

## CYTOGEOGRAPHY OF *SOLIDAGO* SECT. *ARGUTAE* (ASTERACEAE: ASTEREAE)

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### ABSTRACT

Identifications of chromosome count vouchers of 145 previously reported counts for *Solidago arguta*, *S. boottii*, *S. faucibus*, *S. harrisii*, *S. ludoviciana*, *S. patula*, *S. salicina*, *S. sphacelata*, *S. tarda*, *S. vaseyi*, and *S. verna* from Canada and the USA were confirmed or revised following the revised treatment of the section by Semple and Beck (2021); some vouchers could not be located. Chromosome numbers are reported for the first time for 162 individuals of 9 species of *Solidago* sect. *Argutae* native to the eastern USA. All 307 count reports are used to map the cytogeography of each of the 11 species in the section.

*Solidago* sect. *Argutae* (Mack.) Semple & Beck includes plants native to a range of mostly wooded habitats and soils in eastern North America ranging from wet bogs to drier open woods. The section is defined by having petiolate, serrate lower stem and basal rosette leaves that are the largest on the plant, petiole bases that do not sheath the stem, and inflorescences that are relatively few branched and often with noticeably longer divergent lower branches (Semple and Beck 2021).

The section was supported as a monophyletic lineage in a polygenomic study of the entire genus (Semple et al. 2023), although support for grouping subsect. *Patulae* Semple & Beck and subsect. *Brachychaetae* (Torr. & Gray) Semple & Beck with subsect. *Argutae* (Mack.) Nesom was low. *Solidago* subsect. *Brachychaetae* was treated as the separate genus *Brachychaeta* Torr. & Gray (1842), defined by having very short pappus bristles compared to all other species of *Solidago*.

The number of species recognized in sect. *Argutae* has differed among authors (e.g., Small 1933; Fernald 1950; Radford et al. 1968) and over time by the same author(s) (e.g., Cronquist 1968, 1980; Semple and Cook 2006; Semple et al., 2015, 2021). Semple et al. (2021) presented a multivariate morphometric analysis of *Solidago arguta* Ait., *S. boottii* Hook., *S. faucibus* Wieboldt, *S. harrisii* E.S. Steele, *S. ludoviciana* (A. Gray) Small, *S. patula* Muhl., *S. salicina* Ell., *S. sphacelata* Raf., *S. tarda* Mack., *S. vaseyi* Heller, and *S. verna* M.A. Curtis and concluded that these 11 species should be recognized due to distinct morphological and ecological traits.

The work of Jean Beaudry contributed much to the early knowledge on the cytogeography of the sect. *Argutae* in a series of papers beginning in 1959 and ending a decade later. Beaudry and Chabot (1959) reported the first diploid count for *S. patula*. Beaudry (1963) reported diploid counts for *S. arguta*, *S. boottii*, *S. harrisii*, *S. vaseyi*, and *S. verna*. The presence of 1-4 supernumerary chromosomes were reported at several sites in the reports by Beaudry and G. Morton.

## MATERIALS AND METHODS

Meiotic counts were made from pollen mother cells (PMCs) dissected from buds fixed in the field in 3:1 / EtOH: glacial acetic acid 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 PDB 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) and hydrolyzed in 1N HCl for 30 minutes 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 counts are deposited in NY, TENN, UTCH, or WAT in MT unless otherwise indicated (Thiers, updated continuously). Identifications here follow the nomenclature for sect. *Argutae* in Semple and Beck (2021). A list of unpublished counts was emailed by Gary Morton to the first author in 2011 with the instructions to publish them when and however the first author saw fit. All nomenclatural decisions are those of the first author, who also wrote this paper.

## RESULTS

In total, 145 chromosome counts have been reported for individuals of *Solidago* sect. *Argutae* in the literature (Appendix 1) and 162 new counts are reported here (Appendix 2). Identifications were confirmed or revised for 85% of the vouchers for previously published reports listed in Appendix 1; all of the vouchers for *S. vaseyi* were seen in person and checked via SERNEC (2020) in February 2024 by the first author.

## DISCUSSION

The cytogeography of the taxa of *Solidago* sect. *Argutae* is based on 157 chromosome counts previously published (Appendix 1) and 162 reported here (Appendix 2). Species are presented alphabetically in order in 1) subsect. *Argutae* and those that are primarily Appalachian, primarily Ozarkian-western, or polyploid only, 2) those in subsect. *Patulae*, and 3) those in subsect. *Brachychaeta*. The second author reported 169 chromosome counts, which are 59% of the 307 counts reported in total. The majority of these counts were listed in his doctoral thesis (Morton 1973) but were not otherwise published until here. Thus, it is through second author's work that the cytogeography of subsect. *Argutae* can be usefully summarized.

### *Solidago* subsect. *Argutae*

In total, 33 diploid counts from 23 locations have been reported for *Solidago arguta* in the narrow sense by Beaudry and Chabot (1959), Beaudry (1963, 1969), Morton (1973), Semple et al. (1981, 1984, 1993), Semple (1985), and Semple and Cook (2004). The cytogeography for *S. arguta* in the narrow sense is shown in Figure 1. In the broad sense (e.g., Cronquist 1980), *S. arguta* has included plants treated here as *S. vaseyi*, *S. harrisii*, and *S. boottii*. Typical *S. arguta* has glabrous fruits.

In total, 171 counts are known for *Solidago vaseyi*: 41 diploid and 8 tetraploid counts were previously reported for *S. vaseyi* (under various synonyms) by Beaudry (1963, 1969), G. Morton (1973), Anderson et al. (1974), Semple et al. (1981, 1984, 1993, 2015), Semple and Chmielewski (1987), Semple and Cook (2004) and Morton, Venn, and Semple (2018), and 60 diploid and 63 tetraploid counts are given here in Appendix 2. The cytogeography for *S. vaseyi* is shown in Figure 2. Diploids occur throughout the range while tetraploids are concentrated in the southern Appalachian Mountains. Plants included here in *S. vaseyi* have been treated as *S. arguta* var. *caroliniana* A. Gray, *S. arguta* subsp. *caroliniana* (A. Gray) G. Morton, and *S. arguta* subsp. *pseudoyadkinensis* G. Morton. Some collections by Gary Morton had one name on the original collection label and one or

two additional annotations indicating a shift in taxonomic decisions over time. For example, the original identification of *G. Morton* 3676 NY was *S. yadkinensis* (Porter) Small, but was annotated as *S. vaseyi* in 1972 and as *S. arguta* subsp. *caroliniana* in 1981. Morton (1974) treated plants from the coastal plain and piedmont in Virginia, North Carolina, and South Carolina as *S. arguta* subsp. *pseudoyadkinensis* G. Morton based on lower stem leaf width differences, but Semple et al. (2021) in a multivariate study of sect. *Argutae* opted not to recognize the taxon as distinct from *S. vaseyi* and concluded that further work might find support for treating the taxon as either a separate species or a variety within *S. vaseyi*. Leaves of *S. vaseyi* are glabrous, not stiff, and the lower leaves with tapering bases, and the fruits are strigose at least distally. Subsp. *pseudoyadkinensis* was defined as having lower leaves with blades less than 3 cm wide and usually 4-6 times as long as wide (Morton 1974).

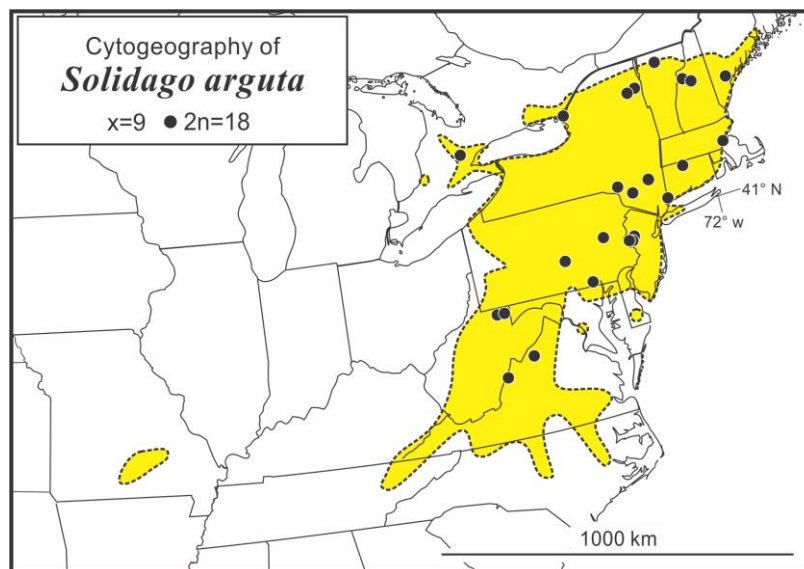


Figure 1. Cytogeography of *Solidago arguta* in eastern North America.

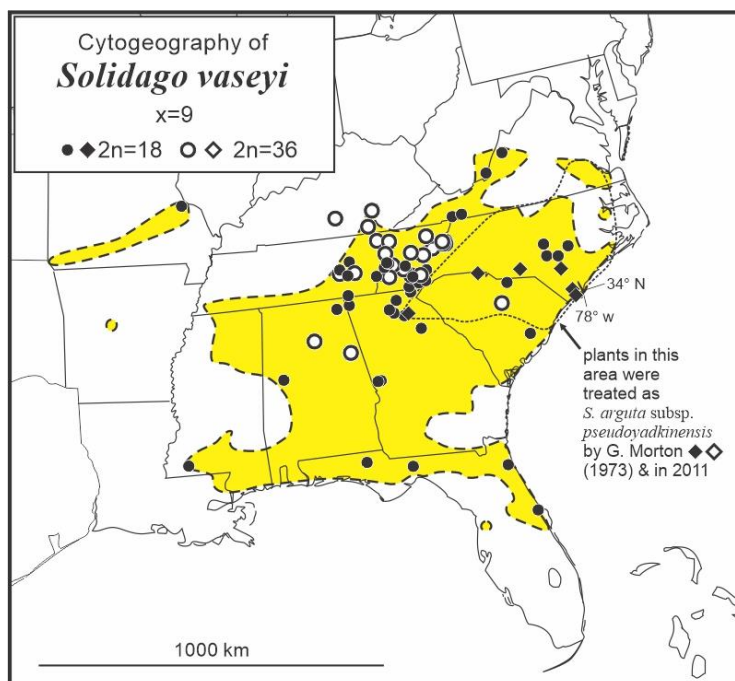


Figure 2. Cytogeography of *Solidago vaseyi* in eastern North America.

In total, 9 diploid counts from 6 locations have been reported for *Solidago harrisii* by Beaudry (1963), Anderson et al. (1974), Semple et al. (2015), and here in Appendix 2. The cytogeography for *S. harrisii* is shown in Figure 3. *Solidago harrisii* has been treated as *S. arguta* var. *harrisii* (Steele) Cronquist. Leaves of *S. harrisii* are relatively firm, the basal leaves usually proximally  $\pm$  truncate and fruits have some hairs on them. The species is native to shale barrens.

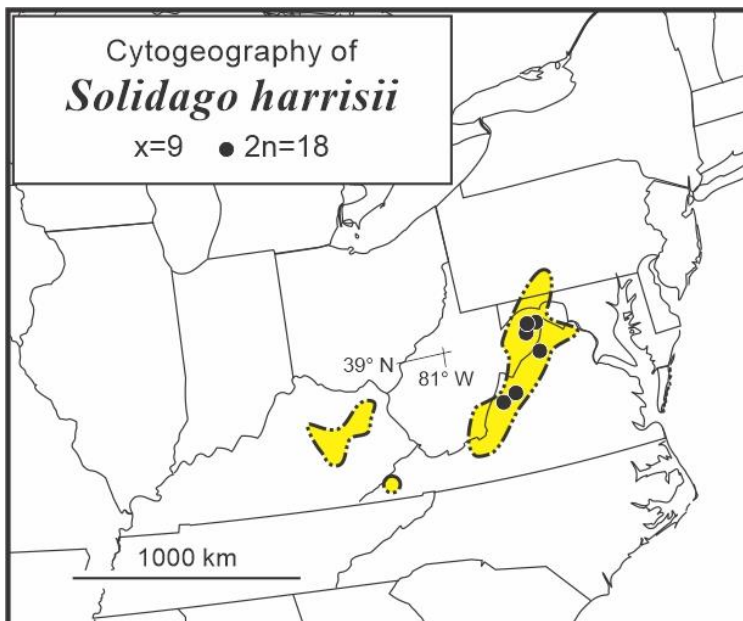


Figure 3. Cytogeography of *Solidago harrisii* in eastern North America.

In total, 3 diploid counts from 2 locations have been published for *Solidago verna* by Beaudry (1963) and G. Morton in Semple et al. (1984). The cytogeography for *S. verna* is shown in Figure 4. *Solidago verna* is the only spring-blooming species in sect. *Argutae* and the only species that is usually densely short strigose on stems and leaf surfaces. *Solidago verna* is the only normally spring-blooming species in the genus in North America. The species is treated as G3–Vulnerable by the Center for Plant Conservation (<https://saveplants.org/plant-profile/4050/Solidago-verna/Spring-flowering-Goldenrod/>).

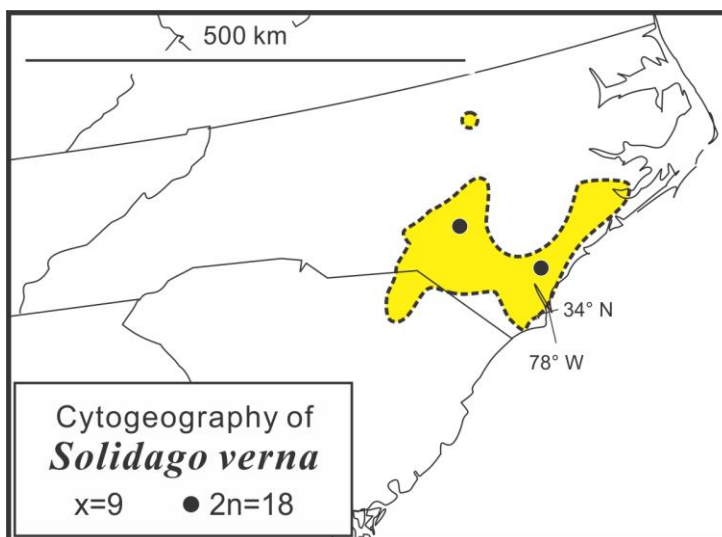


Figure 4. Cytogeography of *Solidago verna* in eastern North America.

In total, 1 diploid and 7 tetraploid counts from 6 locations have been published for *Solidago ludoviciana* Anderson et al. (1974), Semple et al. (1993), and Appendix 2 here. The cytogeography for *S. ludoviciana* is shown in Figure 5. Plants of *S. ludoviciana* have been treated as *Solidago boottii* var. *ludoviciana* A. Gray, *S. strigosa* Small, and *S. arguta* var. *strigosa* (Small) Steyermark. *Solidago ludoviciana* has ascending to appressed distal cauline leaves that are quickly reduced. A report by Beaudry (1969; diploid from Magazine Mountain Arkansas) was rejected by Morton (1973) as “not *S. ludoviciana*, probably a hybrid, parents unknown.”

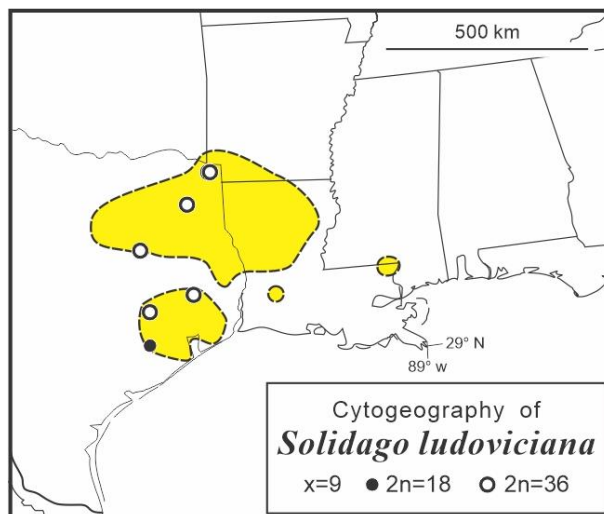


Figure 5. Cytogeography of *Solidago ludoviciana* in eastern North America.

In total, 10 diploid counts and 1 tetraploid count from 8 locations have been reported for *Solidago boottii* by Beaudry (1963), Semple et al. (1993), and Morton, Venn, and Semple (2018). The cytogeography for *S. boottii* is shown in Figure 6. *Solidago boottii* is distinguished by having strigose or strigillose leaves (especially the proximal) and fruits that are strigose.

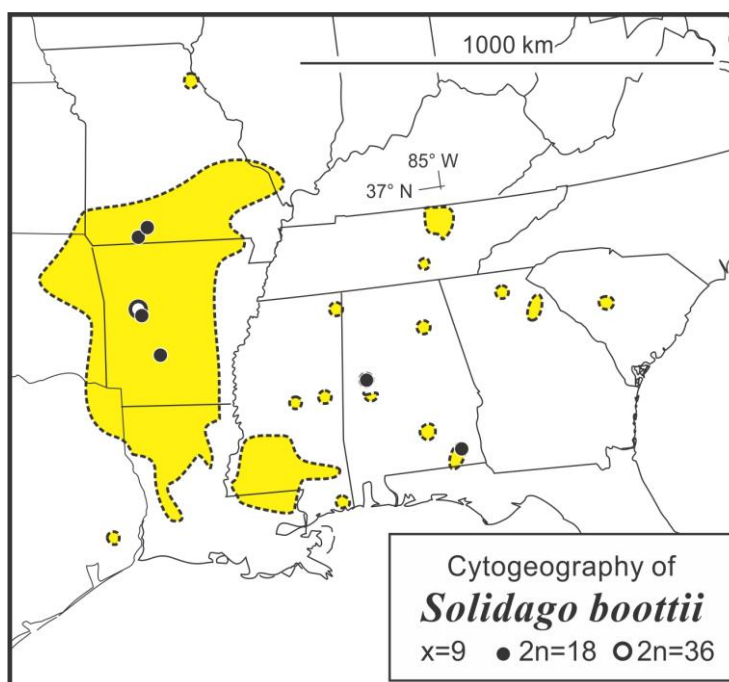


Figure 6. Cytogeography of *Solidago boottii* in eastern North America.

In total, 2 hexaploid  $2n=27_{II}$  counts have been published for *Solidago tarda* by Anderson et al. (1974) and 8 new counts are added here (Appendix 2). The cytogeography for *S. tarda* is shown in Figure 7.

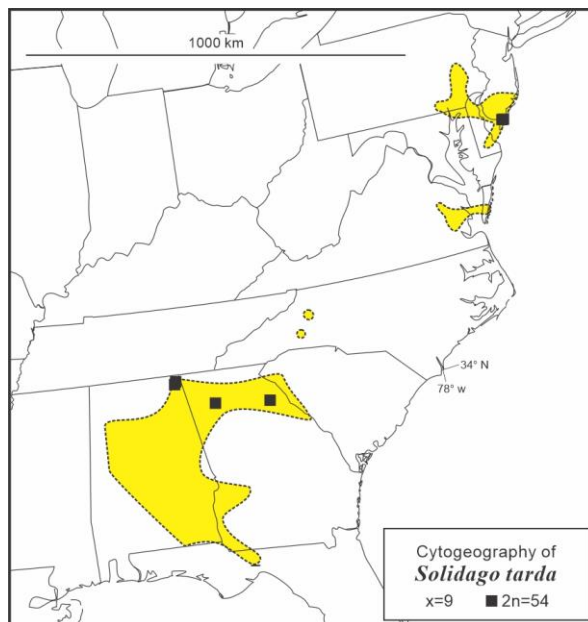


Figure 7. Cytogeography of *Solidago tarda* in eastern North America.

In total, 5 decaploid counts have been published for *Solidago faucibus* by Weiboldt and Semple (2003), Semple et al. (1993, 2004, 2015), and additions are here in Appendix 2. The cytogeography for *S. faucibus* is shown in Figure 8. *Solidago faucibus* is the only decaploid  $2n=90$  in sect. *Argutae*.

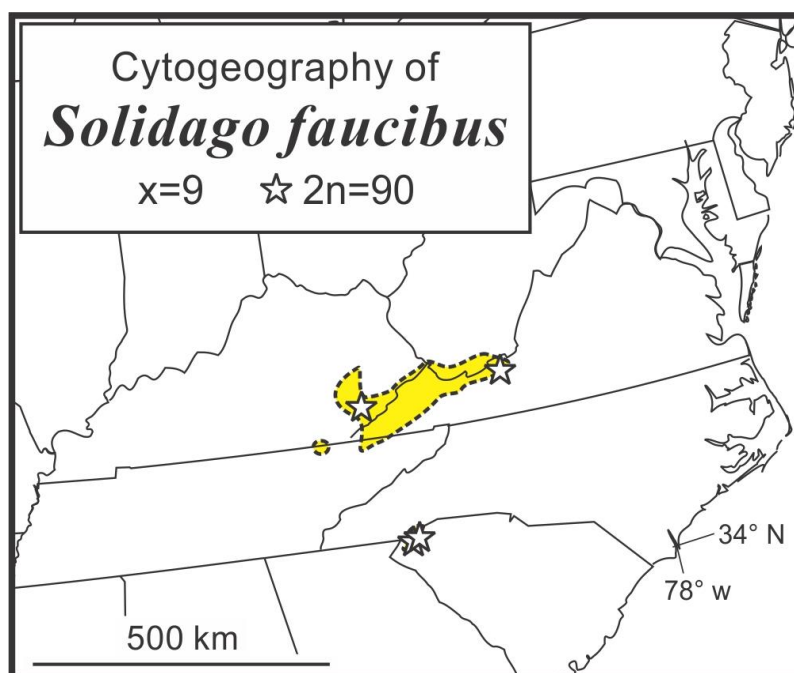


Figure 8. Cytogeography of *Solidago faucibus* in eastern North America.

***Solidago* subsect. *Patulae*** Semple & Beck

In total, 25 diploid counts  $2n=9_{II}$  and  $2n=18$  from 20 locations have been published for *Solidago patula* by Beaudry and Chabot (1959), Beaudry (1963, 1969), Morton (1981), Semple et al. (1981, 1984, 1915), Semple and Cook (2004), and 3 new diploid counts are added here in Appendix 2. The cytogeography for *S. patula* is shown in Figure 9. Leaves of subsect. *Patulae* are finely scabrous.

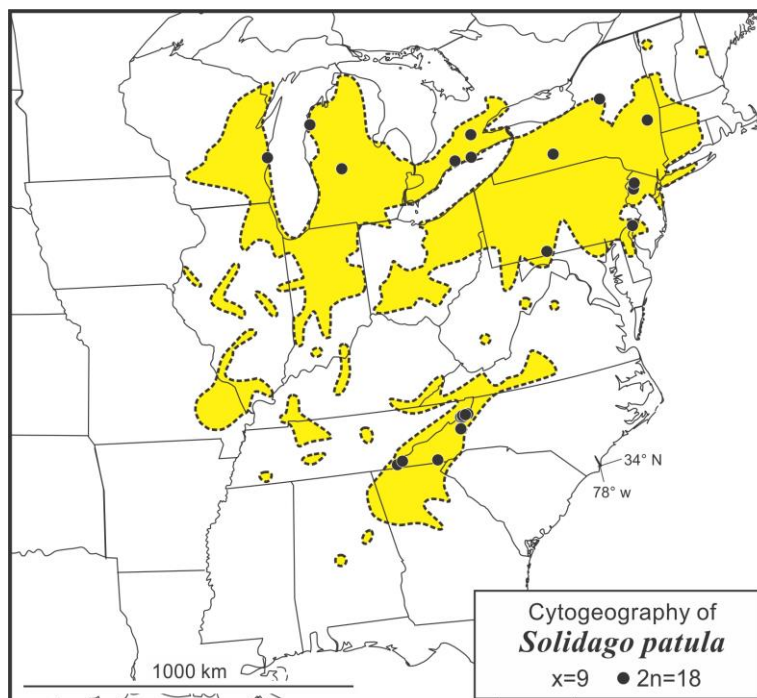


Figure 9. Cytogeography of *Solidago patula* in eastern North America.

In total, 7 diploid counts  $2n=9_{II}$   $2n=18$  have been published for *Solidago salicina* by Beaudry (1963), Jones (1968), and Semple et al. (1993, 2019). The cytogeography for *S. salicina* is shown in Figure 10. The species has been treated as *S. patula* var. *strictula* Torr. & Gray and *S. patula* subsp. *strictula* (Torr. & Gray) Semple. It differs from *S. patula* in usually having numerous small mid to upper stem leaves.

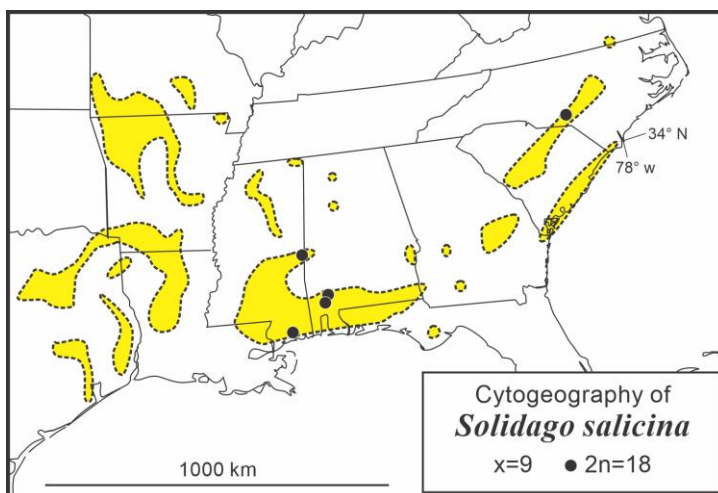


Figure 10. Cytogeography of *Solidago salicina* in eastern North America.

***Solidago* subsect. *Brachychaetae*** (Torr. & Gray) Semple & Beck

In total, 12 diploid counts from 10 locations have been published for *Solidago sphaelata* by Beaudry (1969), Semple et al. (1981, 1984), and Morton, Venn, and Semple (2018) and 1 additional diploid count is reported here (Appendix 2). The cytogeography for *S. sphaelata* is shown in Figure 11. *Solidago sphaelata* is distinguished by have a very short pappus on the top of the strigose ovary/fruit body. It has long-petiolate, cordate proximal leaves and an inflorescence similar to those in subsect. *Argutae*. It was placed in its own monotypic genus *Brachychaeta* Torr. & Gray (1842) but has generally been included in *Solidago*, e.g. Semple and Cook (2006). The species was weakly placed in a clade with subsect. *Patulae*, which was weakly placed as sister to subsect. *Argutae* clade in the polygenomic phylogeny of *Solidago* by Semple et al. (2023).

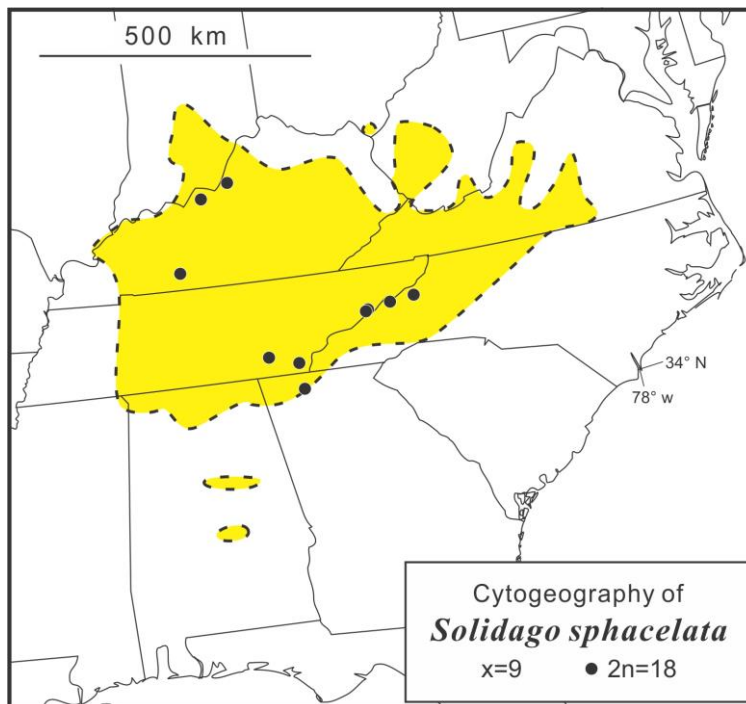


Figure 11. Cytogeography of *Solidago sphaelata* in eastern North America.

**ACKNOWLEDGEMENTS**

This work was supported by Natural Sciences and Engineering Research Council of Canada Operating Grants to J.C.S. Bruce Currie and Brenda Semple are thanked for their assistance in the field.

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Appendix 1. Previously reported chromosome number determinations of *Solidago* sect. *Argutae* from Canada and the USA are arranged alphabetically by species.

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- Solidago arguta* Ait. —  $2n=9_{II}$  U.S.A. **New Jersey**. Hunterdon Co. *G. Morton* 3468 NY! (Morton 1973), *G. Morton* 3469 NY (Morton 1973), *G. Morton* 3470 NY (Morton 1973), *G. Morton* NJ-6 G. Morton personal herb. (Morton 1973), *G. Morton* NJ-7 G. Morton personal herb. (Morton 1973). **Pennsylvania**. Carbon Co. *G. Morton* PA-15 G. Morton personal herb. (Morton 1973), *G. Morton* PA-17 G. Morton personal herb. (Morton 1973); Juniata Co., *Semple & Suario* 9485 WAT (Semple et al. 1993). **Virginia**. Rockingham Co. *G. Morton* VA-8 Morton personal herb. (Morton 1973), *G. Morton* VA-9 G. Morton personal herb. (Morton 1973). —  $2n=18$  CANADA. **Ontario**. Leeds Co. *Beaudry, A. Fautrier & W. Dore* 62-225 MT (Beaudry 1969), *Beaudry, A. Fautrier & W. Dore* 63-227 MT (Beaudry 1969), *Beaudry, A. Fautrier & W. Dore* 63-226 MT (Beaudry 1969); Wellington Co., *Semple & Horsburgh* 10574 WAT (Semple and Cook 2004). U.S.A. **Alabama**. Tuscaloosa Co., *Beaudry* 57-565 MT (Beaudry 1963), *Beaudry* 57-567 MT (Beaudry 1963). **Connecticut**. Fairfield Co., *Lambert* 57-2-1, -2, -3 MT (Beaudry and Chabot 1959); Hartford Co., *Semple & Brouillet* 3619 WAT, MO (Semple et al. 1981). **Maine**. Cumberland Co., *Semple & Keir* 4936 WAT (Semple et al. 1984). **Massachusetts**. Norfolk Co. *Semple & Brouillet* 3525 WAT, CAN, MO (Semple et al. 1981). **New Hampshire**. Grafton Co. *Semple & Brouillet* 3459 WAT, MO, (Semple et al. 1981), *Semple & Brouillet* 3468 WAT, MO (Semple et al. 1981). **New York**. Delaware Co. *Semple* 6818 WAT, NY (Semple et al. 1984); Essex Co. Ringius 1533 WAT (Semple et al. 1984), Ringius 1535 WAT (Semple et al. 1984); Sullivan Co. *Semple Chmielewski & Ringius* 6503 WAT, NY (Semple et al. 1984); Ulster Co., *Beaudry* 57-150 MT (Beaudry 1963). **Pennsylvania**. York Co., *Semple & Ringius* 7614 WAT, NY (Semple 1985). **Virginia**. Bath Co., *Semple* 10727 WAT (Semple and Cook 2004). —  $2n=18+0,2,4,6$  super. U.S.A. **West Virginia**. Preston Co., *Beaudry* 57-269 MT (Beaudry 1963). —  $2n=18+1-4$  super. U.S.A. **West Virginia**. Monongalia Co., *Beaudry* 57-241 MT(2) (Beaudry 1963), *Beaudry* 57-242 MT (Beaudry 1963), *Beaudry* 57-243 MT (Beaudry 1963), *Beaudry* 57-244 MT (Beaudry 1963).
- Solidago boottii* Hook. —  $2n=9_{II}$  U.S.A. **Arkansas**. Pike Co., *G. Morton* 3945 G. Morton personal (Morton 1973), *G. Morton* 3948 NY (Morton 1973), *G. Morton* 3957 NY (Morton 1973); Yell Co., *G. Morton* 3933 NY (Morton 1973), *G. Morton* 3934 NY (Morton 1973), *G. Morton* 3935 NY (Morton 1973). **Missouri**. Taney Co., *G. Morton* 4013 G. Morton personal herb. (G. Morton 1973). —  $2n=18$  U.S.A. **Alabama**. Dale Co. *Morton & Venn* NA16479 JKM(2) (Morton, Venn and Semple 2018); Tuscaloosa Co. *Beaudry* 57-565 MT (Beaudry 1963). **Missouri**: Taney Co., *Semple & Suario* 9935 WAT, MO (Semple et al. 1993). —  $2n=18_{II}$  U.S.A. **Arkansas**. Yell Co., *G. Morton* 3932 G. Morton personal herb. (Morton 1973)
- Solidago faucibus* Wieboldt —  $2n=90$  U.S.A. **Kentucky**. Leslie Co., *Semple & Suario* 9619 WAT (Semple et al. 1993 as *S. aff. flexicaulis*, corrected Wieboldt and Semple 2003). **South Carolina**. Pickens Co., *Wieboldt* 3661 11081 WAT(2) (Wieboldt and Semple 2003), *Semple & Chmielewski* 6170 WAT (Semple et al. 1984 as *S. cf. glomerata*  $2n=ca.96$ , corrected Wieboldt and Semple 2003). **Virginia**. Giles Co., *Wieboldt s.n.* (live collection) WAT (Semple, Cook & Owen 2015).
- Solidago harrisii* E.S. Steele ). —  $2n=9_{II}$  U.S.A. **Virginia**. Shenandoah Co., *G. Morton* 3003 TENN (Anderson et al 1974 erroneously reported as  $n=18$ ). —  $2n=18$  U.S.A. **Virginia**. Bath Co., *Cook & Tereszchuk* 374 WAT, *Cook & Tereszchuk* 375 WAT (Semple, Cook & Owen 2015); Shenandoah Co., *G. Morton* 3003 TENN (Anderson et al 1974 erroneously reported as  $n=18$ ). **West Virginia**. Hampshire Co., *Beaudry & Core* 57-272 MT, *Beaudry & Core* 57-273 MT, *Beaudry & Core* 57-274 MT, *Beaudry & Core* 57-275 MT (Beaudry 1963), *G. Morton* WV-3 TENN (Anderson et al. 1974). —  $2n=18_{II}$  U.S.A. Virginia.
- Solidago ludoviciana* (A. Gray) Small —  $2n=18$  U.S.A. **Texas**. Fort Bend Co., *Semple & Suario* 10074 WAT, ASU, MO, TEX (Semple et al. 1993). —  $2n=18_{II}$  U.S.A. **Texas**. Bowie Co., *G. Morton* 3975 TENN (Anderson et al, 1974), *G. Morton* 3978 NY (Morton 1973), *G. Morton* 3979 NY (Anderson et al. 1974); Upshur Co., *G. Morton* 3974 TENN (Anderson et al. 1974); —  $2n=36$  U.S.A. **Texas**. Grimes Co., *Semple & Suario* 10066 WAT, DAO, TEX (Semple et al. 1993); Polk Co., *Semple & Suario* 10058 WAT, MO, TEX (Semple et al. 1993).
- Solidago tarda* Mack. —  $2n=27_{II}$  U.S.A. **Alabama**. Jackson Co., *G. Morton* 4096 NY (Anderson et al. 1974), **New Jersey**. Cape May Co., *G. Morton* NJ-25 TENN progeny (Anderson et al. 1974).
- Solidago vaseyi* Heller —  $2n=9_{II}$  Florida. Volusia Co. *Semple & Wunderlin* 2538 WAT, FSU, UAC, VDB) Semple et al. 1981. **Missouri**. St. Genevieve Co., *G. Morton* MO-9 Morton personal herb. (G. Morton 1973).

**North Carolina.** Brunswick Co. *G. Morton NC-2* Morton personal herb. (G.Morton 1973), *G. Morton NC-3* Morton personal herb. (G.Morton 1973), *Morton NC-4* Morton personal herb. (G.Morton 1973), *G. Morton NC-22* Morton personal herb. (G.Morton 1973), *G. Morton NC-24* Morton personal herb. (G.Morton 1973), *G. Morton NC-26* Morton personal herb. (G.Morton 1973); Jackson Co. *G. Morton NC-5* Morton personal herb. (G.Morton 1973), *G. Morton NC-7* Morton personal herb. (G.Morton 1973). South Carolina. Berkeley Co., *Semple & Suario 9792* WAT, ASU, JCS, KANU, TEX (Semple et al. 1993); York Co. *G. Morton 3735* Morton personal herb. (G.Morton 1973). **Tennessee.** Monroe Co. *G. Morton TN-31* Morton personal herb. (G.Morton 1973), *G. Morton TN-32* Morton personal herb. (G.Morton 1973), *G. Morton TN-34* Morton personal herb. (G.Morton 1973), *G. Morton TN-35* Morton personal herb. (G.Morton 1973), *G. Morton TN-36* Morton personal herb. (G.Morton 1973). **West Virginia.** Monroe Co. *G. Morton WV-7* Morton personal herb. (G.Morton 1973). —  $2n=18$  U.S.A. **Alabama.** Tuscaloosa Co., *Beaudry 57-567* MT (Beaudry 1963). **Florida.** Washington Co., *Semple 10950* WAT, USF (Semple and Cook 2004). **Georgia.** Dade Co., *Semple 10995* WAT, BRIT, GA (Semple and Cook 2004); Hall Co., J.K. Morton & J. Venn NA16188 TRT (JK Morton, Venn and Semple 2018); Harris Co., *Semple 10978* WAT (Semple and Cook 2004), *Semple 10981* WAT (Semple and Cook 2004); Townes Co., *Semple & Chmielewski 6207* WAT, NY (Semple et al. 1984); Union Co., *Cook & family 625* WAT (Semple et al. 2015). **Mississippi.** Amite Co., *Semple & Suario 10104* WAT (Semple et al. 1993). **North Carolina.** Cumberland Co., *Beaudry & Beal 57-398* MT(2) (Beaudry 1963); Harnett Co., *Beaudry & Beal 57-386* MT (Beaudry 1963), *Beaudry & Beal 57-387* MT (Beaudry 1963); Henderson Co., *Semple 10826* WAT (Semple and Cook 2004); Macon Co., *Semple 10857* WAT (Semple and Cook 2004); Sampson Co., *Beaudry & Beal 57-402* MT (Beaudry 1963); Transylvania Co., *Semple & Chmielewski 6174* WAT, GA (Semple et al. 1993); Wayne Co. *Semple & Chmielewski 6020* WAT (Semple et al. 1984). **South Carolina.** Chesterfield Co., *Semple & Chmielewski 6079* WAT (Semple et al. 1984). **Tennessee.** Blount Co. *Thomas et al. 91449* WAT (Semple & Chmielewski 1987), *Thomas et al. 91474* WAT (Semple & Chmielewski 1987). **Virginia.** Grayson Co., *Semple 10743* WAT, MO (Semple and Cook 2004); Washington Co. *Semple 10763* WAT, VPI (Semple and Cook 2004). —  $2n=18_{II}$  U.S.A. **Tennessee.** Knox Co., *G. Morton 2902* NY (Anderson et al. 1974). —  $2n=18_{II}+1$  super. U.S.A. **North Carolina.** Avery Co. *G. Morton 3681* TENN (Anderson et al. 1974). —  $2n=36$  U.S.A. **Alabama.** Blount Co. *Semple & B. Semple 11192* WAT, BRIT, RM (Semple et al. 2015); Cherokee Co., *Semple & B. Semple 11202* WAT, BRIT (Semple et al. 2015). **Kentucky:** Laurel Co. *Semple & Suario 9613* WAT, MO (Semple et al. 1993); Whitley Co., *Semple, Brammall & Hart 2990* WAT (Semple et al. 1981). **North Carolina:** Avery Co., *Beaudry & Fautrier 62-100* MT (Beaudry 1969, as *S. boottii*). **Tennessee.** Campbell Co., *Semple & B. Semple 11178* WAT Semple et al. 2015).

*Solidago verna* M.A. Curtis —  $2n=9_{II}$  U.S.A. **North Carolina.** Pender Co., *G. Morton GP76* NY (Semple et al. 1984), *G. Morton GP77* NY (Semple et al. 1984). —  $2n=18$  U.S.A. **North Carolina.** Cumberland Co., *Beaudry & Beal 57-399* MT(2) (Beaudry 1963).

#### ***Solidago* sect. *Argutae* subsect. *Patulae***

*Solidago patula* Muhl. —  $2n=9_{II}$  CANADA. **Ontario.** Brant Co., *Semple 2389* WAT, CAN, MO, USF (Semple et al. 1981). **Michigan.** Montcalm Co., *G. Morton 6668* NY, *G. Morton 6669* NY (Semple et al. 1984). **New Jersey.** Sussex Co., *G. Morton 6268* NY (Semple et al. 1984), *G. Morton 6269* NY (Semple et al. 1984); Warren Co., *G. Morton 5935* NY (Semple et al. 1984). **New York.** Steuben Co., *Semple & Suario 9473* WAT, KANU, NY (Semple et al. 1993). **North Carolina.** Mitchell Co., *G. Morton 3874* NY (Semple et al. 1984), *G. Morton 3875* NY (Semple et al. 1984), *G. Morton 3876* NY (Semple et al. 1984). **Pennsylvania.** Bedford Co., *G. Morton 6562* WAT (Semple et al. 1984). **Tennessee.** Polk Co., *G. Morton 8548* voucher not seen (Semple et al. 1984). —  $2n=18$  CANADA. **Ontario.** Elgin Co., *Semple & J. Zhang 10589* WAT (Semple and Cook 2004); Haldimand-Norfolk Reg. Mun., *Semple & Horsburgh 10575* WAT (Semple and Cook 2004). U.S.A. **Michigan.** Manistee Co., *Beaudry & Gagnon 61-390* MT (Beaudry 1969). **New York.** Albany Co., Jean R. Beaudry 57-147 MT (Beaudry & Chabot 1959); Oneida Co., *Semple & Brouillet 3661* WAT, MO (Semple et al. 1981). **North Carolina.** Avery Co., Beaudry, Fautrier & Beatly 62-108 MT (pub. ?). Macon Co., *Semple 11231* WAT (Semple et al. 2015); Macon Co., *Semple 11230* WAT(2), BRIT, NCU (Semple et al. 2015); Mitchell Co., *S & Suario 9655* WAT (Semple et al. 1993); Yancey Co., *Semple & Suario 9686* WAT, KANU (Semple et al. 1993). **Pennsylvania.** Delaware Co., *Beaudry & Wherry 57-227* MT(6), *Beaudry & Wherry 57-228* MT (Beaudry 1963). **Wisconsin.** Sheboygan Co., J.K. Morton & J. Venn NA10947 TRT (Morton 1981).

*Solidago salicina* Ell. —  $2n=9_{II}$  U.S.A. **Mississippi**. Harrison Co., *S* & *Suripto* 10123 WAT, DAO, MO (Semple et al. 1993). Lauderdale Co., *S. Jones* 15342 GA (Jones 1968). —  $2n=18$  U.S.A. **Alabama**. Clarke Co., Beaudry 55-584 MT, *Beaudry* 55-585 MT, *Beaudry* 57-587 MT, (Beaudry 1963); North Carolina. Richmond Co., *S* & *B. Currie* 11800 WAT (Semple et al. 2019).

***Solidago* sect. *Argutae* subsect. *Brachychaeta***

*Solidago sphacelata* Raf. —  $2n=9_{II}$  U.S.A. **North Carolina**. Madison Co., *G. Morton* 3659 NY, *G. Morton* 3663 NY, *G. Morton* 3670 NY (Semple et al. 1984). **Tennessee**. Bledsoe Co., *G. Morton* 3806 NY (Semple et al. 1984); Cocke Co., *G. Morton* 3644 NY, *G. Morton* 3645 NY (Semple et al. 1984); Polk Co., *G. Morton* 8550 (Semple et al. 1984). —  $2n=18$  U.S.A. **Kentucky**. Logan Co., *J.K. Morton* NA18753 TRT (Morton, Venn and Semple 2018). **North Carolina**. Mitchell Co., *Semple & Suripto* 9649 WAT (Semple et al. 1993). **Tennessee**. Cocke Co., *Semple, Brammall & Hart* 3019 wrong number or duplicate in error WAT (Semple et al. 1981). —  $2n=c.18$  U.S.A. **Kentucky**. *Beaudry & Gagnon* 61-303 MT (Beaudry 1969).

Appendix 2. Previously unreported chromosome number determinations of *Solidago* sect. *Argutae* from Canada and the USA are arranged alphabetically by species.

***Solidago* sect. *Argutae* subsect. *Argutae***

*S. faucibus* Wieboldt —  $2n = 90$ . U.S.A. **Virginia**: Giles Co., 2 mi SSW of White Gate, N facing bluff of Walker Creek, *Wieboldt s.n.* (live collection cult. Waterloo, no voucher).

*S. harrisii* E. S. Steele —  $2n = 9_{II}$  U.S.A. **Virginia**: Augusta Co., NW of Augusta Springs, Chestnut Ridge, Hite Hollow Rd by Appalachian Trail, *Semple & B. Semple* 11138 WAT, BRIT, UC; Shenandoah Co., E of Woodstock, *G. Morton* 3005 NY, *G. Morton* 3006 NY, *G. Morton* 3007 NY.

*Solidago tarda* Mack. —  $2n=27_{II}$  U.S.A. **Alabama**. Jackson Co., *G. Morton* 4097 NY, *G. Morton* 4098 NY, *G. Morton* 4123-1 NY. **Georgia**. Bartow Co., entrance to Allatoona Reservoir, *G. Morton* 8566 NY. Clarke Co., Humes Woods (type locality) *G. Morton* 8570 NY, *G. Morton* 8571 NY, *G. Morton* 8572 NY. **New Jersey**. Cape May Co., *G. Morton* 5134 NY, *G. Morton* 5135 (72-75) NY.

*S. vaseyi* Heller (\* = as *arguta* subsp. *pseudoyadkiensis*) —  $2n=9_{II}$  U.S.A. **Alabama**. Jackson Co., SE of Flatrock, *G. Morton* 4480 NY, *G. Morton* 4481 NY. **Florida**. Leon Co., NNW of Chaires, *G. Morton* FL-5 NY, *G. Morton* FL-11 NY; St. John's Co., *G. Morton* 4545 (70-34) NY. **Georgia**. Clarke Co., Athens, *G. Morton* 8528 NY; Clarke Co., Athens, *G. Morton* 8529 NY; Dawson Co., NW of Juno, *G. Morton* 8494 NY, mi marker 16 on Rte 52, *G. Morton* 8489 NY, *G. Morton* 8490 NY, *G. Morton* 8491 NY, *G. Morton* 8493 NY; Hall Co., NW of Lula, *G. Morton* 8496\* NY, *G. Morton* 8497\* NY; Oconee Co., Princeton, *G. Morton* 8520 NY. **Missouri**. Genevieve Co., Pickle Springs, *G. Morton* MO-1 TENN, *G. Morton* MO-7 NY. **North Carolina**. Bladen Co., S of Ammon (type locality), *G. Morton* 3751\* TENN, *G. Morton* 3752\* TENN, *G. Morton* 3753\* NY, *G. Morton* 3757\* NY; Brunswick Co., S of Supply, *G. Morton* 3777\* TENN, *G. Morton* 3778\* NY, *G. Morton* 3779\* NY!, *G. Morton* 3780 NY, bayside of Long Beach, *G. Morton* NC-11\* NY, *G. Morton* NC-23\* NY; Richmond Co., W of Rockingham, *G. Morton* 3747\* TENN, *G. Morton* 3748\* NY, *G. Morton* 3749\* NY; Jackson Co., SE of Soco Gap, *G. Morton* NC-5 NY, *G. Morton* NC-7 NY, *G. Morton* NC-13 NY; Swain Co., S of Lauada, *G. Morton* 3716 TENN. **South Carolina**. Marion Co., N of Centenary, *G. Morton* 3731\* TENN; York Co., N of Centenary, *G. Morton* 3733\* NY, *G. Morton* 3734\* NY. **Tennessee**. Bledsoe Co., E of Pikeville, *G. Morton* 2623 TENN, *G. Morton* 2625 NY, *G. Morton* 2627 NY, E of Pikeville, *G. Morton* 2628 NY; Blount Co., Miller's Cove, *G. Morton* 4431 NY, *G. Morton* 4433 NY; Cumberland Co., SE of Crab, *G. Morton* TN-22 NY; Hamilton Co., Lookout Mt. escarpment, *G. Morton* 4447 NY, *G. Morton* 4448 NY, *G. Morton* 4449 NY; Monroe Co., Doublecamp, Cherokee Natl. Forest, *G. Morton* TN-32 NY; Polk Co., Big Creek, Cherokee Natl. Forest, *G. Morton* 8544 NY; Warren Co., SE of McMinnville, *G. Morton* 8502 NY; Union Co., NW of Paulette, *G. Morton* 2905 TENN. **Virginia**. Augusta Co. *Semple & B. Semple* 11138 WAT, BRIT, UC. **West Virginia**. Monroe Co., *G. Morton* WV-7 Morton personal herb. —  $2n=9_{II}+B$  U.S.A. **North Carolina**. Bladen Co., 5.2 mi S of Ammon on Route 242, *G. Morton* 3754 (69-127) \* NY. —  $2n=9_{II}+Bs$  U.S.A. **Florida**. Leon Co., NNW of Chaires, *G. Morton* FL-7 TENN. **North Carolina**. Bladen Co., S of Ammon (type locality), *G. Morton* 3754\* NY. **South Carolina**. York

Co., Kings Mountain State Park, *G. Morton 3753\** TENN. **Tennessee.** Bledsoe Co., E of Pikeville, *G. Morton 3622* TENN, *G. Morton 3624* NY, *G. Morton 3626* NY. —  $2n=18_{II}$  U.S.A. **North Carolina.** Avery Co., S of Plumtree, *G. Morton 3685* TENN, *G. Morton 3687* NY, *G. Morton 3690* NY; Graham Co., N of Stecoah, *G. Morton 3710* TENN, *G. Morton 3711* NY; Macon Co., S of Cowee Community, *G. Morton 3719* TENN, *G. Morton 3721* NY, *G. Morton 3722* NY, *G. Morton 3723* NY; Madison Co., E of Whiterock, *G. Morton 3651* TENN, *G. Morton 3652* NY, NE of Hotsprings, *G. Morton 3674* NY, *G. Morton 3675* NY, *G. Morton 3676* NY, SW of Whiterock, *G. Morton 3665* NY, *G. Morton 3668* NY, *G. Morton 3686* NY; Swain Co., SE of Lauada, *G. Morton 3712* TENN; Transylvania Co., *G. Morton 3729* (69-109) NY; Yancey Co., SE of Swiss, *G. Morton 3678* TENN, *G. Morton 3679* NY, *G. Morton 3680* NY. **Tennessee.** Blount Co., E of Chilhowee Dam, *G. Morton 3700* TENN, *Morton 3701* NY, *Morton 3703* NY, SE of entrance to Foothills Parkway, *Morton 4429* NY, *Morton 4430* NY, Miller's Cove, *G. Morton 5152* NY, *G. Morton 5154* NY; Cocke Co., E of Newport, *G. Morton 3638* NY, *G. Morton 3640* TENN, *G. Morton 3641* NY, *G. Morton 3642* NY; Knox Co., *G. Morton 2903* NY, Knoxville, *G. Morton TN-24* NY, *G. Morton TN-25* NY, *G. Morton TN-26* UCHT, *G. Morton TN-38* NY; Rhea Co., NW of Dayton, *G. Morton 3799* TENN; Rhea Co., NW of Dayton, *G. Morton 3800* NY, *G. Morton 3801* NY, *G. Morton 3802* NY, *G. Morton 3803* NY, *G. Morton 3804* NY; Van Buren Co., E of Spencer, *G. Morton 3843* TENN, *G. Morton 3845* NY; Washington Co., SE of Embreeville, *G. Morton 3876* TENN, *G. Morton 3877* NY, *G. Morton 3878* NY. —  $2n=18_{II}+supers.$  U.S.A. **North Carolina.** Avery Co., S of Plumtree, *G. Morton 3682* NY. Macon Co., S of Cowee Community, *G. Morton 3720* TENN; Madison Co., E of Whiterock, *G. Morton 3654* TENN, *G. Morton 3657* NY, *G. Morton 3662* NY, *G. Morton 3664* NY, *G. Morton 3666* NY; Transylvania Co., S of Toxaway, *G. Morton 3727* TENN, *G. Morton 3728* TENN, *G. Morton 3730* NY. **Tennessee.** Cocke Co., *G. Morton 3671* NY. —  $2n=36$  U.S.A. Tennessee. Campbell Co., TN-63 NW of Royal Blue, 4.9 km NW of I-75, *Semple & B. Semple 11182* WAT.

***Solidago* subsect. *Patulae*** Semple & J.B. Beck

*S. patula* Muhl. —  $2n = 9_{II}$ . U.S.A. North Carolina: Avery Co., E of Elk Park, NC-194 0.5 km E of US-19E, *Semple 11132* WAT (3), NCU. —  $2n = 18$ . U.S.A. Mitchell Co., Roan Mt., Rhododendron Garden Loop, *S & B. Semple 11119* WAT, NCU. Tennessee: Polk Co., TN-68 NW of Farmer, ca 3 km W of Appalachia, bank of Hiawasse R., *Semple 11576* WAT, TENN.

***Solidago* subsect. *Brachychaeta*** (Torr. & A. Gray) Semple & J.B. Beck

*S. sphacelata* Raf. —  $2n = 9_{II}$ . U.S.A. Kentucky: Jefferson Co. S of Fairdale, Jefferson Co. Memorial Forest, ridge trail, *Semple 11855* WAT.