

**Table S1.** Population used for morphological traits

Population No.	Latitude	Longitude	Phenotype identification	Molecular Identification	Ploidy
Introduced range					
CN01	31.13	121.19	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN02	31.15	121.38	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
CN04	32.03	118.49	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN05	32.11	118.83	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN06	32.09	118.89	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN07	32.30	119.53	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN09	31.49	120.45	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN10	32.02	120.58	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN11	31.93	121.13	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN12	31.53	120.15	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN13	31.50	120.07	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN14	31.02	120.38	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN15	31.22	121.04	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN16	31.49	120.42	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN17	34.44	119.24	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
CN18	31.93	120.02	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN20	32.09	119.24	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN21	32.13	119.33	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN22	33.97	118.31	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN23	33.33	120.15	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN24	34.31	117.21	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN25	31.83	120.27	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN26	33.18	120.35	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN27	27.47	120.37	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN28	29.06	119.39	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN29	30.45	120.44	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN30	29.05	121.37	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN31	30.18	120.19	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN32	30.16	120.13	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
CN33	28.62	119.30	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN34	28.57	121.31	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN35	28.95	118.87	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN36	29.99	120.54	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN38	30.88	120.17	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN39	30.56	117.48	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN40	29.52	121.37	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN41	32.55	117.22	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN42	31.47	117.18	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN43	32.40	117.04	<i>S. canadensis</i>	<i>S. canadensis</i>	6x

CN44	31.22	118.22	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN45	30.25	116.39	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN46	30.70	118.91	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN47	31.59	116.52	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN48	29.74	116.04	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN49	28.73	115.88	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN50	29.35	117.19	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN53	29.35	113.09	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN54	27.85	113.10	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN55	27.10	112.88	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN56	28.26	113.05	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN58	30.74	111.25	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN59	31.62	111.17	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN60	34.79	113.56	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN61	27.73	118.01	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
CN62	25.62	110.65	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
CN64	31.47	120.25	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN65	32.11	118.88	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
CN69	31.97	120.64	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
RUS01	43.12	131.89	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
EU01	6.76	51.43	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
EU02	7.46	51.37	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
EU03	7.46	51.37	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
EU09	2.12	48.81	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
EU10	13.37	52.51	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
EU11	12.49	41.89	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
EU12	11.27	43.78	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
EU13	16.38	48.19	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
EU14	7.53	47.02	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
EU15	7.75	47.22	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
JP01	36.23.59	140.40.29	<i>S. altissima</i>	<i>S. canadensis</i>	6x
JP02	36.27.59	140.39.29	<i>S. altissima</i>	<i>S. canadensis</i>	6x
JP03	36.37.08	140.20.07	<i>S. altissima</i>	<i>S. canadensis</i>	6x
JP04	36.34.92	140.20.52	<i>S. altissima</i>	<i>S. canadensis</i>	6x
JP05	36.33.49	140.51.80	<i>S. altissima</i>	<i>S. canadensis</i>	6x
Cultivated <i>S.canadensis</i> in China					
LYG	34.60	119.18	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
NJ	32.08	118.79	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
YN	25.07	102.76	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
Native range					
CA09	45.50	-75.80	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
CA13	46.31	-72.65	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
CA14	46.76	-71.29	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
US02	34.25	-79.70	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x

US03	34.23	-77.83	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US04	37.80	-81.22	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US06	38.35	-81.65	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US07	37.15	-79.23	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US08	36.97	-81.07	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
US09	36.18	-84.07	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
US10	35.05	-84.90	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US12	40.24	-76.80	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US13	41.08	-75.96	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US14	41.38	-75.03	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US23	41.42	-73.34	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US25	41.49	-71.54	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US27	42.45	-71.24	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US28	43.03	-73.79	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US29	43.14	-77.67	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US30	43.09	-79.00	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US31	42.47	79.32	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US34	42.92	87.94	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US35	39.10	84.28	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US36	39.89	84.17	<i>S. canadensis</i>	<i>S. canadensis</i>	6x
US40	39.47	82.31	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US20	42.05	-80.08	<i>S. altissima</i>	<i>S. canadensis</i>	6x
US33	43.17	-85.63	<i>S. altissima</i>	<i>S. canadensis</i>	6x
US52	43.64	73.24	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US53	43.98	72.63	<i>S. canadensis</i>	<i>S. canadensis</i>	2x
US54	43.94	72.63	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US45	40.47	-86.93	<i>S. altissima</i>	<i>S. canadensis</i>	6x
US58	44.95	92.93	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
US59	45.54	94.27	<i>S. canadensis</i>	<i>S. canadensis</i>	4x/6x
US60	45.61	95.88	<i>S. canadensis</i>	<i>S. canadensis</i>	4x
Closely related species					
US18	41.37	-75.06	<i>S. gigantea</i>	<i>S. gigantea</i>	
US51	43.35	-73.68	<i>S. gigantea</i>	<i>S. gigantea</i>	
US57	45.86	-96.73	<i>S. gigantea</i>	<i>S. gigantea</i>	
SS	45.50	-75.80	<i>S. simplex</i>	<i>S. simplex</i>	
SD	32.12	118.35	<i>S. decurrens</i>	<i>S. decurrens</i>	

Note: Blue represents Europe populations; green represents populations identified previously as *S. altissima*.

**Table S2.** List of distinct localities of *S. canadensis* and *S. altissima* with previously published ploidy level determination.

	Diploid	Tetraploid	Hexaploid
<b>Native rang (North America)</b>	359*	93	294
Abhilasha, D. et al. (2008)	4	2	0
Beaudry, J. R. & Chabot, D. L. (1959)	12	0	7
Beaudry, J. R. (1968)	10	0	0
Beaudry, J. R. & Chabot, D. L. (1957)	1	0	0
Beaudry, J. R. (1970)	3	0	0
Calder, J. A (1968)	0	1	0
Chinnappa, C. C. & Chmielewski, J. G. (1987)	1	0	0
Halverson, K. et al. (2008)	159	62	115
Keil, D. J. & Pinkava, D. J. et al. (1979)	1	0	0
Kapoor, B. M. (1970)	1	0	0
Kapoor, B. M. (1978)	2	0	0
Löve, Á. & Löve, D (1982)	2	0	0
Melville, M. R. & Mortorn, J. K. (1982)	98	0	82
Pringle, J. S. (1979)	1	0	0
Raven, P. H. et al. (1960)	0	0	1
Semple, J. C. et al. (1984)	2	7	12
Semple, J. C. et al. (1989)	16	2	2
Semple, J. C. & Chmielewski, J. G. (1987)	3	7	2
Semple, J. C. (1985)	3	2	6
Semple, J. C. et al. (1992)	1	3	2
Semple, J. C. et al. (1993)	2	2	0
Semple, J. C. et al. (2001)	4	5	9
Semple, J. C. & Cook (2004)	5	0	0
Tomkins D. J. & Grant, W. F. (1978)	8	0	0
van Kleunen, M. & Schmid, B. (2003)	17	0	51
Ward, D. E. & Spellenberg, R. W. (1986)	3	0	3
Ward, D. E. & Spellenberg, R. W. (1988)	0	0	2
<b>Introduced range</b>	150	0	2
Switzerland (Abhilasha, D. et al. 2008; van Kleunen, M. & Schmid, B.,2003)	26	0	0
Poland (Malecka J.1988, Malecka J 1978, Musial, K.1989a, Malecka, J.1989b, van Kleunen, M. & Schmid, B. 2003, Morto J. K. et al. 2018, Musiał K. et al. 2020)	78	0	0
Russia (Probatova et al. 2008)	1	0	0
Germany (Cheng et al. 2020a, van Kleunen, M. & Schmid, B. 2003)	19	0	0

Czech Republic (van Kleunen, M. & Schmid, B. 2003)	8	0	0
France (van Kleunen, M. & Schmid, B. 2003)	8	0	0
Austria (van Kleunen, M. & Schmid, B. 2003)	8	0	0
Belgium (Verloove F. et al. 2017)	0	0	1
Holand (Xu H Q 2016)	1	0	0
UK (Semple J. C 2004)	1	0	0
India (Sarkar, A. K. et al.1980)	0	0	1

Note: Part of the literature does not explicitly mention the number of diploid plants, so the number was the count to one at the collection sites.

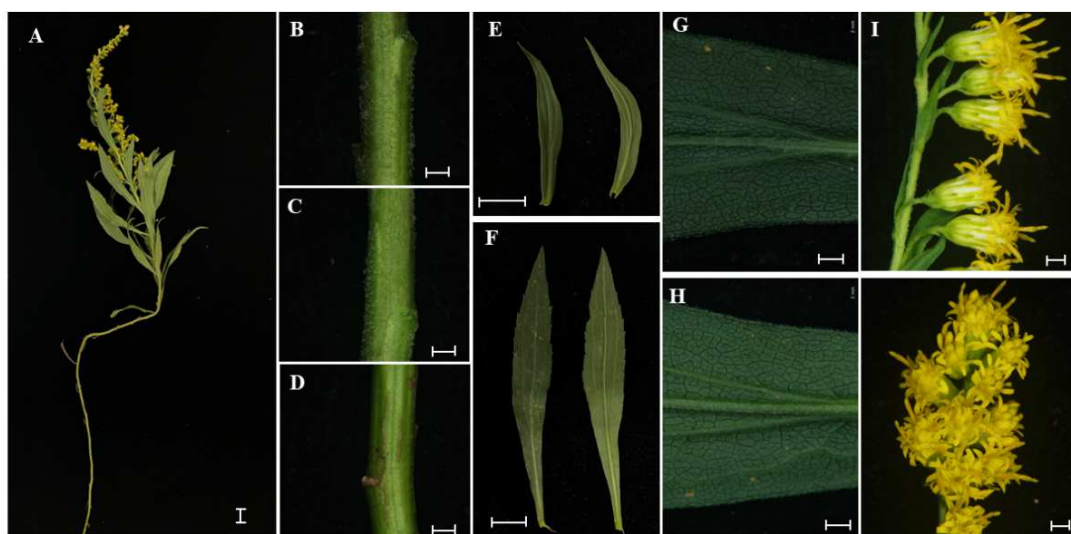
**Table S3.** Test of ITS and *psbA-trnH* intergenic spacer sequences of *Solidago altissima* blasted in NCBI database

Population codes	Accession number from Genebank	Species	Query cover	Homology comparison to <i>S. canadensis</i>	Variable sites
ITS sequences					
JP01-JP04	HQ142590.1	<i>S. canadensis</i>	100%	100%	
US20	HQ142590.1	<i>S. canadensis</i>	100%	100%	
US33	HQ142590.1	<i>S. canadensis</i>	100%	100%	
US45	HQ142590.1	<i>S. canadensis</i>	100%	99.84%	5(C→T)
<i>psbA-trnH</i> intergenic spacer sequences					
JP01-JP04	KX214929.1	<i>S. canadensis</i>	91%	100%	
US20	KX214929.1	<i>S. canadensis</i>	91%	100%	
US33	KX214929.1	<i>S. canadensis</i>	100%	100%	
US45	KX214929.1	<i>S. canadensis</i>	100%	100%	

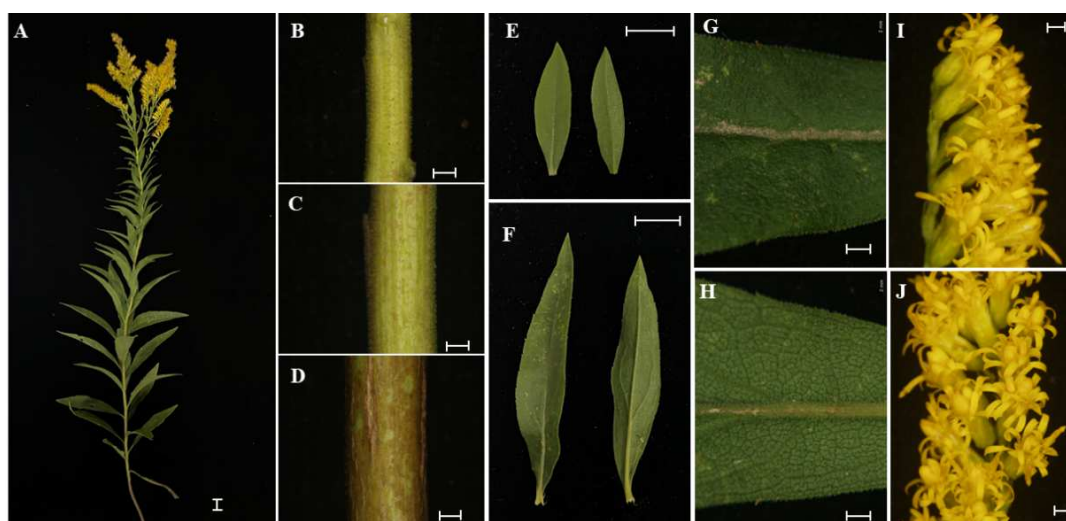
**Table S4.** Flow cytometric ploidy analysis of Europe populations

Population	Ratio of peak positions (Mean± SD)	Number of measurements	Ploidy levels
EU01	1	6	2
EU02	1	6	2
EU03	1	6	2
EU09	2.604±0.055	6	6
EU10	2.623±0.002	6	6
EU11	2.628±0.054	6	6
EU12	2.712±0.065	6	6
EU13	2.671±0.050	6	6
EU14	1	6	2
EU15	1	6	2

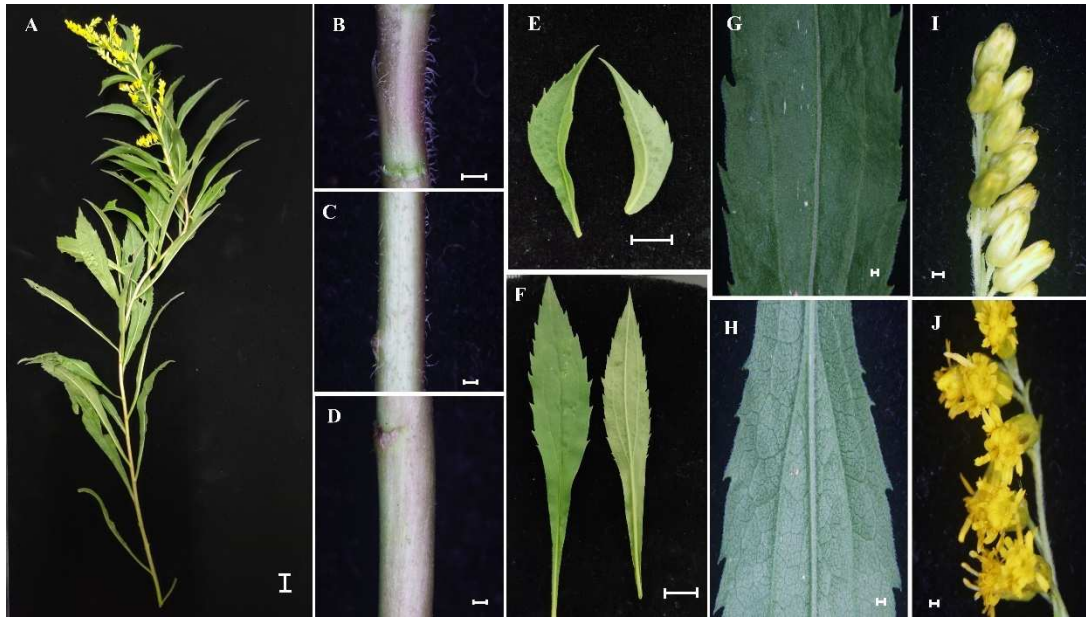
Note: the native diploid population (CA09) used as the internal reference.



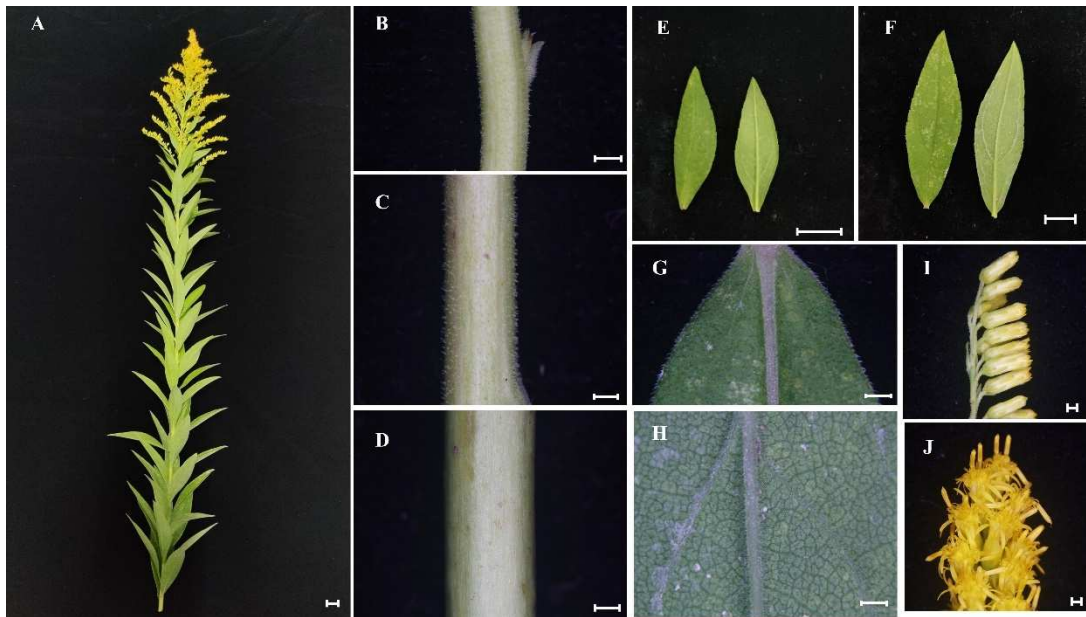
**Figure S1.** Morphology of *S. canadensis* (2x) form Canada. A. Shoot, scale = 1 cm; B-D, upper, middle, lower stem, scale = 2 mm; E-F, upper, lower stem leaves, scale = 1 cm; G-H, upper epidermal veins, lower epidermal veins, scale = 2 mm; I, involucres, scale = 2 mm; J, florets, scale = 2 mm.



**Figure S2.** Morphology of *S. canadensis* (6x) form USA. A. Shoot, scale = 1 cm; B-D, upper, middle, lower stem, scale = 2 mm; E-F, upper, lower stem leaves, scale = 1 cm; G-H, upper epidermal veins, lower epidermal veins, scale = 2 mm; I, involucres, scale = 2 mm; J, florets, scale = 2 mm.



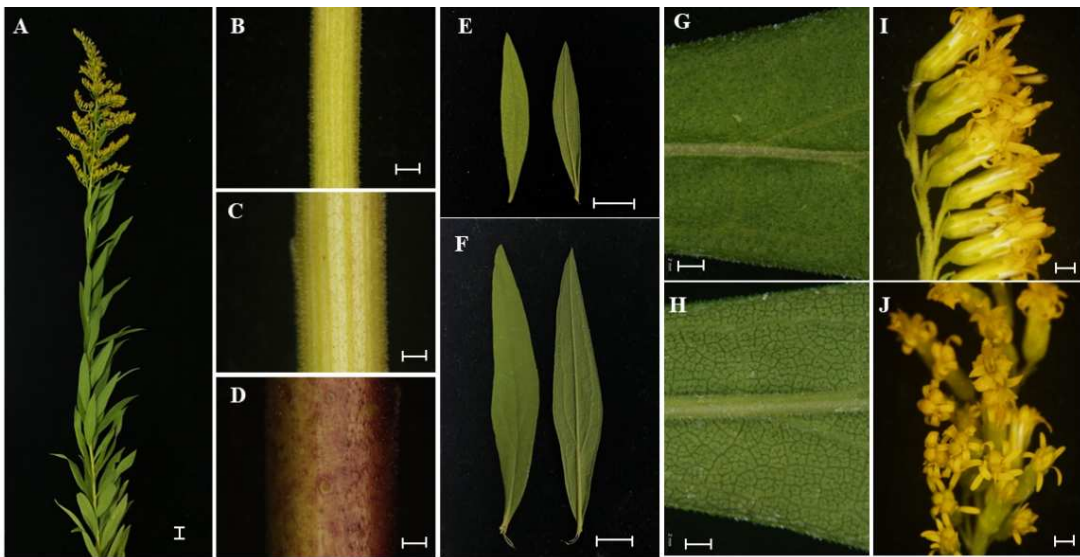
**Figure S3.** Morphology of *S. canadensis* (2x) form Russia. A. Shoot, scale = 1 cm; B-D, upper, middle, lower stem, scale = 2 mm; E-F, upper, lower stem leaves, scale = 1 cm; G-H, upper epidermal veins, lower epidermal veins, scale = 1 mm; I, involucres, scale = 1 mm; J, florets, scale = 1 mm.



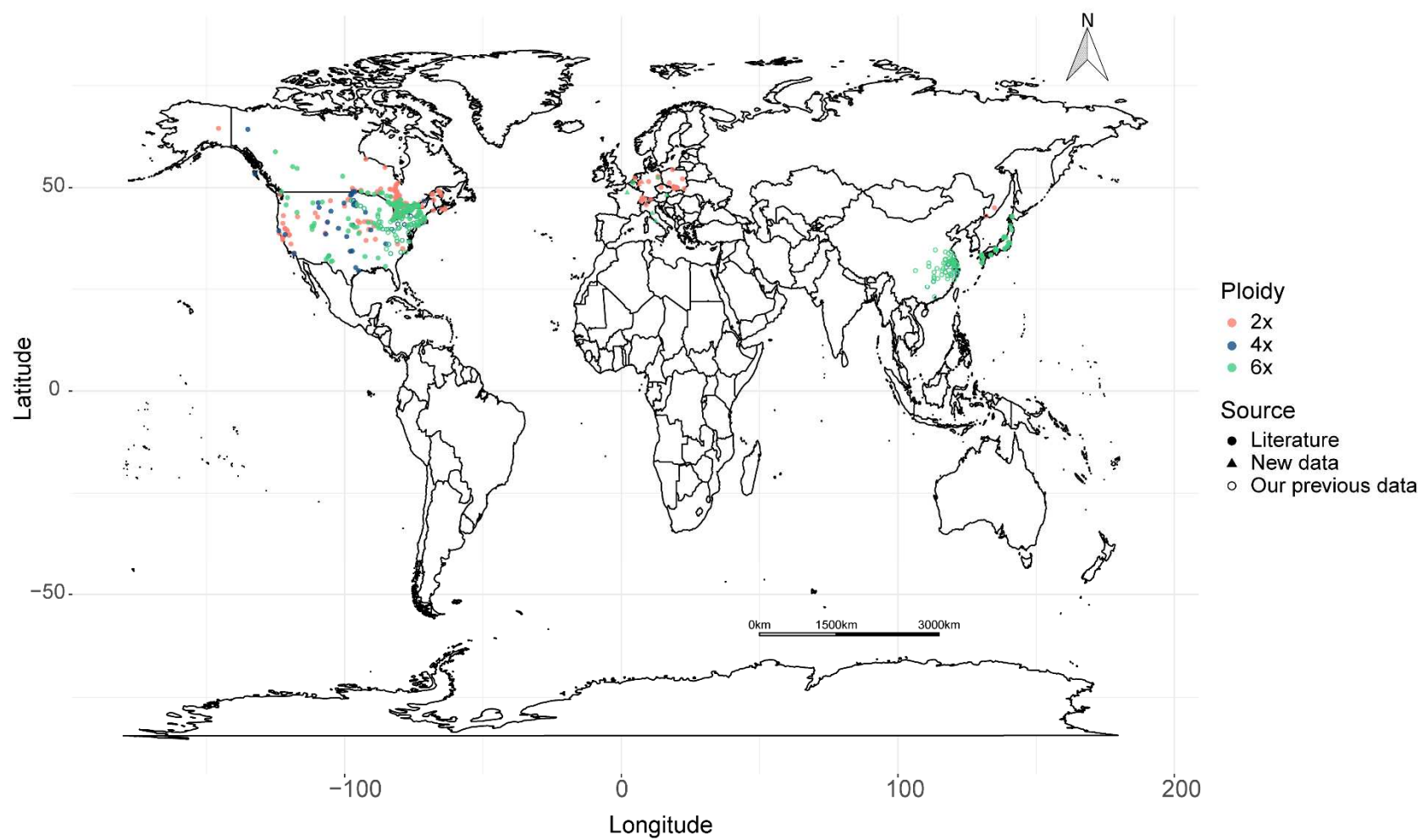
**Figure S4.** Morphology of *S. canadensis* (6x) form China. A. Shoot, scale = 1 cm; B-D, upper, middle, lower stem, scale = 2 mm; E-F, upper, lower stem leaves, scale = 1 cm; G-H, upper epidermal veins, lower epidermal veins, scale = 1 mm; I, involucres, scale = 1 mm; J, florets, scale = 1 mm.



**Figure S5.** Morphology of *S. canadensis* (2x) form Europe. A. Shoot, scale = 1 cm; B-D, upper, middle, lower stem, scale = 2 mm; E-F, upper, lower stem leaves, scale = 1 cm; G-H, upper epidermal veins, lower epidermal veins, scale = 2 mm; I, involucres, scale = 2 mm; J, florets, scale = 2 mm.



**Figure S6.** Morphology of *S. canadensis* (6x) form Europe. A. Shoot, scale = 1 cm; B-D, upper, middle, lower stem, scale = 2 mm; E-F, upper, lower stem leaves, scale = 1 cm; G-H, upper epidermal veins, lower epidermal veins, scale = 2 mm; I, involucres, scale = 2 mm; J, florets, scale = 2 mm.



**Figure S7.** Cytogeography of *S. canadensis* at the Northern Hemisphere. The source of population information was shown in Table S2, our previous data was described in Cheng et al. [6].