

THE CYTOGEOGRAPHY OF *SYMPHYOTRICHUM ERICOIDES* AND *S. FALCATUM* (ASTERACEAE: ASTEREAE)

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ABSTRACT

The geographic of chromosome cytotypes for *Symphytotrichum ericoides* ($2n=5_{II}$, 10, 10_{II} , 20) and *S. falcatum* ($2n=5_{II}$, 10, 10_{II} , 20, 15_{II} , 30, 35) are presented based on 106 previously published reports and 176 new reports for a total of 282 counts for the two species.

Symphytotrichum ericoides (L.) Nesom (Fig. 1) and *S. falcatum* (Lindl.) Nesom (Fig. 2) are two similar and closely related, small to midsize-headed, white-rayed aster species native to much of western and central North America except for much of the southeastern USA. Together they comprise the only two species of *S. sect. Ericoidei* (Torr. & Gray) Nesom. These species occur in a range of habitats including well drained, sandy or gravelly, disturbed soils, prairies, glades, dunes, salt flats, fields, shores, railroad rights-of-way, and roadsides (Jones 1978a, b; Brouillet et al. 2006). The ranges of the four varieties accepted here are sympatric on the Great Plains and lower elevations in the central Rocky Mountains., but are allopatric in the northern Rocky Mountains. (*S. falcatum* var. *falcatum*), and the northeastern USA and adjacent Canada (*S. ericoides* var. *ericoides*). *Symphytotrichum ericoides* is distinguished by having small involucre and short ray floret straps (Fig 1B), while *S. falcatum* has larger involucre and longer ray straps (Fig. 2B-C) with variation in part due to differences in ploidy level of individuals within and between species. Plants are either rhizomatous [*S. ericoides* var. *ericoides* and *S. falcatum* var. *commutatum* (Torr. & Gray) Nesom] or cormoid [*S. ericoides* var. *pansum* (Blake) Nesom and *S. falcatum* var. *falcatum*].

The most comprehensive biosystematics studies of the two species were published by Almut Jones (1978a, 1978b) based on her doctoral thesis research. Relative shape and size of the involucre (Fig. 3), length of outer phyllaries, and orientation of the phyllary ends were used by Jones (1978a) to distinguish two varieties within her subsp. *ericoides*, and two varieties within her *A. ericoides* subsp. *pansus* (Blake) Jones. Jones (1978a) recognized two varieties in *A. falcatum* subsp. *falcatum* and two varieties in her *A. falcatus* subsp. *commutatum* (Torr. & Gray) Jones based on differences in stem pubescence and stem and inflorescence branching patterns. Stems vary from sparsely to densely hispid-strigose in both species with hair orientation and length varying (Fig 1D; Fig 4); hair densities can vary sometimes on a single stem with lower stems being glabrous with age (Fig. 5). *Aster ericoides* var. *pansus* (Blake) B. Boivin was defined by Jones (1978a) as having plants forming many-stemmed clumps, stems erect, sturdy, typically with copious spreading indument. *Aster ericoides* var. *prostratus* (Kuntze) Blake [*Symphytotrichum ericoides* var. *prostratum* (Kuntze) Nesom] was delimited by Jones (1978a) as plants forming few-stemmed clusters, the stems decumbent or ascending, slender, indument typically sparse and appressed-strigose. *Aster ericoides*



Figure 1. *Symphotrichum ericoides*. **A-B.** Habit and heads; Ontario, var. *ericoides* (Semple 2051 WAT). **C.** Habit, var. *pansum*; Idaho (Semple & Brouillet 4400 WAT). **D.** Rhizomatous rootstock; var. *ericoides* (Fig. 60 D, Semple et al. 2002). **E.** Cormoid rootstock, var. *pansum*; Wyoming (Semple & Brouillet 4442 WAT).

L. var. stricticaulis (Torr. & Gray) F.C. Gates [*Symphotrichum ericoides* var. *stricticaule* (Torr. & Gray) Nesom] was defined by Jones (1978a) to include plants forming few-stemmed clusters, the stems decumbent or ascending, slender, indument typically sparse and appressed-strigose. These varieties were not accepted by Brouillet et al. (2006). *Aster falcatum* var. *commutatus* (Torr. & A. Gray) A.G. Jones was defined by Jones (1978a) as having stems decumbent or ascending, usually branched from near the base, inflorescence diffuse-paniculate, or inflorescences sometimes a simple raceme, heads rarely secund, inflorescence diffuse-paniculate, or inflorescences sometimes times a simple raceme, usually with 40-50(60) florets. *Aster falcatum* var. *crassulus* Cronq. was defined by

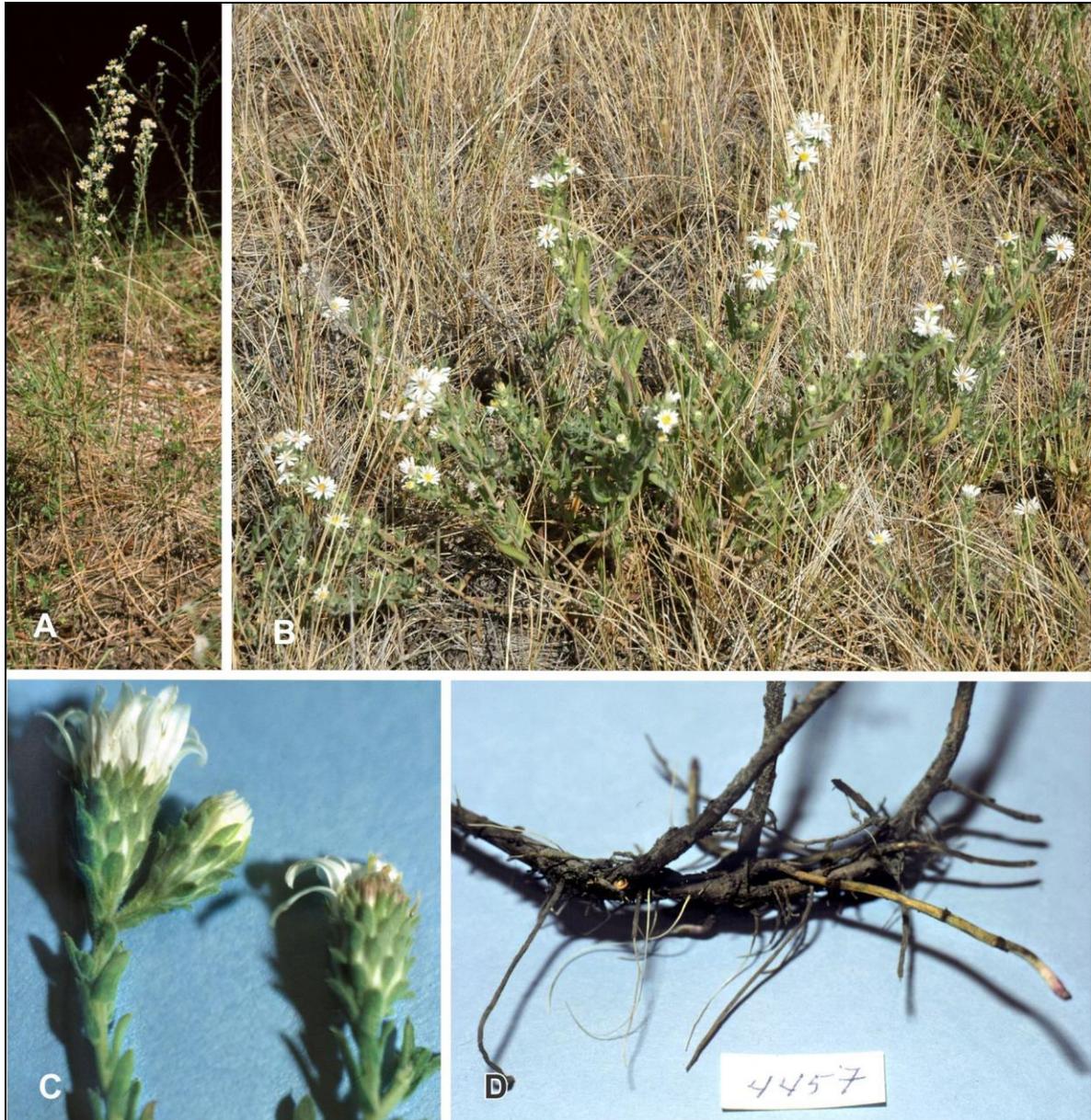


Figure 2. *Symphotrichum falcatum*. **A.** Habit; Arizona, var. *commutatum* (Semple & Heard 7886 WAT; this would be var. *stricticaule* if it was recognized as a separate variety). **B.** Habit; var. *commutatum*; $2n=30$, Montana (Semple & B. Semple 11384 WAT). **C.** Heads, var. *commutatum*, $2n=30$; Wyoming (Semple & Brouillet 4457 WAT). **D.** Rhizomatous rootstock; var. *commutatum*, $2n=30$, Wyoming (Semple & Brouillet 4457 WAT).

Jones (1978a) as having stems erect, usually divaricately branched near the middle; inflorescence compound-racemiform; heads often somewhat secund, with 35-40(-45) florets. These varieties were not accepted by Brouillet et al. (2006). Stem hair length and density vary considerably (Fig. 4). Identification problems occur when herbarium sheet collections lack lower portions of the plant, and thus the presence of rhizomatous or cormoid rootstocks cannot be determined. Normal ploidy related variation influencing involucre height in both species also makes identification less certain.

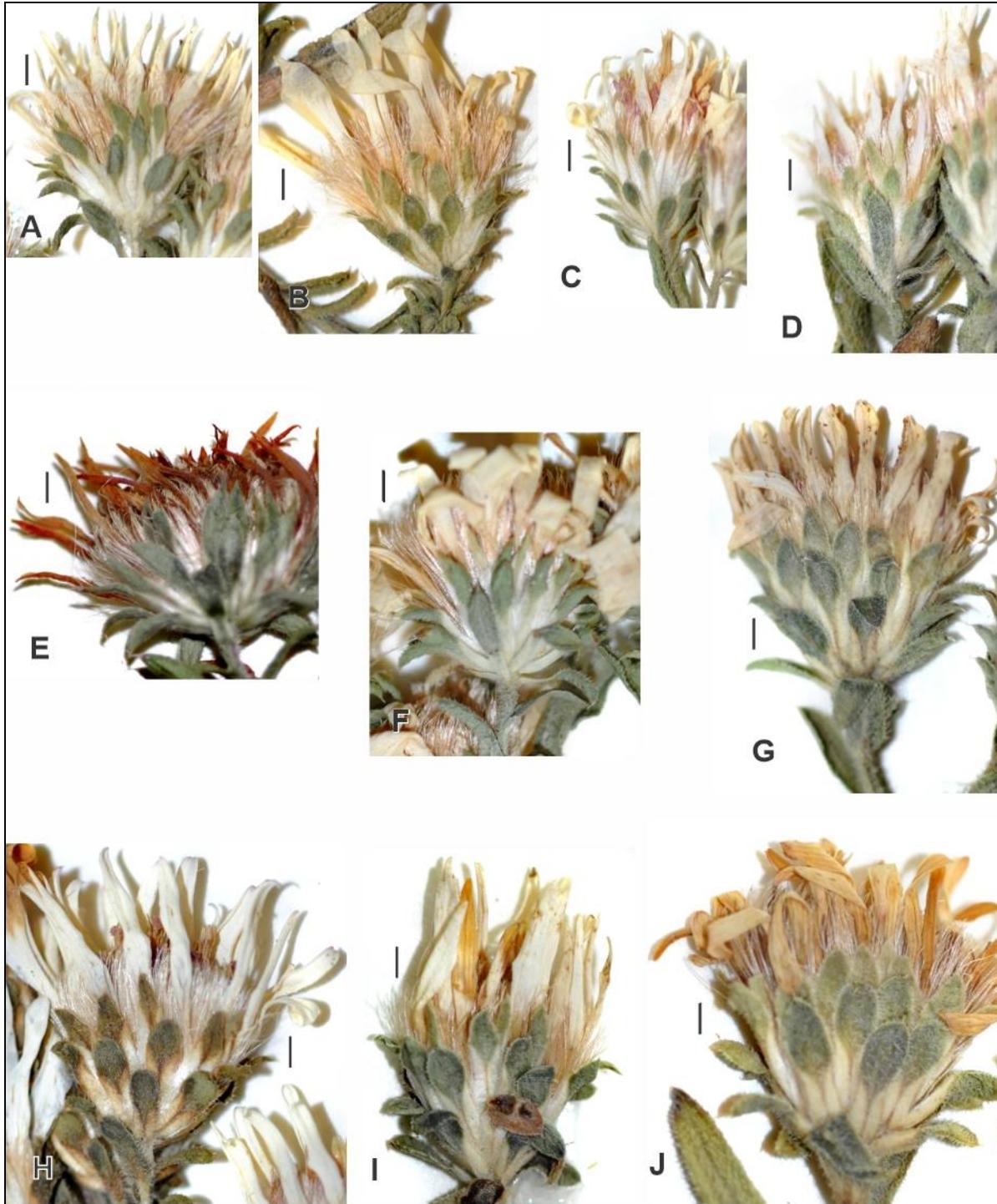


Figure 3. Involucre size and ploidy level variation in *S. ericoides* and *S. falcatum*. **A-B.** Var. *ericoides*. **A.** Semple & Chmielewski 7917 WAT, $2n=10$. **B.** Semple & Heard 7287 WAT, $2n=20$. **C-D.** Var. *pansum*. **C.** Semple & Heard 7917 WAT, $2n=10$. **D.** Semple & Xiang 10197 WAT, $2n=30$. **E.** Var. *falcatum*, Semple & Cli - Michaud 11174 WAT, $2n=10$. **F-J.** Var. *commutatum*. **F.** Semple & Chmielewski 9041 WAT, $2n=10$. **G.** Semple & Brouillet 4251 WAT, $2n=20$. **H.** Semple & Chmielewski 4471 WAT, $2n=30$. **I.** Semple & B. Semple 10641 WAT, $2n=30$. **J.** Semple & Brouillet 7012 WAT, $2n=35$. Scale bars = 1 mm.



Figure 4. Stem hair variation on mid to upper stems of *Symphytotrichum ericoides* and *S. falcatum*. **A.** Var. *ericoides*, Texas (Semple & Heard 8226 WAT). **B.** Var. *ericoides*, Oklahoma (Semple & Heard 8255 WAT). **C.** Var. *ericoides*, Wisconsin (Semple & Chmielewski 8855 WAT). **D.** Var. *pansum*, Arizona (Semple & Heard 7927 WAT). **E.** Var. *pansum*, Texas (Semple & Heard 8230 WAT). **F.** Var. *pansum*, Utah (Semple & Chmielewski 8874 WAT). **G.** Var. *commutatum*, New Mexico (Semple & Heard 8020 WAT). **H.** Var. *commutatum*, Arizona (Semple & Heard 8146 WAT). **I.** Var. *commutatum* (Semple & Chmielewski 9041 WAT). **J.** Var. *commutatum*, Arizona (Semple & Chmielewski 9032 WAT). Scale bars = 1 mm.

In total, 73 chromosome number counts have been reported previously (Appendix 1) for individuals of *Symphytotrichum ericoides* (many to variety indicated in Appendix 1) mostly as either *Aster ericoides*, *Lasallea ericoides* (L.) Semple & Brouillet, or *Virgulus ericoides* (L.) Reveal & Keener. Thirty-eight diploid counts ($2n=5_{II}$, $2n=10$) were reported for *Aster ericoides*, *Aster ericoides* ssp./var. *ericoides*, *Lasallea ericoides* var. *ericoides*, *Virgulus ericoides* var. *ericoides*, or *Symphytotrichum ericoides* var./ssp. *ericoides* by Van Faasen (1963), Keil and Pinkava (1976), Semple (1976), Jones (1978b), Semple and Brouillet (1980 as *Lasallea e.*), Semple (1981 as *Lasallea*

e.), Chinnappa and Chmielewski (1987 as *A. e.*), Semple (1985), Semple et al. (1989, 1992, 1993), Semple and Cook (2004), and Semple et al. (2015). Tetraploid counts ($2n=10_{II}$, $2n=20$) have been reported for *A. ericoides* var. *ericoides* by Jones (1978b), Semple et al. 1992 as *Virgulus e.* var. *e.*), and Semple et al. (2001). Twenty-four diploid counts ($2n=5_{II}$, $2n=10$) were reported for *Aster ericoides* var. *pansus*, *Lasallea ericoides* var. *pansus*, *Virgulus ericoides* var. *pansus*, or *Symphotrichum ericoides* var. *pansum* by Jones (1978b). Four tetraploid counts ($2n=10_{II}$, $2n=20$) have been reported for var. *pansum* by Jones (1978b as *A. ericoides* ssp. *pansus*), and Chinnappa and Chmielewski (1987 as *A. ericoides*). Semple (1976) described and illustrated the diploid karyotype of *S. ericoides* (as *Aster ericoides*) with the NOR near the distal end of the short arm of the largest chromosome in the karyotype, which is typical for *Symphotrichum* subg. *Virgulus* (Semple & Brouillet 1980).

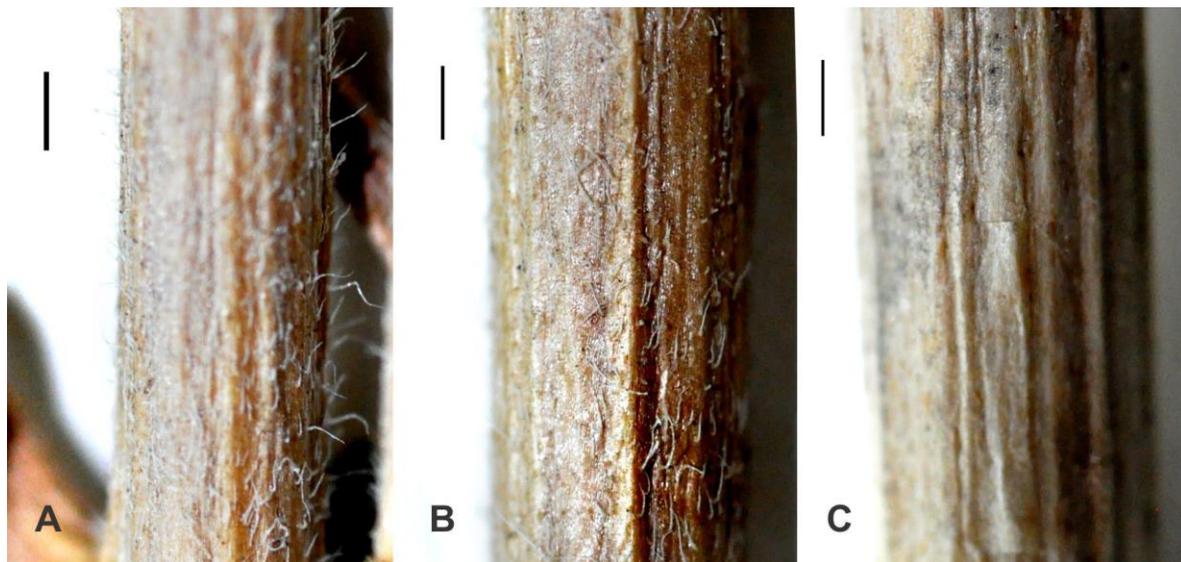


Figure 5. Variation in stem hair density with age of stem, *Symphotrichum falcatum* var. *commutatum*, Semple & B. Semple 5526 WAT. **A.** Stem in lower inflorescence. **B.** Mid stem. **C.** Lower stem that has lost hairs. Scale bars = 1 mm.

In total, 33 chromosome counts have been reported previously for *S. falcatum* mostly under the names *Aster falcatum* Lindl., *Lasallea falcatum* (Lindl.) Semple & Brouillet, or *Virgulus falcatum* (Lindl.) Reveal & Keener. Three diploid counts ($2n=10$; Semple et al 1992, 2019), and one hexaploid count ($2n=30$; Semple et al. 2001) have been reported for var. *falcatum*. Twelve tetraploid counts ($2n=10_{II}$, $2n=20$); Anderson et al. 1974, Jones 1978b, Semple and Brouillet 1980, Semple 1981, Löve and Löve 1982, Windham and Schaak 1983), 16 hexaploid counts ($2n=15_{II}$, $2n=30$; Jones 1978b, Semple and Brouillet 1980, Ward 1983, Semple et al. 1992, 2001), and one octoploid count ($2n=ca.20_{II}$; Semple and Brouillet 1980) have been reported for var. *commutatum* (as *A. commutatus*, *V. falcatum*, *Lasallea falcata*, or *Virgulus falcatum*). The cytogeography of these taxa has not been presented previously.

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 previously unpublished counts have been deposited in WAT in MT or MT (or will be and are currently in the possession of the first author). Locations of vouchers for all Windham counts are listed in Appendix 2. Identifications were reconfirmed for this study by the first author either from collections on hand in Waterloo, from digital images taken by the first author, from images available on line through SERNEC (2022), and from digital images provided by the staff of the herbarium at the Jardin botanique (MT) in Montréal, Québec.

RESULTS AND DISCUSSION

An additional 176 new chromosome number reports are listed in Appendix 2 for a total of 282 counts for *Symphyotrichum ericoides* and *S. falcatum*. The cytogeography of *Symphyotrichum ericoides* var. *ericoides* is shown in Fig. 6, the cytogeography of *S. ericoides* var. *pansum* is shown in Fig. 7, the cytogeography of *S. falcatum* var. *falcatum* is shown in Fig. 8, and the cytogeography of *S. falcatum* var. *commutatum* is shown in Fig. 9. No counts have been reported for either species from populations in Mexico.

Diploids, triploids, tetraploids, and hexaploids have been documented in *Symphyotrichum ericoides* (Figs. 6 and 7). Diploids have been sampled throughout the ranges of both var. *ericoides* and var. *pansum*, and only diploids have been encountered in the mountains and prairies of western Canada. Tetraploids of var. *ericoides* occur on the Great Plains from North Dakota south to Oklahoma and east to eastern Illinois. Tetraploids belonging to var. *pansum* were sampled in Nebraska, Oklahoma, Colorado and New Mexico. One hexaploid individual of var. *pansum* was sampled from northern Wyoming.

Diploids, triploids, tetraploids, hexaploids, septaploids and octoploids have all been reported in *Symphyotrichum falcatum*, with tetraploids and hexaploids predominant (Fig. 7). Two varieties are recognized here, differing primarily in the morphology of the rootstock (rhizomatous in var. *commutatum* and cormoid in var. *falcatum*). Var. *falcatum* occupies the northern and western portions of the range, while var. *commutatum* occurs to the south and east. The two are sympatric in the central portion of the species's range, with a broad region of overlap extending from Manitoba and Alberta in the north to New Mexico and Arizona in the south (Fig. 7).

Sampling is relatively sparse to absent in much of the range of var. *falcatum*. Diploids are relatively uncommon in var. *falcatum*. The only count obtained from the northern allopatric portion of the range was diploid, and additional plants of this cytotype have been sampled on the rim of the Mogollon Plateau in Arizona and southwestern New Mexico. Tetraploids in var. *falcatum* are known from southern Alberta, Saskatchewan, and Manitoba and eastern Colorado. Hexaploids in var. *falcatum* were sampled rarely in southern Alberta and North and South Dakota.

Sampling in var. *commutatum* was relatively dense in the U.S. and less south on the plains in Canada. Diploids in var. *commutatum* were sampled in Arizona, New Mexico, the panhandle of Texas, and northcentral Nebraska. Tetraploids in var. *commutatum* were sampled many times in populations from North Dakota east to Wisconsin and south to Oklahoma, Texas, and New Mexico and once in central Arizona on the rim of the Mogollon Plateau. Hexaploids in var. *commutatum* were sampled many times from southern Alberta south to New Mexico and Arizona. One septaploid individual of var. *commutatum* was sampled in central Montana. One octoploid individual of var. *commutatum* was sampled on the prairie in southwestern Manitoba.

A much greater range in involucre height was observed in individuals of *S. falcatum* with the taller involucre usually occurring in higher ploidy level individuals than was observed in both varieties of *S. ericoides* (Fig. 3). Although *S. falcatum* is often separated from *S. ericoides* based on having taller involucre, there is some overlap between the shortest mature involucre of diploid *S. falcatum* and the tallest involucre of polyploid individuals identified as *S. ericoides*. Thus, involucre height alone is insufficient to distinguish the two species in some cases.

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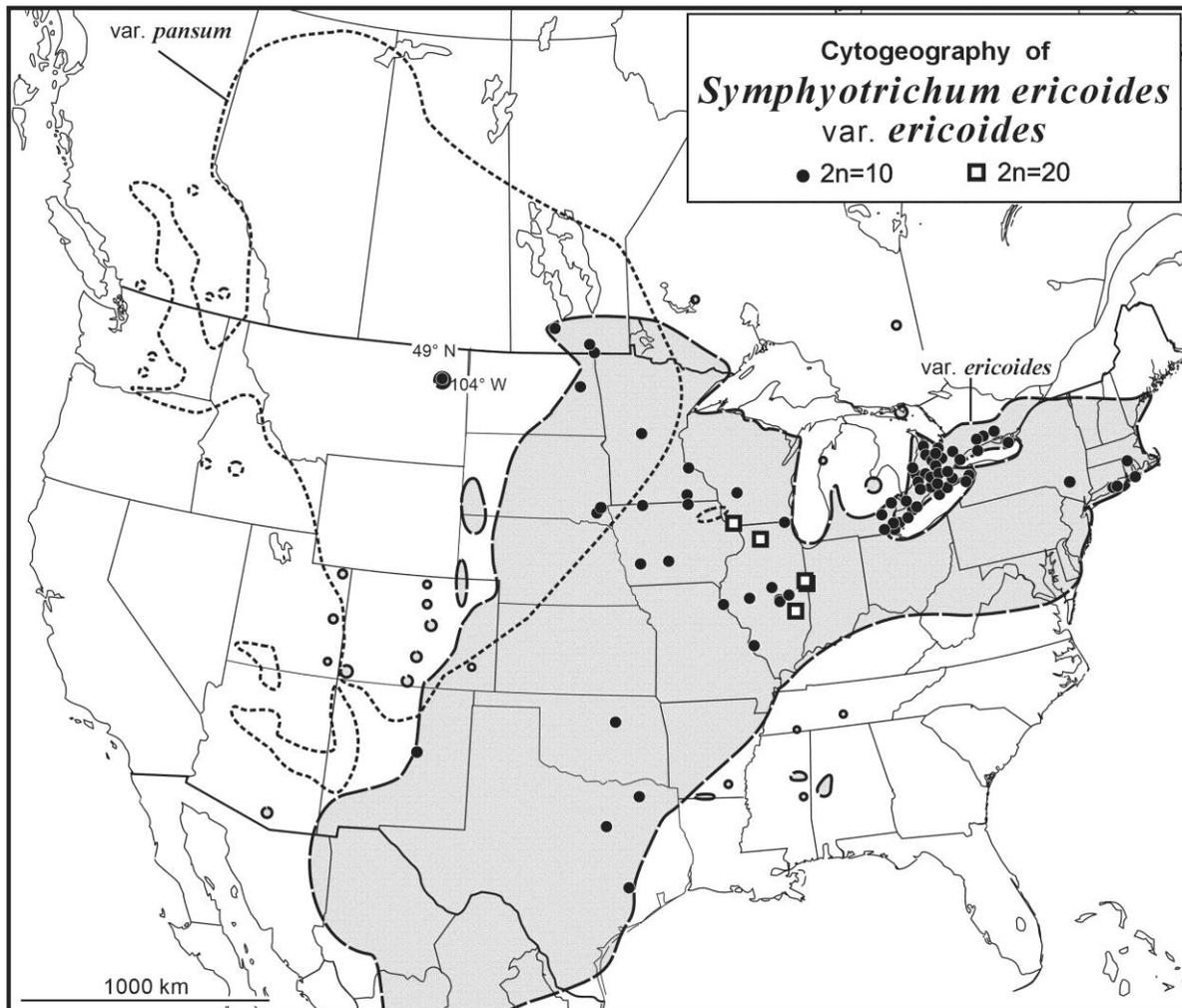


Figure 6. Distribution of cytotypes of *Symphotrichum ericoides* var. *ericoides*; range based on all collections seen and literature.

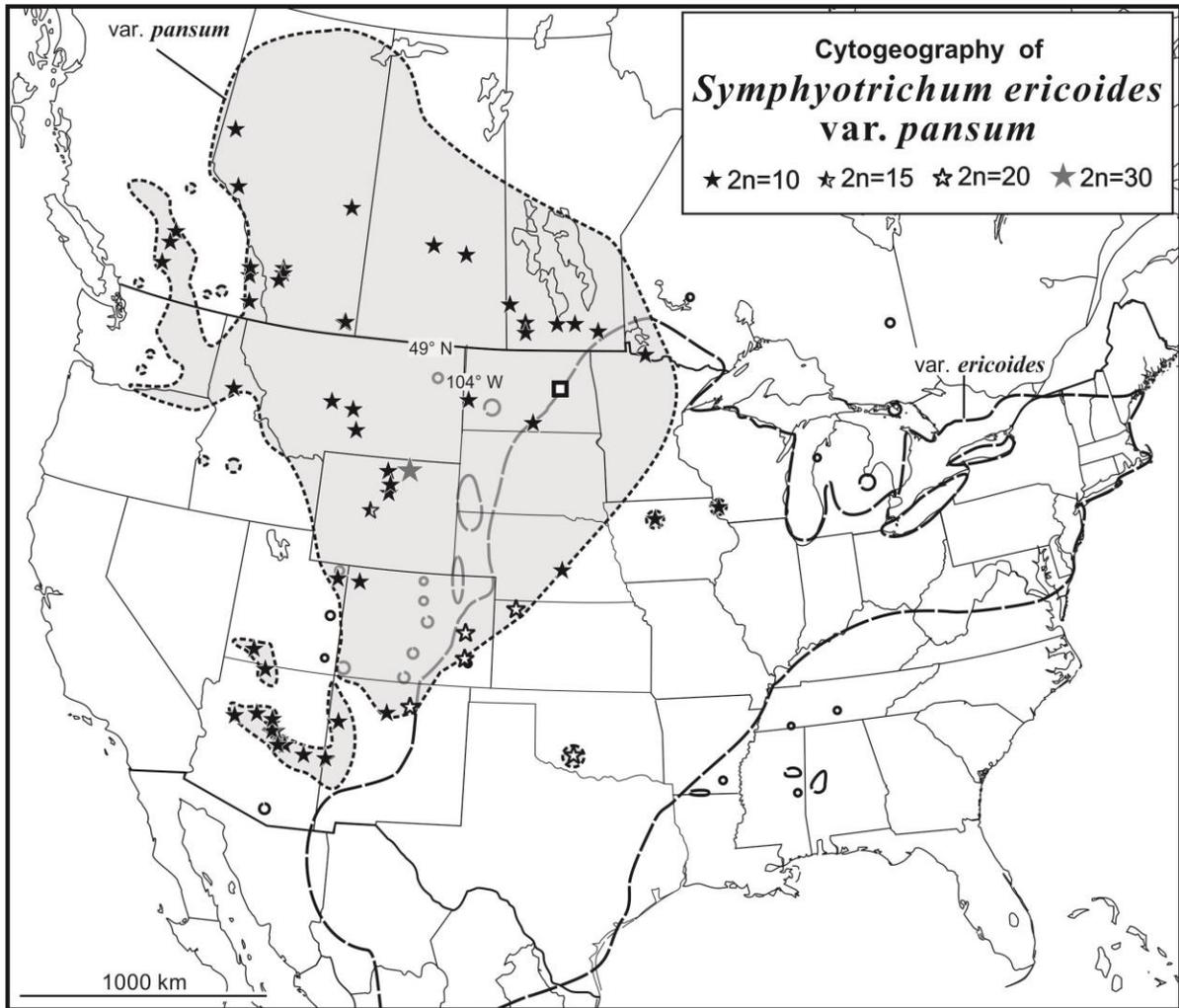


Figure 7. Distribution of cytotypes of *Symphyotrichum ericoides* var. *pansum*; range based on all collections seen and literature.

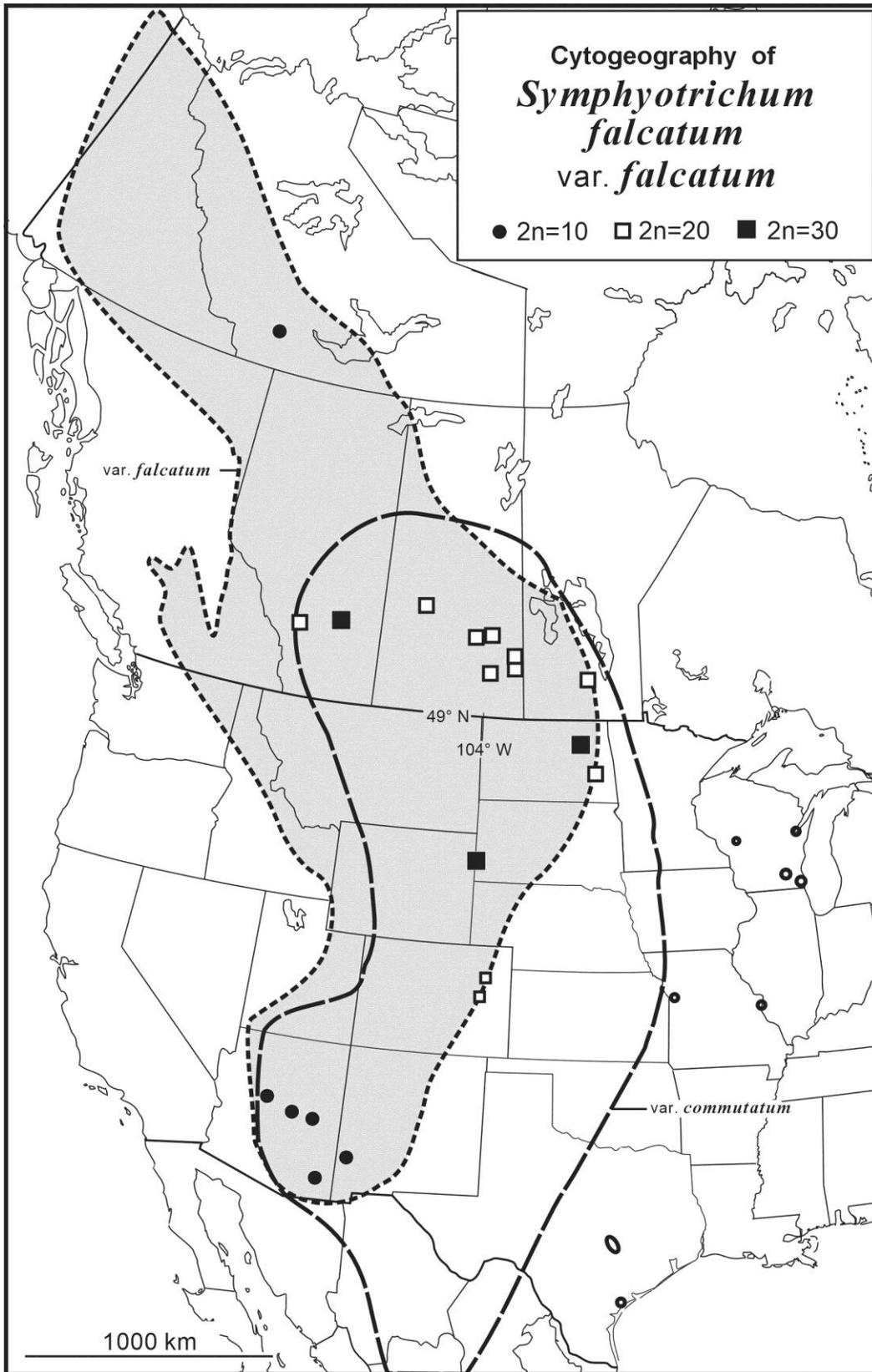


Figure 8. Distribution of cytotypes of *Symphyotrichum falcatum* var. *falcatum* (dots, squares); ranges based on all collections seen and literature.

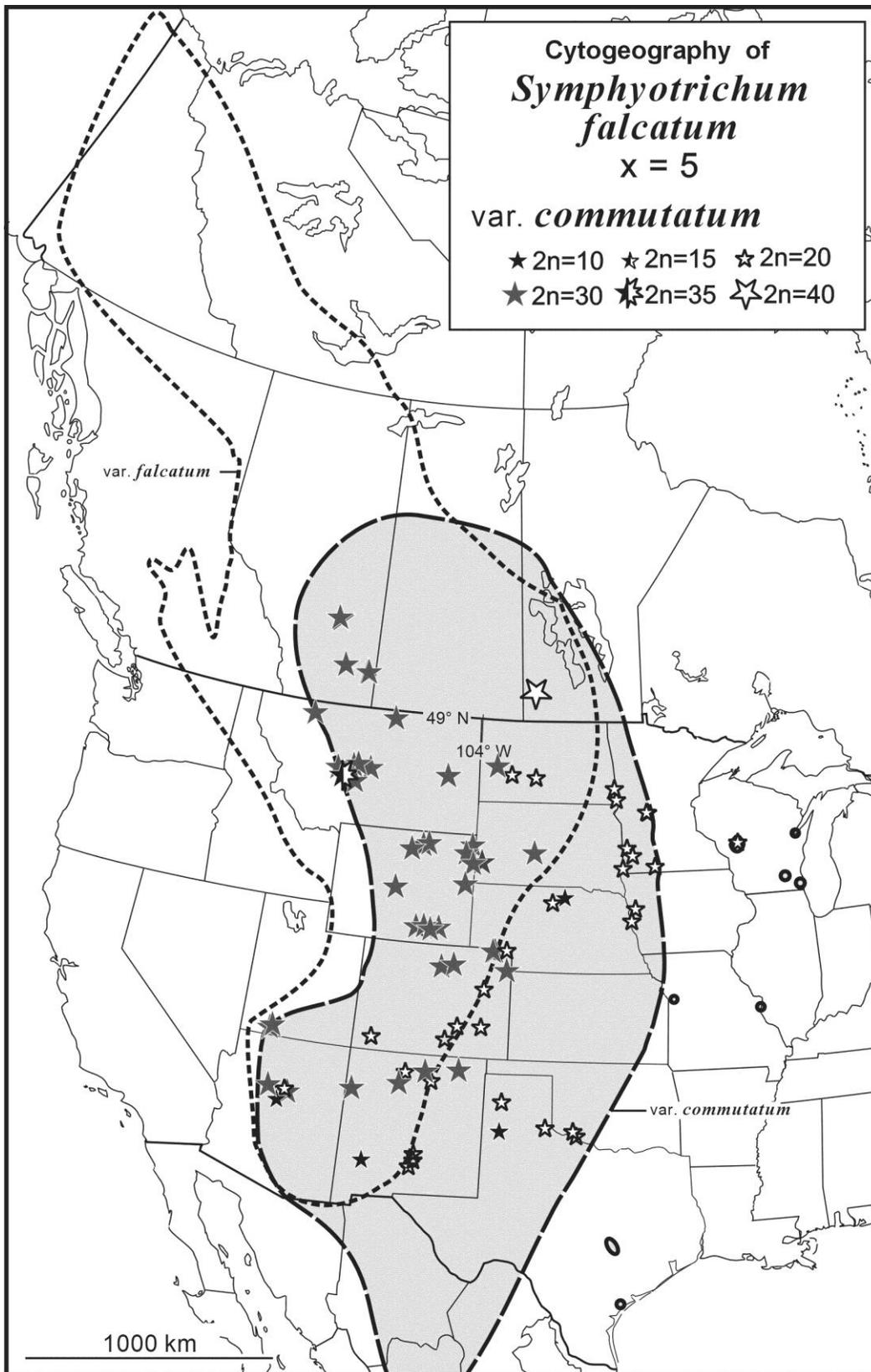


Figure 9. Distribution of cytotypes of *Symphyotrichum falcatum* var. *commutatum* (stars); ranges based on all collections seen and literature.

Appendix 1. Previously reported chromosome number determinations in *Symphyotrichum ericoides* and *S. falcatum* from Canada and the United States; all vouchers in WAT; *Bt* = L. Brouillet; *Ch* = J. Chmielewski; *Hd* = S. Heard; *S* = J.C. Semple.

Symphyotrichum ericoides (L.) G.L. Nesom var. *ericoides* — $2n=5_{II}$ U.S.A. **Arizona**. Gila Co., *Lehto Pinkava & Keil 18989* ASU (Keil and Pinkava 1976). **Illinois**. Champaign Co., *A. Jones 208* Confirm this: (Jones 1978b, as *2x*, ssp. pan.); Mason Co., *A. Jones 257* ILL (Jones 1978b) *2x*, ssp. pan.); McLean Co., *A. Jones 371* ILL (Jones 1978b, as *A. eri.*); Piatt Co., *A. Jones 314* ILL (Jones 1978b, as *A. eri.*), *A. Jones 346* ILL (Jones 1978b, *A. eri* ssp. pan.). **Indiana**. Benton Co. *A. Jones 905* ILL (Jones 1978b). **Iowa**. Guthrie Co. *A. Jones 528* ILL (Jones 1978, as *A. eri.*). **Minnesota**. Fillmore Co. *A. Jones 443* ILL (Jones 1978b as *A. eri.*); Martin Co. *A. Jones 445* ILL (Jones 1978 as). **Oklahoma**. *A. Jones 891* ILL (Jones 1978b as *A. eri.*). **Wisconsin**. Racine Co. *A. Jones 1226* ILL (Jones 1978b as *A. eri.*). — $2n=10$ CANADA. **Manitoba**. S of Winnipeg, *S 10647* (Semple and Cook 2004); N of Ridgeville, *S & Ch 6703* WAT (Semple 1985 as *Virgulus eri.*). **Ontario**. Bruce Co., *Cook & S. Faulkenham 13* WAT (Semple and Cook 2004); Essex Co., *S 11108* WAT (Semple et al. 2015); Haldimand-Norfolk R.M.: *Bt 737* MT (Semple and Brouillet 1980 as *Lasallea eri.*); Halton Co., *S 2120* WAT (Semple 1976 as *A. eri.*); Huron Co., *S 2459* WAT (Semple and Brouillet 1980 as *Lasallea eri.*); Kent Co., *S 2473* WAT (Semple and Brouillet 1980 as *Lasallea e.*); Lambton Co., *S 2465* WAT (Semple and Brouillet 1980 as *Lasallea eri.*); Lennox and Addington Co., *S2051* WAT (Semple 1976 as *A. eri.*); Waterloo R.M., *S & Chmielewski 9094* WAT (Semple et al. 1989 as *Virgulus eri.* var. pan.); York Co., *S et al. 2082* WAT (Semple 1976 as *A. eri.*). U.S.A. **Connecticut**. New London Co., *S & Bt 3596* WAT (Semple and Brouillet 1980 as *Lasallea eri.*) *Semple & Brouillet 3600* WAT (Semple and Brouillet 1980 as *Lasallea eri.*). **Illinois**. St. Clair Co., *S & Suario 9408* WAT (Semple et al. 1993 as *Virgulus eri.* var. *eri.*). **Massachusetts**. Bristol Co., *S & Bt 3575* WAT (Semple and Brouillet 1980 as *Lasallea e.*); Norfolk Co., *S & Bt 3527* WAT (Semple and Brouillet 1980 as *Lasallea eri.*). **Michigan**. Jackson Co., *Van Faasen 279* herb? (Van Faasen 1963 as *A. eri.*). **Minnesota**. Crow Wing Co., *S & Hd 8794* WAT (Semple et al. 1989 as *Virgulus eri.* var. *eri.*); Omstead Co., *S 9053* WAT (Semple et al. 1989 as *Virgulus eri.* var. *eri.*). **New Mexico**. Guadalupe Co., *S & Hd 8090* WAT (Semple et al. 1992 as *Virgulus eri.* var. pan.). **New York**. Greene Co., *S & Bt 3633* WAT (Semple and Brouillet 1980 as *Lasallea eri.*). **Texas**. Dallas Co., *S & Suario 10006* WAT (Semple et al. 1993 as *Virgulus eri.* var. *eri.*); Grimes Co., *S & Suario 10067* WAT (Semple et al. 1993 as *Virgulus eri.* var. *eri.*). **Wisconsin**. Juneau Co. *A. Jones 586* ILL (Jones 1978b as *A. eri.* ssp. *eri.*). Pierce Co., *S & Ch 8855* WAT (Semple et al. 1989 as *V. eri.* var. *eri.*; in error as 8885). — $2n=10+0-3$ supers. U.S.A. **Texas**. Lamar Co., *S & Suario 10001* WAT (Semple et al. 1993 as *Virgulus eri.* var. *eri.*). — $2n=10_{II}$ U.S.A. **Illinois**. *A. Jones 457* ILL (Jones 1978b as *A. eri.* ssp. *eri.*). **Indiana**. Benton Co. *A. Jones 470* ILL (Jones 1978b as *A. eri.* ssp. *eri.*), *A. Jones 471* (Jones 1978 as *A. eri.* ssp. *eri.*), *A. Jones 904* ILL (Jones 1978b as *A. eri.* ssp. *eri.*). — $2n=20$ U.S.A. **Illinois**. Winnebago Co., *S 9048* WAT (Semple et al. 1992 as *Virgulus eri.* var. pan.). **Oklahoma**. *A. Jones 892* ILL (Jones 1978b as *A. eri.* ssp. *eri.*). **South Dakota**. Minnehaha Co., *S & Xiang 10180* WAT (Semple et al. 2001).

Symphyotrichum ericoides (L.) G.L. Nesom var. *pansum* (S.F. Blake) G.L. Nesom — $2n=5_{II}$ CANADA. **British Columbia**. Fraser Valley Dist., *A. Jones 1151* ILL (Jones'78, as *A. eri.* ssp. pan.); Kamloops, *Jones 1159* ILL (Jones 1978b as *A. eri.* ssp. pan.); Medicine Hat Dist., *A. Jones 1202* ILL (Jones 1978), *Jones 1203* ILL (Jones 1978b as *A. eri.* ssp. pan.); W of Brandon, *S & Shea 1907* WAT (Semple 1976 as *A. eri.*); E of Winnipeg, *S & Shea 1905* WAT (Semple 1976 as *A. eri.*, in error as 1909). U.S.A. **Illinois**. Champaign Co. *Jones 204* ILL (Jones 1978 as *A. eri.* ssp. pan.); Mason Co., *A. Jones 884* ILL (Jones 1978 as *A. eri.* ssp. pan.); McLean Co., *Jones 370* ILL (Jones 1978b, as *A. eri.* var. *prostratus*); Piatt Co. *Jones 239* ILL (Jones 1978 *A. eri.* ssp. pan.), *Jones 347* ILL (Jones 1978b as *A. eri.* ssp. pan.), *Jones 364B* (Jones 1978b as *A. eri.* ssp. pan.), *Jones 365* ILL (Jones 1978 as *A. eri.* ssp. pan.). **Iowa**. Polk Co., *Jones 412* ILL (Jones 1978, as *A. eri.* ssp. pan.), *Jones 415* ILL (Jones 1978, as *A. eri.* ssp. pan.). **South Dakota**. Minnehaha Co., *Jones 428* ILL (Jones 1978b as *A. eri.* ssp. pan.). — $2n=10$ CANADA. **Alberta, Alberta**. S of Calgary, *Hart 60* WAT (Semple and Brouillet 1980 as *Lasallea eri.*), E of Grand Prairie, *S & S 10609* WAT (Semple et al. 2001, as var. *eri.*). **British Columbia**. Kamloops, *Chinnappa 853* calgary (Chinnappa and Chmielewski 1987 as *A. eri.*). **Manitoba**. between Delta and Oakland, *Löve & Löve 5198* WIN (Löve and Löve 1964 as *A. pan.*); SE of Lenore, *S & Bt 4192* WAT (Semple 1985 as *Virgulus eri.*); SE of

Ridgeville, *S* 6703 WAT (Semple 1985 as *Virg. eri*). U.S.A. **Arizona**. Yavapai Co., *S* & *Ch* 8995 WAT (Semple et al. 1992 as *V. eri*. var. *pan.*). **Iowa**. Polk Co. A. Jones 413 (Jones 1978b, as *A. eri*. ssp. *pan.*). **Utah**. Uintah Co., *S* & *Ch* 8874 (Semple et al. 1992 as *V. eri*. var. *pan.*). **Wyoming**. Washokie Co., *S* & *Bt* 4445 WAT (Semple 1981 as *Lasallea eri*). — $2n=10+3Bs$. CANADA. **Alberta**. Calgary, *Chinnappa* 449 (Chinnappa and Chmielewski 1987 as *A. eri*). — $2n=10_{II}$ U.S.A. U.S.A. **Colorado**. A. Jones 1045 ILL (Jones 1978 as *A. eri*. var. *pan.*). **Kansas**. Jones 895 ILL (Jones 1978, as *A. eri*. var. *pan.*). **Oklahoma**. Jones 894 ILL (Jones 1978b as *A. eri*. var. *pan.*). **Wyoming**. Johnson Co., *S* & *Xiang* 10197 WAT (Semple et al. 2001 as *V. falcatum*)

Symphyotrichum falcatum (Lindl. in Hook.) var. *commutatum* (Torr. & A. Gray) G.L. Nesom — $2n=10_{II}$ U.S.A. US **Arizona**. Coconino Co., *Windham* 82-3 ASC (Windham and Schaak 1983 as *Virgulus fal.* var. *comm.*) **Colorado**. Lincoln Co., *S* & *Hd* 7712 WAT (Semple et al. 1989 as *Virgulus falc.*). **Iowa**. Woodbury Co., Jones 427 ILL (Jones 1978b as *A. fal.* var. *crassulus*). **Minnesota**. Pipestone Co., Jones 450 ILL (Jones 1978 as *A. eri*. var. *crassulus*), Jones 451 ILL (Jones 1978b as *A. fal.* var. *crassulus*). **Nebraska**. Burt Co., Jones 424 ILL (Jones 1978b 1978b as *A. fal.* var. *crassulus*). — $2n=c.10_{II}$ CANADA. **Saskatchewan**. E of Balgonie, *S* & *Shea* 1927 WAT (Semple and Brouillet 1980 as *Lasallea fal.*). U.S.A. **New Mexico**. Rio Arriba Co. *Raven* 20610 NY (Anderson et al. 1974 as *A. fal.* as, $n=9$). — $2n=20$ CANADA. **Manitoba**. Delta, *Löve* & *Löve* 6207 herb.? (Löve and Löve 1982 as *Virgulus falc.*). **Saskatchewan**. W of Kandahar, near Big Quill Lake, *S* & *Bt* 4234 (Semple 1981 as *Lasallea fal.*). U.S.A. **North Dakota**. Richland Co., *D. Schwert* 14 WAT (Semple and Brouillet 1980 as *Lasallea fal.*). — $2n=15_{II}$ CANADA. **Alberta**. Jones 1178 ILL (Jones 1978b as *A. fal.* var. *comm.*); Medicine Hat Dist., Jones 1203a ILL (Jones 1978b as as *A. fal.* var. *comm.*), Jones 1194 ILL (Jones 1978b as *A. fal.* var. *com.*). U.S.A. **Montana**. Blaine Co., Jones 1208 ILL (Jones 1978b as *A. fal.* var. *com.*). **New Mexico**. McKinley Co., *Spellenberg* & *Ward* 6195 NY (Ward 1983 as *A. fal.* var. *comm.*). **Wyoming**. Albany Co., Jones 1082 ILL (Jones 1978 as *A. fal.* var. *com.*). — $2n=30$ CANADA. **Alberta**. Midland Prov. Park, *S* 10642 WAT (Semple et al. 2001). U.S.A. **Colorado**. Boulder Co. E of Lyons, *Semple et al* 5815 WAT (Semple et al. 1992). **Montana**. Broadwater Co., *S* & *Xiang* 10318 WAT (Semple et al. 2001); Gallatin Co., *S* & *Xiang* 10242 WAT (Semple et al. 2001). **Wyoming**. Carbon Co., *S* & *Zhang* 10411 WAT (Semple et al. 2001); *S* & *Xiang* 10200 WAT (Semple et al. 2001), *S* & *Xiang* 10203 WAT (Semple et al. 2001); Washakie Co., *S* & *Xiang* 10223 WAT (Semple et al. 2001). — $2n=c.20_{II}$ CANADA. **Manitoba** Hargrove, *S* & *Shea* 1913 WAT (Semple and Brouillet 1980 as *Lasallea fal.*)

Symphyotrichum falcatum (Lindl. in Hook.) G.L. Nesom var. *falcatum* — $2n=10$ CANADA. Northwest Territory. Fort Simpson, *S* & *R. Cli-Michaud* 11174 WAT (Semple et al. 2019). U.S.A. **Arizona**. Yavapai Co., *S* & *Ch* 8995 WAT (Semple et al. 1992 as as *Virgulus eri*. var. *pan.*); **New Mexico**. Grant Co., *S* & *Ch* 9040 WAT (Semple et al. 1989 as *Virg. eri*. var. *pan.*). — $2n=30$ CANADA. **Alberta**. N of Drumheller, *S* 10643 WAT (Semple et al. 2002).

Appendix 2. Previously unreported chromosome number determinations in *Symphyotrichum ericoides* and *S. falcatum* from Canada and the United States; all vouchers in WAT in MT unless otherwise indicated; *Br* = R. Brammall, *Bt* = L. Brouillet; *Ch* = J. Chmielewski; *Hd* = S. Heard, *S* = J.C. Semple; *S* & *S* = J.C. & B. Semple.

Symphyotrichum ericoides (L.) G.L. Nesom var. *ericoides* — $2n=10$ CANADA. **Ontario**. Essex Co., *S* of Windsor, *S et al.* 6789. U.S.A. **Iowa**. Guthrie Co. W of Dexter, *S* & *Bt* 4509; Kossuth Co. W of Wesley, *S* & *Ch* 5160. **Illinois**. Adams Co., W of Paloma, *S* & *Bt* 7375; Livingston Co. E of Forrest, *S* & *Bt* 7388. **Indiana**. Porter Co., W of Beverly Shores, *S* & *Bt* 4519. **Kansas**. Atchison Co. S of Atchison, *S* & *Ch* 5237. **Michigan**. Delta Co., E of Bark River, *S* & *Ch* 5026; Oakland Co., Orion, *Ch* & *Hart* 1017; St. Clair Co., E of Goodells, *Ch* & *Hart* 1021; Wayne Co. W of Dearborn, *Ch* & *Hart* 906. **Minnesota**. Jackson Co.

S of Windam, *S & Ch* 5145; Murray Co. N of Avoca, *S & Ch* 5140. **Missouri**. Harrison Co. Bethany, *S & Ch* 5228, E of Bethany, *S & Ch* 5226; Moniteau Co. E of California, *S & Ch* 5299; Pike Co. E of Bowling Green, *S & Ch* 5312; Putnam Co., E of Unionville, *S & Ch* 5218, *S & Ch* 5220. **North Dakota**. Stutsman Co., N of Buchanan, *S et al.* 6679; Walsh Co. Grafton, *S et al.* 6698. **Oklahoma**. Johnston Co., OK-7 3.7 km W of Reagan, *S & Hd* 8255. **South Dakota**. Campbell Co., S of Mound City, *S et al.* 6664; Haakon Co. W of Midland, *S et al.* 6647. **Texas**. Hamilton Co., S of Hamilton, *S & Ch* 6454. **Wisconsin**. Adams Co. WI-73, w of county line, *S & Ch* 5053; Iowa Co., *S & Ch* 5192; Jackson Co., E of Osseo, *S & Ch* 5068; Marathon Co., WI-34 at Eu Pleine River, *S & Ch* 5047; Pepin Co., Durand, *S & Ch* 5075. — $2n=10_{II}$ U.S.A. **Nebraska**. Johnson Co. W of Crab Orchard, *S & Bt* 7351; Lancaster Co. E of Waverly, I-80 c. 4 km E of US-6, *S & Hd* 7695. — $2n=20$ U.S.A. **Nebraska**. Cherry Co., E of Gordon, *S & Bt* 4486. Lincoln Co. North Platte, *S* 6527; Nemaha Co., W of Auburn, *S & Bt* 7356; Thayer Co. US-136 W of US-281, *S & Bt* 7344; Webster Co. S of Red Cloud, *S & Bt* 7338.

Symphotrichum ericoides (L.) G.L. Nesom var. *pansum* (S.F. Blake) G.L. Nesom — $2n=5_{II}$ CANADA. **Alberta**. Jasper Nat'l Pk., AB-16 6.3 mi W of Pochontas, 0.3 mi W of Jasper House Historic Site, *S & Bt* 4341. **Manitoba**. near Dacotah, TransCanada Hwy, 1.3 mi E of MB-322, *S & Bt* 4162. **Ontario**. Rainy River Dist., W of Barwick, *S & Bt* 4133. U.S.A. **Arizona**. Apache Co., E of McNary along AZ 260 in the White Mountains, *Windham* 2528 (NY); Coconino Co., N of Clints Well along Forest Route 211 near Bushy Knoll, *Windham* 97-212 (BALT, UT), E of Flagstaff near Mormon Lake at turnoff to Kinnickinick Lake, *Windham* 97-214 (DUKE, MO, UT), SSW of Flagstaff, confluence of Pumphouse and Fry Canyons, *Windham* 96-262 (UT), along U.S. 89A at head of Oak Creek Canyon, *Windham* 96-264 (DUKE, UT), SW of Flagstaff on ridge above Phone Booth Tank, *Windham* 97-218 (DUKE, NY, UT), along road near S edge of Rogers Lake, *Windham* 97-220 (DUKE, MO, UC, UTSE), SE of Happy Jack along Forest Route 294 near Landmark Mtn., *Windham* 96-274 (UT), N of Jacob Lake along U.S. 89A on Kaibab Plateau, *Windham et al.* 96-295 (UT), along Interstate 17 near head of Pine Tank Canyon, *Windham* 96-270 (UT), AZ-87 NE of Strawberry, *S & Hd* 7917, along AZ 260 near head of Horsetank Wash, *Windham* 2894 (MO, UT), SE of Williams along road at base of White Horse Knoll, *Windham* 96-259 (UT as var. *stricticaule*), W of Williams along Cataract Lake Rd. near Cataract Lake, *Windham* 96-254 (UT as var. *stricticaule*); Gila Co., SE of Christopher Creek along AZ 260 at base of Mogollon Rim, *Windham* 98-356 (COLO as var. *stricticaule*); Navajo Co., SW of Heber along AZ 260 at head of Little Wildcat Canyon, *Windham* 98-354 (UT as var. *stricticaule*); Yavapai Co., SSW of Jerome on Mingus Mountain at head of Burnt Canyon, *Windham* 98-372 (DUKE, UT), SW side of Foxboro Lake along Schnebly Hill Rd., *Windham* 91-300 (BRY); Yavapai Co., SSW of Jerome on Mingus Mountain at head of Burnt Canyon, *Windham* 98-372 (DUKE, UT). **Nebraska**. Hall Co., near rest area on I-80 near road to Juniata and Alda, *S & Hd* 7697. **New Mexico**. Catron Co., S of Luna along U.S. 180 in the San Francisco Mts., *Windham* 2818 (UT), WNW of Luna along U.S. 180 on ridge above San Francisco River, *Windham* 2819 (MO, UT); McKinley Co., S of Fort Wingate along NM 400 at NW end of Zuni Mountains, *Windham* 2553 (NY, UT). **Oklahoma**. Commanche Co., W of Lawton, *S & Hd* 8238. **Texas**. Cottle Co. US-83 N of Paducah, *S & Hd* 8233; Kent Co.: TX-208 N of Snyder, Scurry Co. line, *S & H* 8226. — $2n=5_{II}+1_{I}$ super. U.S.A. **Texas**. Stonewall Co., N of Aspenmont, *S & Hd* 8230. — $2n=10$ CANADA. **Alberta**. Calgary, *Chinnappa* CC3746 UAC; W of Mannville, *S & Bt* 4281. **British Columbia**. S of Brisco, *Ch* CC4896; N of Windermere Lake, *S & Bt* 4360; N of Wasa, *S & Bt* 4372. **Manitoba**, MB-83 3.5 mi S of Birtle, 0.1 mi S of MB-568, *S & Bt* 4198. **Saskatchewan**, Elstow, *S & Bt* 4239; W of Kandahar, *S & Bt* 4235. U.S.A. **Arizona**. Cochise Co. AZ-181, W of Chiricahua Nat'l Monument, *S & Ch* 9032; Coconino Co., S of Flagstaff at 144 Nakai Trail in Kachina Village, *Windham* 96-240 (ARIZ, ASU, BRY, CPH, DUKE, MO, NLU, NY, UT, UW; as var. *stricticaule*). **Idaho**, Lewis Co., S of Kamiah, *S & Bt* 4400. **Montana**. Meagher Co., Bair Reservoir, *S & Bt* 7001; Rosebud Co., SE of Vananda, *S & Bt* 6985; Stillwater Co., S of Absarokee, *S & Bt* 4429. **New Mexico**. Sierra Co. Kingston, *S & Ch* 9041. **North Dakota**. Emmons Co., N of Linton, *S et al* 6665; Stark Co., E of Gladstone, *S & Bt* 6971. **Texas**. Erath Co., S of Morgan Mill, *S & Ch* 6457; Milam Co. E of Rockdale, *S & Ch* 6444. **Utah**. Washington Co., E of New Harmony along road at edge of cemetery, *Windham* 97-346 (DUKE). **Wisconsin**. Jackson Co., Jackson, *S & Ch* 5148. **Wyoming**. Big Horn Co., S of Greybull, *S & Bt* 4442. Washakie Co., Ten Sleep, WY-31 at Nowood R., N end of town, *S & B.* Semple 11291. — $2n=5_{II}+1_{I}$ super. U.S.A. **Texas**. Stonewall Co. N of Aspenmont, *S & Heard* 8230. — $2n=6_{II}$. U.S.A. **Arizona**. Coconino Co., ENE of Sedona along Schnebly Hill Road at Foxboro Lake, *Windham* 96-243 (UT). — $2n=10$ U.S.A. **Wisconsin**. Crawford Co., S of Prairie du Chien, *S & Ch* 5185. — $2n=10+2$ super. U.S.A. **North Dakota**. Golden Valley Co. near Buffalo Gap, *S & Bt* 6976. — $2n=15$ U.S.A.

Wyoming. Fremont Co. E of Lander, *S & Bt* 7226. — $2n=20$ CANADA. **Saskatchewan.** NW of Springside, *S & Bt* 4222-A; SE of Bredenbury, *S & Bt* 4211. U.S.A. **Colorado.** Bent Co. US-50 E of co. line, *S & Bt* 7291; Pueblo Co. E of Avondale, *S & Bt* 7284; Sedgwick Co. S of Sedgwick, *S et al* 6531. **Kansas.** Barton Co. S of Russell, *S & Bt* 7322; Russell Co., N of Saline River, *S & Bt* 7325. **Minnesota.** Lincoln Co. S of Lake Benton, *S & Ch* 5127; Stearns Co., W of Belgrade, *S & Ch* 5090; Wilkins Co., W of Nashua, *S & Ch* 5109. **Nebraska.** Holt Co. US-20 at Willow Swamp Creek, *S & Bt* 4497, N of Ruidosa, *S & H* 8146. **New Mexico.** Mora Co. NM-3 SW edge of Holman, *S & Hd* 8075; Otero Co., SW of Ruidoso, US-70 at junct. of Reservation Rd. #4, *S & Hd* 8050; Rio Arriba Co. N of Chimayo, NM-68 3.8 km S of Velarde, *S & Hd* 8051. **North Dakota.** Eddy Co. S of Sheyenne, *S et al* 6682; Richland Co. E of Fairmont, *S & Ch* 5112. **South Dakota.** Marshall Co., E of Britton, *S, & Ch* 5118. — $2n=20+2$ super. U.S.A. **Oklahoma.** Tillman Co. S of Manitou, *S & Ch* 6467. — $2n=30$ U.S.A. **Colorado.** Teller Co., E of Florissant, *S & Bt* 7263. **New Mexico.** Taos Co., NM-3 12.5 km SE of Rachos De Taos, *S & Hd* 8057. **Montana.** Custer Co. E of Miles City, *S & Bt* 6979. Glacier Co., US-2 2 km E of Browning, *S & B. Semple* 11384; Judith Basin Co., US-87/MT-200 6.7 km SE of Stanford, *S & B. Semple* 11392; Wheatland Co., W of Shawmut, *S & Bt* 6995. **Wyoming.** Albany Co., E of Centennial, *S & Bt* 7241; Carbon Co. W of Ryan Park, WY-130 E of WY-230, *S & Bt* 7233; Crook Co. E of Sundance, US-14 right of way at I-90 exit, *S & Xiang* 10190; Niobrara Co. N of Lusk, *S et al* 6626; Weston Co.. W of Newcastle, US-16 7.1 km E of US-85, edge of Black Hills, *S & B. Semple* 11296. — $2n=35$ U.S.A. **Montana.** Broadwater Co. E of Townsend, *S & Bt* 7012.

Symphyotrichum falcatum (Lindl. in Hook.) var. *commutatum* (Torr. & A. Gray) Semple — $2n=10$ U.S.A. **Arizona.** Navajo Co. SW of Show Low, *S & Ch* 9025; Yavapai Co. AZ-279 28 km E of Camp Verde, *S & Ch* 9015. Wisconsin. **Nebraska.** Rock Co. W of Newport, *S & Bt* 4493. — $2n=10_{II}$ CANADA. **Saskatchewan.** W of *S & Bt* 4251. U.S.A. **Colorado.** Montezuma Co., 10 mi E and 0.5 mi S of Cortez, *S & B. Semple* 5526; Logan Co., E of Proctor, *S et al* 5836. — $2n=20$ CANADA. **Saskatchewan.** SE of Bredenbury, *S & Bt* 4211; NW of Springside, *S & Bt* 4222-A. U.S.A. CO. Bent Co., US-50 E of co. line, *S & Bt* 7291; Sedgwick Co., S of Sedgwick, *S et al* 6531. **Minnesota.** Jackson Co., Jackson, *S & Ch* 5149. **Nebraska.** Brown Co. US-20, e of county line, *S & Bt* 4488. **New Mexico.** Lincoln Co., N of Ruidosa, *S & Hd* 8146; Mora Co. NM-3 SW edge of Holman, *S & Hd* 8075; Otero Co. SW of Ruidoso, US-70 at junct. of Reservation Rd. #4, *S & Heard* 8150. **North Dakota.** Morton Co. Sweet Briar Lake, *S & Bt* 6963; Richland Co. E of Fairmont, *S & Ch* 5112. **Oklahoma.** Cotton Co. W of Randlett, *S & Ch* 6464; Tillman Co. S of Manitou, *S & Ch* 6468. **Texas.** Childress Co. TX-256 W of US-83, *S & Ch* 6469; Potter Co. TX-1061, NW of TX-2381, *S & Ch* 6477. — $2n=15_{II}$ U.S.A. **Arizona.** Coconino Co., S of Flagstaff along Interstate 17 near Kachina Village exit, *Windham* 96-221 (ASU, COLO, NY). **Colorado.** Yuma Co. US-385 just S of US-34, *S & Hd* 7707. **New Mexico.** Sandoval Co., NNE of Jemez Springs along NM 4 in Cañon de San Diego, *Windham* 2612 (UT). **Utah.** Kane Co., N of Glendale along U.S. 89 near East Fork of the Virgin River, *Windham* 97-236 (BRIT, DUKE, MO, NY, UT; as var *crassulum*), US-89alt just S of Kanab by Victory Baptist Church, *S & Hd* 7883. — $2n=15_{II} + 1$ super. U.S.A. **Arizona.** Coconino Co., W of Williams along Cataract Lake Rd. near Cataract Lake. *Windham* 96-253 (MO, UT; ; as var *crassulum*). — $2n=30$ CANADA. **Alberta.** N of Drumheller, Midland Prov. Park, *S* 10641. U.S.A. **Colorado.** Boulder Co. E of Lyons, *S et al* 5815; Logan Co. E of Proctor, *S et al* 5836, 5837; Teller Co., E of Florissant, *S & Bt* 7263. **Montana.** Custer Co. E of Miles City, *S & Bt* 6979; Glacier Co., US-2 2 km E of Browning, *S & B. Semple* 11384; Judith Basin Co., US-87/MT-200 6.7 km SE of Stanford, *S & B. Semple* 11392; Meagher Co. US-12, Bair Reservoir rest area, *S & Bt* 6999; Wheatland Co. W of Shawmut, *S & Bt* 6995. **North Dakota.** Benson Co. W of Ft. Totem, *S et al* 6685; Stark Co., E of Gladstone, *S & Bt* 6972. **New Mexico.** Taos Co. NM-3 12.5 km SE of Rachos De Taos, *S & Hd* 8057. **South Dakota.** Custer Co. US-16 6.5 mi SE of Wyo. state line, W of Custer, *S & Bt* 4471; Haakon Co. W of Midland, *S & B. Semple* 6648. **Wyoming.** Albany Co., E of Centennial, *S & Bt* 7241; Carbon Co., W of Ryan Park, WY-130 E of WY-230, *S & Bt* 7233; Crook Co., E of Sundance, US-14 right of way at I-90 exit, *S & Xiang* 10190; Niobrara Co., N of Lusk, *S et al* 6626; Weston Co., W of Newcastle, US-16 7.1 km E of US-85, edge of Black Hills, *S & B. Semple* 11296, US-16 SE of county line, *S & Bt* 4457. — $2n=35$ U.S.A. **Montana.** Broadwater Co. E of Townsend, *S & Bt* 7012.

Symphyotrichum falcatum (Lindl. in Hook.) G.L. Nesom var. *falcatum* — $2n=10$ US AZ. Gila Co. AZ-260 40 Km E of Payson, *S & Ch* 9019.