginiana* var. *silicola,* and *Ilex vomitoria* [Maritime Shrub Stunted Tree Subtype (Schafale 2012); CEGL003833]. In these instances, the plant is more upright, with larger leaves and lighter flowers (e.g., *Schoonover II 107a*). The upright form also occurs on Bald Head Island [in Maritime Evergreen Forest South Atlantic Subtype (Schafale 2012); CEGL007032] and on North Island in Tom Yawkey Wildlife Center (John B. Nelson, pers. comm.; unknown plant association). All of these communities are listed as either G2 or G3, vulnerable or imperiled rangewide (Schafale 2012; NatureServe 2018).

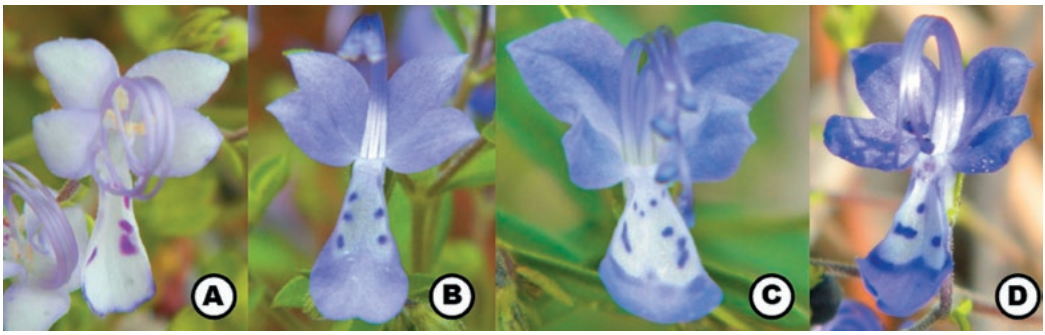

Fig. 5. Flowers of: A) *Trichostema nesophilum*, B) *T. dichotomum*, C) *T. setaceum*, and D) *T. suffrutescens*. Photos by R. Kevan Schoonover McClelland.

Specimens examined: **NORTH CAROLINA. Brunswick Co.:** dry sand dunes on edge of residential development, Bald Head Island, Frying Pan Way, 4 Nov 2004, *Buchanan & Suiter 562* (NCU 584208); open sandy area among residences, originally sand dunes, ocean side of South Bald Head Wynd at Cladach Court, near SE end of Bald Head Island, 2 Oct 2008, *Suiter & Kunz 2536* (NCU 588505-588516); dredged material islands at mouth of Lockwood Folly River, covered with almost pure oyster shells, 25 May 1981, *Leonard 7507* (NCU 512925); Smith's Island, 4 Sep 1939, *Wells s.n.* (DUKE 71952, NCSC 8814); on shell mounds, Battery Island, 28 Oct 1950, *Boyce & Godfrey 1586* (NCSC 29778); Smith Island, 27 Jul 1965, *Cooper 2888* (NCSC 67807); Smith Island, 3 Jul 1940, *Wells s.n.* (NCSC 8811); salt marsh, Zeke Island, 7 mi S of Carolina Beach, 2 Sep 1939, *Carl & Wells s.n.* (NCSC 8815); back dune grassland between dune and maritime forest edge, Bald Head Island State Natural Area, just inside northern border, 12 Sep 2017, *Schoonover, II 105* (NCU); established dune system, Bald Head Island State Natural Area, just inside southern border, 15 Oct 2017, *Schoonover, II 113* ((NCU holotype). **Carteret Co.:** edge of evergreen scrub, Bogue Bank, 8 mi. W of Atlantic Beach, 15 Sep 1964, *Phipps, MacInnes, & Lubke 3695* (NCU 397967); clearing in maritime forest, Fort Macon State Park Nature Trail, 18 Sep 2017, *Schoonover, II 107* (NCU); established dune grassland on coastal estuarine island, Rachel Carson Reserve, Bird Shoal, 1 Oct 2017, *Schoonover, II 108* (NCU); established dune system, Shackleford Banks, 2 Oct 2017, *Schoonover, II 109* (NCU); established dune system, Core Banks, 3 Oct 2017, *Schoonover, II 110* (NCU). **Dare Co.:** semi-stable sand flat on lee side of main dune, Cape Hatteras National Seashore, between Frisco and Hatteras village, W side of NC 12, 15 Aug 2012, *Sorrie 13073* (NCU 601371); unstable sand dunes, Cape Hatteras National Seashore, S side of Hatteras village, entrance to 4WD road through dunes, 15 Aug 2012, *Sorrie 13074* (NCU 601372); semi-stable dunes, Cape Hatteras National Seashore, S of Open Pond, 24 Oct 2012, *Sorrie 13126* (NCU 647186, 647187); semi-stable low dunes W of high foredune, Cape Hatteras National Seashore, S of Avon, E of NC 12, 26 Oct 2012, *Sorrie 13131* (NCU 647188); maritime hammock, disturbed area, Buxton, 6 Oct 1973, *Boufford 12215* (CM 255639); established dune system, Salvo, 8 Oct 2017, *Schoonover, II 112*; stable dune field behind main foredune, Pea Island National Wildlife Refuge, southern end of park below New Inlet, 9 Sep 2018, *McClelland 178*. **Hyde Co.:** established dune system, Ocracoke Island, 8 Oct 2017, *Schoonover, II 111*. **New Hanover Co.:** manmade sand hillock covered with scrub, on N side of hillock near Federal Point, Fort Fisher State Park, 10 Sep 2016, *Schoonover, II & McClelland 81* (NCU 648247); manmade sand hillock covered with scrub, on N side of hillock near Federal Point, Fort Fisher State Park, 10 Sep 2016, *Schoonover, II & McClelland 82* (NCU 648248); backside of dune complex, edge of grilling area at Fort Fisher State Recreation Area, 10 Sep 2016, *Schoonover, II 83* (NCU 648249); backside of dune complex, edge of grilling area at Fort Fisher State Recreation Area, 10 Sep 2016, *Schoonover, II & McClelland 84* (NCU 648250). **Pender Co.:** plants located on Topsail Island from 130 South Anderson on the NW side of the street, S to Barwick Avenue, as well as down Barwick Ave on the SW side of the street, 5 Oct 2012, *Kunz & Suiter s.n.* (NCU 600191). **SOUTH CAROLINA. Charleston Co.:** interdune swale flat, National Wildlife Refuge, Cape Island, located on the northern, accreting end of the island, about 125 m E of Cape Romain Harbor, 130 m W of the ocean, 1 km S of island's northern tip, 19 Sep 2014, *Rankin s.n.* (NCU 634150, USCH 116147); *Uniola paniculata-Heterotheca subaxillaris-Conyza canadensis* dune, Cape Romain NWR – Cape Island, 17 Jul 2009, *Carolina Vegetation Survey 112-08-1376* (NCU). **Georgetown Co.:** top of back dune, about 1.6 mi N of Coast Guard Station, on E side of North Island, 15 May 1990, *Nelson 8995* (USCH 51213); open sand of old dunes, about 2600' S of Coast Guard light, North Island, 27 Sep 1991, *Nelson 11579* (NCU 561185, USCH 55537); on old, exposed dune top, about 3000 ft SSE of old Coast Guard light, near the beach, North Island, 27 Sep 1991, *Nelson 11582* (USCH 55539); on open dune line, exposed and very windy, about 3000 ft NE of old Coast Guard light looking over beach, North Island, 27 Sep 1991, *Nelson 11584* (NCU 561188, USCH 55540); top of old dune line, about 2600 ft S of old Coast Guard light, W side of North Island, 27 Sep 1991, *Nelson 11590* (USCH 20068); about 2600 ft S of old Coast Guard light, North Island, 27 Sep 1991, *Nelson 11591* (NCU 560877, USCH 20188); on lower edges of old dune valleys, maritime forest, just NE of lower terminus of Goose Blind Rd, Pine Ridge on lower part of South Island, 17 Feb 1993, *Nelson & Cely 13774* (USCH 59815); open sand behind dunes and near open salt flats, about 1/4 mi N of parking lot at NE end of Huntington Beach State Park, E side of US 17, about 12 mi N of Georgetown, 27 Sep 2003, *Nelson 24295* (NCU 580608, 580609; USCH 94128); *Ilex vomitoria-Juniperus virginiana* var. *silicicola-Quercus virginiana* shrubland, Debordieu Beach, 17 Jul 2009, *Carolina Vegetation Survey 112-06-1378* (NCU).

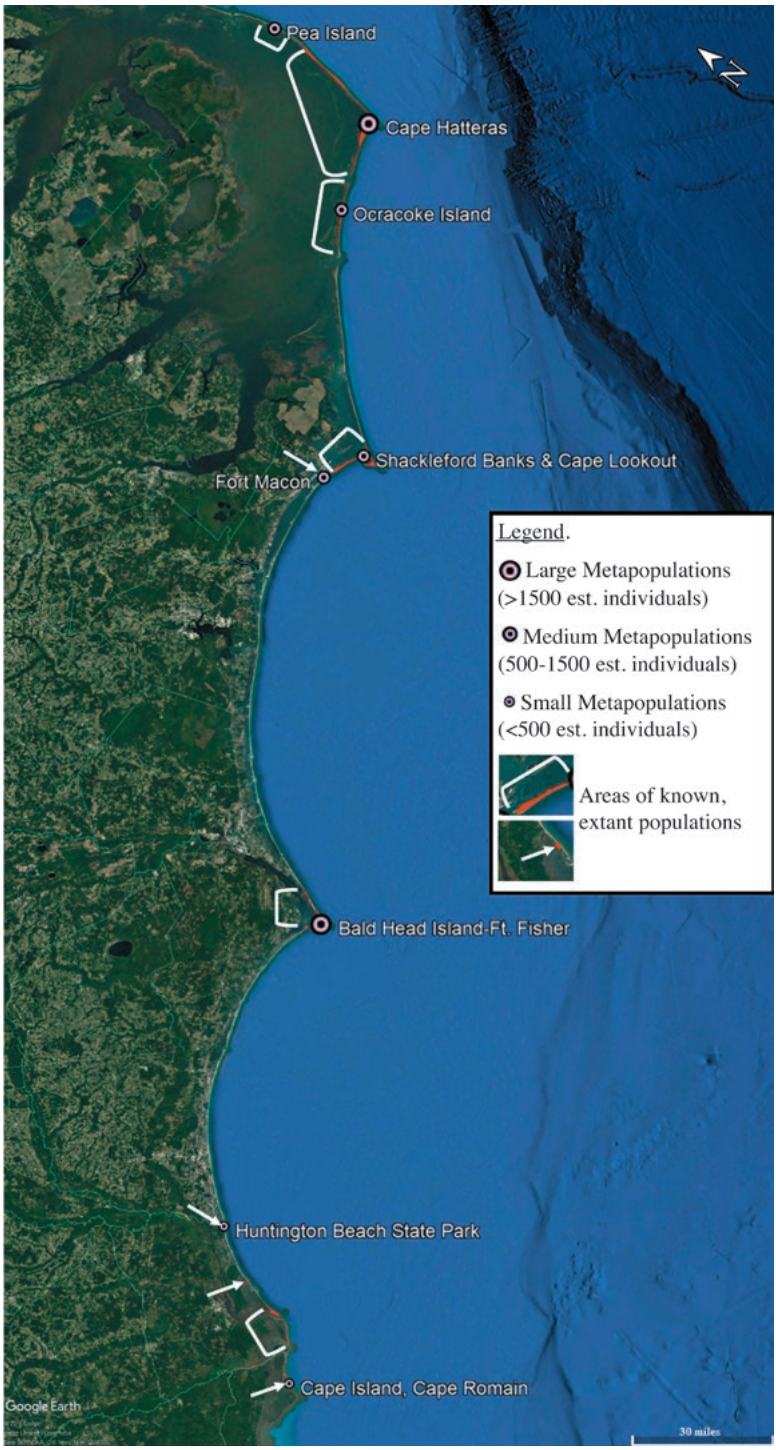

Fig. 6. Distribution map of *Trichostema nesophilum*. Red shaded areas are only labeled with locality information where the population size has been estimated.

Fig. 7. Stable Dune Barren, Southern Subtype (Schafale 2012; CEGL004234), typical habitat of *Trichostema nesophilum*. Photo by R. Kevan Schoonover McClelland.

Following is the new key to *Trichostema* sect. *Trichostema* (adapted from Weakley 2015).

1. Plant annual, herbaceous, branching in the middle and upper part of the plant; larger leaves 1.5–6.5 cm long, ovate-oblong to lanceolate, length-width ratio of 2.5–18; open corollas and flower buds light to dark blue; stems with bearded nodes, long spreading trichomes (these sometimes sparse), short spreading trichomes, and/or short, downwardly curved or appressed trichomes (when present with long spreading trichomes, these are generally restricted to the base of the plant; otherwise, present throughout) [throughout eastern North America].
   2. Leaves broadly lanceolate to oblong or elliptic, length-width ratio of 2.5–6; stems with a combination of long spreading, short spreading, and downwardly curved or appressed trichomes, the last being generally restricted towards the base of the plant; nodes bearded [occurring in a wide variety of habitats] _____ **T. dichotomum**
   2. Leaves narrowly lanceolate to linear, length-width ratio of 5–18; stems with downwardly curved or appressed trichomes throughout; nodes not bearded [occurring primarily in nutrient rich sandy sites and on the edges of granite flatrocks] _____ **T. setaceum**
1. Plant perennial, with a woody base, branching throughout or in the lower part of the plant; larger leaves 1–4 cm long, oblong to obovate, length-width ratio of 1.5–3.5; open corollas either dark blue or pink-lavender to nearly white; flower buds either indigo-black or pink-lavender; stems with short spreading trichomes and short downwardly curved or appressed trichomes; nodes not bearded [restricted to either peninsular Florida or the barrier islands of North and South Carolina].
   3. Plant bushy, intricately branched and rebranched throughout the plant; leaves generally oblong or rhombic; flowers pink-lavender to nearly white; flower buds pink-lavender; anthers lemon yellow [restricted to barrier islands of North and South Carolina] _____ **T. nesophilum**
   3. Plant virgate with majority of branching occurring at or near the base of the plant, the several branches virgate and ascending and minimally (or not at all) further branched; leaves generally oblong to obovate; flowers dark blue; flower buds indigo-black; anthers blue [restricted to peninsular Florida] _____ **T. suffrutescens**

The genus *Trichostema* is currently under study by the first author of this section (RKSM) for his graduate dissertation at UNC-Chapel Hill. This species will be included with his work on a molecular phylogeny of *Trichostema.* There are several other entities in Florida that do not match current species concepts (see Lewis 1945) and were not included in the morphometric data for this publication. These entities are currently lumped under three species (*Trichostema dichotomum, T. setaceum,* and *T. suffrutescens*) and are also under study.

POACEAE

Dichanthelium: Three species in the *D. scabriusculum* complex are given names in *Dichanthelium*

Primary author: Richard J. LeBlond

The *Dichanthelium scabriusculum* (Elliott) Gould & C.A. Clark complex comprises five species originally described as belonging to *Panicum: P. aculeatum* Hitchc. & Chase, *P. cryptanthum* Ashe, *P. mundum* Fernald, *P. recognitum* Fernald, and *P. scabriusculum* Elliott. Three of the names—*P. aculeatum, P. cryptanthum,* and *P. scabriusculum*—were recognized by Hitchcock and Chase (1910), with *P. mundum* later described in 1936, and *P. recognitum* in 1938. All five names were recognized and treated by Silveus (1942) and Hitchcock and Chase (1951). Radford et al. (1968) only recognized *Panicum scabriusculum* and did not mention the others even in synonymy. Gould and Clark (1978) included all five names in *D. scabriusculum*. Freckmann and Lelong (2003) placed *P. cryptanthum* in synonymy with *D. scabriusculum*, and regarded the others as sterile or putative hybrids.

The combination *Dichanthelium cryptanthum* (Ashe) LeBlond was made by LeBlond in Weakley et al. (2011). New combinations are here made for *D. aculeatum* (Hitchc. & Chase) LeBlond, *D. mundum* (Fernald) LeBlond, and *D. recognitum* (Fernald) LeBlond (see treatments below).

The five species share leaf blade size, shape, and texture. Lowest sheaths are usually papillose-pilose. Collectively, larger leaf blades are stiff, 6–25 cm long × 5–16(18) mm wide, with slightly narrowed to rounded to cordate bases. Leaf surfaces are glabrous (hirsute in one specimen of *D. recognitum*), and scabrous in some species. Vernal panicles are large, 6–20 cm long and half to nearly as wide. Spikelets are strongly nerved (less so in *D. mundum*). Autumnal branching in all five is from the middle and upper nodes, with moderately reduced autumnal leaves.

Ligule structure is important for identification of these species. In *Dichanthelium cryptanthum* and *D. scabriusculum*, the ligule is strictly membranous, though it can be slightly erose at the apex, (0.1)0.3–0.6 mm long in *D. cryptanthum* and 0.5–1.3 mm long in *D. scabriusculum*. The ligule in *D. aculeatum* is membranous proximally and ciliate distally (rarely ciliate only), with the membranous portion (0)0.05–0.4 mm long, and the ciliate portion 0.2–1.1 mm long. The ligule in *D. mundum* and *D. recognitum* is entirely ciliate (rarely with a short membrane), 0.5–1.1 (2.0) mm long in *D. mundum*, and 0.3–1.1 (2.1) mm long in *D. recognitum*. In one specimen of *D. mundum* and two of *D. recognitum*, the cilia have been fused into a membrane-like structure by a hardened varnish-like material, but the individual cilia remain evident. Sharing nearly identical ligule features, *D. mundum* and *D. recognitum* are distinguished by several other characters, including spikelet length, first glume length and shape, relative length of second glume, and fertile lemma length.

Two difficult-to-assign specimens were encountered during the analysis. An 1866 specimen from Wicomico Co., Maryland (*Commons* 50, NCU) has the spikelet length and ciliate ligule of *D. aculeatum*, but the shorter first glume and fertile lemma of *D. scabriusculum*. It is here treated as belonging to *D. aculeatum*, but intermediate to *D. scabriusculum*. A 2004 specimen from Carolina Co., Maryland (*Knapp* 950, NCU), has the membranous-ciliate ligule of *D. aculeatum,* but otherwise is *D. scabriusculum,* and is treated as the latter.

Here is a key to all five species in the complex (smooth relates to scabrous, while glabrous relates to pilosity):

1. Spikelets (2.6)2.8–3.4(3.6) mm long; first glume (0.9)1.1–1.6 mm long; ligule a ciliate membrane, the membrane (0)0.05–0.4 mm long, the cilia 0.2–1.1 mm long; vernal panicles strongly scabrous, often with stiff spreading hairs, but not otherwise pubescent, with usually < 30 spikelets; fertile lemma 2.2–2.7 mm long _____ **D. aculeatum**

1. Spikelets 1.8–2.8(3.0) mm long; first glume 0.3–1.1 mm long; ligule an eciliate membrane 0.3–1.3 mm long, or of cilia only; vernal panicles smooth to moderately scabrous, glabrous to short-pubescent, with usually > 30 spikelets; fertile lemma 1.6–2.2 mm long.
   2. Upper internodes usually scabrous and glabrous; ligule an eciliate membrane (0.1)0.3–1.3 mm long; peduncle scabrous to smooth, glabrous (rarely pubescent); spikelets lance-ovate, acute; second glume and sterile lemma exceeding fertile lemma by 0.3–0.8 mm in at least some spikelets.
      3. Lowest elongate internode usually > 2 mm wide; nodes glabrous to puberulent; larger blades 10–25 cm long, 8–16 mm wide; ligule 0.5–1.3 mm long; panicles usually 10–20 cm long; spikelets 2.1–2.8 mm long; first glume 0.3–0.6(0.8) mm long, usually < 1.5× as long as wide, reniform to suborbicular to broadly ovate, apex truncate to subacute ____ **D. scabriusculum**
      3. Lowest elongate internode usually < 2 mm wide; nodes often bearded; larger blades 7–12 cm long, 6–9 mm wide; ligule (0.1)0.3–0,.6 mm long; panicles usually 6–10 cm long; spikelets 2.0–2.4(2.6) mm long; first glume 0.7–1.1 mm long, usually > 1.5 × as long as wide, lanceolate, apex blunt to acute ____ **D. cryptanthum**
   2. Upper internodes smooth, glabrous to pubescent; ligule ciliate, 0.5–1.1(2.1) mm long, membrane absent or minute (<0.1 mm); peduncle pubescent, non-scabrous; spikelets obovoid to elliptic, obtuse, bluntly pointed, or subacute; second glume and sterile lemma equaling fertile lemma, or exceeding it by < 0.2 mm (second glume shorter than lemmas in *D. recognitum*).
      4. Lowest internodes usually purple-villous; nodes retrorsely (-spreading) bearded; spikelets 1.8–2.2 mm long, moderately densely pubescent; first glume broadly ovate, subacute, 0.4–0.7 mm long, usually < 1.5× as long as wide; second glume about as long as sterile and fertile lemmas; fertile lemma 1.7–1.8 mm long ____ **D. mundum**
      4. Lowest internodes glabrous or pubescent or spreading villous, usually not purplish; nodes glabrous, sparsely pubescent to sparsely bearded; spikelets 2.2–2.8(3.0) mm long, sparsely pubescent; first glume broadly ovate, 0.7–1.1 mm long, usually > 1.5× as long as wide; second glume shorter than lemmas by (0)0.05–0.3 mm; fertile lemma 2.1–2.2 mm long ____ **D. recognitum**

Range and habitat data, as well as additional morphological data, are provided in the following treatments.

Dichanthelium aculeatum (Hitchc. & Chase) LeBlond, **comb. nov.** Basionym: *Panicum aculeatum* Hitchc. & Chase, Rhodora 8:209. 1906. Type: U.S.A. MARYLAND: Montgomery Co./Prince Georges Co.: large clump by small slough, border of woods, 27 Jul 1904, Tacoma Park, *Chase 2520* (holotype: US 2383592; isotype: NY 381572).

Additional specimens examined. **U.S.A. CONNECTICUT. Tolland Co.:** 21 Jun 1911, *Bissell s.n.* (CBS, DUKE, US, YU). **DELAWARE. Sussex Co.:** 11 Sep 1963, *Uhler & Hotchkiss s.n.* (US). **DISTRICT OF COLUMBIA:** 2 Sep 1912, *Hubbard 463* (US). **MARYLAND. Montgomery Co./Prince Georges Co.:** 17 Jul 1905, *Chase 5439* (NY, US). **Prince Georges Co.:** 20 Aug 1916, *Chase 7523* (ISC, NY). **Wicomico Co.:** 13 Sep 1866, *Commons 50* (NCU). **MASSACHUSETTS. Barnstable Co.:** 4 Aug 1989, *Sorrie 4818 & LeBlond* (GH). **Franklin Co.:** 23 Aug 1977, *Ahles 1977* (NCU). **NEW YORK. Nassau Co.:** 4 Jul 1903, *Bicknell s.n.* (NY, US); 11 Jul 1903, *Bicknell s.n.* (NY); 1 Jul 1906, *Bicknell s.n.* (NY, US); 16 Jul 1911, *Bicknell s.n.* (NY); 18 Jun 1920, *Ferguson 5668* (NY); 31 May 1921, *Ferguson 187* (NY); 30 Aug 1921, *Ferguson 802* (NY, US); 26 Oct 1921, *Ferguson 1136* (US); 26 Nov 1921, *Ferguson 1191* (NY); 4 Jun 1922, *Ferguson 1298* (NY); 11 Jun 1922, *Ferguson 1388* (GH), *1389* (NY); 6 Jul 1922, *Ferguson s.n.* (NY); 9 Jul 1925, *Ferguson 4104* (NY); 11 Sep 1926, *Ferguson 6087* (NY); 22 Jun 1927, *Ferguson 5663* (DUKE, NY). **Oneida Co.:** 21 Jun 1921, *House 8140* (DUKE). **NORTH CAROLINA. Hyde Co.:** 8 Jun 1906, *Chase 3210* (US) (paratype). **Orange Co.:** 30 Jun 1940, *Silveus 5986* (DUKE). **OHIO. Tuscarawas Co.:** 27 Jun 1967, *Cusick 4839* (NCU).

In the protologue, the type location is stated as "Tacoma Park, D.C.," but the Tacoma Park collection site is currently recognized as occurring in Maryland. In addition to the paratype from North Carolina (*Chase 3210*, US), two other paratypes are named in the protologue, *Hitchcock & Chase 94* and *House 1041,* both from Tacoma Park. These latter two collections were not encountered during this investigation.

Panicum aculeatum was recognized by Hitchcock and Chase (1910, 1951), Small (1933), Silveus (1942), Blomquist (1948), Fernald (1950), and Gleason (1952). It was placed in synonymy with *Panicum scabriusculum* Elliott by Gleason and Cronquist (1991), with *Dichanthelium scabriusculum* (Elliott) Gould & Clark by Gould and Clark (1978) and Kartesz (1999), and as a putative hybrid by Freckmann and Lelong (2003). It was not recognized even in synonymy by Radford et al. (1968).

Dichanthelium aculeatum is most easily distinguished by its ligule and larger spikelets. The proximal portion of the ligule is a membrane 0.05–0.4 mm long, with the distal portion comprised of cilia 0.2–1.1 mm long, and extending from the summit of the membrane. The other taxa in the complex have either an entirely membranous (*D. cryptanthum, D. scabriusculum*) or entirely ciliate ligule (*D. mundum, D. recognitum*). Spikelets are (2.6)2.8–3.4(3.6) mm long in *D. aculeatum*, with first glumes (0.9)1.1–1.6 mm long. The other taxa in the complex collectively have spikelets 1.8–2.8(3.0) mm long, with first glumes 0.3–1.1 mm long. The fertile lemma is distinctly longer in *D. aculeatum*—(2.2)2.4–2.7 mm vs. 1.6–2.2 mm in the other taxa. *Dichanthelium aculeatum*

vernal panicles usually have < 30 florets, while the other taxa in the complex usually have > 30 florets in vernal panicles.

Dichanthelium aculeatum populations are few and scattered from New York and Massachusetts south to North Carolina, and west to Ohio (Fig. 8). The species has also been documented from Connecticut, Delaware, District of Columbia, and Maryland. It was reported from Virginia by Hitchcock and Chase (1951), very likely based on the 1937 specimen from Sussex Co. (*Fernald & Long 7279,* GH) that was originally identified as *Panicum aculeatum,* but is *D. recognitum*. Populations usually occur near rivers, lakes, or swamps in open to wooded areas.

Dichanthelium mundum (Fernald) LeBlond, **comb. nov.** Basionym: *Panicum mundum* Fernald, Rhodora 38:392–394. 1936. Type: U.S.A. Virginia: peaty clearing at border of cypress (*Taxodium*) swamp, 4 mi NW of Homeville, 25 Aug 1936, *Fernald & Long 6499* (holotype: GH 23513; isotypes: F 73333; GH 23511, 23512; MO 1112687; NY 381645; US 1682808, 3274309).

Additional specimens examined. **U.S.A. ALABAMA. Jackson Co.:** 16 Jun 1992, *Kral 80823* (TENN). **NORTH CAROLINA. Durham Co.:** 31 Jul 1937, *Blomquist 9791* (DUKE, FSU, NY). **Wilson Co.:** 10 Jul 1934, *Blomquist 6328* (DUKE). **TENNESSEE. Cumberland Co.:** 13 Jul 1965, *Rogers 34189* (NCU). **VIRGINIA. Sussex Co.:** 19–20 Jul 1936, *Fernald & Long 6017* (GH, NY) (TOPOTYPE); 10 Jun 1938, *Fernald 8077& Long* (DUKE) (TOPOTYPE). **Virginia Beach Co.:** (formerly Princess Anne Co.) 16 Jun 1935, *Fernald, Griscom, & Long 4541, 4542* (GH, paratype); 30 Jul 1942, *Fernald 14272 & Long* (GH).

Fernald (1936) described *Panicum mundum* as "one of the neatest and most definite of species." It was treated as a full species by Silveus (1942), Blomquist (1948), Fernald (1950), Hitchcock and Chase (1951), and Gleason (1952). It was placed in synonymy with *Panicum commonsianum* Ashe by Gleason and Cronquist (1991), and with *Dichanthelium ovale* (Elliott) Gould & Clark var. *addisonii* (Nash) Gould & Clark by Gould and Clark (1978) and Kartesz (1999). Freckmann and Lelong (2003) regarded it as a rare and apparently putative hybrid of *D. scoparium* (Lamarck) Gould with *D. dichotomum* (Linnaeus) Gould. It was not recognized even in synonymy by Radford et al. (1968).

Dichanthelium mundum has the overall appearance of other taxa in the *D. scabriusculum* complex with its stiff and relatively large leaves with glabrous surfaces and rounded bases, and with its moderately reduced autumnal leaves on branches from the middle nodes. Its spikelets are only 1.8–2.2 mm long, compared to 2.2–3.4(3.6) mm in the other taxa in the complex. The lowest internodes are hirsute and purplish at least distally (greenish and glabrous in *Kral 80823* from Cumberland Co., Tennessee). Upper internodes are variously hairy or glabrous. Lowest nodes are bearded, usually retrorsely. The ciliate ligule is mostly 0.5–1 mm long, but to 2 mm in the *Fernald 8077* topotype collection from Sussex Co., Virginia. First glumes are 0.4–0.7 mm long, broadly ovate and tapering to a subacute summit. The spikelet apex is obtuse to bluntly pointed.

Apparently a very rare species, *Dichanthelium mundum* is known from only six collection sites, with the most recent collection from 1992. The populations are scattered east to west from the Virginia Coastal Plain through the North Carolina Piedmont into the Mountain province of eastern Tennessee and northern Alabama (Fig. 9). The grass has been found bordering swamps and river marshes, in sandy and peaty meadows and swales, and in open pine woods. The phytogeography and habitat suggest a periglacial influence.

Dichanthelium recognitum (Fernald) LeBlond, **comb. nov.** Basionym: *Panicum recognitum* Fernald, Rhodora 40:331–332. 1938. Type: U.S.A. New Jersey: Albion, headwaters of branch of Timber Creek, 27 Jun 1912, *Long 7671* (holotype: GH 23008; isotype: US 2383593).

Additional specimens examined. **U.S.A. CONNECTICUT. Hartford Co.:** 25 Aug 2002, *Morehead 4954 & Thomas* (NCU); 4 Jun 2004, *Morehead 5165* (NCU). **NEW JERSEY. Camden Co.:** 7 Sep 1910, *Long 4944* (GH), *4946* (GH, NY) (topotypes); 27 Jun 1912, *Long 7672* (GH, NY), *7676* (GH) (paratypes); 9 Jul 1912, *Long 7790, 7792, 7794* (GH, topotypes); 12 Jun 1917, *Long 15,030* (GH?, paratypes); 29 Jun 1918, *Long 19,315* (GH?, paratype). **Cape May Co.:** 6 Jul 1912, *Brown 59* (GH, paratype). **Ocean Co.:** *Long 13,006* (GH?, paratype). **NEW YORK. Weschester Co.:** Jul 1876, *Howe s.n.* (NY). **NORTH CAROLINA. Alleghany Co.:** 26 Jul 1932, *Blomquist 1178* (DUKE). **PENNSYLVANIA. Chester Co.:** 4 Jul 1903, *Stone 5305* (GH?, paratype). **Lancaster Co.:** 9 Jul 1904, *Carter s.n.* (GH?, paratype). **RHODE ISLAND. Providence Co.:** 14 Jun 1942, *Palmer 46134* (US). **TENNESSEE. Polk Co.:** 20 Jul 1969, *Rogers 44050* (TENN). **VIRGINIA. Sussex Co.:** 11 Sep 1937, *Fernald & Long 7279* (GH).

Fernald (1938) described *Panicum recognitum* from specimens at the Philadelphia Academy that "for many years" had been "set apart … as a strange species." It was treated as a full species by Silveus (1942), Fernald

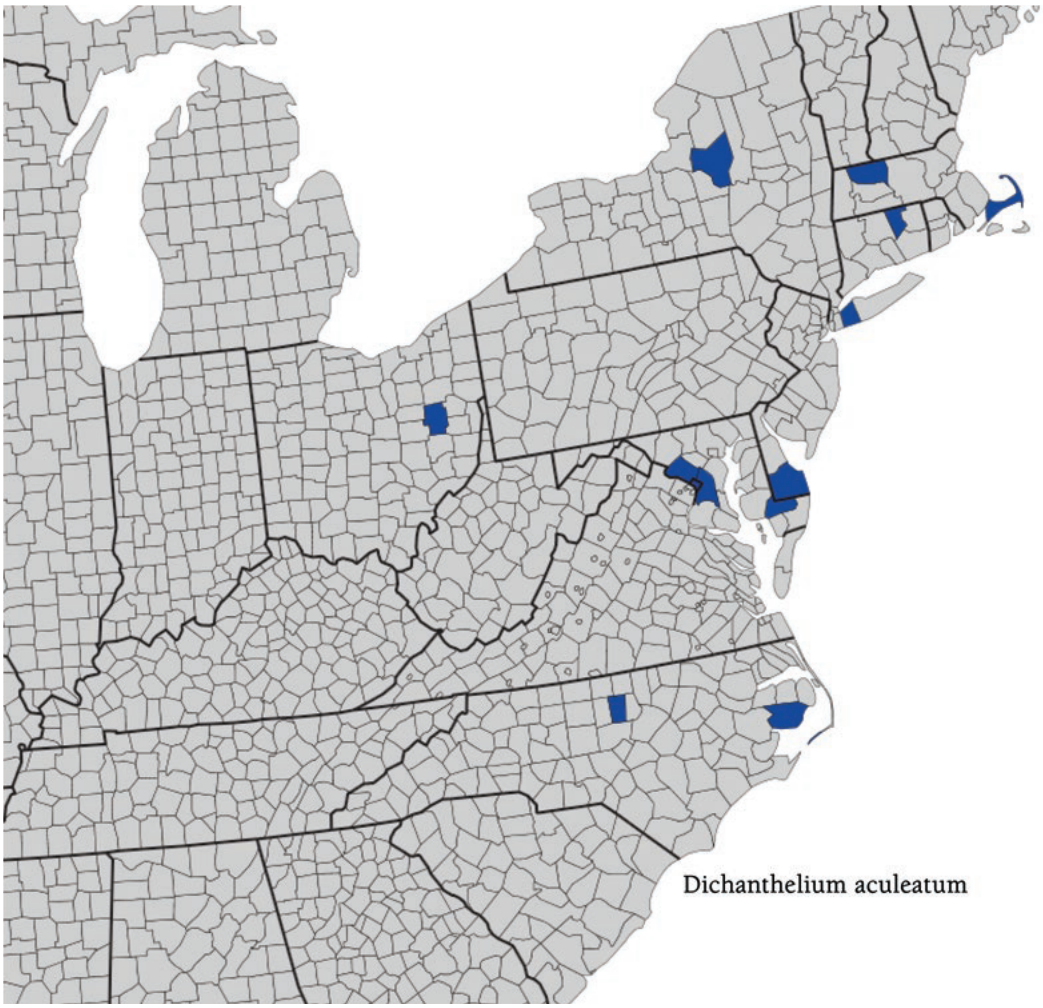

Fig. 8. Known distribution of *Dichanthelium aculeatum*. All records are pre-1990. Prepared by Richard LeBlond, June 2018.

(1950), Hitchcock and Chase (1951), and Seymour (1982). It was treated as a synonym of *Dichanthelium scabriusculum* by Gould and Clark (1978) and Kartesz (1999). Freckmann and Lelong (2003) regarded it as "rare sterile hybrids of *Dichanthelium dichotomum* and perhaps *D. scoparium*." It was disregarded altogether by Gleason (1952) and Gleason and Cronquist (1991). It was also disregarded by Radford et al. (1968) by virtue of their failure to recognize *P. aculeatum,* which in North Carolina included a specimen collected by Blomquist from Alleghany Co. and subsequently identified by him as *P. aculeatum,* but which in fact was *P. recognitum* (*Blomquist 1178,* DUKE).

Dichanthelium recognitum is most readily identified by its ciliate ligule and obtuse, bluntly pointed, or subacute spikelets. It is the only member of the complex with a second glume usually shorter than the lemmas, by (0)0.05–0.3 mm. Lower nodes and internodes are variously glabrous to pubescent, with the nodes rarely retrorsely bearded. The ligule is normally 0.3–1.1 mm long, but measured to 2.1 mm in one specimen.

The relatively few populations are concentrated from Connecticut and Rhodes Island south to New Jersey and southeastern Pennsylvania, then disjunctly to southeastern Virginia and the Mountain province of North

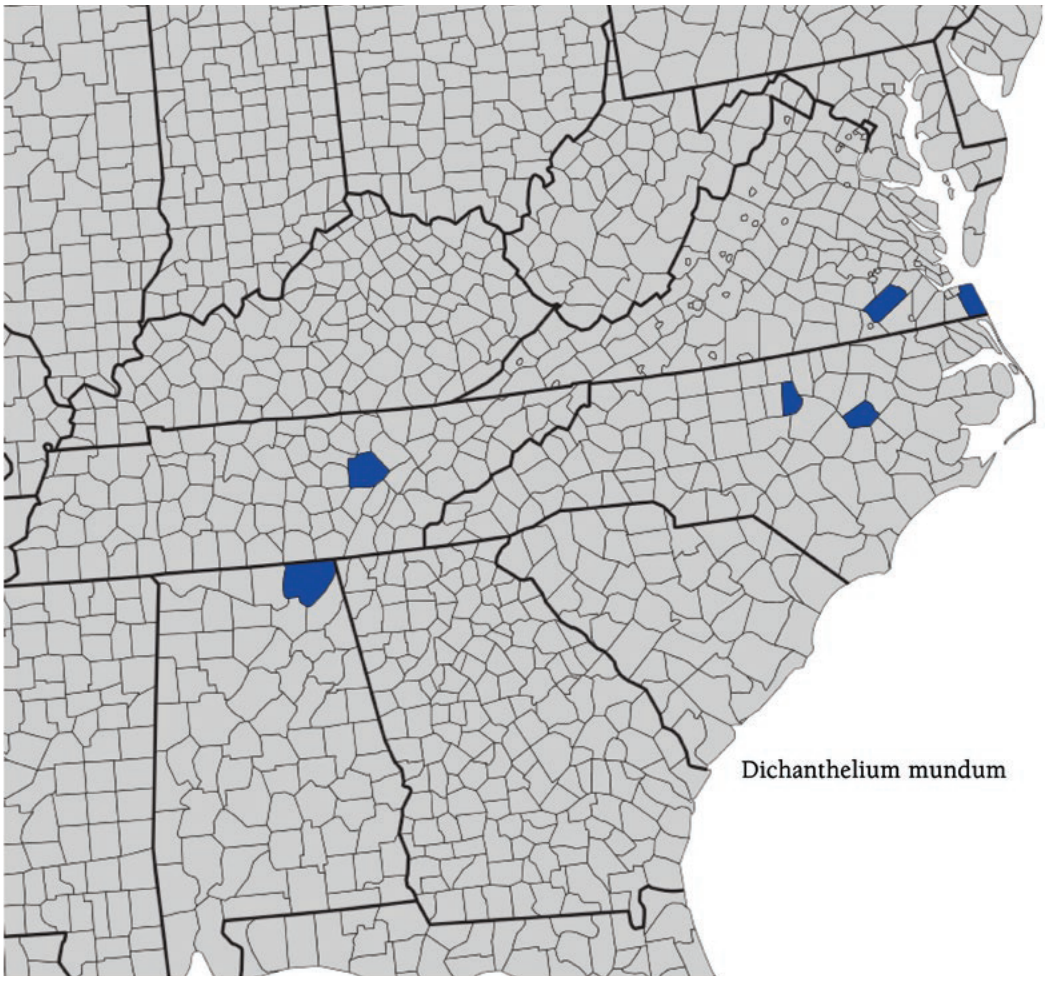

Fig. 9. Known distribution of *Dichanthelium mundum*. All records are pre-1993. Prepared by Richard LeBlond, June 2018.

Carolina and Tennessee (Fig. 10). This distribution is similar to the phytogeographic pattern identified by Sorrie and Weakley (2001) as bimodal coastal plain/Appalachian Mountains. Habitats are mostly wet soils adjacent to creeks, swamps, ponds, and bogs, but it has also been reported from dry woods.

Paspalum: *Paspalum arundinaceum* (syn. *P. pleostachyum*) is adopted for Florida

Primary authors: Alan R. Franck and J. Lange

Paspalum pleostachyum Döll was first reported for south Florida by Long and Lakela (1971) and has remained naturalized in Florida, as evidenced by several recent herbarium specimens. The name has also been applied to plants in the West Indies. For the Lesser Antilles, Gould (in Howard 1979) wrote "*Paspalum arundinaceum* and *P. pleostachyum* (including *P. secans*) probably belong to a single species complex, in which case *P. arundinaceum* is the oldest valid name." An analysis of these three names mentioned by Gould suggests they refer to only one species presently occurring in Florida and the West Indies. Their application in the West Indies and later adoption in Florida began with the work of Mary Agnes Chase and Albert S. Hitchcock.

When *Paspalum secans* was first described from the West Indies, no comparison was made with *P.*

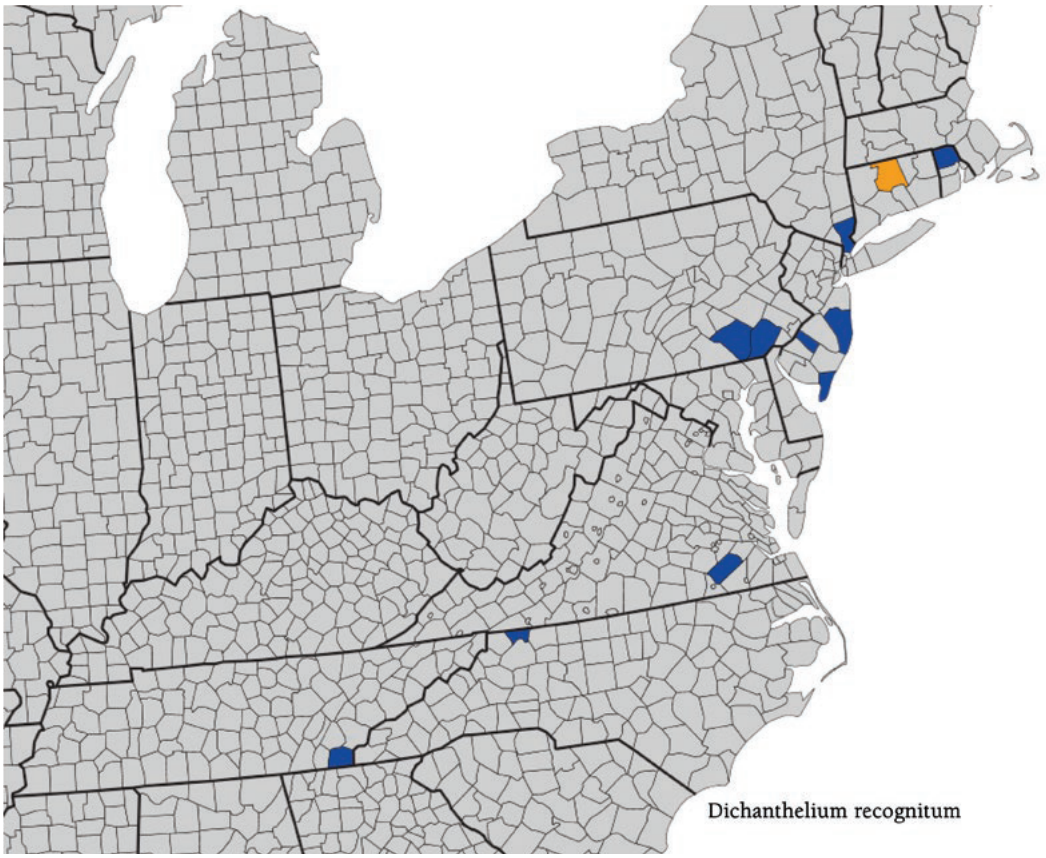

Fig. 10. Known distribution of *Dichanthelium recognitum*. Orange (post-1997); blue (pre-1998). Prepared by Richard LeBlond, June 2018.

arundinaceum nor with *P. pleostachyum* (Hitchcock & Chase 1917). Later, Chase (1929) recognized and applied all three names to the flora of the West Indies. *Paspalum pleostachyum* was characterized as "plant not robust; if more than one meter tall culms relatively slender," while the other two (*P. arundinaceum* and *P. secans*) were characterized as "plants robust; culms commonly more than 1 meter" (Chase 1929; Hitchcock 1936). Anent *P. arundinaceum* and *P. secans*, Chase (1929) wrote that "a much larger amount of material now shows the two to be distinct, though closely related." *Paspalum arundinaceum* was described as "racemes thick; spikelets somewhat crowded; rachis 1 mm wide" and "racemes usually 12 to 18" but varying from "9 to 25" (Chase 1929; Hitchcock 1936). *Paspalum secans* was described as "racemes slender; spikelets not crowded; rachis 0.7 mm wide" and "racemes mostly 7 to 12" but varying from "3 to 19" (Chase 1929; Hitchcock 1936). Presumably, from these concepts, Long and Lakela (1971) considered *P. pleostachyum* to be applicable to Florida material.

For Jamaica, Adams (1972) followed the distinctions given by Chase but wrote that *P. arundinaceum* and *P. secans* are "easily confused" and "may not be really distinct." Proctor (1982) then added *P. pleostachyum* to the Jamaican flora, probably based on Chase's taxonomy.

For the Lesser Antilles, Gould (in Howard 1979) established *P. secans* as a synonym of *P. pleostachyum*, and, as noted above, suspected his concepts of *P. arundinaceum* and *P. pleostachyum* only truly referred to one species. Gould characterized *P. arundinaceum* as "panicle branches thick, the spikelets closely placed and crowded in 4 regular rows," in contrast to *P. pleostachyum*, described as "panicle branches relatively slender, the spikelets not closely placed and in 4 well-defined rows."

For the Bahamas, Correll and Correll (1982) established *P. secans* as a synonym of *P. arundinaceum,* writing that "In the Bahamas the two entities cannot be differentiated […] We are recognizing only one species." Following Chase's concepts, plants that were "not robust" were still considered to be distinct as *P. pleostachyum* (Hill 1976; Correll & Correll 1982).

It is interesting that the floras of the Bahamas, Jamaica, and Lesser Antilles all attempted to apply the taxonomy of Chase using all three names (either as distinct or as synonyms) and reported difficulties in distinguishing them. An analysis of herbarium specimens from Florida and the West Indies at FTG and USF shows that all of the putative distinctions break down. Plants with narrow rachises (< 1 mm wide) can still be "robust" with relatively thick stems and a height more than 1 m. The type specimens of all three names have rachises less than 1 mm (ca. 0.6–0.8 mm) wide, contradicting the characterization of wider rachises in *P. arundinaceum* (Chase 1929). For the *Flora Mesoamericana*, only *P. arundinaceum* was applied (without mention of *P. pleostachyum* or *P. secans*), and its rachis width was given as 0.5–1 mm (Pohl & Davidse 1994), further reducing the usefulness of the rachis width as a diagnostic character. *Paspalum secans* was considered a synonym of either *P. arundinaceum* (Correll & Correll 1982) or *P. pleostachyum* (Howard 1979), supportive of their morphological continuity. Searching for other putative distinctions, such as blades pubescent for *P. pleostachyum* (Allen & Hall 2003) and glabrous for *P. arundinaceum* (Pohl & Davidse 1994), reveals specimens with pubescent blades also being "robust" with wider rachises, combining characters of the two. For *P. pleostachyum*, Long and Lakela (1971) instead described the blades as "varyingly pubescent" or "glabrescent." There is also no discernible difference in the spacing or arrangement of the spikelets (Gould in Howard 1979) among the type specimens or other collections. The alleged distinctions do not separate *P. arundinaceum* (holotype at FI, barcode FI012302), *P. pleostachyum* (holotype at G, barcode G00176705; isotype at US, barcode 00140287), or *P. secans* (holotype at US, barcode 00140322).

Of the plants occurring in Florida (and the West Indies), there appears to be only one species worthy of recognition. Considering the names that have been applied, *P. arundinaceum* would be the oldest available name, as suggested by Gould (in Howard 1979) and accepted by Hall (2019).

PORTULACACEAE

Portulaca: Addition of *Portulaca minuta* to the native flora of North America

Primary authors: Keith A. Bradley, James F. Matthews, and Chad Anderson

Portulaca minuta Correll (Portulacaceae) was described from the Bahamas by Correll (1979), where it has been considered endemic (Correll & Correll 1982; Freid et al. 2014; Acevedo-Rodríguez & Strong 2019). Within the Bahamas it is apparently rare. Correll and Correll (1982) reported it from their map regions 6 and 9, which correspond to the Exuma Islands area and the Andros, Bimini, and Berry islands area. Correll's type collection is from Great Exuma Island (*Correll 49976,* A, F, FTG, MO, NY, US). Correll also collected the species on South Andros Island at the Congo Town Airport (*50027,* FTG, NY). These are the only collections known to the authors.

We here report the first documented occurrence of *P. minuta* in the United States.

U.S.A. FLORIDA. Monroe Co.: Big Pine Key, National Key Deer Refuge, in shallow, ephemeral freshwater pools in open barren limestone flat, a transition area between pine rockland and tidal mangroves; with sparse *Pinus elliottii* var. *densa* and shrubs, 12 Sep 2013, *Bradley 2725* (USF).

Pine rocklands are a fire-maintained pine savanna ecosystem restricted in the United States to the extreme southern Florida mainland and the lower Florida Keys (Myers & Ewel 1990). They also occur on some island groups within the Bahama archipelago, including Abaco, Andros, Grand Bahama, New Providence, and Caicos islands. Pine rocklands are similar in vegetation structure and ecology to coastal plain pine savannas throughout the southeast, but they differ in occurring on a substrate of exposed Miami oolitic limestone and have a West Indian floristic component, especially of shrubs and palms with wider distributions in the Bahamas and Caribbean islands.

In 2013 while conducting vegetation monitoring on Big Pine Key, Florida within the National Key Deer

Refuge, Bradley and Anderson encountered an unusual yellow-flowered *Portulaca* species. While it resembled *P. oleracea,* the habitat and habit suggested a different species. A specimen was identified as *P. minuta* using Correll (1979) and Correll & Correll (1982) and by comparisons with other *Portulaca* species from the West Indies. This represents the first report of the species from outside the Bahamas.

The population of *Portulaca minuta* occurs in an atypical example of the pine rockland ecosystem, even within the context of Big Pine Key. This microhabitat, covering only about a hectare, features broad expanses of solid oolitic limestone slabs that are almost completely unvegetated. These slabs may represent dried marls overtopping oolite (Dickson 1955). Where this substrate is interrupted by broken limestone and exposed soil, there are scattered, densely vegetated shrub and palm islands under a sparse canopy of stunted *Pinus elliottii* var. *densa*. Other taxa include *Leucothrinax morrisii, Eugenia foetida, Mosiera longipes, Guapira discolor, Sideroxylon celastrinum, Ernodea littoralis, Senna mexicana* var. *chapmanii,* and *Morinda royoc.* Herbs are sparse and include *Euphorbia porteriana, Abildgaardia ovata,* and *Rhynchospora floridensis.* Despite the regular fire interval in most pine rockland habitats, this small area probably has a much lower fire periodicity because of the lack of continuous fuel, with low intensity fires unable to transverse broad expanses of bare rock. This population was found along the eastern edge of the island less than 200 m from tidal wetlands.

Within these flat expanses of limestone are shallow, ephemeral freshwater depressions with thin soil layers, and small holes and crevices. It is within these pools and crevices that *P. minuta* is found. The pools resemble those found on granitic flatrocks of the southeastern piedmont (Keeley & Zedler 1998) and probably retain rain water for short times. As a taprooted perennial, the species can presumably tolerate the predicted wet and dry cycles of these pools. A survey of the area counted 387 plants in 2013. Plants were also observed by Daniel Clark (Refuge Manager) and Tony Pernas (National Park Service) in 2018.

Portulaca minuta is a yellow-flowered taprooted perennial with opposite, obovate to obovate-elliptic leaves (Figs. 11, 12). It is similar and closely related to the cosmopolitan *P. oleracea*, which differs in being a fibrous-rooted annual with alternate leaves. Overall, *P. minuta* has the aspect of a very small *P. oleracea*, the only species with which it can be confused in Florida and the Bahamas. The enlarged taproot and opposite leaves of *P. minuta* readily separate the two species (Figs. 11, 12). Style branches also differ, with 3 branches in *P. minuta* and 3 to 6 in *P. oleracea*. *Portulaca minuta* typically has 4 petals (Correll 1979), although at least one cultivated plant photographed in 2018 had 5 petals. *Portulaca oleracea,* in contrast, has 5 petals.

The habitat where *Portulaca minuta* was discovered on Big Pine Key is similar to its preferred habitat in the Bahamas, with the closest collection site approximately 390 km away. The similarity of *P. minuta* to *P. oleracea* could have easily caused it to be overlooked, even if a botanist had visited this small, difficult-to-access population. Flowers are also open only on sunny days. We consider this to be a previously undiscovered natural population.

We include a revised field key to the genus *Portulaca* in the United States, adapted from the *Flora of North America*, Vol 4 (Matthews 2003). These modifications allow the addition of *Portulaca minuta*.

Key based on flowering material

1. Petals yellow, orange, copper, bronze or white.
   2. Flowers 25 mm or more diam.
      3. Plants perennial; roots tuberous; stems stiffly erect; sw USA ____ **P. suffrutescens**
      3. Plants annual; roots fibrous; stems prostrate to suberect; widespread ____ **P. grandiflora** (in part)
   2. Flowers 20 mm or less diam.
      4. Leaf blades terete or hemispheric, linear to lanceolate, usually 3 mm or less wide.
         5. Stem nodes and inflorescences with conspicuous trichomes; flowers less than 8 mm diam.; Midwest and sw United States ____ **P. halimoides**
         5. Stem nodes and inflorescences with inconspicuous trichomes; flowers more than 9 mm diam.; tropical Florida ____ **P. rubricaulis**
      4. Leaf blades flattened, obovate or spatulate (sometimes lanceolate in *P. umbraticola*) 2–15 mm or more wide.
         6. Capsules encircled by expanded membranaceous wing ____ **P. umbraticola**
         6. Capsules not winged.
            7. Leaves alternate to subopposite; petals 5; fibrous roots, widely distributed annual in various habitats ____ **P. oleracea**

Fig. 11. Flowering *Portulaca minuta*. Photo by D. Clark.

7. Leaves opposite; petals 4 (5); tap rooted perennial; narrowly restricted, restricted to limestone outcrops in pine rocklands in the Florida Keys, with a wider distribution in the Bahama archipelago ____ **P. minuta**

1. Petals pink to purple.
8. Flowers 25 mm or more diam.; petals 15 mm or longer ____ **P. grandiflora** (in part)
8. Flowers to 25 mm diam.; petals 12 mm or shorter.
9. Leaf blades flattened, 2–12 mm wide, obovate to spatulate or oblanceolate ____ **P. amilis**
9. Leaf blades terete to hemispheric, 0.5–3 mm wide, linear to lanceolate.
10. Petals deeply 2-lobed; stamens 40 or more; stem nodes with inconspicuous trichomes; [restricted to sandstone outcrops in s. Georgia] ____ **P. biloba**
10. Petals not 2-lobed; stamens usually fewer than 30; stem nodes with conspicuous trichomes; [widespread in the United States].
11. Petals medium pink to almost white; seeds 0.6 mm or more diam., elongate; [restricted to granitic (or rarely diabase) outcrops in Georgia, South Carolina, North Carolina, Virginia] ____ **P. smallii**
11. Petals dark pink to purple; seeds 0.6 mm or less diam.; orbiculate; widespread throughout se, lower Midwest, and sw United States ____ **P. pilosa**

Key based on Vegetative and Fruiting Material

1. Leaf blades flattened.
2. Capsules each encircled by expanded, membranaceous wing ____ **P. umbraticola**
2. Capsules not winged.
3. Trichomes at stem nodes absent or inconspicuous.
4. Capsules 4–9 mm wide; styles 3–6; seeds 0.7–1 mm; leaves alternate to subopposite ____ **P. oleracea**
4. Capsules 2 mm wide; styles 3; seeds 0.5 mm; leaves opposite ____ **P. minuta**
3. Trichomes at stem nodes conspicuous ____ **P. amilis**

1. Leaf blades terete to hemispheric.
5. Stem nodes with inconspicuous trichomes.
6. Seeds 0.7 mm or more diam.; surface cells distinctly stellate tuberculate ____ **P. biloba**

Fig. 12. Taproot and habitat of *Portulaca minuta*. Photo by K. Bradley.

6. Seeds less than 0.7 mm diam.; surface cells obscurely stellate, without tubercles _____ **P. rubricaulis**
5. Stem nodes with conspicuous trichomes.
7. Seeds 0.6–1 mm diam.
8. Longest leaves usually longer than 20 mm; capsules usually more than 4 mm diam. _____ **P. grandiflora**
8. Longest leaves usually shorter than 15 mm; capsules 3.5 mm or less diam _____ **P. smallii**
7. Seeds 0.3–0.65 mm diam.
9. Capsules 2 mm or less diam.; seed coat with densely arranged, flattened; stellate cells, tubercles absent; seeds averaging 0.5 mm or less diam _____ **P. halimoides**
9. Capsules 1.5–5 mm diam.; seed coat with loosely arranged; stellate cells, tubercles, seed coat with loosely arranged stellate cells; tubercles usually present; seeds averaging more than 0.5 mm diam.
10. Plant annual; roots fibrous to slightly fleshy; stems prostrate or suberect to erect _____ **P. pilosa**
10. Plant perennial; roots tuberous; stems stiffly erect _____ **P. suffrutescens**

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REFERENCES

Acevedo-Rodríguez, P. & M.T. Strong. 2019. Flora of the West Indies: Catalogue of the Seed Plants of the West Indies. Smithsonian Institution, National Museum of Natural History. Washington, DC, U.S.A.

Adams, C.A. 1972. Flowering plants of Jamaica. University of the West Indies, Mona, Jamaica.

Allen, C.M. & D.W. Hall. 2003. *Paspalum*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. 25:566–599. Oxford University Press, New York, U.S.A.

Atalay, Z., F. Celep, F. Bara, & M. Dogan. 2016. Systematic significance of anatomy and trichome morphology in *Lamium* (Lamioideae; Lamiaceae). Flora 225:60–75.

Blomquist, H.L. 1948. The grasses of North Carolina. Duke University Press, Durham, U.S.A.

Chase, A. 1929. The North American species of *Paspalum*. Contr. U.S. Natl. Herb. 28:1–310.

Correll, D.S. 1979. New species and varieties from the Bahamas, Caicos and Turks Islands. J. Arnold Arbor. 60(1):154–162.

Correll, D.S. & H.B. Correll. 1982. Flora of the Bahama Archipelago: Including the Turks and Caicos Islands. J. Cramer, Vaduz, Germany.

Dickson, J.D. 1955. An ecological study of the Key deer. Florida Game and Fresh Water Fish Commission, Tech. Bull. No. 3.

Fernald, M.L. 1936. Plants from the Coastal Plain of Virginia. Rhodora 38:392–394.

Fernald, M.L. 1938. Contributions from the Gray Herbarium of Harvard University–No. CXXII: VIII. New species, varieties and transfers. Rhodora 40:331–332.

Fernald, M.L. 1950. Gray's manual of botany, eighth (centennial) edition. D. Van Nostrand Co., New York, U.S.A.

Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Fed. Rev. 58(188):51144–51190.

Freckmann, R.W. & M.G. Lelong. 2003. *Dichanthelium*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. 25:406–451. Oxford University Press, New York, U.S.A.

Freid, E., J. Francisco-Ortega, & B. Jestrow. 2014. Endemic seed plants in the Bahamian Archipelago. Bot. Rev. 80(3):204–230.

Gleason, H.A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. New York Botanical Garden and Hafner Press, New York, New York, U.S.A.

Gould, F.W. & C.A. Clark. 1978. *Dichanthelium* (Poaceae) in the United States and Canada. Ann. Missouri Bot. Gard. 65:1088–1132.

Gleason, H.A. & A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada, second edition. New York Botanical Garden, Bronx, NY.

Hall, D.W. 2019. Grasses of Florida. University Press of Florida, Gainesville, Florida, U.S.A.

Hill, S.R. 1976. Additions to the Bahama flora. Sida 6:321–327.

Hitchcock, A.S. 1936. Manual of the grasses of the United States. Misc. Publ. U.S.D.A. 243:1–439.

Hitchcock, A.S. & A. Chase. 1910. The North American species of *Panicum*. Contr. U.S. Natl. Herb. 15:1–396.

Hitchcock, A.S. & A. Chase. 1917. Grasses of the West Indies. Contr. U.S. Natl. Herb. 18:261–471.

Hitchcock, A.S. & A. Chase. 1950 [1951]. Manual of the grasses of the United States, second edition. Misc. Publ. U.S.D.A. 200.

Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T. and C.A. Meacham. Synthesis of the North American flora, version 1.0. North Carolina Botanical Garden, Chapel Hill, North Carolina, U.S.A.

Howard, R.A. 1979. Flora of the Lesser Antilles. Arnold Arboretum, Harvard University, Jamaica Plain, Massachusetts, U.S.A.

Huang, M., D.J. Crawford, J.V. Freudenstein, & P.D. Cantino. 2008. Systematics of *Trichostema* (Lamiaceae): Evidence from ITS, ndhF, and morphology. Syst. Bot. 33(2):437–446.

Keeley, J.E. & P.H. Zedler. 1998. Characterization and global distribution of vernal pools. In: Ecology, conservation, and management of vernal pool ecosystems. California Native Plant Society. Pp. 1–14.

Lewis, H. 1945. A revision of the genus *Trichostema*. Brittonia 5(3):276–303.

Lewis, H. 1960. Chromosome numbers and phylogeny of *Trichostema*. Brittonia 12:93–97.

Lewis, H. & L. Rzedowski. 1978. The genus *Trichostema* (Labiatae) in Mexico. Madroño 25(3):151–154.

Long, R.W. & O. Lakela. 1971. A flora of tropical Florida: A manual of seed plants and ferns of Southern Peninsular Florida. University of Miami Press, Coral Gables, Florida, U.S.A.

Matthews, J.F. 2003. *Portulaca*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. 4:496–501. Oxford University Press, New York, U.S.A.

Myers, R.L. & J.L. Ewel. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, U.S.A.

NatureServe. 2018. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: March 10, 2019).

North Carolina Natural Heritage Program. 2016. Element occurrence report for *Trichostema* sp. 1. North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh, North Carolina, U.S.A.

Pohl, R.W. & G. Davidse. 1994. *Paspalum*. In: G. Davidse, M. Sousa Sánchez & A.O. Chater, eds. Flora Mesoamericana 6:6–335. Universidad Nacional Autónoma de México, México, D. F.

Proctor, G.R. 1982. More additions to the flora of Jamaica. J. Arnold Arbor. 63:199–315.

Radford, A.E, H.E. Ahles, & C.R. Bell. 1968. Manual of the flora of the Carolinas. University of North Carolina Press, Chapel Hill, North Carolina, U.S.A.

Salmaki, Y., S. Zarre, Z. Jamzad, & C. Brauchler. 2009. Trichome micromorphology of Iranian *Stachys* (Lamiaceae) with emphasis on its systematic implication. Flora 204:371–381.

Schafale, M.P. 2012. Guide to the natural communities of North Carolina fourth approximation. North Carolina Department of Environment, Health, and Natural Resources, Division of Parks and Recreation, Natural Heritage Program, Raleigh, North Carolina, U.S.A.

Seyedi, Z. & Y. Salmaki. 2015. Trichome morphology and its significance in the systematics of *Phlomoides* (Lamiaceae; Lamioideae, Phlomideae). Flora 213:40–48.

Seymour, F.C. 1982. The flora of New England. Phytologia Mem. 5. Harold N. Moldenke and Alma L. Moldenke, Plainfield, New Jersey, U.S.A.

Silveus, W.A. 1942. Grasses: Classification and description of species of *Paspalum* and *Panicum* in the United States. Published by the author, San Antonio, Texas, U.S.A.

Small, J.K. 1903. Flora of the southeastern United States. New York, New York, U.S.A.

Small, J.K. 1913. Flora of the southeastern United States: Being descriptions of the seed-plants, ferns and fern-allies growing naturally in North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, and in Oklahoma and Texas east of the one hundredth meridian. New York, New York, U.S.A.

Small, J.K. 1933. Manual of the southeastern flora, being descriptions of the seed plants growing naturally in Florida, Alabama, Mississippi, eastern Louisiana, Tennessee, North Carolina, South Carolina, and Georgia. University of North Carolina Press, Chapel Hill, North Carolina, U.S.A

Sorrie, B.A. & A.S. Weakley. 2001. Coastal plain vascular plant endemics: Phytogeographic patterns. Castanea 66:50–82.

Turland, N.J., J.H. Wiersema, F.R. Barrie, W. Greuter, D.L. Hawksworth, P.S. Herendeen, S. Knapp, W.-H. Kusber, D.-Z. Li, K. Marhold, T.W. May, J. McNeill, A.M. Monro, J. Prado, M.J. Price, & G.F. Smith, eds. 2018. International code of nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Veg. 159. Koeltz Botanical Books, Glashütten, Germany. DOI https://doi.org/10.12705/Code.2018

Villaseñor, J.L. 2016. Checklist of the native vascular plants of Mexico. Revista Mex. Biodivers. 87:559–902.

Weakley, A.S. 2015. Flora of the southern and mid-Atlantic states, working draft of 21 May 2015. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, North Carolina, U.S.A.

Weakley, A.S. [in prep.]. Flora of the southeastern United States, first edition. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, North Carolina, U.S.A.

Weakley, A.S., R J. LeBlond, B.A. Sorrie, L.D. Estes, K.G. Mathews, C.T. Witsell, K. Gandhi, & A. Ebihara. 2011. New combinations, rank changes, and nomenclatural and taxonomic comments in the vascular flora of the southeastern United States. J. Bot. Res. Inst. Texas 5: 437–455.

Weakley, A.S., D.B. Poindexter, R.J. LeBlond, B.A. Sorrie, C.H. Karlsson, P.J. Williams, E.L. Bridges, S.L. Orzell, B.R. Keener, A. Weeks, R.D. Noyes, M. Flores-Cruz, J.T. Diggs, G.D. Gann, & A.J. Floden. 2017. New combinations, rank changes, and nomenclatural and taxonomic comments in the vascular flora of the southeastern United States. II. J. Bot. Res. Inst. Texas 11:291–325.

Weakley, A.S., B.A. Sorrie, R.J. LeBlond, D.B. Poindexter, A.J. Floden, E.E. Schilling, A.R. Franck, & J.C. Kees. 2018b. New combinations, rank changes, and nomenclatural and taxonomic comments in the vascular flora of the southeastern United States. IV. J. Bot. Res. Inst. Texas 12(2):461–480.

Weakley, A.S., D.B. Poindexter, R.J. LeBlond, B.A. Sorrie, E.L. Bridges, S.L. Orzell, A.R. Franck, M. Schori, B.R. Keener, A.R. Diamond, Jr., A.J. Floden, & R.D. Noyes. 2018a. New combinations, rank changes, and nomenclatural and taxonomic comments in the vascular flora of the southeastern United States. III. J. Bot. Res. Inst. Texas 12(1):27–67.

Wunderlin, R.P. 1982. Guide to the vascular plants of central Florida. University Press of Florida, Gainesville, Florida, U.S.A.

Wunderlin, R.P. 1998. Guide to the vascular plants of Florida. University Press of Florida, Gainesville, Florida, U.S.A.

Wunderlin, R.P., B.F. Hansen, A.R. Franck, & F.B. Essig. 2018. Atlas of Florida plants (http://florida.plantatlas.usf.edu/). [S.M. Landry and K.N. Campbell (application development), USF Water Institute.] Institute for Systematic Botany, University of South Florida, Tampa, Florida, U.S.A.

Xiang, C.-L., Z.-H. Dong, H. Peng, & Z.-W. Liu. 2010. Trichome micromorphology of the East Asiatic genus *Chelonopsis* (Lamiaceae) and its systematic implications. Flora 205:434–441.