

CYTOGEOGRAPHY OF *SOLIDAGO ALTISSIMA* (ASTERACEAE: ASTEREAE) IN NORTH AMERICA

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ABSTRACT

The cytogeography of *Solidago altissima* is based on 520 previously published and newly reported chromosome counts obtained from wild plants collected throughout the range of the species in North America. Diploids occur in var. *gilvocanescens*. Tetraploids and hexaploids occur in var. *altissima*, var. *gilvocanescens*, and var. *pluricephala*. Differences in frequency and patterns of distribution of each ploidy level were found among the three varieties.

Solidago altissima L. is a widely distributed North American species of sect. *Unilaterales* subsect. *Triplinerviae* ser. *Canadensae* Semple & Beck, which also includes *S. brendae* Semple, *S. canadensis* L. (type species), *S. elongata* Nutt., *S. fallax* (Fern.) Semple, *S. lepida* DC., *S. rupestris* Raf., *S. shortii* Torr. & Gray, and *S. turneri* Semple (Semple & Beck 2021; Semple 2021; Semple 2021, occasionally updated).

Solidago altissima is distinguished from the other species in ser. *Canadensae* by a combination of traits, including lower stems being moderately to densely short hairy becoming more densely so distally, upper stem leaves with few small or no marginal serrations, and leaf surfaces and abaxial veins being moderately to densely short strigose-villose hairy. Individuals can be confused with more hairy forms of *S. canadensis* (upper leaves usually obviously serrate and glabrate to only sparsely hairy) and *S. lepida* (inflorescence parts usually with stipitate glands and lower stems hairless to very sparsely hairy; upper stem leaves variable in margin serrations and indument). Involucre height can also be useful in separating the polyploid eastern varieties of *S. altissima* from always diploid *S. canadensis*. The difficulties in separating the species are made clear by the inclusion of the multiple species recognized here being included historically as varieties or subspecies by some authors in a much more broadly defined *S. canadensis*: *S. canadensis* subsp. *elongata* (Nutt.) Keck, *S. canadensis* var. *fallax* (Fern.) Beaudry, *S. canadensis* var. *gilvocanescens* Rydb., *S. canadensis* var. *lepida* (DC.) Cronq., *S. canadensis* var. *rupestris* (Raf.) Porter, *S. canadensis* var. *salebrosa* (Piper) M.E. Jones, and *S. canadensis* var. *scabra* (Muhl. ex Willd.) Torr. & Gray.

Although the ranges overlap to some extent, three regionally distinct varieties are recognized within *Solidago altissima* (Semple et al. 2015). Var. *altissima* is native to the central and northeastern states of the eastern USA. and adjacent Canada. Var. *gilvocanescens* (Rydb.) Semple is native on the Great Plains from Alberta to Texas and extends eastward in prairie and prairie-like habits of the Prairie Peninsula to west-central Ohio; this variety can be difficult to distinguish from more hairy-stemmed forms of *S. canadensis* var. *hargerii* Fern. in ecotone prairie-forest areas of the midwestern U.S.A. and eastern Manitoba (Semple et al. 2015). Var. *pluricephala* M.C. Johnston is common in the southeastern USA and extends westward along the Gulf coast to southern Texas and becomes scattered up the greater Rio Grande Valley into trans-Pecos Texas and southern New Mexico (and possibly adjacent Mexico); this variety can have glabrous lower older stems resulting from loss of lower stem hairs as stems enlarge in diameter; it usually has a more elongated inflorescence than the more broadly conical-secund inflorescences of the other two varieties.

Blooming times vary over the ranges of the varieties and are shifted later by higher ploidy levels, although actual times depend on differences in growing conditions in different years. Overall, the species blooms from early August to October. Typical *Solidago altissima* blooms in very late August and September and sometimes as late as December in southern Ontario in years with a late frost. The typical variety blooms later in the season than locally sympatric plants of *S. canadensis* and lower ploidy level populations of var. *gilvocanescens*, with more northern populations blooming earlier than southern ones. On the prairies in Canada, var. *gilvocanescens* blooms in August into September, while much further south in Oklahoma and Texas it blooms in September and October. At its southern limits, var. *altissima* blooms in September and October. The southern var. *pluricephala* blooms in September and October in the northern part of its range, but late September through October in Florida and Texas.

Solidago altissima has become an aggressive invasive in many places outside its native range in North America. Evidence documenting the presence of *S. altissima* var. *altissima* in western Europe was presented by Verloove et al. (2017). Semple et al. (2013, 2015) presented evidence that it was *S. canadensis* var. *hargeri*, not *S. altissima* that was the common diploid with hairy lower stems invasive in much of western and central Europe. Chen & Semple (2011) reported the presence of *S. altissima* in eastern China, where it is an aggressive invasive; *S. canadensis* is also present but restricted to locations near or in botanical gardens and universities, where it is sometimes an escaped garden cultivar. Sakata et al. (2015) determined that the widely invasive *S. altissima* in Japan originated from a small number of garden cultivated plants. Evidence documenting the invasive presence of *S. altissima* var. *pluricephala* in Oceania, India, and South Africa was presented by Semple & Uesugi (2017), Semple & Rao (2017), and Cheek & Semple (2016), respectively.

Diploids ($2n=9_{II}$, $2n=18$), tetraploids ($2n=18_{II}$, $2n=36$), and hexaploids ($2n=27_{II}$, $2n=54$) have been reported numerous times in *Solidago altissima* in North America, although often either only to species, under a synonym, or as *S. canadensis* (Beaudry & Chabot 1959; Beaudry 1963, 1969; Morton 1981; Semple et al. 1981; Melville & Morton 1982; Löve & Löve 1982; Semple et al. 1984, 1989, 1992; 1993, 2001, 2015, 2019; Semple 1985; Ward & Spellenberg 1986, 1988; Semple & Chmielewski 1987; Turner & Zhao 1992; Zhao & Turner 1993; Semple & Cook 2004; Morton et al. 2020). Invasive and cultivated individuals of *S. altissima* in Europe and south and eastern Asia also have been reported to be hexaploid (e.g., Sarkar et al. 1980 as *S. canadensis*; Sakata et al. 2013; Verloove et al. 2017).

The goal of this investigation was to determine the varietal identity of all herbarium vouchers for previously published counts by all authors and to report a small number of counts inadvertently missed in multiple previous reports by the J.K. Morton lab and the J.C. Semple Astereae lab, both at the University of Waterloo in Ontario. A map could then be generated showing the locations and varietal identities of the large number of chromosome counts known for the species.

MATERIALS AND METHODS

Meiotic counts were made from pollen mother cells (PMCs) dissected from buds fixed in the field in 3:1 ethanol (EtOH): glacial acetic acid for a minimum of 24 hours under refrigeration and subsequently stored under refrigeration in 70% EtOH. Mitotic counts were made from root tip cells taken from transplanted wild rootstocks or from seedlings grown from achenes collected in the wild. Root tips were pretreated in 0.01% colchicine or saturated paradichlorobenzene for 2–3 hours, fixed in either Modified Carnoy's Fixative (4:3:1 chloroform:EtOH:glacial acetic acid) or Acetic Alcohol Fixative (3:1 EtOH:glacial acetic acid) for a minimum of 24 hours under refrigeration and hydrolyzed in 1N HCl for 30 min at 60°C before squashing. Anther sacs containing PMCs and meristematic root tips were squashed in 1% acetic orcein and counts of chromosomes were made from freshly prepared material.

Vouchers for all J.K. Morton collections (including with other collectors) are deposited at TRT (acronyms follow Thiers 2017). Vouchers for J.C. Semple and L. Brouillet collections are deposited in WAT in MT and should be cited as at WAT. All identifications were made by J.C. Semple based on morphological data presented in Semple et al. (2015) and traits presented in the key at the end of this paper.

Ranges of the varieties and blooming times were determined based on field observations over five decades and on herbarium specimens examined in person or as digital images posted online (SERNEC Data Portal 2022; SEInet Data Portal 2021). Nearly all cytovouchers were observed in person during herbarium visits or as loans over multiple years or more recently as digital images on SERNEC and SEInet. As of 3 Feb 2022 SERNEC has data on 8789 specimens, the vast majority of which include digital images. Several thousand of these were examined sampling randomly or in detail along the margins of the ranges of the varieties.

RESULTS

In total, 520 chromosome counts from 463 locations across North America are known for *Solidago altissima*. Forty-seven previously unpublished chromosome counts with location data are presented in Appendix 1. These include 21 hexaploid ($2n=54$) reports from 11 provinces and states for *S. altissima* var. *altissima*, six diploid ($2n=18$), 10 tetraploid ($2n=18_{II}$, $2n=36$), and five hexaploid ($2n=54$) counts from eight states for var. *gilvocanescens*, and five hexaploid ($2n=54$) counts from three states for var. *pluricephala*. In total, 465 previously published chromosome counts have been reported from 424 locations in North America for *S. altissima* and these are listed by variety with location and publication data summarized in Appendix 2. For var. *altissima*, four tetraploid ($2n=36$) counts from three locations and 274 hexaploid ($2n=27_{II}$, $2n=54$) counts from 241 locations have been previously reported: 278 counts from 244 locations in total from North America. For var. *gilvocanescens*, 21 diploid ($2n=18$) counts from 20 locations, 49 tetraploid ($2n=18_{II}$, $2n=36$) counts from 41 locations, and eight hexaploid ($2n=27_{II}$, $2n=54$) counts from eight locations have been previously reported: 78 counts from 73 locations in total from North America. For var. *pluricephala*, 21 tetraploid ($2n=18_{II}$, $2n=36$) counts from 21 locations, one pentaploid ($2n=45$) count, and 88 hexaploid ($2n=27_{II}$, $2n=54$) counts from 86 locations have been previously reported: 110 counts from 108 locations in total from North America. The distribution of all 520 chromosome counts for *S. altissima* from North America is shown in Fig. 1, with the ranges of the three varieties based on more than 3000 herbarium collections examined.

DISCUSSION

Immediately obvious from Fig. 1 is the predominantly allopatric distribution of the three varieties of *Solidago altissima*. The ranges of the two more northern varieties are sympatric in much of the prairie-forest ecotone extending from southern Manitoba to southern Oklahoma and eastward across the Prairie Peninsula to far western Ohio. This region is a mixture of forest and prairie habitats, with var. *altissima* occurring in fields and disturbed areas along forest margins and var. *gilvocanescens* occurring in disturbed areas and native prairie habitats. Hexaploids ($2n=54$; black squares in Fig. 1, yellow shading) occur throughout the range of var. *altissima* from New Brunswick to southeastern Manitoba south to North Carolina and Arkansas. Two widely separated disjunct areas in the range of var. *altissima* include small numbers of tetraploids ($2n=36$; white squares in Fig. 1); one area in the Ozark Mountains of Arkansas and Oklahoma and a second in New Jersey and southern New York. The tetraploid Ozark Plateau populations may represent the region of origin of var. *altissima* which then evolved hexaploids that had the adaptations necessary to greatly expand further to the northeast in disturbed and more open habitats in the central and northern deciduous forest regions. The occurrence of a tetraploids in New Jersey and adjacent New York was unexpected and needs further investigation. Alternatively, hexaploids in var. *altissima* may have initially arisen multiple times in multiple locations along the western margins of its range, which is a pattern

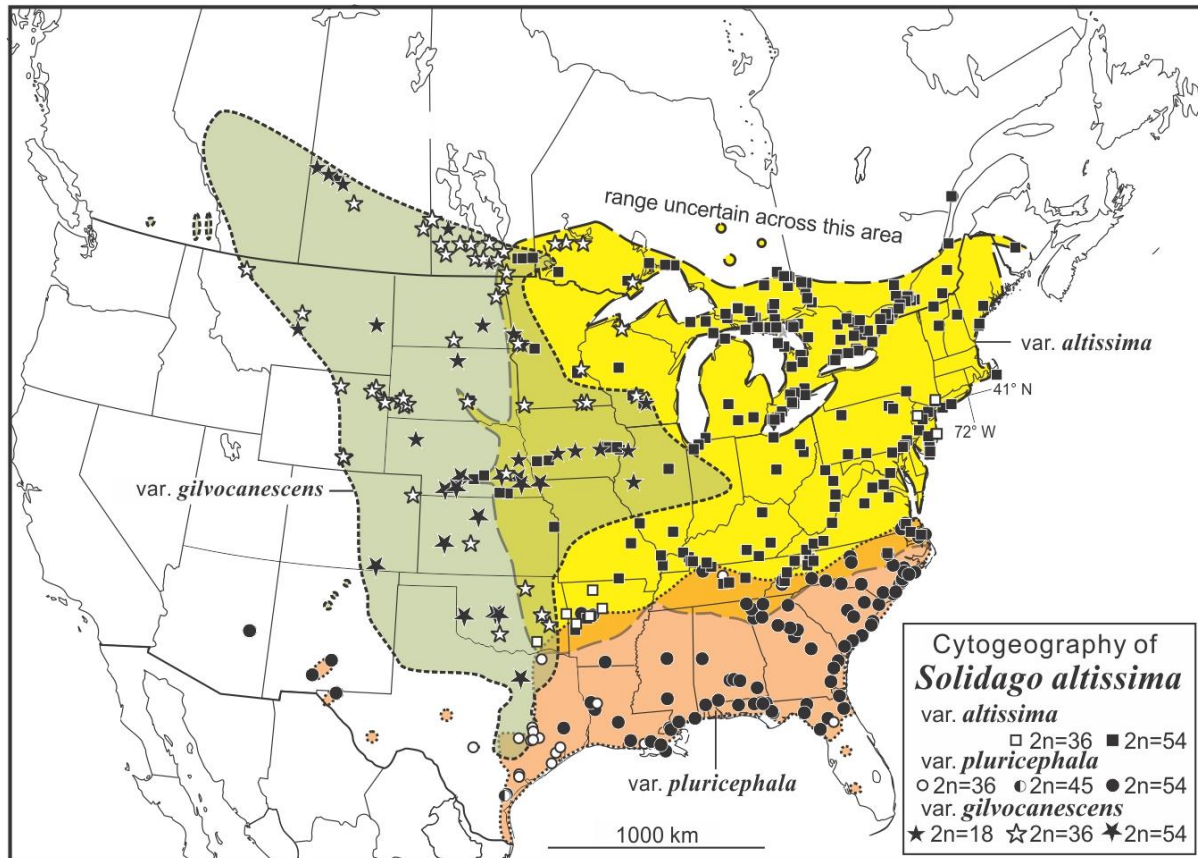


Figure 1. The cytogeography of *Solidago altissima* in North America based on all new counts reported (Appendix 1) and published counts (Appendix 2).

indicated for polyploids in other groups of goldenrods (Peirson et al. 2012). Halverson et al. (2008) reported that AFLP marker data suggested that polyploid cytotypes in *S. altissima* likely had multiple origins from different diploid lineages.

Figure 1 reveals clear patterns in the distribution of ploidy levels in var. *gilvocanescens*, the prairies and Great Plains variety of the species. Diploids ($2n=18$; black stars in Fig. 1; gray green shading) have been sampled across the northern Great Plains from Saskatchewan to Manitoba south to Nebraska and east, possibly exclusively, into the Prairie Peninsula. Tetraploids ($2n=36$; white stars in Fig. 1) occur throughout most of the range of var. *gilvocanescens* and appear to be the dominant ploidy level on some portions of the Great Plains. A low number of hexaploids ($2n=54$; inverted black stars in Fig. 1) have been sampled in southern Nebraska, Oklahoma, northeastern Texas, and southern Colorado in areas with relatively low rates of sampling. No counts have been reported from plants native to northeastern New Mexico and the Texas Panhandle region. Additional sampling of this area is needed to determine whether only hexaploids are present or if diploids and tetraploids are present at low frequencies.

The range of var. *pluricephala* is allopatric over much of its distribution throughout the southern U.S.A. from coastal North Carolina to Florida to the southern coastal plain of Texas and as far west as southern New Mexico (Fig. 1, orange shading). The hexaploid in eastern Arizona may be adventive. Note that most other collections labeled as *Solidago altissima* from Arizona are misidentified specimens of *S. velutina*. The range of var. *pluricephala* is sympatric with that of var. *altissima* in a band extending from North Carolina to eastern Oklahoma. The range of var.

pluricephala is sympatric with var. *gilvocanescens* in eastern Texas, where prairie habitats and woodland habitats are intermixed. Hexaploids ($2n=54$; black dots in Fig. 1) of var. *pluricephala* occur throughout the range of the variety. Tetraploids ($2n=36$; white dots in Fig. 1) occur most frequently in Texas and less so in Louisiana. Single tetraploid counts have been reported from northern Florida in an area with prairie-like habits and from central Tennessee along a roadside. The single pentaploid count ($2n=45$; half black/half white dot in Fig. 1) is from an area in coastal Texas where both tetraploids and hexaploids of var. *pluricephala* have been documented.

The biogeography of the three varieties of *Solidago altissima* strongly suggests that they are adapted to different ecological conditions. It is assumed that the original diploid native range of *S. altissima* was in prairie habitats where the only diploids in the species occur today, but the range would have been significantly different during peak glacial times 18,000 years ago (Brouillet & Whetstone 1992; Delcourt & Delcourt 1993). Thus, the range of diploid *S. altissima* was likely allopatric to the range of diploid only *S. canadensis* (Semple 2022 occasionally updated) in the northeastern USA or eastern Canada. The evolution of polyploid races in *S. altissima* allowed the species to significantly increase its range and become sympatric with *S. canadensis* at the local level in the northeastern U.S.A. and adjacent Canada. This is the reverse of the pattern occurring in *S. gigantea*, where the range was extended from the eastern U.S.A. and Canada onto the Great Plains by the derived hexaploids (Martino et al. 2020).

KEY TO VARIETIES OF *SOLIDAGO ALTISSIMA* AND *S. CANADENSIS*

1. Upper stem leaves narrowly lanceolate, margins with some well-developed serrations, undersurface vein glabrate to sparsely strigose-villose; involucre 2–3 mm tall at flowering.
 2. Lower to mid stems glabrous; Canada and northern USA ***S. canadensis* var. *canadensis***
 2. Lower to mid stems sparsely to moderately strigose-villose; rare in Canada becoming the only variety from North Carolina to Missouri ***S. canadensis* var. *hargeri***
1. Upper stem leaves narrowly to broadly lanceolate, margins with few or no small serrations, undersurface veins moderately to densely strigose-villose; involucre (2–)3–4 mm tall at flowering.
 3. Upper stem leaves lanceolate to broadly lanceolate or narrowly ovate, margins sometimes with several obvious serrations, involucre 2.0–3.5(–4) mm tall; prairie habitats from Alberta to northern Texas on the Great Plains, eastward on the Prairie Peninsula to western Ohio ***S. altissima* var. *gilvocanescens***
 3. Upper stem leaves lanceolate, margins entire or the serrations very small; involucre 3–4 mm tall at flowering.
 4. Inflorescences broadly conical secund, lower stems densely strigose-villose; eastern Manitoba to New Brunswick south to southeastern Oklahoma and North Carolina ***S. altissima* var. *altissima***
 4. Inflorescences longer than broad, conical secund, lower stems sometimes glabrous/glabrate with age; southeastern Virginia to eastern Oklahoma south to Florida and southern Texas and scattered in trans-Pecos Texas, southern New Mexico and possibly northern Mexico ***S. altissima* var. *pluricephala***

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APPENDIX 1. Previously unpublished chromosome counts of individuals of *Solidago altissima* (counts by J.K. Morton unless otherwise indicated). *M* & *V* = J.K. Morton & J. Venn; *S* & *Bt* = J.C. Semple & L. Brouillet.

Solidago altissima var. *altissima* — $2n=54$. CANADA. **Manitoba:** E of Winnipeg, ca. 2 mi W of MB-302 jct., *M* & *V* NA14238 (TRT). **Ontario:** Thunder Bay Dist., Nipigon, *M* & *V* NA14273 (TRT). U.S.A. **Arkansas:** Conway Co., AR-9, ca. 2 mi N of Center Ridge, *M* & *V* NA16264 (TRT). **Illinois:** Union Co., S of Alto Pass, *Morton* NA18736 (TRT). **Indiana:** Porter Co., jct US-20 and IN-49, *S* & *Bt* 4523 (WAT), boundary of Indiana Dune State Park, near US-12, *M* & *V* NA10957 (TRT). **Iowa:** Cass Co., IA-173, S of I-80, *M* & *V* NA15998 (TRT); Cedar Co., W of Durant, jct US-6 and Co.Rd.-Y30, *S* & *Bt* 4518 (WAT); Iowa Co., US-6, ca. halfway between Ladora and Marengo, *M* & *V* NA16022 (TRT); Pottawattamie Co., E/W road 2 concessions S of I-680, exit 21 (Co.Rd.-L34), *M* & *V* s.n. (TRT), I-680/29, exit 66E, *M* & *V* NA15996 (TRT); Johnson Co., I-80, exit 246, at Sinclair gas station, *M* & *V* NA16026 (TRT). **Kentucky:** Laurel Co., KY-80, S side, 8 km W of London, Daniel Boone Nat'l For., *Morton* NA18757 (TRT); Trigg Co., US-68, Land between the Lakes, Long Creek Waterfowl Refuge, *Morton* NA18749 (TRT). **Maine:** Cumberland Co., Cape Elizabeth, Crescent Beach State Park, ME-77, S of Portland, *M* & *V* NA17644 (TRT), Portland, Park Ave. (ME-77S) near I-295, exit 6, *M* & *V* NA17643 (TRT). **Missouri:** Mississippi Co., NW of Charleston, US-60 just E of I-57, *M* & *V* NA16232 (TRT); Oregon Co., MO-19 at Eleven Pt., river access path, *M* & *V* NA16245 (TRT). **Nebraska:** Brown Co., US-20 5.5 mi E of county line, picnic area, *S* & *Bt* 4487 (WAT); Holt Co., Willow Swamp Creek, US-20 and US-275, *S* & *Bt* 4496 (WAT). **North Carolina:** Currituck Co., US-158W, S of Jarvisburg, ca. 3 mi. N of the bridge across Currituck Sound, *Morton* NA18779 (TRT); Wilson Co., I-95 business loop between Elm City and Sharpbourg, *M* & *V* NA16569 (TRT).

Solidago altissima var. *gilvocanescens* (Rydb.) Semple — $2n=18$. CANADA. **Saskatchewan:** SK-16 W of Marshall, 0.3 mi E of Burke Rd., *S* & *Bt* 4265 (WAT); *M* & *V* NA14154 (TRT; counted by JKM). U.S.A. **Iowa:** Cedar Co., N/S rd., N of I-80 between exits 265 and 267, by Cedar R., *Morton* & *Venn* s.n.; Poweshiek Co., IA-21 ca. 0.5 mi N of I-80, *S* & *Bt* 4513 (WAT). **Montana:** Dawson Co., E of Fallon, I-94 3.7 mi E of rest area, Bad Route Rd. exit, *S* & *Bt* 6978 (WAT; count by JCS). **Nebraska:** Dodge Co., Elkhorn R., NE-91 0.8 mi E of RR crossing in Nickerson, *S* & *Bt* 4503 (WAT). **North Dakota:** Stutsman Co., N of Buchanan, *Semple et al.* 6678 (WAT; counted by JCS). — $2n=18_{II}$. U.S.A. **Kansas:** Pawnee Co., W of Garfield, *S* & *Bt* 7306 (WAT; count by JCS). — $2n=36$. CANADA. **Manitoba:** N of Ridgeville, *Semple et al.* 6705 (WAT; count by JCS); near Dacotah, TransCanada Hwy (Man-1) 1.3 mi E of MB-332 (to Starbuck), *S* & *Bt* 4160 (WAT); TransCanada (MB-1) 2 mi E of rd to Lenore, Oak Lake, *S* & *Bt* 4189 (WAT); 3.4 mi S of Birtle, MB-83 0.1 mi S of MB-568, *S* & *Bt* 4201 (WAT); MB-242 (Bagot-Westbourne Rd.) at dirt road parallel to TransCanada Hwy (MB-1), *S* & *Bt* 4174 (WAT). U.S.A. **Iowa:** Guthrie Co., Sheeder Prairie State Preserve, IA-44, ca. 5 mi. W of Guthrie Center, *M* & *V* NA16007 (TRT). **Montana:** Wheatland Co., US-12 2.3 mi W of Shawmut, *S* & *Bt* 6997 (WAT; count by JCS). **South Dakota:** Custer Co., Black Hills, US-16A 0.6 mi S of county line, near scenic lookout, *S* & *Bt* 4474 (WAT). — $2n=54$. U.S.A. **Nebraska:** Dawson Co., I-80, ca. 8 mi. E of Lexington (mile 245), *M* & *V* NA15986 (TRT); Furnas Co., US-6/34, ca. 5 mi. E of Cambridge, *M* & *V* NA15979 (TRT); Seward Co., *S* & *B.* *Semple* 6515 (WAT); York Co., US-81 ca. 0.5 mi. S of I-80, ca. 3.5 mi. S of York, *M* & *V* NA15992 (TRT). — $2n=$ ca. 54. U.S.A. **Kansas:** Scott Co., US-83, ca. 20 mi. N of Garden City (mp 92), *M* & *V* NA15967 (TRT).

Solidago altissima var. *pluricephala* M.C. Johnston — $2n=54$. U.S.A. **Alabama:** Crenshaw Co., AL-10, ca. 5 mi. E of Luverne (c mile 163), *M* & *V* NA16476 (TRT). **Louisiana:** Iberia Par., US-90 at LA-14/New Iberia exit, *M* & *V* NA16428 (TRT); Lafourche Par., LA-1, ca. 10 mi. N of Grand Isle, *M* & *V* NA16443 (TRT). **North Carolina:** Swain Co., between Smokemount campground and Oconaluftee Visitor Centre, *M* & *V* NA16170 (TRT).

Solidago altissima aff. var. *pluricephala* M.C. Johnston — $2n=54$. U.S.A. **North Carolina:** Randolph Co., US-64 2 m W of Asheboro, near Back Creek, *Morton* s.n. (TRT).

APPENDIX 2. Previously published chromosome counts of *Solidago altissima* with some location, voucher, and publication data. Varietal identifications are those assigned during compilation of the data on each report and examination of the voucher. Many of the reports were to species only. *MM* = M. Melville; *M* & *V* = J.K. Morton & J. Venn; *S* = J.C. Semple.

Solidago altissima var. *altissima* (originally published as *S. alt.* var. *alt.* unless otherwise indicated) — $2n=36$
 U.S.A. **Arkansas:** Boone Co., *S* & *Heard* 8307A (WAT; Semple & Chmielewski 1987), *S* & *Heard* 8307 B (WAT; Semple & Chmielewski 1987); Scott Co., *S* & *Heard* 8284 (WAT; Semple & Chmielewski 1987). **Oklahoma:** Alta Co., *S* & *Heard* 8257 (WAT; Semple & Chmielewski 1987 as var. *gilvo.*); Sequoyah Co., *M* & *V* NA16290 (TRT; Morton et al. 2020). — $2n=27$ _{II}. CANADA. **Ontario:** Algoma Dist., *S* & *Brammall* 2872 (WAT; Semple et al. 1981 to sp.); Kent Co., *S* & *Brammall* 2908 (WAT; Semple et al. 1981 to sp.). **Québec:** L'Assomption, *Beaudry* 55-140 (MT; Beaudry & Chabot 1959, to sp.), *Beaudry* 55-144 (MT; Beaudry & Chabot 1959, to sp.). U.S.A. **Illinois:** Alexander Co., *G. Morton* 5118 (NY; Semple et al. 2019); Bureau Co. *Semple* & *Heard* 7689 (WAT; Semple et al. 1989). **Michigan:** Ingham Co., *G. Morton* 6655 (NY; Semple et al. 2019); Ionia Co., *G. Morton* 6684 (NY; Semple et al. 2019); Lenawee Co., *G. Morton* 6638 (NY; Semple et al. 2019). **New Jersey:** Cape May Co., *G. Morton* 5129 (UCHT; Semple et al. 2019); Passaic Co., *G. Morton* 6304 (NY; Semple et al. 2019); Somerset Co., *G. Morton* 5187 (UCHT; Semple et al. 2019); Warren Co., *G. Morton* 5882 (UCHT; Semple et al. 2019), *G. Morton* 5889 (UCHT; Semple et al. 2019), *G. Morton* 5894 (UCHT; Semple et al. 2019). **New York:** Westchester Co., *G. Morton* 5194 (NY; Semple et al. 2019), *G. Morton* 5200 (NY; Semple et al. 2019), *G. Morton* 5232 (UCHT; Semple et al. 2019), *G. Morton* 7492 (NY; Semple et al. 2019), *G. Morton* 7493 (NY; Semple et al. 2019). **Ohio:** Erie Co., *G. Morton* 6722 (NY; Semple et al. 2019). **Pennsylvania:** Clearfield Co., *G. Morton* 6614 (NY; Semple et al. 2019). **Virginia:** Rappahannock Co., *G. Morton* 5124 (NY; Semple et al. 2019). — $2n=54$. CANADA. **Manitoba:** Reynolds, *M* & *V* NA14250 (TRT; Morton et al. 2020); Sandilands Prov. For., *M* & *V* NA14261 (TRT; Morton et al. 2020). **New Brunswick:** York Co., *Morton s.n.* (TRT; Morton et al. 2020); York Co., *M* & *V* NA17614 (TRT; Morton et al. 2020). **Ontario:** Algoma Dist., *MM* 637 (WAT; Melville and Morton 1982 to sp.), *S* & *Brammall* 2872 (WAT; Melville and Morton 1982 to sp.), *Semple* & *Brammall* 2883 (WAT; Semple et al. 1981 to sp.; Melville and Morton 1982 to sp.); *MM* 638 (WAT; Melville and Morton 1982 to sp.), *MM* 672a (WAT; Melville and Morton 1982 to sp.), *MM* 659 (WAT; Melville and Morton 1982 to sp.), *MM* 677 (WAT; Melville and Morton 1982; listed as both *alt.* and *S. lepida* "verging on"), *MM* 682 (WAT; Melville and Morton 1982, to sp.), *MM* 885 (WAT; Melville and Morton 1982 to sp.), *MM* 887 (WAT; Melville and Morton 1982, to sp.), *MM* 888 (WAT; Melville and Morton 1982 to sp.), *Morton* NA10703 (TRT; Melville and Morton 1982, to sp.); Bruce Co., *M* & *V* NA10811 (TRT; Melville and Morton 1982 to sp.; Morton et al. 2020), *M* & *V* NA10831 (TRT; Morton et al. 2020), *MM* 1969 (WAT; Melville and Morton 1982); Dundas Co., *MM* 1770 (WAT; Melville and Morton 1982 to sp.); Durham Co., *MM* & *Brouillet* 1216 (WAT; Melville and Morton 1982 to sp.), *MM* 1699 (WAT; Melville and Morton 1982 to sp.), *MM* 1700 (WAT; Melville and Morton 1982 to sp.); Elgin Co., *MM* 1880 (WAT; Melville and Morton 1982 to sp. *MM* 1887 (WAT; Melville and Morton 1982 to sp.), *MM* 1888 (WAT; Melville and Morton 1982 to sp.), *Morton* NA17780 (TRT; Morton et al. 2020 loc as NB), *MM* 1897 (WAT; Melville and Morton 1982 to sp.), *Cook* & *Parks* C-21 (WAT; Semple and Cook 2004 as ssp. *alt.*), *M* & *V s.n.* (Morton et al. 2020 sine coll., loc as NB); Frontenac Co., *MM* 1245 (WAT; Melville and Morton 1982, to sp.), *MM* 1745 (WAT; Melville and Morton 1982 to sp.), *MM* 1812 (WAT; Melville and Morton 1982 to sp.), *MM* & *Brouillet* 1240 (WAT; Melville and Morton 1982 to sp.); Grenville Co., *MM* 1259 (WAT; Melville and Morton 1982 to sp.), *MM* 1761 (WAT; Melville and Morton 1982 to sp.); Grey Co., *MM* 1936 (WAT; Melville and Morton 1982 to sp.), *Cook* & *Faulkenham* C-19 (WAT; Semple and Cook 2004 as ssp. *alt.*); Hastings Co., *MM* & *Brouillet* 1224 (WAT; Melville and Morton 1982 to sp.), *MM* 1728 (WAT; Melville and Morton 1982 to sp.); Huron Co., *Ringius* 1509 (WAT; Semple et al. 1984 to sp.); Kent Co., *Semple* & *Brammall* 2908 (WAT; Melville and Morton 1982 sp.), *MM* 1896 (WAT; Melville and Morton 1982 to sp.); *MM* & *Brouillet* 1307 (WAT; Melville and Morton 1982 to sp.); Leeds Co., *Beaudry et al.* 62-221 (MT; Beaudry 1969, to sp.), *Beaudry et al.* 62-222 (MT; Beaudry 1969, to sp.); Lennox and Addington Co., *MM* 1818 (WAT; Morton et al. 2020, loc as NB); Manitoulin Dist., *S* & *Brammall* 2312 (WAT; (Semple et al. 1981 to sp.; Melville and Morton 1982, to sp.), *Morton* NA10751 (WAT; Melville and Morton 1982 to sp.), *Morton* NA12652 (WAT; Melville and Morton 1982, to sp.); *Morton* NA12576 (WAT; Melville and Morton 1982, to sp.), *Morton* NA14299 (WAT; Melville and Morton 1982 to sp.); Middlesex Co., *MM* 1914 (WAT; Melville and Morton 1982, to sp.), *MM* 1916 (WAT; Melville and Morton 1982, to sp.); Nipissing Dist., *MM* & *Brouillet* 1380 (WAT; Melville and

Morton 1982, to sp.), *MM 1366* (WAT; Melville and Morton 1982, to sp.), *S & Brammall 2814* (WAT; Melville and Morton 1982, to sp.), *Morton NA17798* (TRT; Morton et al. 2020), *Morton NA17800* (TRT; Morton et al. 2020); Northumberland Co., *MM 1719* (WAT; Melville and Morton 1982, to sp.); Ottawa-Carleton R.M., *MM 1797* (WAT; Melville and Morton 1982, to sp. to sp.); Oxford Co., *MM 1877* (WAT; Melville and Morton 1982 to sp.); Parry Sound Dist., *MM 789* (WAT; Melville and Morton 1982, to sp.), *MM 819* (WAT; Melville and Morton 1982, to sp.), *MM 820* (WAT; Melville and Morton 1982, to sp.), *MM 1180* (WAT; Melville and Morton 1982, to sp.), *MM 1181* (WAT; Melville and Morton 1982, to sp.), *MM 1193* (WAT; Melville and Morton 1982, to sp.), *S & B. Semple 11073* (WAT; Semple et al. 2015); Peterborough Co., *MM 1708* (WAT; Melville and Morton 1982, to sp.), *MM 1851* (WAT; Melville and Morton 1982, to sp.); Rainy River Dist.; *MM 1056* (WAT; Melville and Morton 1982, to sp.), *MM 1092* (WAT; Melville and Morton 1982, to sp.), *MM 1822* (WAT; Melville and Morton 1982, to sp.); Renfrew Dist., *MM 1825* (WAT; Melville and Morton 1982 to sp.), *MM 1827* (WAT; Melville and Morton 1982, to sp.); Russell Co., *MM & Brouillet 1274* (WAT; Melville and Morton 1982 to sp.), *MM & Brouillet 1280* (WAT; Melville and Morton 1982 to sp.); Stormont Co., *MM 1266* (WAT; Melville and Morton 1982 to sp.), *MM 1775* (WAT; Melville and Morton 1982 to sp.), *MM 1780* (TRT; Morton et al. 2018); Sudbury Dist.: *MM 771* (WAT; Melville and Morton 1982, to sp.), *MM 776* (WAT; Melville and Morton 1982, to sp.), *MM 1600* (WAT; Melville and Morton 1982, to sp.), *MM 1601* (WAT; Melville and Morton 1982, to sp.); Temiskaming Dist., *Morton NA17804* (TRT; Morton et al. 2020), *M & V NA17807* (TRT; Morton et al. 2020), *Morton NA17808* (TRT; Morton et al. 2020), *Cook & Seiden C-84* (WAT; Semple et al. 2019); Thunder Bay Dist.; *MM 867* (WAT; Melville and Morton 1982, to sp.), *MM 920* (WAT; Melville and Morton 1982, to sp.), *MM 1005* (WAT; Melville and Morton 1982, to sp.). **Québec:** Beauce Co., *M & V NA17503* (TRT; Morton et al. 2020 loc as NB); Cap St-Jacques, *Beaudry & Rolland-Germain 63-240-1* (MT; Beaudry 1969 to sp.), *Beaudry & Rolland-Germain 63-240-2* (MT; Beaudry 1969 to sp.), *Beaudry & Rolland-Germain 63-240-5* (MT; Beaudry 1969 to sp.); N of Fabre *Morton NA17803* (TRT; Morton et al. 2020); N of Laniel, *Morton NA17802* (TRT; Morton et al. 2020 loc as NB); E of Lennoxville; *M & V NA17502* (TRT; Morton et al. 2020 loc as NB); Montmagny Co., *M & V NA17507* (TRT; Morton et al. 2020 loc as NB); Rougemont, *S & Brouillet 3423* (WAT; Semple et al. 1981 to sp.); Rouville Co., *Beaudry 55-182-1* (MT; Beaudry & Chabot 1959 to sp.), *Beaudry 55-182-2* (MT; Beaudry & Chabot 1959 to sp.); Sault-au-Mouton, *M & V NA15242* (TRT; Morton et al. 2020); Hwy 101, *M & V NA15232* (TRT; Morton et al. 2020); N of Temiskaming, *Morton NA17806* (TRT; Morton et al. 2020). U.S.A. **Arkansas:** Garland Co., *Cook & Tereszchuk C-211* (WAT; Semple et al. 2015); Logan Co., *M & V NA16288* (TRT; Morton et al. 2020); Polk Co., *Cook & Tereszchuk 222* (WAT; Semple et al. 2015); Yell Co., *S & Heard 8285A* (WAT; Semple & Chmielewski 1987). **Illinois:** Clark Co., *Morton NA18718* (TRT; Morton et al. 2020); Clinton Co., *Morton NA18728* (TRT; Morton et al. 2020); Cumberland Co., *Morton NA18723* (TRT; Morton et al. 2020); Hamilton Co., *S & Suripto 9418* (WAT; Semple et al. 1993); Jackson Co., *Morton NA18733* (TRT; Morton et al. 2020); Livingston Co., *S & Brouillet 7387* (WAT; Semple 1985 to sp.). **Indiana:** Lake Co., *M & V NA16032* (TRT; Morton et al. 2020), *M & V NA16033* (TRT; Morton et al. 2020). **Iowa:** Iowa Co., *M & V NA16019* (TRT; Morton et al. 2020); **Kansas:** Johnson Co., *S & Chmielewski 5251* (WAT; Semple et al. 1984 to sp.); **Kentucky:** Adair Co., *M & V NA18755* (TRT; Morton et al. 2020), *M & V NA18756* (TRT; Morton et al. 2020); Ballard Co., *M & V NA16231* (TRT; Morton et al. 2020); Christian Co., *S & Suripto 9434-1* (WAT; Semple et al. 1993); Harlan Co., *Morton NA18761* (TRT; Morton et al. 2020); Harrison Co., *S & Suripto 9592* (WAT; Semple et al. 1993); Leslie Co., *Cook & Tereszchuk 205* (WAT; Semple et al. 2015); Lyon Co., *Morton NA18742* (TRT; Morton et al. 2020); Nicholas Co., *S 11549* (WAT; Semple et al. 2019); Todd Co., *Morton NA18751* (TRT; Morton et al. 2020); Trigg Co., *M & V NA16220* (TRT; Morton et al. 2020); Whitley Co., *S, Brammall & Hart 2993* (WAT; Semple et al. 1981 to sp.). **Maine:** Kennebec Co., *M & V NA17637* (TRT; Morton et al. 2020). **Maryland:** Baltimore Co., *M & V NA16576* (TRT; Morton et al. 2020); Baltimore Co., *M & V NA16577* (TRT; Morton et al. 2020), *M & V NA16578* (TRT; Morton et al. 2020); Prince George's Co., *M & V NA16574* (TRT; Morton et al. 2020). **Massachusetts:** Nantucket Co., *McKeever 63-194* (MT; Beaudry 1969, to sp.), *McKeever 63-197* (MT; Beaudry 1969, to sp.), *McKeever 63-198* (MT; Beaudry 1969, to sp.), *McKeever 63-199* (MT; Beaudry 1969, to sp.), *McKeever 63-200* (MT; Beaudry 1969, to sp.). **Michigan:** Alger Co., *M & V s.n.* (TRT; Morton et al. 2020); Berrien Co., *M & V NA16037* (TRT; Morton et al. 2020); Cheboygan Co., *M & V NA10919* (TRT; Morton et al. 2020); Chippewa Co., *Hiltunen 60-219-4* (MT; Beaudry 1969, to sp.); Luce Co., *M & V s.n.* (TRT; Morton et al. 2020); Mackinac Co., *M & V NA10928* (TRT; Morton et al. 2020). **Minnesota:** Hennepin Co., *M & V s.n.* (TRT; Morton et al. 2020). **Missouri:** St. Louis Co., *Beaudry 63-201-1* (MT; Beaudry 1969, to sp.), *Beaudry 63-201-2* (MT; Beaudry 1969, to sp.),

Beaudry 63-201-3 (MT; Beaudry 1969, to sp.), *Beaudry* 63-201-5 (MT; Beaudry 1969, to sp.); Washington Co., *S. Suripto* & *Ahmed* 9395 (WAT; Semple et al. 1993 to sp.). **Nebraska:** Buffalo Co., *M* & *V* NA15989 (TRT; Morton et al. 2020); Hall Co., *M* & *V* s.n. (TRT; Morton et al. 2020); Hayer Co., *Semple* & *Brouillet* 7346 (WAT; Semple et al. 1984 to sp.); Jefferson Co., *Semple* & *Brouillet* 7349 (WAT; Semple et al. 1992); Johnson Co., *S* & *Brouillet* 7353 (WAT; Semple 1985 to sp.); Red Willow Co., *M* & *V* NA15978 (TRT; Morton et al. 2020). **New Hampshire:** Coos Co., *M* & *V* NA17659 (TRT; Morton et al. 2020), *M* & *V* NA17660 (TRT; Morton et al. 2020), *M* & *V* NA17661 (TRT; Morton et al. 2020). **New Jersey:** Atlantic Co., *M* & *V* NA16083 (TRT; Morton et al. 2020), *M* & *V* NA16084 (TRT; Morton et al. 2020), *M* & *V* NA16086 (TRT; Morton et al. 2020); Burlington Co., *M* & *V* NA16093 (TRT; Morton et al. 2020), *M* & *V* NA16097 (TRT; Morton et al. 2020); Cape May Co., *M* & *V* NA16105 (TRT; Morton et al. 2020). **New York:** Allegany Co., *Morton* NA18672 (TRT; Morton et al. 2020), *Morton* NA18675 (TRT; Morton et al. 2020); Cattaraugus Co., *Morton* NA18678 (TRT; Morton et al. 2020); Delaware Co., *S* 6816 (WAT; Semple et al. 1984 to sp.); Nassau Co., *S* 6840 (WAT; Semple et al. 1984 to sp.); Schuyler Co., *M* & *V* NA16062 (TRT; Morton et al. 2020), *M* & *V* NA16064 (TRT; Morton et al. 2020); Suffolk Co., *Semple* 6847 (WAT; Semple et al. 1984 to sp.). **North Carolina:** Avery Co., *Cook* & *Tereszchuk* 304 (WAT; Semple et al. 2015); Caldwell Co., *Morton* NA18765 (TRT; Morton et al. 2020) Camden Co., *Morton* NA18780 (TRT; Morton et al. 2020); *Morton* NA18771 (TRT; Morton et al. 2020). **Ohio:** Crawford Co., *Morton* NA18705 (TRT; Morton et al. 2020); Franklin Co., *M* & *V* NA18709 (TRT; Morton et al. 2020); Stark Co., *M* & *V* NA18701 (TRT; Morton et al. 2020); Tuscarawas Co., *Cook* & *D. Cook* 46 (WAT; Semple and Cook 2004, location incorrect as PA). **Oklahoma:** McIntosh Co., *M* & *V* NA16295 (TRT; Morton et al. 2020). **Pennsylvania:** Bucks Co., *M* & *V* NA16078 (TRT; Morton et al. 2020); Chester Co., *M* & *V* NA16108 (TRT; Morton et al. 2020), *M* & *V* NA16109 (TRT; Morton et al. 2020), *M* & *V* NA16110 (TRT; Morton et al. 2020); Fulton Co., *M* & *V* NA16127 (TRT; Morton et al. 2020); McKean Co., *Morton* NA18680 (TRT; Morton et al. 2020), *Morton* NA18681 (TRT; Morton et al. 2020); Somerset Co., *M* & *V* NA16129 (TRT; Morton et al. 2020); Wyoming Co., *M* & *V* NA16069 (TRT; Morton et al. 2020), *M* & *V* NA16074 (TRT; Morton et al. 2020), *M* & *V* NA16075 (TRT; Morton et al. 2020). **South Dakota:** Brule Co., *M* & *V* NA15679 (TRT; Morton et al. 2020). **Tennessee:** Cannon Co., *M* & *V* NA16206 (TRT; Morton et al. 2020); Carter Co., *Cook* & *Tereszchuk* 283 (WAT; Semple et al. 2015), *Cook* & *Tereszchuk* 289 (WAT; Semple et al. 2015), *Cook* & *family* 519 (WAT; Semple et al. 2015), *Cook* & *family* 527 (WAT; Semple et al. 2015); *Morton* NA18763 (TRT; Morton et al. 2020); Greene Co., *M* & *V* NA16162 (TRT; Morton et al. 2020); Robertson Co., *M* & *V* NA16214 (TRT; Morton et al. 2020), *M* & *V* NA16215 (TRT; Morton et al. 2020); Rutherford Co., *M* & *V* NA16210 (TRT; Morton et al. 2020); Sevier Co., *M* & *V* NA16166 (TRT; Morton et al. 2020). **Vermont:** Orleans Co., *M* & *V* NA17670 (TRT; Morton et al. 2020). **Virginia:** Albermarle Co., *Semple* & *Chmielewski* 5934 (WAT; Semple et al. 1984 to sp.); Caroline Co., *M* & *V* NA16571 (TRT; Morton et al. 2020); Isle of Wright Co., *S* & *Chmielewski* 5998 (WAT; Semple et al. 1984 to sp.); Prince William Co., *M* & *V* NA16572 (TRT; Morton et al. 2020); Roanoke Co., *M* & *V* NA16153 (TRT; Morton et al. 2020); Washington Co., *M* & *V* NA16161 (TRT; Morton et al. 2020). **West Virginia:** Marion Co., *S* 10693 (WAT; Semple and Cook 2004 as ssp. alt.); Monroe Co., *Cook* & *Tereszchuk* 339 (WAT; Semple et al. 2015); Pocahontas Co., *M* & *V* NA16143 (TRT; Morton et al. 2020); Randolph Co., *M* & *V* NA16142 (TRT; Morton et al. 2020); Taylor Co., *M* & *V* NA16137 (TRT; Morton et al. 2020), *M* & *V* NA16138 (TRT; Morton et al. 2020). **Wisconsin:** Clark Co., *M* & *V* NA15196 (TRT; Morton et al. 2020); Columbia Co., *M* & *V* NA15652 (TRT; Morton et al. 2020). Juneau Co., *M* & *V* NA15656 (TRT; Morton et al. 2020). — $2n = \text{ca. } 54$. CANADA. **Québec:** Chambly Co., Beaudry 55-188 (MT; Beaudry & Chabot 1959 to sp.); Montréal Co., *LaFontaine* 55-179 (MT; Beaudry & Chabot 1959 to sp.). U.S.A. **Michigan:** Chippewa Co., *Hiltunen* 60-214-3 (MT; Beaudry 1969, to sp.). — $2n = 54 + 1-2$. CANADA. **Québec:** Montcalm Co., *Marcellin-Sylvio* 55-210b (MT; Beaudry & Chabot 1959 to sp.). — $2n = \text{ca. } 54 + 1-2$ CANADA. **Québec:** Deux Montagnes Co. *Beaudry* 55-210 (MT; Beaudry & Chabot 1959 to sp.) Moncalm Co., *Marcellin-Sylvio* 55-210 (MT; Beaudry & Chabot 1959 to sp.).

Solidago altissima aff. var. *altissima* (originally published as *S. alt.* var. *alt.* unless otherwise indicate) — $2n = 18_{II}$. U.S.A. **New Jersey:** Ocean Co., *G. Morton* 5147 (NY; Semple et al. 2019), *G. Morton* 5234 (UCHT; Semple et al. 2019). **New York:** Warren Co., *G. Morton* 5910 (UCHT; Semple et al. 2019). Westchester Co., *G. Morton* 5195 (NY; Semple et al. 2019). — $2n = 54$. CANADA. **Ontario:** Haldimand-Norfolk Reg.Mun., *MM* 1873 (WAT; Melville & Morton 1982 to sp.); Rainy River Dist., *MM* 1092 (WAT; Melville & Morton 1982 to sp.); Parry Sound Dist., *MM* 797 (WAT; Melville & Morton 1982 to sp.), *MM* 806 (WAT; Melville & Morton 1982 to sp.), *MM* 818 (WAT; Melville & Morton 1982 to sp.); Sudbury

Dist., MM 771 (WAT; Melville & Morton 1982 to sp), MM 776 (WAT!; Melville & Morton 1982 to sp), MM 867 (WAT; Melville & Morton 1982 to sp); Thunder Bay Dist., MM 920 (WAT; Melville and Morton 1982 to sp.), MM 939 (WAT; Melville and Morton 1982 to sp.).

Solidago altissima var. *gilvocanescens* (Rydb.) Semple (originally published as *S. alt.* var. *gilvo.* unless otherwise indicated) — $2n=18$. CANADA. **Manitoba:** Kleeefield, *Bernard* 58-274 (MT; Beaudry 1963); NW of Ste. Agathe, *S* 10645 (WAT; Semple et al. 2001); Otterburne, *Bernard* 58-262 (MT; Beaudry 1963), *Bernard* 58-267 (MT; Beaudry 1963); Sandilands, *Löve & Löve* 6162 (not seen; Löve & Löve 1982; as *S. can.* ssp. *gilvo.* **Saskatchewan:** E of Maymont, *M & V* NA14208 (TRT; Morton et al. 2020); W of Radison, *M & V* NA14210 (TRT; Morton et al. 2020). U.S.A. **Illinois:** Adams Co., *S & Brouillet* 7367 (WAT; Semple 1985 as *S. can.* var. *can.*); Johnson Co., *S & Heard* 8329 (WAT; Semple & Chmielewski 1987 as *S. can.* var. *can.*); La Salle Co., *M & V* NA16030 (TRT; Morton et al. 2020). **Iowa:** Iowa Co., *M & V* NA16015 (TRT; Morton et al. 2020); Polk Co., *M & V* NA16012 (TRT; Morton et al. 2020); Scott Co., *M & V* NA16028 (TRT; Morton et al. 2020). **Minnesota:** Clay Co., *M & V* NA15168 (TRT; Morton et al. 2020); Grant Co., *M & V* NA15171 (TRT; Morton et al. 2020); Winona Co., *M & V* NA15660 (TRT; Morton et al. 2020). **Nebraska:** Gosper Co., *M & V* NA15984 (TRT; Morton et al. 2020); Sheridan Co., *S & B. Semple* 11413 (WAT; Semple et al. 2019). **South Dakota:** Walworth Co., *S & B. Semple* 6659 (WAT; Semple et al. 1984 as *S. gilvo.*). **Wisconsin:** Columbia Co., *M & V* NA15651 (TRT; Morton et al. 2020). — $2n=18$. U.S.A. **Oklahoma:** Stephens Co., *S & Heard* 8246B (WAT; Semple & Chmielewski 1987). — $2n=36$. CANADA. **Manitoba:** Gladstone, *M & V* NA14225 (TRT; Morton et al. 2020); Johnson, *M & V* s.n. (TRT; Morton et al. 2020); Loretto, *Morton & Venn* NA14230 (TRT; Morton et al. 2020), *Morton & Venn* NA14231 (TRT; Morton et al. 2020); Neepawa, *M & V* NA14224 (TRT; Morton et al. 2020); W of Portage-la-Prairie, *S & Brouillet* 4168 (WAT; Morton et al. 2020); Otterburne, *Bernard* 58-264 (MT; Beaudry 1963 as *S. gilvo.*), *Bernard* 58-264 (MT; Beaudry 1963 as *S. gilvo.*), *Bernard* 58-264 (MT; Beaudry 1963 as *S. gilvo.*), *Bernard* 58-265 (MT; Beaudry 1963 as *S. gilvo.*), *Bernard* 58-268 (MT; Beaudry 1963 as *S. gilvo.*), *Bernard* 63-105 (MT; Beaudry 1969 as *S. gilvo.*). **Ontario:** Thunder Bay Dist., *M & V* NA14268 (TRT; Morton et al. 2020). **Saskatchewan:** W of Churchbridge, *S & Brouillet* 4210 (WAT; Morton et al. 2020); S of Somme, *Hooper* 83091104 (WAT; Semple et al. 1984 to sp.). U.S.A. **Colorado:** Yuma Co., *S & Heard* 7706 (WAT; Semple & Chmielewski 1987). **Minnesota:** Grant Co., *M & V* NA15661 (TRT; Morton et al. 2020), *M & V* NA15663 (TRT; Morton et al. 2020), *M & V* NA15170 (TRT; Morton et al. 2020); Olmsted Co., *S* 9056 (WAT; Semple et al. 1992); Rock Co., *M & V* NA15672 (TRT; Morton et al. 2020); Washington Co., *M & V* NA15186 (TRT; Morton et al. 2020); Wilkins Co., *S & Chmielewski* 5110 (Semple et al. 1984 as *S. gilvo.*). **Montana:** Glacier Co. *Semple & B. S* 11389 (WAT; Semple et al. 2019); Judith Basin Co., *S & B. Semple* 11396 (WAT; Semple et al. 2019). **Nebraska:** Sheridan Co., *S & B. Semple* 11415 (WAT; Semple et al. 2019). **North Dakota:** Emmons Co., *S et al.* 6672 (WAT; Semple et al. 1984 as *S. gilvo.*); Grand Co., *S et al.* 6689 (WAT; Semple et al. 1984 as *S. gilvo.*); Walsh Co., *S* 6699 (WAT; Semple et al. 1984 as *S. gilvo.*). **Oklahoma:** Latimer Co., *Morton* s.n. (TRT; Morton et al. 2020); McIntosh Co., *M & V* NA16294 (TRT; Morton et al. 2020); Stephens Co., *S & Heard* 8246A (WAT; Semple & Chmielewski 1987), *S & Heard* 8246B (WAT; Semple & Chmielewski 1987). **South Dakota:** Custer Co., *M & V* NA15688 (TRT; Morton et al. 2020), *M & V* NA15690 (TRT; Morton et al. 2020), *M & V* NA15691 (TRT; Morton et al. 2020); Lyman Co., *Morton & J. Venn* NA15681 (TRT; Morton et al. 2020). Texas: Kerr Co., *M & V* NA16366 (TRT; Morton et al. 2020). **Wisconsin:** Juneau Co., *M & V* NA15655 (TRT; Morton et al. 2020). **Wyoming:** Carbon Co., *S, Supto & Ahmed* 9208 (WAT; Semple et al. 2001), *S, Supto & Ahmed* 9210 (WAT; Semple et al. 2001); Crook Co., *S & Xiang* 10193 (WAT; Semple et al. 2001), *M & V* NA15699 (TRT; Morton et al. 2020); Johnson Co., *M & V* NA15700 (TRT; Morton et al. 2020); Weston Co., *M & V* NA15693 (TRT; Morton et al. 2020), *M & V* NA15696 (TRT; Morton et al. 2020). — $2n=54$. U.S.A. **Colorado:** Las Animas Co., *M & V* NA15964 (TRT; Morton et al. 2020). **Kansas:** Osborne Co., *S & Brouillet* 7327 (WAT; Semple 1985 to sp.). **Missouri:** Atchison Co., *S & Brouillet* 7362 (WAT; Semple 1985 to sp.). **Nebraska:** Lancaster Co., *M & V* NA15994 (TRT; Morton et al. 2020); York Co., *M & V* NA15993 (TRT; Morton et al. 2020 as var. *alt.*). **Oklahoma:** Beckham Co., *M & V* NA16304 (TRT; Morton et al. 2020). **Texas:** Dallas Co., *Beaudry & Shinnars* 57-625 (MT; Beaudry 1963 to sp.); Pottawatomie Co., *M & V* NA16297 (TRT; Morton et al. 2020).

Solidago altissima aff. var. *gilvocanescens* (Rydb.) Semple (originally published as *S. alt.* var. *gilvo.* unless otherwise indicate) — $2n=18$. US MN Wilkin Co., *M & V* NA15175 (TRT; Morton et al. 2020). — $2n=36$.

CANADA. **Ontario:** Kenora Dist., *M & V NA14266* (TRT; Morton et al. 2020). **Oklahoma:** Canadian Co., *M & V NA16303* (TRT; Morton et al. 2020).

Solidago altissima var. *pluricephala* M.C. Johnston (originally published as *S. alt.* var. *pluri.* unless otherwise indicated) — U.S.A. **Louisiana:** — $2n=36$ U.S.A. **Arkansas:** Yell Co., *M & V NA16271* (TRT; Morton et al. 2020), *Morton & J. Venn NA16273* (TRT; Morton et al. 2020). **Florida:** Alachua Co., *Heard 2003-108b* (ISC; Semple et al. 2015). **Louisiana:** Assumption Par., *M & V NA16432* (TRT; Morton et al. 2020); Natchitoches Par., *Nesom et al. 7848* (TEX; Nesom et al. 7848; Zhao 1996 to sp.). **Tennessee:** Davidson Co., *S & Chmielewski 9124* (WAT; Semple et al. 1992 as *S. can.* aff. *can.*, corrected in Semple and Cook 2004 to *S. alt.* ssp. *alt.*). **Texas:** Brazoria Co., *Nesom et al. 7503* (TEX; Zhao & Turner 1993 to sp.), *Nesom 7260* (WAT; Turner & Zhao 1992); Brazos Co., *Nesom et al. 7507* (TEX; Zhao & Turner 1993 to sp.); Fayette Co., *M & V NA16414* (TRT; Morton et al. 2020); Grimes Co., *S & Suropto 10069* (WAT; Semple et al. 1993 as var. *alt.*); Harris Co., *S & Suropto 10076* (WAT; Semple et al. 1993 as var. *alt.*); Lamar Co., *S & Suropto 10002* (WAT; Semple et al. 1993 as var. *alt.*); Lee Co., *Nesom et al. 7509* (TEX; Zhao & Turner 1993 to sp.); Refugio Co., *M & V NA16399* (TRT; Morton et al. 2020); Victoria Co., *M & V NA16410* (TRT; Morton et al. 2020), *M & V NA16411* (TRT; Morton et al. 2020); Washington Co., *M & V NA16415* (TRT; Morton et al. 2020), *Nesom 7263* (TEX not seen; Turner & Zhao 1992 to sp.), *Nesom et al. 7508* (TEX; Zhao & Turner 1993 to sp.). — $2n=45$ US TX San Patricio Co., *M & V NA16394* (TRT; Morton et al. 2020). — $2n=27$ II. U.S.A. **New Mexico:** Dona Ana Co., *Ward 83-081* (NMC; Ward and Spellenberg 1986 as *S. can.* var. *scabra*); Eddy Co., *Ward 84-027* (NMC; Ward & Spellenberg 1986 *S. can.* var. *scabra*); Otero Co., *Ward 81-208* (NMC; Ward and Spellenberg 1986 *S. can.* var. *scabra*). **Texas:** Culberson Co., *Ward 84-029* (NMC; Ward and Spellenberg 1988 as *S. can.* var. *scabra*). — $2n=54$. US U.S.A. **Alabama:** Butler Co., *M & V NA16472* (TRT; Morton et al. 2020), *M & V NA16473* (TRT; Morton et al. 2020); Dale Co., *M & V NA16480* (TRT; Morton et al. 2020); Escambia Co., *M & V NA16471* (TRT; Morton et al. 2020); Greene Co., *S & Chmielewski 6365* (WAT; Semple et al. 1984 to sp.); Mobile Co., *M & V NA16466* (TRT; Morton et al. 2020). **Arkansas:** Union Co., *S & Chmielewski 6413* (WAT; Semple et al. 1984 to sp.); Yell Co., *Semple & Heard 8285 B* (WAT; Semple and Chmielewski 1987 as var. *alt.*), *M & V NA16270* (TRT; Morton et al. 2020). **Arizona:** Navajo Co., *M & V NA15900* (TRT; Morton et al. 2020). **Florida:** Alachua Co., *Heard 2003-127* (ISC; Semple et al. 2015); Calhoun Co., *M & V NA16483* (TRT; Morton et al. 2020); Clay Co., *M & V NA16540* (TRT; Morton et al. 2020); Holmes Co., *S & Godfrey 3176* (WAT; Semple et al. 1981 to sp.); Jackson Co., *S & Chmielewski 6338* (WAT; Semple et al. 1984 to sp.), *S 10949* (WAT; Semple and Cook 2004 as ssp. *alt.*); Levy Co., *M & V NA16505* (TRT; Morton et al. 2020), *M & V NA16506* (TRT; Morton et al. 2020); Liberty Co., *S 11686* (WAT; Semple et al. 2019); Madison Co., *S 11679* (WAT; Semple et al. 2019); Nassau Co., *M & V NA16541* (TRT; Morton et al. 2020); Okaloosa Co., *S, Brouillet & Canne 3887* (WAT; Semple et al. 1981 to sp.); Taylor Co., *M & V NA16493* (TRT; Morton et al. 2020). **Georgia:** Bartow Co., *M & V NA16196* (TRT; Morton et al. 2020); Brantley Co., *M & V NA16542* (TRT; Morton et al. 2020); Bryan Co., *M & V NA16546* (TRT; Morton et al. 2020); Dade Co., *S 11002* (WAT; Semple and Cook 2004 as ssp. *alt.*); Dekalb Co., *M & V NA16189* (TRT; Morton et al. 2020); Floyd Co., *Cook & Tereszchuk 251* (WAT; Semple et al. 2015); Greene Co., *S 10870* (WAT; Semple and Cook 2004 as ssp. *alt.*); Habersham Co., *M & V NA16183* (TRT; Morton et al. 2020); Johnson Co., *S, Brouillet & Canne 4044* (WAT; Semple et al. 1981 to sp.); Long Co., *M & V NA16544* (TRT; Morton et al. 2020); Murray Co., *Cook & Tereszchuk 262* (WAT; Semple et al. 2015); Walker Co., *Cook & Tereszchuk C-243* (WAT; Semple et al. 2015); Whitfield Co., *M & V NA16200* (TRT; Morton et al. 2020). **Louisiana:** LaFourche Par., *M & V NA16437* (TRT; Morton et al. 2020), *M & V NA16438* (TRT; Morton et al. 2020); St. Landry Par., *M & V NA16425* (TRT; Morton et al. 2020); St. Tammany Par., *M & V NA16447* (TRT; Morton et al. 2020), *M & V NA16448* (TRT; Morton et al. 2020); Terrebonne Par., *M & V NA16434* (TRT; Morton et al. 2020); Vernon Par., *S & Suropto 10046* (WAT; Semple et al. 1993 as var. *alt.*). **Mississippi:** Attala Co., *M & V s.n.* (TRT; Morton et al. 2020); Hancock Co., *M & V NA16454* (TRT; Morton et al. 2020), *M & V NA16455* (TRT; Morton et al. 2020); Jackson Co., *M & V NA16461* (TRT; Morton et al. 2020), *M & V NA16462* (TRT; Morton et al. 2020). **North Carolina:** Brunswick Co., *S 11647* (WAT; Semple et al. 2019); Carteret Co., *M & V NA16566* (TRT; Morton et al. 2020); Columbus Co., *Morton NA18775* (TRT; Morton et al. 2020); Gaston Co., *S, Brouillet & Canne 4069* (Semple et al. 1981 to sp.); Guilford Co., *S & Suropto 9714* (WAT; Semple et al. 2015); *S & Suropto 9753* (WAT; Semple et al. 1993 as var. *alt.*); Jones Co., *Morton NA18778* (TRT; Morton et al. 2020); Lenoir Co., *M & V NA16568* (TRT; Morton et al. 2020); Onslow Co., *Morton s.n.* (TRT; Morton et al. 2020), *M & V NA16559* (TRT; Morton et al. 2020), *Morton NA18777* (TRT; Morton et al. 2020); Pender Co., *M & V NA16556*

(TRT; Morton et al. 2020); Pitt Co., *S* & *Suripto* 9737 (WAT; Semple et al. 1993 as var. *alt.*); Swain Co., *M* & *V* NA16172 (TRT; Morton et al. 2020); Union Co., *Morton* NA18770 (TRT; Morton et al. 2020). **South Carolina:** Charleston Co., *Cook et al.* 689 (WAT; Semple et al. 2015); Clarendon Co., *M* & *V* NA16553 (TRT; Morton et al. 2020); Colleton Co., *S* & *Suripto* 9800 (WAT; Semple et al. 1993 as var. *alt.*); Florence Co., *M* & *V* NA16554 (TRT; Morton et al. 2020); Georgetown Co., *Cook et al.* C-651 (WAT; Semple et al. 2015) *Cook et al.* (WAT; Semple et al. 2015); Horry Co., *Cook et al.* C-645 (WAT; Semple et al. 2015); Jasper Co., *M* & *V* NA16547 (TRT; Morton et al. 2020), *M* & *V* NA16548 (TRT; Morton et al. 2020); Orangeburg Co., *M* & *V* NA16552 (TRT; Morton et al. 2020); Sumter Co., *Cook et al.* C-637 (WAT; Semple et al. 2015), *Cook et al.* C-638 (WAT; Semple et al. 2015); **Tennessee:** Montgomery Co., *S* & *Suripto* 9437 (WAT; Semple et al. 1993 as var. *alt.*); White Co., *M* & *V* *s.n.* (TRT; Morton et al. 2020). **Texas:** Polk Co. *M* & *V* NA16419 (TRT; Morton et al. 2020); San Patricio Co., *M* & *V* NA16397 (TRT; Morton et al. 2020); Victoria Co., *M* & *V* NA16411 (TRT; Morton et al. 2020). **Virginia:** Southampton Co., *Semple* 11622 (WAT; Semple et al. 2019); Sussex Co., *M* & *V* NA16570 (TRT; Morton et al. 2020). — $2n=54 + 5$ supernumeraries. U.S.A. **Louisiana:** Sabine Par., *Beaudry & Ewan* 57-624 (MT; Beaudry 1963 to sp.).

Solidago altissima aff. var. *pluricephala* M.C. Johnston — $2n=54$. U.S.A. **Georgia:** Putnam Co., *S* 10872 (WAT; (Semple and Cook 2004 as var. *alt.*).