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THE CYTOGEOGRAPHY OF *SOLIDAGO* SUBSECT. *RADULAE* (ASTERACEAE: ASTEREAE)

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ABSTRACT

The cytogeography of six of the seven species of *Solidago* subsect. *Radulae* is presented, based on 312 chromosome count reports. *Solidago altiplanities* is diploid 2*n*=18 based on just one report. *Solidago californica* is mostly diploid 2*n*=18 (36 reports) with just two tetraploid 2*n*=36 reports. *Solidago gattingeri* is diploid 2*n*=18 (2 reports). *Solidago mollis* includes tetraploids 2*n*=36 (8 reports) and hexaploids 2*n*=54 (8 reports). *Solidago radula* is mostly diploid 2*n*=18 (11 reports) but includes some tetraploids 2*n*= 36 (4 reports) and one possible hexaploid 2*n*=54 report. *Solidago velutina* includes diploids 2*n*=18 (66 reports), tetraploids 2*n*=36 (18 reports), and rarely hexaploids 2*n*=54 (1 report). The chromosome number of *S. hintoniorum* is unknown.

As delimited by Semple and Beck (2021), based on the polygenomic phylogeny of Semple et al. (2023 in press), *Solidago* subsect. *Radulae* (Rydb.) Semple & J.B. Beck of *sect. Unilaterales* G. Don includes seven species: *S. altiplanities* C. & J. Taylor (Fig. 4 in Semple et al. 2015b), *S. californica* Nutt. (Figs. 1-2 in Semple et al. 2018), *S. gattingeri* Chapm. ex A. Gray (Figs. 1-2), *S. hintoniorum* Nesom (Figs 3-4 in Semple et al. 2018), S. *mollis* Bartl. (Figs. 5-6 in Semple et al. 2018), *S. radula* Nutt. (Figs. 12-13 in Semple et al. 2018), and *S. velutina* DC., the type species of the subsection (Figs. 14-17 in Semple et al. 2018).

Previously, *Solidago altiplanities* has been grouped with *S. canadensis* and *S. altissima* in subsect. *Triplinerviae* (Torr. & Gray) Nesom following Nesom (1993) and Semple & Cook (2006). Nesom (1989) reviewed the nomenclatural history of *S. velutina* and described *S. macvaughii* Nesom as similar. Nesom (1993) included *S. hintoniorum* Nesom in subsect. *Thyrsiflorae* A. Gray, but it was not included in subsect. *Thyrsiflorae* by Semple et al. (2017). Nesom (1993) included *Solidago macvaughii*, *S. mollis*, *S. radula*, and *S. velutina* (including *S. california*) in subsect. *Nemorales* along with *S. nana* and *S. nemoralis* Ait. (including *S. decemflora*) as did Semple et al. (2018). Semple and Beck (2021) cited as the defining morphological traits of subsect. *Radulae* the more elongated rhizomes, more scabrous (stiffer) hairs on leaves, and large lower stem leaves with two, more pronounced lateral veins and the mid vein producing a trinervate appearance. *Solidago nana*, *S. nemoralis*, and *S. decemflora* are of subg. *Nemorales* (Mack.) Semple & Beck, which was defined by Semple and Beck (2021) as having leaves generally not triple-nerved, stem and leaf hairs soft, leaves gray-green to sometimes whitish, and basal rosettes often present at flowering. Semple and Beck (2021) placed *S. macvaughii* in subsect. *Triplinerviae* (Torr. & Gray) Nesom.

Raven et al. (1960) reported the first chromosome counts for *Solidago* subsect. *Radulae* with four diploid counts of $2n=9_{II}$ for *S. californica* and two diploid counts of $2n=9_{II}$ for *S. sparsiflora*, treated here as a synonym of *S. velutina*. Beaudry (1969) reported the first counts for *S. gattingeri* and *S. radula*, both diploid 2*n*=18. Anderson et al. (1974) reported the first hexaploid count for *S. mollis*, and Semple et al. (1984) reported the first tetraploid count for *S. mollis*. Semple & Chmielewski (1987) reported the only count for *S. altiplanities* but under the name *S. speciosa* Nutt. var. *rigidiuscula* (Torr. & Gray) Porter, which Semple & Cook (2004) corrected to *S. altiplanities*. All previously reported counts are listed in Table 1 with identifications confirmed from herbarium vouchers for nearly all of the 310 reports.

MATERIALS AND METHODS

Chromosome counts were determined following the methods described in Semple (1985) and Semple & Cook (2004). Cytovouchers for nearly all reports were examined during visits to or in loans obtained from ASU, MT, NY, NMC, TEX, TRT, WAT in MT, and UC. Digital images of vouchers not seen in person were obtained via searches of SEINET (2023) and SERNEC (2022).

Figure 1. *Solidago gattingeri*, Rutherford Co., Tennessee, *Kral 56466* (BRIT).

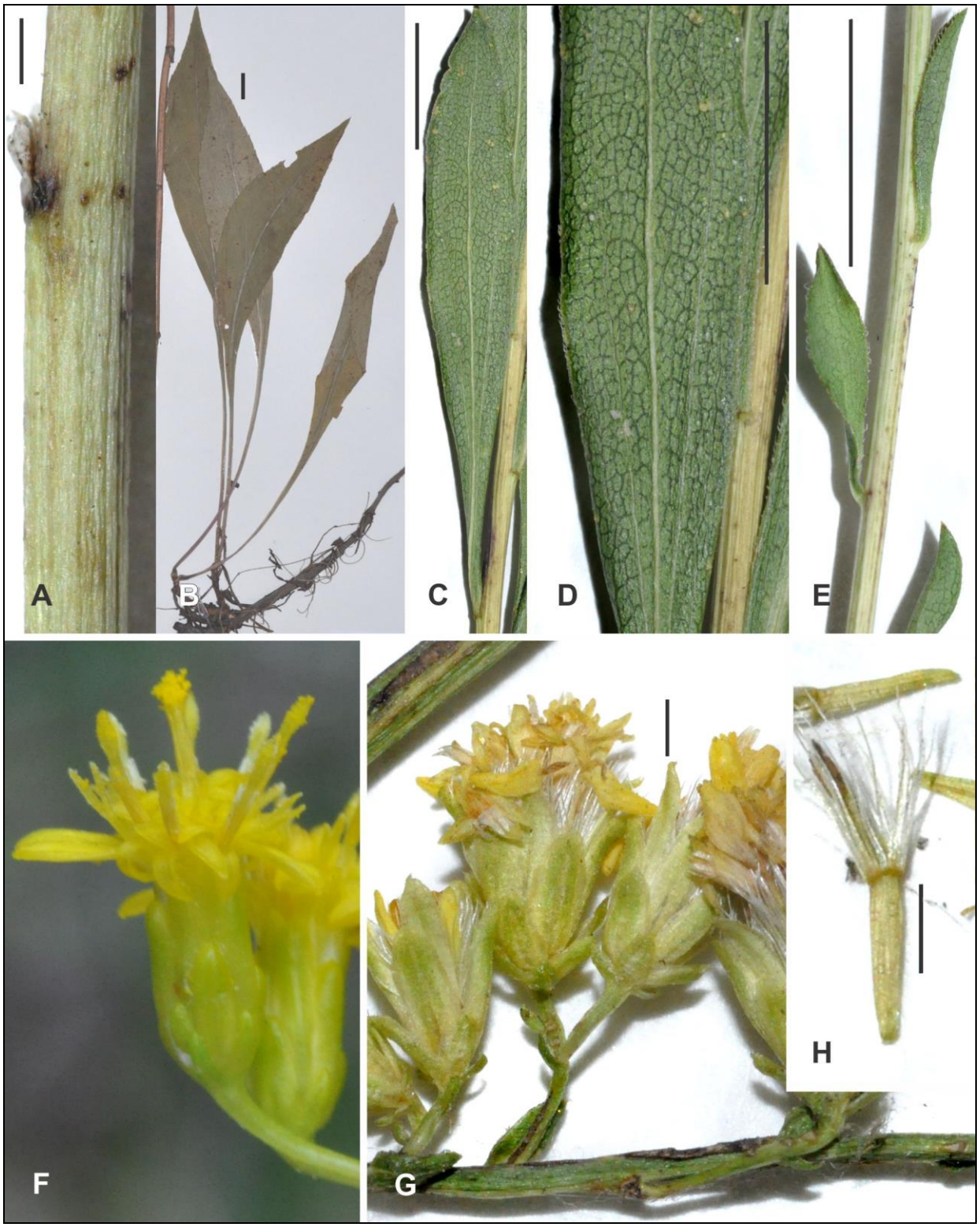

Figure 2. *Solidago gattingeri* — morphological details. **A.** Lower stem, *Semple et al. 11856* (WAT). **B.** Large basal rosette leaves, *Kral 40655* (MO). **C-D**. Mid stem leaf and blade detail, *Semple et al. 11856* (WAT). **E.** Upper stem stem leaves, *Semple et al. 11856* (WAT). **F-G.** In field and dried heads, *Semple et al. 11856* (WAT). **H.** Near mature fruit.

Table 1. Previously published chromosome number determinations in *Solidago* subsect. *Radulae*.

Solidago altiplanities C. & J. Taylor —2*n*=9_{II} U.S.A. **Texas:** Cottle Co., *Semple & Heard 82*34 WAT (Semple and Chmiewski 1987, as. *S. speciosa* var. *rigidiuscula*; corrected Semple and Cook 2004),

Solidago californica Nutt. — 2*n*=9_{II} U.S.A. **California:** Alameda Co., *Solbrig 2814* not seen (Raven et al 1960); Los Angeles Co., *Semple et al. 5610* WAT (Semple 1985); Riverside Co., *Solbrig 2772* NY (Raven et al. 1960); San Benito Co., Semple et al. 9346 WAT (Semple et al. 1992); San Benito Co., *Chasaki et al 2814* DS (Raven et al. 1960); Santa Cruz Co., *Semple & B. Semple 5671* WAT (Semple 1985); San Diego Co., *Solbrig 2761* NY (Raven et al. 1960); San Luis Obispo Co. *McLeod & Keil K10975* not seen (Keil and Pinkava 1979). — 2*n*=9_{II}+ supernumeraries U.S.A. **California:** Lassen Co., *G. Morton & Anderson 5035* not seen (Semple et al. 1984). — 2*n*=18 U.S.A. **California:** Kern Co., *Semple et al. 9365* WAT (Semple et al. 2001), *Semple & Chmielewski 8947* WAT (Semple et al. 2001), *Semple & Heard 8651* WAT (Semple et al. 1989); Lassen Co. *G. Morton & Anderson 5037* WAT (Semple et al. 1984); Los Angeles Co., *Semple & B. Semple 5*614 WAT (Semple et al. 1984); Mariposa Co., *Morton & Venn NA15817* TRT, *Morton & Venn NA15823* TRT (Morton, Venn and Semple 2018); Plumas Co., *Semple et al.* 9303 and *9307* WAT (Semple et al. 2001); Riverside Co., *Semple & Chmielewski 8980* WAT (Semple et al. 1989); San Benito Co., *Semple et al. 9346-1* WAT (Semple et al. 2001); San Bernadino Co., *Morton & Venn NA15840* TRT ((Morton, Venn and Semple 2018)); San Diego Co., Semple & B. Semple 5580 WAT (Semple et al. 1984); San Mateo Co., *Beaudry 59-199* and *59-200* MT (Beaudry 1969); Shasta Co., *Semple et al. 9698* WAT (Semple 1985), *Semple et al. 9300* WAT (Semple et al. 2001); Siskiyou Co., *Semple & Heard 8465* WAT (Semple, Chmielewski & Lane 1989), *Morton & Venn NA15780* TRT, *Morton & Venn NA15782* TRT and *Morton & Venn NA15784* TRT ((Morton, Venn and Semple 2018)), *Semple & Heard 8498* WAT (Semple, Chmielewski & Lane 1989); Sonoma Co., *Semple & Heard 8578* WAT (Semple, Chmielewski & Lane 1989); Tuolumne Co., Morton & Venn NA15813 TRT (Morton, Venn and Semple 2018), *Semple & Heard 8730* WAT (Semple, Chmielewski & Lane 1989); Ventura Co., *Morton & Venn NA15855* TRT (Morton, Venn and Semple 2018). **Oregon:** Douglas Co., *Semple & Brouillet 7141* WAT (Semple et al. 1984). — 2*n*=36 U.S.A. **California:** Sonoma Co. *Morton & Venn NA15800* TRT and *Morton & Venn NA15809* TRT (Morton, Venn and Semple 2018)

Solidago gattingeri Chapm. ex A. Gray — 2*n*=18 U.S.A. **Tennessee.** Rutherford Co., *De Selm 59-240-1* MT (Beaudry 1969).

Solidago mollis Bartl. — 2*n*=18_{II} U.S.A. **Kansas:** Ford Co., *Semple & Brouillet 7296* WAT and *Semple & Brouillet 7304* WAT (Semple 1985). **Oklahoma:** Greer Co. *Semple & Heard 8235* WAT (Semple, Chmielewski & Lane 1989, as 2n=9II; corrected in Semple and Cook 2004). **South Dakota:** Minnehaha Co., Semple & Xiang 10181 WAT (Semple et al. 1993). **Wyoming:** Crook Co., *Semple & Xiang 10188* WAT (Semple et al. 2001). — 2*n*=36 U.S.A. **South Dakota:** Haakon Co., *Semple & B. Semple 6644* WAT (Semple et al. 1984). **Wyoming:** Crook Co., *Morton & Venn NA15697* TRT ((Morton, Venn and Semple 2018)). — 2*n*=27_{II} U.S.A. **Colorado:** Kit Carson Co., *G. Morton 4991* NY(2) (Anderson et al. 1974); Pueblo Co., *Anderson 3132* BYU, NY (Semple et al. 1984). **Montana:** Rosebud Co., *Semple & Brouillet 6984* WAT (Semple 1985). — 2*n*=54 CANADA. Manitoba, *Löve & Löve S3797* not seen (Löve & Löve 1982a). U.S.A. **Montana:** Fergus Co. published as Judith Basin Co., Semple & B. Semple 11395 WAT (Semple et al. 2019). **North Dakota:** Emmons Co., *Semple et al. 6668* WAT (Semple et al. 1984). **South Dakota:** Shannon Co., *Morton & Venn NA15686* TRT (Morton, Venn and Semple 2018).

Solidago radula Nutt. — 2*n*=18 U.S.A. **Arkansas:** Perry Co., *Demaree 59-260-1, -3* MT (Beaudry 1969); Pope Co., *Semple & Heard 8296* WAT (Semple & Chmielewski 1987 as *S. ulmifolia*; corrected Semple et al. 2019); Pulaski Co., *Demaree 63-49-1, -2, -3, -4, -5* MT (Beaudry 1969). **Louisiana:** Natchitoches Par., *Semple & Suripto 10038* WAT (Semple et al. 1993); Winn Par., *Thomas & Kessler 79082* WAT (Semple and Chmielewski 1987). **Missouri:** Iron Co., *Cook & Parks 468* WAT and *Cook & Parks 469* WAT (Semple, Cook and Owen 2015); Washington Co., *Semple et al. 9388* WAT (Semple et al. 1993). **Tennessee:** Dekalb Co., *Demaree 63-40-1, -2, -3, -4, -5* MT (Beaudry 1969). — 2n=36 U.S.A. **Arkansas:** Stone Co., Morton & Venn NA16258 TRT (Morton, Venn and Semple 2018). **Texas:** Erath Co., *Semple & Chmielewski 6461* WAT (Semple et al. 1984 as *S. mollis* var. *angustifolia*; corrected here). Kerr Co., *Morton & Venn NA16362* TRT and *Morton & Venn NA16364* TRT (Morton, Venn and Semple 2018)

Solidago aff. *radula* Nutt. — 2*n*=18 U.S.A. **Texas:** Gonzales Co., *Semple & Brouillet 3351* WAT (Semple et al. 2019).

Solidago velutina DC. (many published as either *S. sparsiflora* or *S. velutina* subsp. *sparsiflor*a) — 2*n*=9_{II} MEXICO. **Coahuila:** *Roberts & Keil 10420* not seen (Keil and Stuessy 1977). **Durango:** *King 3762* US, TEX (Turner et al 1962). **Nuevo Leon:** *Nesom et al. 7740* TEX (Zhao Zai‐Ming 1996). **Zacatecas:** Ward 80-061 NMC (Ward and Spellenberg 1986). U.S.A. **Arizona:** Cochise Co., Ward & Peterson 83-027 NMC and Ward & Petersen 83-067 NMC (Ward and Spellenberg 1986); Coconino Co., *Solbrig 2795* not seen (Raven et al. 1960), *Pinkava et al. P13715* ASU (Keil et al. 1988), *Keil 11738* ASU (Keil and Pinkava 1979), *Semple et al. 5547* WAT (Semple 1985); Gila Co., *Semple & Heard 7926* WAT (Semple and Chmielewski 1987); Navajo Co., *Lehto, Pinkava & Keil 18956A* ASU (Keil and Pinkava 1981); Santa Cruz Co., *Keil & Pinkava K11029* ASU (Keil et al. 1988); Yavapai Co., Keil K11457 ASU (Keil et al. 1988). **Colorado:** Garfield Co., *G. Morton & Anderson 5013* WAT (Semple et al. 1984), Spellenberg & Soreng 5798 NMC (Ward and Spellenberg 1986); Pitkin Co., *Spellenberg & Soreng 5802* NMC (Ward and Spellenberg 1986); Mesa Co., *G. Morton & Anderson 5014* NY (Anderson et al 1974). **New Mexico:** Grant Co., *Ward et al. 80-013* NMC, *Ward 80-023* NY, *Ward & Spellenberg 80-045* NMC, *Ward & Spellenberg 81-586* NMC, and *Ward & Spellenberg 80-047* NMC (Ward and Spellenberg 1986); Hidalgo Co., *Spellenberg 6312b* NMC (Ward and Spellenberg 1986); McKinley Co., *Ward 81-492* NMC (Ward and Spellenberg 1986); Otero Co., *Ward 81-461* NMC, *Ward 81-576* NMC (Ward and Spellenberg 1986); Lincoln Co. (as Otero Co.), *Ward & Spellenberg 80-033* NMC (Ward and Spellenberg 1986); San Juan Co., *Ward 83-083* NMC (Ward and Spellenberg 1986). **Nevada:** Clark Co., *Raven 13705* not seen (Raven et al. 1960). **Utah:** Washington Co., *Semple & Heard 7863* WAT (Semple et al. 1989). — 2*n*=18 MEXICO. San Luis Potosi; *Ward et al. 80-059 NMC* and *Ward et al. 80-060 NMC* (Ward and Spellenberg 1986). U.S.A. **Arizona:** Apache Co., Morton & Venn NA15901 TRT (Morton, Venn and Semple 2018); Cochise Co., *Morton & Venn s.n.* TRT (Morton, Venn and Semple 2018); Coconino Co., *Morton & Venn NA15868* TRT, *Morton & Venn NA15871* TRT, *Morton & Venn NA15874* TRT, *Morton & Venn NA15878* TRT, *Morton & Venn NA15879* TRT, and *Morton & Venn NA15880* TRT (Morton, Venn and Semple 2018); Navajo Co., *Morton & Venn NA15892* TRT, and *Morton & Venn NA15897* TRT (Morton, Venn and Semple 2018); Yavapai Co., Morton & Venn s.n. TRT (Morton, Venn and Semple 2018). **Colorado:** *Semple & B. Semple 6536* WAT (Semple et al. 1984). **New Mexico:** Bernalillo Co., *Semple et al. 9382* WAT (Semple et al. 2001); Catron Co., *Semple & Heard 8028* WAT (Semple and Chmielewski 1987) *Morton & Venn NA15914* TRT, *Morton & Venn NA15915* TRT, *Morton & Venn NA15916* TRT, *Morton & Venn NA15918* TRT and *Morton & Venn NA15921* TRT (Morton, Venn and Semple 2018); Colfax Co. *Morton & Venn NA15960* TRT (Morton, Venn and Semple 2018); Lincoln Co., *Semple & Heard 8120* WAT, *Semple & Heard 8121* WAT, and *Semple & Heard 8142* WAT (Semple and Chmielewski 1987); Taos Co., *Morton & Venn NA15957* TRT and *Morton & Venn NA15958* TRT (Morton, Venn and Semple 2018). **Texas:** Culberson Co., *Semple & Heard 8175* WAT and *Semple & Heard 8180* WAT (Semple et al. 1992). **Utah:** Beaver Co., *Semple & B. Semple 11270* WAT (Semple et al. 2019); Garfield Co., *Semple & Heard 7846* WAT (Semple and Chmielewski 1987); Kane Co., *Semple & Heard 7852* WAT (Semple and Chmielewski 1987); Utah Co., *Semple & Chmielewski 8882* WAT (Semple et al. 1989). **Wyoming:** Fremont Co., *Semple & Zhang 10418* WAT (Semple et al. 2001), *Morton & Venn NA15713* TRT (Morton, Venn, and Semple 2018). — 2*n*=18_{II} U.S.A. **New Mexico:** Grant Co., *Ward et al. 80-028* NMC (Ward and Spellenberg 1986); Lincoln Co., *Ward 81-581* NMC and *Ward 81-585a* NMC (Ward and Spellenberg1986). **Wyoming:** Johnson Co., Anderson 2710 BRY (Anderson et al'74). — 2*n*=36 U.S.A. **Arizona:** Coconino Co., *Semple & Chmielewski 9003* WAT (Semple et al. 1992), Morton & Venn NA15881 TRT (Morton, Venn and Semple 2018). **Colorado:** Garfield Co., *Semple & Zhang 1044*5 WAT (Semple et al. 2001). **New Mexico:** Colfax Co., *Morton & Venn NA15963* TRT (Morton, Venn and Semple 2018); San Miguel Co., *Morton & Venn NA15953* TRT (Morton, Venn and Semple 2018); Santa Fe Co., *Morton & Venn NA15944* TRT (Morton, Venn and Semple 2018). **Nevada:** White Pine Co., *Semple et al. 5749* WAT (Semple et al. 1984). **Utah:** Garfield Co., Semple & B. Semple 11247 WAT (Semple et al. 2019); Salt Lake Co., *Semple et al. 9241* WAT (Semple et al. 2001); Summit Co., *Semple & Chmielewski 8886* WAT (Semple et al. 1989); Wasatch Co., Semple & Chmielewski 8876 WAT (Semple et al. 1989). **Wyoming:** Teton Co., *Semple & Zhang 10437* WAT (Semple et al. 2001). — 2*n*=c.36 U.S.A. **Utah:** Cache Co., *Morton & Venn NA15722* TRT (Morton, Venn and Semple 2018). Place of original unknown: from seed, Oslo Bot. Garden, 1951, *J.K. Morton s952* TRT (Morton, Venn and Semple 2018). — 2*n*=54 U.S.A. **Colorado:** Gilpin Co., *Semple & B. Semple 5806* WAT (Semple et al. 1984).

RESULTS AND DISCUSSION

Additional chromosome counts of 2*n*=18 were determined from one individual of *Solidago gattingeri* and 2*n*=54 from one individual of *S. radula* are reported here (Table 2). In total, 312 chromosome counts are known for individuals of *Solidago* subsect. *Radulae*. Only one diploid 2*n*=18 has been sampled in *S. altiplanities* (Fig. 3, dot). Thirty-six diploid 2*n*=18 and two tetraploid 2n=36 individuals have been sampled in *S. californica* (Fig. 4, black dots for 2*x* and white squares with black outlines for 4*x*). Only two diploids 2*n*=18 from Tennessee have been sampled in *S. gattingeri* (Fig. 5, black dots for 2*x*); no portion of the range west of the Mississippi has been sampled.

Table 2. Previously unpublished chromosome number determinations in *Solidago* sect. *Radulae* (vouchers in WAT).

Solidago gattingeri Chapm. ex A. Gray — 2*n*=18 U.S.A. **Tennessee**: Rutherford Co., E of Murfreesboro, glade, *Semple, Estes, Crabtree, Campbell, & Brock 11856* WAT.

Solidago radula Nutt. — 2*n*=18 U.S.A. **Missouri:** Taney Co., *Semple & Suripto 9937* WAT. — 2*n*=54 U.S.A. T**ennessee:** Cocke Co., S of Del Rio, TN-107 ca. 2 km S of US-25/70/TN-9, *Cook & Family C-727* WAT (the identity of the transplanted rootstock was not confirmed to be the same as the voucher specimen because the transplant died before the count was made from stored and fixed root tips).

Eight tetraploid 2*n*=36 and eight hexaploid 2*n*=54 individuals of *Solidago mollis* have been sampled over much of the range of the species on the Great Plains (Fig. 6, white squares with black outlines for 4*x* and solid black squares for 6*x*). Only hexaploids are known in the northern end of the range of *S. mollis* in Manitoba, North Dakota, and Montana, while only tetraploids are known from the southern end of the range in south-central Kansas and Oklahoma. Both ploidy levels occur in the central portion of the range. Much more sampling is needed to determine whether or not this pattern holds up.

Eleven diploid 2*n*=18 individuals, four tetraploid 2*n*=36 individuals, and one possible hexaploid 2*n*=54 individual have been sampled over the range of *Solidago radula* (Fig. 7, dots for 2*x*, white squares with black outlines for 4*x*, sold black square for 6*x*). The tetraploid samples from Texas could be treated as *S. radula* var. *laeta* (Greene) Fern., being similar to narrow leaved individuals of *S. mollis* but having leaves that are finely short scabrous (shark skin-like); these also have been treated as *Solidago mollis* Bartl. var. *angustata* Shinners. The multivariate study of subsect. *Nemoralis* by Semple et al. (2018) included a comparison of specimens of *S. nana* (now in subg. *Nemorales*) and *S. mollis* and *S. radula* (now in subg. *Pleiactila* Raf. subsect. *Radulae*) with the two *S. radula* tetraploids from Kerr Co., Texas, the *S. radula* tetraploid from Arkansas, and one *S. radula* diploid from Iowa and cytologically unknown *S. radula* from Georgia being placed a posteriori into *S. mollis* with 54-68% probabilities based on similarities in leaf shape and floral part sizes; leaf indument traits were not included. Thus, some diploid and some tetraploid individuals of *S. radula* can be misidentified as *S. mollis* if indument traits are not emphasized. Further study on *S. radula* var. *laeta* in Texas is needed to justify recognizing the variety as more than just extremes at the end of a continuum in variation within *S. radula*.

Sixty-six diploid 2*n*=18 individuals, eleven tetraploid 2*n*=36 individuals, and one hexaploid 2*n*=54 individual have been sampled over the range of *Solidago velutina* (Fig. 8, dots for 2*x*, white squares with black outlines for 4*x*, sold black square for 6*x*). Diploids occur through the range of the species from Wyoming to central Mexico. Tetraploids occur in Wyoming, Utah, Colorado, Arizona, and New Mexico, but have not been reported from Mexico. One hexaploid has been reported from Gilpin Co., Colorado, in the foothills of the Front Range of the Rocky Mountains.

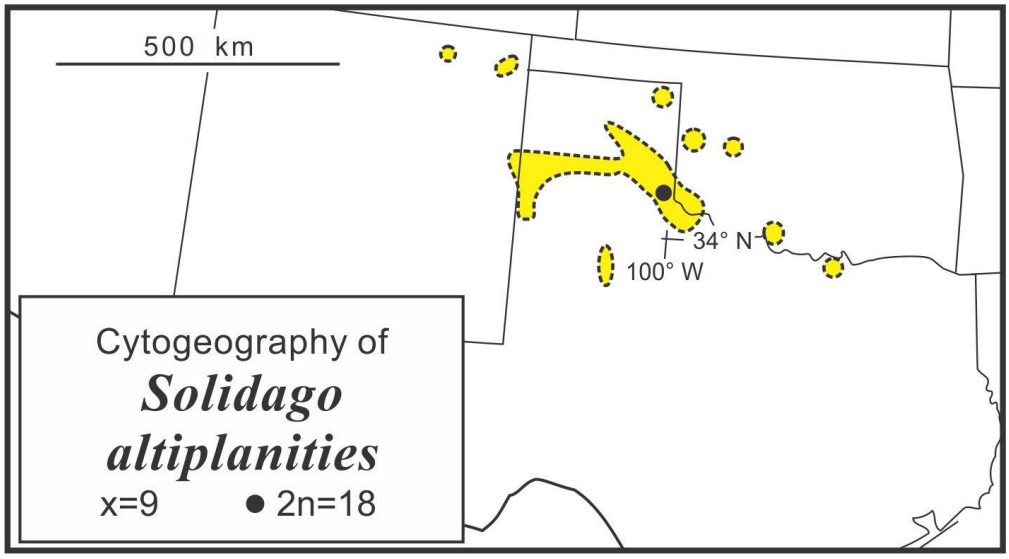

Figure 3. Cytogeography of *Solidago altiplanities*; range based on all collections seen and literature.

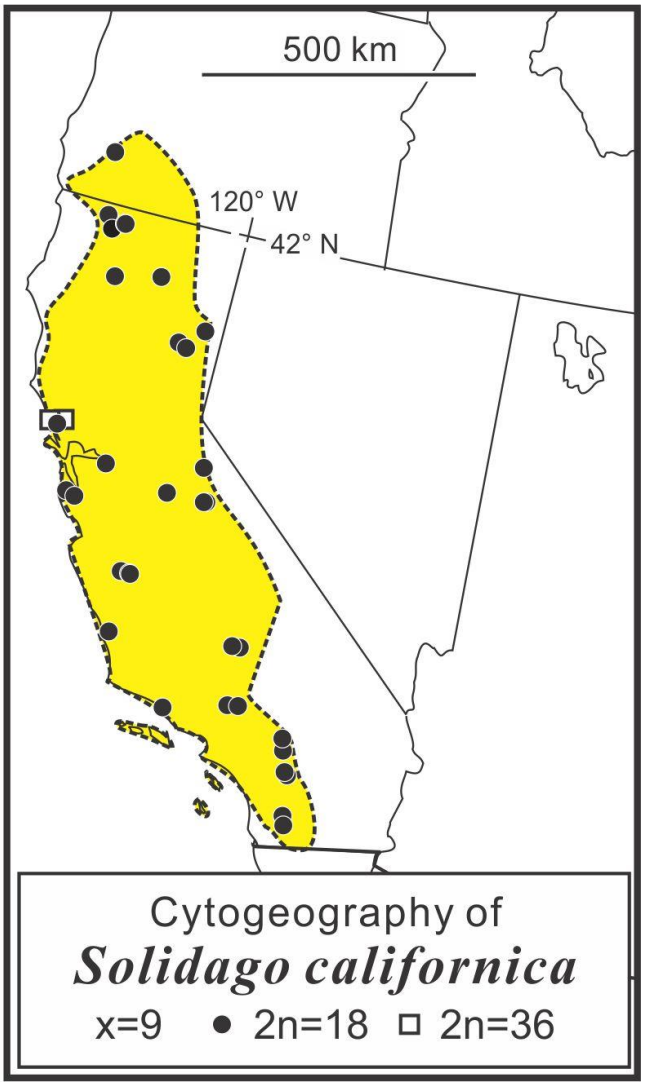

Figure 4. Cytogeography of *Solidago californica*. Range based on all collections seen and literature.

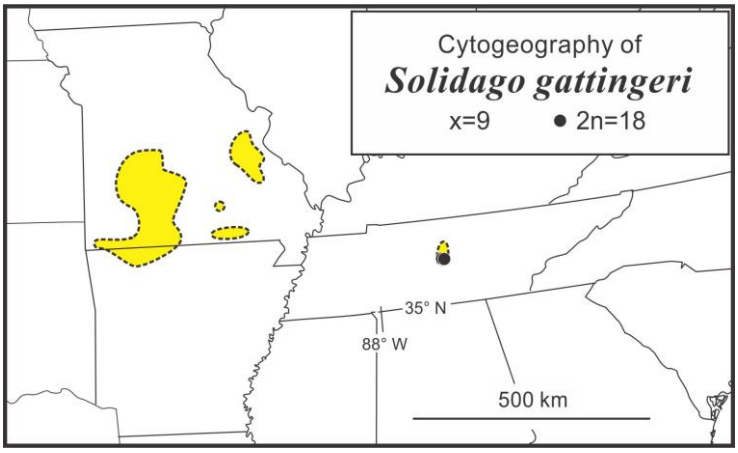

Figure 5. Cytogeography of *Solidago gattingeri*. Range based on all collections seen and literature.

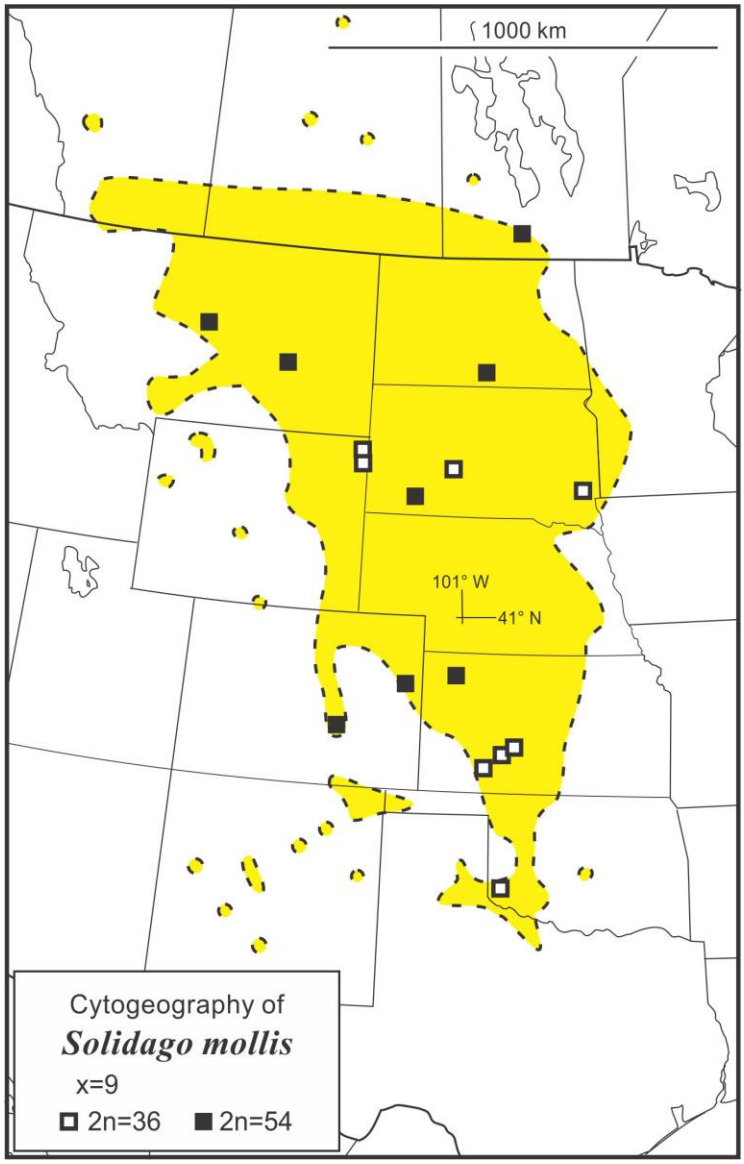

Figure 6. Cytogeography of *Solidago mollis*. Range based on all collections seen and literature.

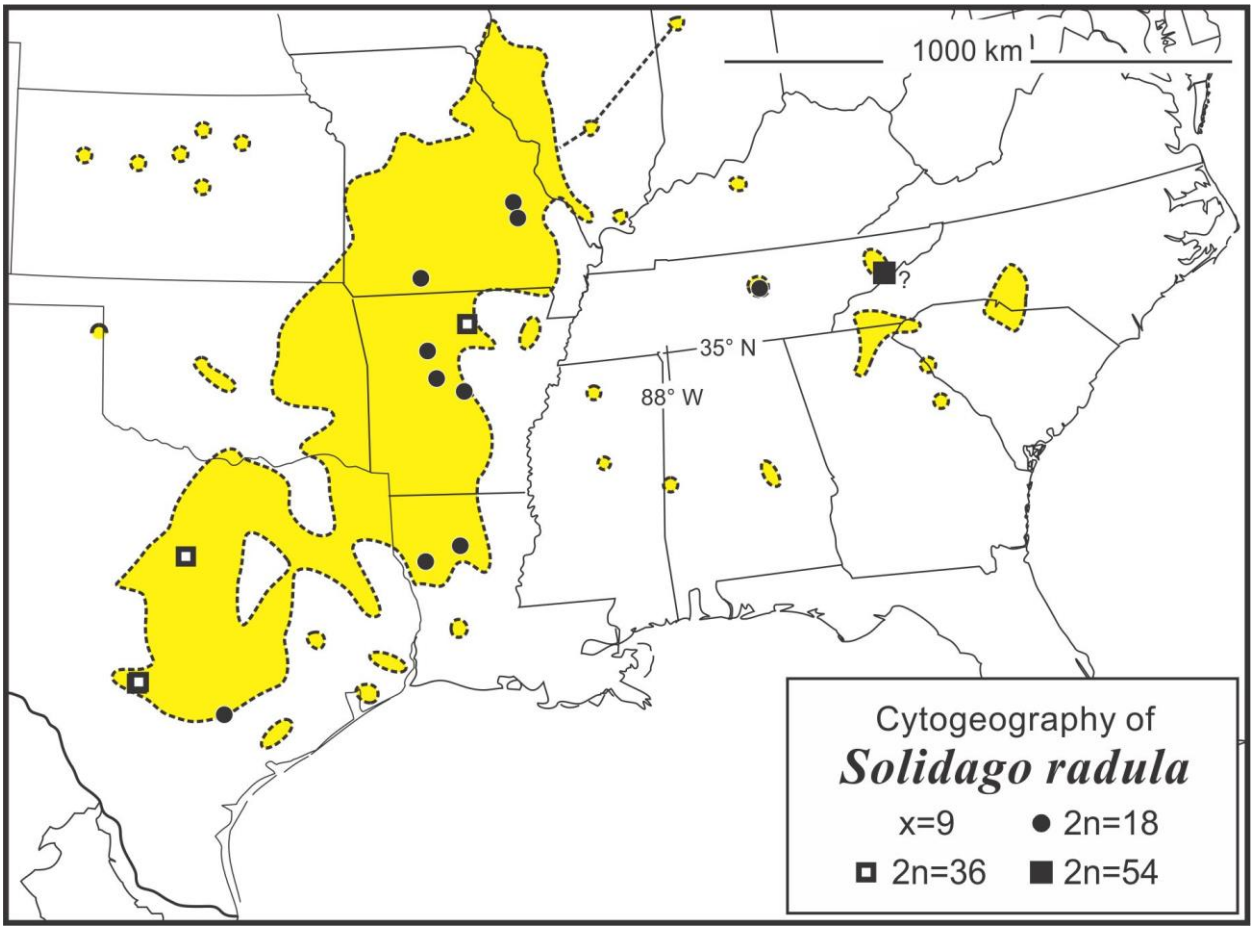

Figure 7. Cytogeography of *Solidago radula*. Range based on all collections seen and literature.

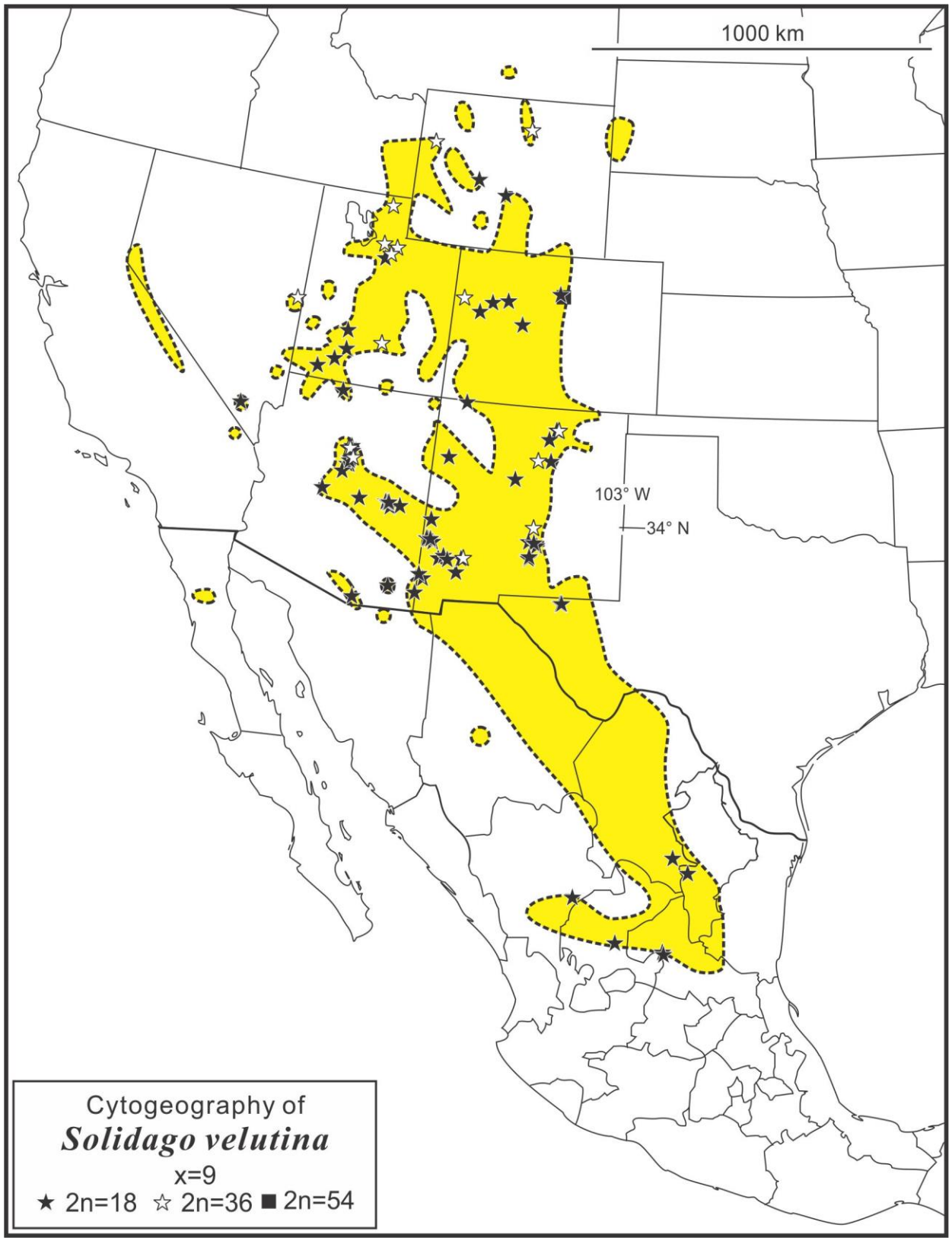

Figure 8. Cytogeography of *Solidago velutina*. The single hexaploid count is from north-central Colorado. Range based on all collections seen and literature.

LITERATURE CITED

Anderson, L.C., D.W. Kyhos, T. Mosquin, A.M. Powell, and P.H. Raven. 1974. Chromosome numbers in Compositae. IX. *Haplopappus* and other Astereae. Amer. J. Bot. 61: 665–671.

Beaudry, J.-R. 1969. Études sur les *Solidago* L. IX. Une troisième liste de nombres chromosomiques des taxons du genre *Solidago* et de certains genres voisins. Naturaliste canad. 96: 103–122.

Keil, D.J. and D. Pinkava. 1979. In A. Lovë (ed.). IOPB chromosome number reports LXIII. Taxon 28: 271–273.

Keil, D. and T. Stussey. 1977. Chromosome counts of Compositae from Mexico and the United States. Amer. J. Bot. 64: 791–798.

Keil, D.J., M.A. Luckow, and D.J. Pinkava. 1988. Chromosome studies in Asteraceae from the United States, Mexico, the West Indies, and South America. Amer. J. Bot. 75: 662–668.

Morton, J.K., J. Venn, and J.C. Semple. 2018. Chromosome number determinations in *Solidago* (Asteraceae: Astereae). Rhodora 119: 341–348.

Nesom, G.L. 1989. Taxonomy of *Solidago velutina* (Asteraceae: Astereae) with a new related species from Mexico. Phytologia 67: 297–303.

Nesom, G.L. 1993. Taxonomic infrastructure of *Solidago* and *Oligoneuron* (Asteraceae: Astereae) and observations on their phylogenetic position. Phytologia 75: 1–44.

Raven, P., O. Solbrig, D. Kynos, and R. Snow. 1960. Chromosome numbers in Compositae. I. Astereae. Amer. J. Bot. 47: 124–132.

SEINet Portal Network. 2023. <http//:swbiodiversity.org/seinet/index.php>. Accessed multiple times in April and May 2023 and earlier.

Semple, J.C. 1985. Chromosome number determinations in Fam. Compositae tribe Astereae. Rhodora 87: 517–527.

Semple, J.C. and J.B. Beck. 2021. A revised infrageneric classification of *Solidago* (Asteraceae: Astereae). Phytoneuron 2021-10: 1–6.

Semple, J.C. and J.G. Chmielewski. 1987. Chromosome numbers in Fam. Compositae, Tribe Astereae. II. Additional counts. Rhodora 89: 319–325.

Semple, J.C. and R.E. Cook. 2004. Chromosome number determinations in fam. Compositae, Tribe Astereae. VII. Mostly eastern North American and some Eurasian taxa. Rhodora 106: 253–272.

Semple, J.C. and R.E. Cook. 2006. *Solidago* Linnaeus. Pp. 107–166, in Flora North America Editorial Committee (eds.). Flora of North America, Vol. 20. Asteraceae, Part 2. Astereae and Senecioneae. Oxford Univ. Press, New York and Oxford.

Semple, J.C., J.G. Chmielewski, and M. Lane. 1989. Chromosome numbers in Fam. Compositae, Tribe Astereae. III. Additional counts and comments on some generic limits and ancestral base numbers. Rhodora 91: 296–314.

Semple, J.C., R.E. Cook, and E. Owen. 2015a. Chromosome numbers in Fam. Compositae, Tribe Astereae. VIII. Eastern North American taxa. II. Rhodora 117: 80–91.

Semple, J.C., K. Kornobis, and S. Bzovsky. 2018. A multivariate morphometric analysis of *Solidago* subsect. *Nemorales* (Asteraceae: Astereae). Phytoneuron 2018-42: 1–40.

Semple, J.C., Jie Zhang, and Chun Sheng Xiang. 1993. Chromosome numbers in Fam. Compositae, Tribe Astereae. V. Eastern North American taxa. Rhodora 95: 234–253.

Semple, J.C., G. S. Ringius, C. Leeder, and G. Morton. 1984. Chromosome numbers of goldenrods, *Euthamia* and *Solidago* (Compositae: Astereae). II. Additional counts with comments on cytogeography. Brittonia 36: 280–292. Addendum — Brittonia 37: 121–121. 1985.

Semple, J.C., R.E. Cook, G.H. Morton, J.B. Beck, and R. Lopez Laphitz. 2019. Chromosome number determinations in Fam. Compositae, Tribe Astereae. IX. North American taxa. II. Rhodora 121: 37–53.

Semple, J.C., Chun Sheng Xiang, Jie Zhang, M. Horsburgh, and R. Cook. 2001. Chromosome number determinations in Fam. Compositae, Tribe Astereae. VI. Western North American taxa and comments on generic treatments of North American asters. Rhodora 103: 202–218.

Semple, J.C., H. McMinn-Sauder, M. Stover, A. Lemmon, E. Lemmon, and J.B. Beck. 2023, in press. Goldenrod herbariomics: Hybrid sequence capture reveals the phylogeny of *Solidago*. Amer. J. Bot. 110.

Semple, J.C., H. Rahman, S. Bzovsky, M.K. Sorour, K. Kornobis, R. Lopez Laphitz, and L. Tong. 2015b. A multivariate morphometric study of the *Solidago altissima* complex and *S. canadensis* (Asteraceae: Astereae). Phytoneuron 2014-10: 1–31.

SERNEC. 2020. Southeast Regional Network of Expertise and Collections. <www.sernecportal.org> Accessed multiple times in April and May 2023 and earlier.

Turner, B.L., A.M. Powell, and R.M. King. 1962. Chromosome numbers in Compositae. VI. Additional Mexican and Guatemalan species. Rhodora 64: 251–271.

Ward, D.E. and R.W. Spellenberg. 1986. Chromosome counts of angiosperms of western North America. Phytologia 61: 119–125.

Zhao, Z.-M. 1996. Documented chromosome numbers 1996.2. Miscellaneous U.S.A. and Mexican species, mostly Asteraceae. Sida 17: 259–263.