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Typification of the North American species of *Trillium* subg. *Trillium* (Melanthiaceae: Parideae)

AARON J. FLODEN^{1,3*} & WESLEY M. KNAPP^{2,4}

¹ Missouri Botanical Garden, 4344 Shaw Blvd, St. Louis, Missouri, USA 63110

² NatureServe, 2550 South Clark Street, Suite 930, Arlington, Virginia, USA 22202

³ afloden@mobot.org; <https://orcid.org/0000-0002-8185-0415>

⁴ Wesley_Knapp@NatureServe.org; <https://orcid.org/0000-0002-5289-5649>

* Correspondence author

Abstract

Here we provide type information and synonymy for the accepted North American species of *Trillium* subg. *Trillium* and notes on the distribution and character variation for some species. Lectotypes are designated for *T. flexipes*, *T. rugelii* and *T. vaseyi*. We also lectotypify the names *T. cernuum* var. *declinatum* f. *billingtonii* and *T. cernuum* var. *declinatum* f. *walpolei*, which have been associated with both *T. cernuum* and *T. flexipes*; *T. cernuum* f. *tangerae*; and *T. rhomboideum* var. *album* (= *T. rugelii*), which has often been associated with *T. erectum*.

Key words: flora of North American nomenclature, Liliales, monocot nomenclature, Trilliaceae

Introduction

The North American species of *Trillium* Linnaeus (1753: 339) subg. *Trillium* include some of the pedicellate species of *Trillium*, which have been recovered as monophyletic in phylogenetic studies (Osaloo *et al.* 1999, Farmer & Schilling 2002, Farmer 2006). A subgeneric classification based on morphology and molecular data has recently formally recognized this group as *Trillium* subg. *Trillium* (*T.* subgenus *Anthopium* Rafinesque 1830: 97) with a narrow concept that includes only the *T. erectum*-group species (Lampley *et al.* 2022). *Trillium* subg. *Trillium* is the only clade in *Trillium* that has a North American-Asian disjunction (Case & Case 1997). The other clades are strictly North American, and the distribution of *Trillium* subg. *Trillium* is disjunct with one species in western North America, the diminutive and stenoendemic *T. hibbersonii* (Taylor & Szczawinski 1974: 250) O'Neill & Farmer in O'Neill *et al.* (2020: 193), and the remainder in the Midwest and eastern North America. Most North American diversity is in the Southern Appalachians with several local endemics, e.g., *T. simile* Gleason (1906: 391) and *T. vaseyi* Harbison (1901: 24). Most species in eastern North America have broad distributions and sometimes correspondingly broad phenotypes, e.g., *T. flexipes* Rafinesque (1840: 133) with distinctive regional variation in flower shape and size and floral fragrance. There are six Asian species, and all six species occur in Japan (Case & Case 1997). Only two Asiatic species also occur outside of Japan, *T. camschatense* Ker-Gawler (1805: t. 855), in north-eastern Asia and *T. tschonoskii* Maximowicz (1884: 218) occurring from the middle Himalayas south to Taiwan. Notable morphological variation occurs over the large area of distribution in *T. tschonoskii*. Hara (1969, 1971) described *T. tschonoskii* var. *himalaicum* Hara (1969: 373) from high-elevation coniferous forest of the eastern Himalayas.

Here, we provide a nomenclatural synopsis of the accepted species of *Trillium* subg. *Trillium* in North America with synonymy, typification as needed according to Turland *et al.* (2018) and discussion of the taxonomy in advance of a molecular study investigating taxonomy and potential hybridization (Floden *et al.* unpubl.). Observations of *Trillium* in the field and cultivation show that variation in petal color and flower position should be expected. Teratological variation including leaf, tepal, and petal merosity are also observed frequently (Peattie 1927). Some of these are a single-year occurrences due to damage of the meristem during shoot formation, but others are persistent and of horticultural appeal (Case & Case 1997, Case 1997). Farwell (1918, 1925) named numerous forms from single gatherings that

exhibited color, tepal, and leaf merosity mutations. We here provide assessments and notes on specimens that include teratological and color forms.

Trillium of Rafinesque

Rafinesque (1808, 1830, 1840) described numerous species of *Trillium* and provided the first subgeneric classification, which has been found to accurately reflect the molecular phylogenetics of the genus (Lampley *et al.* 2022). Most of his species have no types, and due to his limited or incomplete descriptions these are placed in synonymy where they best fit using his descriptions and distributions he provided. No attempts have been made to typify these names in synonymy because most Rafinesque collections have been lost, destroyed or discarded (Stuckey 1971). We do provide the locality information that he provided in his protologues, which supports placement of each name in synonymy with an accepted species based on their geographic distribution. For the one Rafinesque species in *T.* subg. *Trillium* that is an accepted species, *T. flexipes*, we lectotypify this based on a specimen at P (Durand Herbarium).

We observed type specimens from numerous herbaria: A, BLH, BM, CM, DAO, E, F, GH, GSMNP, K, LINN, MICH, MIN, MO, NEBC, NCU, NY, P, PH, QFA, S, S-G, TENN and US. Additional specimens at these herbaria and others were studied through online portals (SERNEC, 2023). In addition, we have observed the species in the field and cultivation in a common garden over successive years. AF has seen every eastern North American species in the wild except for *T. cernuum*. Fieldwork since 1999 has been performed by AF in AL, AR, GA, IL, IN, KS, KY, LA, MO, MS, NC, OH, SC, TN and TX, and common garden cultivation of many species has taken place for an equal duration. WK has over 21 years as a Natural Heritage Program Botanist working across the eastern United States and seen all accepted species of *T.* subg. *Trillium* in the field. Fieldwork since 2000 has been performed by WK in AL, AR, DE, GA, MA, MD, ME, MI, MO, MN, NC, NH, NY, OH, PA, SC, TN, TX, VA, VT, and WV. Based on our examinations of North American species of *T.* subg. *Trillium*, we recognize seven species, although current taxonomy does not appear to fully reflect the morphological and molecular diversity of the group (Floden *et al.* unpub.).

Trillium cernuum L., *Sp. Pl.* 1: 339–340. 1753

Type:—USA. In Carolina, [no collector given], 469.1 (LINN!, lectotype designated by Gleason, *Bull. Torrey Bot. Club* 33: 390, 1906)

Heterotypic synonyms: *Trillium brevipetalum* Raf., *Med. Fl.* 2: 100. 1830. Type:—Near the lakes, Ontario and Erie. Type not located.

Trillium glaucum Raf., *Med. Fl.* 2: 102. 1830. Type:—In Pennsylvania, near Philadelphia, Maryland, Virginia, “& c.” Type not located.

Trillium hamosum Raf., *Med. Fl.* 2: 101. 1830. Type:—In the Pocono Mountains, Pennsylvania, discovered by Steinhauer. Type not located.

Trillium medium Raf., *Med. Fl.* 2: 102. 1830. Type:—from New England south to Virginia. Type not located.

Trillium declinatum (A.Gray) Gleason, *Bull. Torrey Bot. Club* 33: 389. 1906. *nom. illeg.*

Basionym: *Trillium erectum* var. *declinatum* A.Gray, *Manual* [Gray], ed 5: 523. 1867. Type:—USA. 1863, *Robbins s.n.* (holotype,;GH 00030145 digital image!; isotypes, GH00030146 digital image!, MO-104984!).

Notes:—Patrick annotated MO 104984 as *Trillium cernuum*, against which Gray (1867) compared his var. *declinatum* in the protologue.

The name at species level is preceded by *T. declinatum* Raf., which is *T. catesbaei*, and Fernald (1932) provided the new name *T. gleasonii*. Patrick also annotated NY00319876(!) as lectotype but never published this. This collection, NY00319876, was annotated by Patrick as *T. flexipes*. This may have been one of the specimens that Gray (1867) used as part of his description of var. *declinatum*, but he cited only collections by Robbins from Lake Superior with no mention of additional specimens in his description of var. *declinatum*. Fernald (1932) later provided a new name, *T. gleasonii*, because *T. declinatum* Raf. preceded *T. declinatum* (A.Gray) Gleason. We here assign this concept to *T. cernuum*.

Trillium cernuum var. *macranthum* Eames & Wiegand, *Rhodora* 25: 191. 1923. Type:—USA. New York: Tompkins, Valley of Fall Creek, Round Marshes (Gracie’s Swamp) and vicinity, Dryden, low woods, north end of marshes, 31 May 1914, *Eames & MacDaniels 2012* (holotype: GH00030148!; isotypes: CM0361 digital image!, F0046068F digital image!, MIN1002612 digital image!, S-G-7311 digital image!).

Note:—Eames & Wiegand (1923) discussed variation in *T. cernuum*.

Trillium cernuum f. *viride* Cayouette & Cayouette, *Naturaliste Canad.* 111: 326. 1984.

Type:—CANADA: Quebec: Saguenay–Lac-Saint-Jean (Quebec), Saguenay, Ilets-Jermie, 48°53’N–68°48’W, 12 Jul 1973, *Cayouette 73-418* (holotype: not located; isotypes: DAO000466224 digital image!, CM0491 digital image!, GH00030151 digital image!, MICH1192833 digital image!, NY00319873 digital image!, US00288583 digital image!).

Trillium cernuum f. *marginatum* Cayouette & Cayouette, *Naturaliste Canad.* 111: 326. 1984.

Type:—CANADA. Quebec: Comté de Gaspé-quest, Mont-Saint-Pierre, 49°13’ N–65°49’0. Erablière à bouléau jaune, en flanc de côteau, exposition sud-est. 13 Jun 1973, *Cayouette & Quattara 73-145* (holotype” QFA; isotypes: CM0360 digital image!, DAO000466223

digital image!, GH 00030150 digital image!, MICH1192832 digital image!, NY00319872 digital image!, US00288582 digital image!).

Trillium cernuum f. *tangerae* Wherry, *Bartonia* 23: 49. 1945. Type:—USA. Pennsylvania: Adams County, 2 miles west-southwest of Iron Springs, moist rocky woods, 5 May 1945, *Wherry s.n.* (holotype: PH00028390, lectotype designated here, digital image!; isolectotype: PH00028389 digital image!).

Note:—Patrick annotated PH00028390 as lectotype. We formalize this designation here.

Trillium cernuum var. *terrae-novae* Boivin, *Rhodora* 55: 101–102. 1953. Type:—CANADA. Newfoundland: west coast near Stephenville, west side of E. Harmon Air Force Base, in wet black soil under Alder bushes, 9 June 1949, *Bassett 293* (holotype: DAO 000466288 digital image!).

***Trillium erectum* L., *Sp. Pl.* 1: 340. 1753.**

Type:—USA. Habitat in Virginia, *s.d.*, *s.coll* (LINN!, lectotype designated by Reveal, *Phytologia* 72: 1–4, 1992).

Heterotypic synonyms:

Trillium pendulum Willd., *Neue Schriften Ges. Naturf. Freunde Berlin* iii, 421. 1801. Type not located.

Trillium rhomboideum var. *atropurpureum* Michx., *Fl. Bor. Amer.* 1: 215. 1803. Invalid name.

Trillium rhomboideum Michx., *Fl. Bor. Amer.* 1: 215–216. 1803. *nom. superfl.*, cited *T. erectum* L. as synonym.

Trillium foetidum Salisb., *Parad. Lond. Tt.* 35. 1805. Type:—USA. Virginia: *Bartram s.n.* Type not located.

Trillium acuminatum Raf., *Med. Repos.* 5: 361. 1808. Type not located.

Trillium album Small, in part, see *T. rugelii*.

Trillium erectum var. *album* (Michx.) Pursh, *Fl. Amer. Sept.* (Pursh) 1: 245. 1814. Type:—North America. Sep., *Michaux s.n.* (holotype: P 00730404 digital image).

Note:—This name is based on Michaux's *T. rhomboideum* var. *album*. Pursh (1814) based his new combination on Michaux's name, but this appears to have been without observation of Michaux's type gathering because it (at P) is evidently *T. rugelii* (see below), whereas the K specimen of *T. erectum* var. *album* Pursh is a white-flowered form of *T. erectum*.

Trillium erectum var. *atropurpureum* Pursh, *Fl. Amer. Sept.* 1: 245. 1814 [1813]. Type:—USA. Amer., Sept., *Michaux s.n.* (holotype: not located; isotype: P00730489 digital image!).

Trillium purpureum Kin ex Elliott (1817: 430). *A sketch of the botany of South-Carolina and Georgia* 1: 430. Type:—USA. Pennsylvania: Philadelphia, *Kin s.n.* (holotype: PH digital image!; isotype: MO 2140261!).

Trillium latifolium Raf., *Med. Fl.* 2: 96. 1830. Type:—In Kentucky. Type not located.

Trillium nutans Raf., *Med. Fl.* 2: 99. 1830. Type:—From Canada to Carolina. Type not located.

Trillium flavum Raf., *Med. Fl.* 2: 100. 1830. Type:—In the mountains from New York to Virginia. Type not located.

Trillium spatulatum Raf., *Med. Fl.* 2: 101. 1830. Type:—In the mountains Alleghany. Type not located.

Trillium divaricatum Raf., *Med. Fl.* 2: 102. 1830. Type:—In the Alleghany and Cumberland mountains. Type not located.

Trillium atropurpureum M.A.Curtis ex L.C.Beck, *Bot. North. Middle States* 361. 1833. Type not located.

Trillium rhombifolium Raf., *Autik. Bot* 133. 1840. Type:—Apalachian [sic] Mts. Alabama & c. Type not located.

Trillium erectum var. *flavum* Torr., *Fl. New York* 2: 296. 1847. Type:—USA. New York: Hamilton or Madison counties, *Douglas s.n.* (holotype: NY 00319877 digital image!; isotypes: GH 00030156 digital image!), non, *Trillium erectum* var. *flavum* H.H.Eaton ex A.Eaton, *nom. nud.*

Trillium erectum subsp. *rubrum* Clute, *Amer. Bot. (Binghamton)* 9: 76. 1905. *nom. nud.*

Note:—Clute (1905) discussed the default name for the type color form, reddish, and the necessity, if it was at all worthy of formal description, to name the color forms that are different from the typical color form and often co-occur with one or more color forms.

Trillium erectum f. *albiflorum*, Ralph Hoffm. *Proc. Boston Soc. Nat. Hist.* 36: 244. 1922. Type:—USA. Massachusetts: Berkshire County, Stockbridge, rich woods, 23 May 1920, *Hoffman s.n.* (holotype: NEBC 00032163!).

Trillium erectum var. *cahnae* Farw., *Amer. Midl. Naturalist* 9: 266. 1925. Type:—USA. Michigan: Oakland, Vicinity of Clawson, 12 May 1924, *Cahn 6874a* (holotype: BLH0000369 digital image!).

Trillium erectum f. *sessiloides* Boivin, *Rhodora* 55: 102. 1953. Type:—CANADA. Ontario: Carleton, Beechwood, close to the cemetery gate, May 1899, *s.coll.* 1822 (holotype: DAO000466292 digital image!).

Trillium erectum L. var. *horizontale* Louis-Marie, *Rev. Oka Agron. Inst. Agric.* 14: 151. 1940. Type:—CANADA. Quebec: Comté des Deux-Montagnes, bois riche, N.-E. à Ontario, 30 Apr 1958, *Meunier s.n.* (holotype: S-G-7309 digital image!).

Notes:—Within populations of *T. erectum* and its close relative *T. sulcatum*, plants can exhibit an array of floral color variation and orientation. Variation is often found regionally where the characters are consistent, but there are regions also where great variability within a single population has been observed. For instance, in the southern Appalachians, flowers can be white, greenish, yellow, pink, and typical maroon. The typical predominant color form is maroon, but in the Southern Appalachians white forms exist in large

uniform colonies (see also *T. simile*). In most populations, a single color is predominant with only occasional other colors, whereas other populations can have a mixture. The position of the flower can also vary from the typical form with erect peduncles and the flowers held facing outward, but some populations have the peduncles held horizontally in plane with the leaves, declining below the plane of the leaves, or pendent like those of *T. rugelii* or *T. vaseyi*. This variation we consider to be normal and do not recognize formal designations based on color or flower position in most cases. An exception, if found to be genetically distinct, are the large white flowered plants forming uniform populations in some regions of the Southern Appalachians (see also under *T. simile*).

***Trillium flexipes* Raf., *Autik. Bot.* 133. 1840.**

Type:—USA. Kentucky: s.d., *Rafinesque s.n.*, (P 1776245 digital image!, lectotype, designated here).

Rafinesque (1840) described *Trillium flexipes* from plants in “West Kentucky and Tennessee” with sessile leaves, 3-nerved, the peduncle “inclinato flexuoso,” lanceolate-acuminate sepals and white obovate-acute petals. No collector was provided in his description, but it was presumably one of his. A specimen at P (P01776245) from the Durand Herbarium has a label that provides only “Kentucky, Rafinesque.” Given that this is the only likely type material that we have located, we have designated this as the lectotype.

Heterotypic synonyms: *Trillium album* Small, in part, see under *T. rugelii*.

Trillium cernuum var. *declinatum* f. *walpolei* Farw., *Rep. Michigan Acad. Sci.* 21: 363. 1920. Type:—USA. Michigan: Washtenaw County, Ypsilanti, copses, flowers purple, 19 May 1918, *Farwell 4849* (BLH0000359 digital image!, lectotype designated here; isolectotypes: BLH0000360 digital image!, GH00030152 digital image!, MICH1192832 digital image!, MICH1192834 digital image!).

Note:—Patrick annotated the BLH specimen as lectotype, but he never published this. We formalize this here and designate BLH0000359 as lectotype.

Trillium cernuum var. *declinatum* f. *billingtonii* Farw., *Rep. (Annual) Michigan Acad. Sci.* 21: 363. 1920. Type:—USA. Michigan: Washtenaw County, Ypsilanti, copses, flowers brown, 19 May 1918, *Farwell 4850* (MICH1192831, lectotype designated here, digital image!; isolectotypes, BLH0000361 digital image!, BLH 00030151 digital image!, BLH0000362 digital image!, GH00030149 digital image!).

Note:—McVaugh annotated the MI specimen as lectotype. Patrick later also annotated this specimen as the lectotype, but neither officially published this designation.

Trillium erectum var. *blandum* Jennison, *Rhodora* 40: 486. 1938. Type:—USA. North Carolina: Swain Co., Opp. Ela, in rich shaded woods loam, elevation 1850 ft., 9 May 1937, *Jennison 2185* (holotype: TENN; isotype: GSMNP01232). A paratype is at US.

Trillium flexipes f. *walpolei* (Farwell) Fernald, *Rhodora* 46: 17. 1944. Basionym: *Trillium cernuum* var. *declinatum* f. *walpolei* Farw. Fernald (1944) considered this to be a red-flowered form of *T. flexipes* and the anther and pollen color support this, though the status of these red-flowered *T. flexipes*-like plants remains unclear, but they could be hybrids with sympatric *T. erectum*.

Trillium flexipes is widely distributed over a large part of the Midwest from South Dakota eastward to Pennsylvania and south into northern Arkansas and Alabama. Over this area, it is variable in floral position (erect vs. reflexed or pendent) and fragrance (Case & Case 1997, AF pers. obs.). Within some parts of this distribution, it is uniform in morphology, e.g., in northern Alabama (Case & Case 1997, AF pers. obs.) where the plants have large upright flowers, overlapping large petals and an intense fragrance. In Missouri where AF has observed many plants the flowers are variably reflexed, declining, or horizontal and held just above the leaves to erect, but the flowers are smaller with narrowly ovate-lanceolate petals and without the distinctive powerful fragrance of some southern forms. Even within a geographic region, fragrance varies over the flowering period, and during a single day the fragrance varies from morning to afternoon (AF pers. obs.). For instance, Alabamian *T. flexipes* open with a distinctive mild tea rose-like fragrance discernible at close range in the early part of the day, but a southern magnolia-like fragrance is noticeable at a meter or more away by midday. Missouri forms have a mild, but pleasant floral fragrance.

***Trillium hibbersonii* (T.M.C. Taylor & Szczaw.) D.O’Neill & S.B. Farmer, *Phytotaxa* 436: 193. 2020.**

Basionym: *Trillium ovatum* Pursh forma *hibbersonii* T.M.C. Taylor & Szczaw., *Syesis* 7: 250. 1974.

Type:—CANADA. British Columbia: near Boat Basin, Hesquiatic Harbour, west coast of Vancouver Island, elev. 2000 ft., 1938, *Hibberson s.n.* (holotype: UBC!).

Homotypic synonyms: *Trillium ovatum* Pursh var. *hibbersonii* (T.M.C. Taylor & Szczaw.) G.W. Douglas & P. Pojar, *Canad. Field-Naturalist* 115: 343. 2001. *Trillium hibbersonii* Wiley, *nom. nud.*, *Rare wildflowers of North America*. 1968.

***Trillium rugelii* Rendle, *J. Bot.* 39: 331–332, pl. 426, f. B. 1901.**

Type:—USA. North Carolina: on the mountains of the Broad River, Mar 1841, *Rugel s.n.* (BM 327335 & BM 001009870 [one sheet] digital image!, lectotype, designated here; isolectotypes: E00346019 digital image!).

Heterotypic synonyms: *Trillium affine* Rendle, *J. Bot.* 39: 334. 1901. Type:—USA. Georgia: *s.d.*, *Rugel s.n.* (holotype: BM 000547280 digital image!)

Trillium album (Michx.) Small, *Fl. S.E. US.* 278. 1903. Basionym: *Trillium rhomboideum* var. *album* Michx., *Fl-Bor.-Amer.* 1: 215. 1803.

Type:—P00730404 digital image!, lectotype, designated here) (see also *T. erectum*).

Notes:—*Trillium rugelii* was described in 1901 by Rendle from a Rugel collection at BM. In the protologue, he stated “Specimens in Herb. Mus. Brit.” There is one sheet at BM that has two stems, one of which was selected as a lectotype, as noted on the annotation label by Patrick (c. 1981), but this typification was never formally published. The stem on the upper left was selected as the lectotype by Patrick and the stem on the right was selected as an isolectotype despite the presence of a single collection label. The ICN rules (ICN 8.2) state that this should be treated as a single gathering. Thus, we select the sheet at BM as the lectotype (BM327335 & BM001009870).

The combination *T. album* was made by Small (1903). The basionym was Michaux’s *T. rhomboideum* var. *album*, which was based on specimens that are in fact *T. rugelii*. Here, we typify the name *T. rhomboideum* var. *album* and designate the specimen at P (00730404) as the lectotype of *T. rhomboideum* var. *album*.

Notes:—Case (1997) reported differences in fragrance between the forms in the Southern Appalachians vs. plants from the middle and northern parts of Alabama. He described them as strongly fragrant of old garden roses but did not mention that of the mountain plants. Observations by AF of *T. rugelii* from Tennessee south to Alabama and east to South Carolina have shown that floral fragrance is variable and often similar to some forms of foamflower (*Tiarella*), fragrant violets, or *Cyclamen*. The intensity of the fragrance varies over the distribution, but the floral fragrance is often stronger in more southern populations.

Trillium simile Gleason, *Bull. Torrey Bot. Club* 33: 391. 1906.

Type:—USA. North Carolina: moist woodlands near Tryon, 28 April 1904, *Gleason 14933-a* (holotype: NY00051079 digital image!).

Homotypic synonyms: *Trillium vaseyi* var. *simile* (Gleason) Barksdale, *J. Elisah Mitchell Sci. Soc.* 54: 285. 1938. *Trillium erectum* var. *vaseyi* f. *simile* (Gleason) Ahles, *J. Elisah Mitchell Sci. Soc.* 80: 172. 1964.

Notes:—The concept of *T. simile* has been greatly expanded and the morphological characters misapplied since its description. Gleason (1906) compared *T. simile* to *T. rugelii* in his description and diagnosis of this new species, stating it differed by its longer stamens, yellow anthers (vs. purple), and proportionately longer filaments. Gleason was familiar with *T. rugelii* and its typical habit of declining to reflexed flowers held beneath the leaves, so his comparison of this novelty suggests that the type gathering of *T. simile* had flowers held beneath the leaves. In his description, he even stated that the peduncles were “declined or cernuous” (Gleason 1906). Barksdale (1938) placed *T. simile* at varietal status under *T. vaseyi*, also confirming the original concept of Gleason (1906) that the flowers were pendent. Barksdale (1938) was confident that *T. simile* was merely a color variant of *T. vaseyi* occurring in mixed populations with the white form being rare but also in isolated uniformly white-flowered populations. Peattie (1927) argued that *T. simile* has erect peduncles, but sometimes declined flowers based on the type gathering and his field experience. Although the type at NY does have the flowers in an upright position, it is not apparent whether this is due to a pressing artifact or the plants truly having erect peduncles. The current concept is that of a large plant, with erect peduncles, large creamy-white petals that usually are overlapping at their bases, a dark ovary, and yellow pollen (Case & Case 1997, Case 1997). Forms like this occur throughout the Southern Appalachians (Case 1997). Some specimens have been observed in herbaria that share this morphology from Ohio, West Virginia, and Virginia (AF pers. obs.). Barksdale (1938) said that Small’s (1933) treatment could apply to nearly any white-flowered erect *Trillium* with a dark ovary, and it appears that the current concept does not match the type based on the protologue in which Gleason (1906) compared his new species to *T. rugelii*.

Floral fragrance in *Trillium* has been used as a field character when comparing related species. Peattie (1927), Small (1933), Case (1997), and others have mentioned the sweet or delicious floral scent of *T. simile*, which the authors have observed on various erect and reflexed forms in the Southern Appalachians that fit both concepts of *T. simile*. A form that is common in and around the Great Smoky Mountain National Park (North Carolina and Tennessee) at lower elevations on rich mesic slopes has been considered the typical form with large creamy-white, erect flowers (Case & Case 1997), but this form has a fragrance identical to that of the higher elevation reddish forms of *T. erectum*, i.e., wet dog or egg whites. Forms with erect peduncles have been observed with a sweet apple-like fragrance, and declining forms observed in western North Carolina and northern Georgia have been observed with a distinctive spicy clove-like or a tea rose-like fragrance. Like *T. flexipes*, it may be that the fragrance changes temporally over the flowering period to attract potential pollinators or to even deter herbivory, and that the volatiles producing the fragrance vary during the day due to temperature. In addition to the fragrance difference, *T. simile* differs from *T. erectum* in its much longer filaments and anthers that surpass the ovaries, but there has never been a wide-range study that surveys this character and its taxonomic value. Molecular analyses of *T. subg. Trillium* may resolve this complex of white-flowered species.

Trillium sulcatum Patrick, *Brittonia* 36: 27–35, f. 1–5. 1984.

Type:—USA. Tennessee: Grundy Co., rich bouldery woods at base of N-facing slope near Deer Lick Falls in Layne Cove, elev. ca. 420 m, western escarpment Cumberland Plateau, 2 km due N of Monteagle, 21 Apr 1980, *Patrick, Perkins & Horn 1122* (holotype: TENN!; isotypes: BH, DUKE10000089 digital image!, GH00030175 digital image!, MO-104974!, NCU00000629 digital image!, NY00319900 digital image!, UNA, US00406395 digital image!).

Heterotypic synonyms: *Trillium erectum* var. *sulcatum* Barksdale, *J. Elisha Mitchell Sci. Soc.* 54: 280–281. 1938. Type:—USA. North Carolina: Surry Co., in deep woods near Roaring Gap, 27 Apr 1937, *Lyons s.n.* (holotype: NCU00000625 digital image!; isotypes, NCU00000621 digital image!, NCU00000622 digital image!, NCU00000623 digital image!, NCU00000624 digital image!, NCU00000626 digital image!).

Note:—This name was published without a Latin diagnosis and is thus invalid. The date of collection is given as “1934” on plants.jstor.org, but the specimen labels read 1937.

Trillium sulcatum f. *albolutescens* T.S.Patrick, *Brittonia* 36: 30. 1984. Type:—USA. North Carolina: Ashe Co.; rich shady western slopes of “The Peak,” in western part of Ashe County, 16 May 1950, *Harper 4167* (holotype: MO-104973!; isotypes: GH00030176 digital image!, NY00319901 digital image!, US00406185 digital image!).

Notes:—This species is similar to *T. erectum* but occurs mostly to the west, largely on the Cumberland Plateau in Kentucky, Tennessee and adjacent Alabama. The two are sympatric in a small portion of their distributions in eastern Kentucky, north-eastern Tennessee, south-western Virginia, and north-western North Carolina along the Blue Ridge escarpment of the Southern Appalachians. In some cases, the two species are hard to separate based and may be better regarded as a single variable species with a broad range of variation and similarities in floral fragrance and habitat preferences. However, in cultivation, lower-elevation *T. sulcatum* is a better garden plant and more vigorous. In the Ridge and Valley of Tennessee, white-flowered forms in uniform populations have been misidentified as *T. flexipes*, but these forms have dark ovaries and the wet-dog floral fragrance of the typical forms (AF pers. obs.).

Trillium vaseyi Harbison, *Biltmore Bot. Stud.* 1: 24. 1901.

Type:—USA. North Carolina: M. N. Caro, 1878, *Vasey s.n.* (US00091979 digital image!, lectotype, designated here: isoelectotypes: F0046074F digital image!, GH00030177 digital image!, NY00319910 digital image!, NY00319911 digital image!, P01776194 digital image!, PH00028410 digital image!).

Homotypic synonym: *Trillium erectum* var. *vaseyi* (Harbison) Ahles, *J. Elisha Mitchell Sci. Soc.* 80: 172. 1964.

Heterotypic synonym: *Trillium vaseyi* f. *album* House, *Muhlenbergia* 6: 73. 1910. Type:—USA. North Carolina: Haywood Co., No. Pigeon Gap Trail, 4000 ft. alt., 9 May 1909, *House 4146* (holotype: US 00091980 digital image!).

Notes:—Harbison (1901) named *Trillium vaseyi* for G. R. Vasey, who collected this species in the North Carolina mountains in 1878. There are many specimens collected by Vasey in several herbaria. The Biltmore Herbarium was transferred to US, and we select the US collection (00091979) as the lectotype. One of the duplicates at NY (00319911) has a collection number of “No 477” handwritten on the preprinted labels similar to that of most other duplicates. We consider this to be an isoelectotype despite the collection number on the label.

Annotations on NCU00000631 were noted by Patrick, and he considered this a syntype because Harbison had labeled it “co-type.” No other collection was mentioned in the protologue aside from Vasey’s gathering.

Trillium vaseyi and *T. simile* co-occur in some regions, and in these mixed populations they hybridize if their flowering periods overlap (Case & Case 1997). Although they do share pendent flowers and long anthers, the anther and sometimes pollen color of *T. vaseyi* is yellow or purple to lavender, whereas that of *T. simile* is always yellow. Moreover, observation in the field over two decades shows that *T. vaseyi* typically flowers two to three weeks later than *T. simile* when they are sympatric (AF pers. obs). Forms of *T. vaseyi* with white petals still have a reddish ovary and purple anthers (Peattie 1927).

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