A GEOGRAPHIC SUMMARY OF CHROMOSOME NUMBER REPORTS FOR NORTH AMERICAN ASTERS AND GOLDENRODS (ASTERACEAE: ASTEREAE)[1]

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ABSTRACT

A microcomputer system that facilitates record keeping of text-based nomenclatural and cytotaxonomic files is described. The system was used to maintain records on asters and goldenrods. More than 4,800 chromosome number reports for asters (*Aster, Virgulaster, Virgulus*) and over 2,000 reports for goldenrods (*Solidago* excluding *Euthamia*) were analyzed. By far the greatest number of chromosome number reports (2,110) were for Ontario, Canada. The numbers of counts for each taxon (species, subspecies, or variety) for each province or territory in Canada and state in the United States and for all of Mexico were determined. The total number of chromosome number reports and estimated numbers of taxa (species, subspecies, and varieties) of asters and of goldenrods by province, territory, and state were compared and are presented graphically. Both asters and goldenrods achieve their greatest morphological diversity in the eastern United States, peaking in North Carolina. The numbers of counts for asters and goldenrods in each area were fairly highly correlated ($r = 0.70$ excluding Ontario; $r = 0.97$ including Ontario) as were the numbers of taxa counted including Ontario ($r = 0.73$), but the percentages of taxa counted per area were not strongly correlated ($r = 0.49$). Asters show more diversity in western North America than goldenrods, and 86% of the areas had more aster than goldenrod taxa.

My work on various members of the Astereae began under the tutelage of Walter H. Lewis more than two decades ago. Walter's early guidance and inspiration are gratefully acknowledged, and this cytotaxonomic paper is dedicated to him.

Asters and goldenrods are common in many habitats throughout most of North America north of Mexico. *Aster* L. sens. lat. (*Aster* of Jones, 1980a; *Aster, Virgulus* Raf. (synonym: *Lasallea*) and *Virgulaster* Semple of Semple & Brouillet, 1980a, and Semple et al., 1989) are estimated to include about 145 species and more than 225 subspecies and varieties in Canada, the United States, and Mexico. Numerous studies have reported chromosome numbers for many of these taxa (see Semple & Brouillet, 1980b, and additional references cited below). Base numbers of $x = 9$, 8, and 7 occur in *Aster* sens. str. (Semple & Brouillet, 1980a); base numbers of $x = 21$ and 13 occur in *Virgulaster*; and base numbers of $x = 9$, 5, and 4 occur in *Virgulus*. *Aster* sens. lat. includes all of these base numbers (Jones, 1980a, b). *Solidago* L. (excluding *Euthamia* Nutt.) is estimated to include about 90 species and more than 140 subspecies and varieties in Canada, the United States, and Mexico. Chromosome numbers have been reported for most of these taxa (see Semple et al., 1984, and additional references cited below); all taxa have a chromosomal base number of $x = 9$. Polyploidy is common in both asters and goldenrods. More than 6,900 individual chromosome number reports exist for *Aster* sens. lat. and *Solidago* in North America alone. In order to keep track of these reports and to have convenient access to the data, a system of microcomputer hardware and software was assembled. It is described below. Some geographic generalizations about chromosome number reports for asters and goldenrods in North America were arrived at using the system and are presented below.

MATERIALS AND METHODS

HARDWARE

Programs were run on a Waitronics Esprit 386/25 personal computer (8/25 MHz clock speed)

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with a 387/25 math coprocessor, eight megabytes of memory, a 100 megabyte hard drive (15 msec. access time), and a Zenith VGA color monitor. (Waitronics Ltd. (Waterloo, Ontario N2J 2Y9, Canada) is one of a number of local companies assembling microcomputers (IBM clones) that are sold at reduced prices to the University of Waterloo for research purposes.)

SOFTWARE

All software used to tabulate and analyze the chromosome count data were widely available commercial products. The data and word-processing programs were accessed using *DESQview* (Quarterdeck Office Systems, Santa Monica, California 90405, U.S.A.). This memory management program allows the user to run more than one program at a time and to transfer screen data from one program to another regardless of the compatibility of the individual programs. For example, a personal appointment calendar program can be running in the background, while word processing and data entries are being performed in two additional programs.

Raw data were entered into files using *askSam* Version 4.1b (Access Stored Knowledge via Symbolic Access Method; askSam Systems, 1989). Each report was entered as ASCII text without field designation in the following order: taxon (binomial and subspecies or variety if appropriate); chromosome number reported in standardized format (e.g., "2*n*=9II" or "2*n*=18" differentiating meiotic from mitotic reports); country (e.g., "CDN, US, MEXICO"); province, territory, or state (postal code abbreviation, e.g., "ON"); county, regional municipality, parish, or district (e.g., "Waterloo Reg.Mun."); details of location data (e.g., "Hwy-7 4 km W of Kitchener, rdside ditch"); collector and collection number; location of voucher(s) if not WAT; abbreviated publication data including any synonym used (e.g., "Anderson et al.'74, as A. h., as n=32"; in the original publication the report was listed as $n = 32$ under the name *Aster hesperius*), and any miscellaneous comments (e.g., observations about vouchers or a summary(ies) of published comments about the count or voucher, such as corrected identifications). The following are examples of report entries (in quotes and exactly as entered) with explanatory comments in brackets [=] added here but not included in the data file:

1. └A. alpigenus┘ ssp. └alpigenus┘ 2n=36 US CA. Mono Co.: Tioga Pass, 0.25 mi E of Yosemite Nat'l Pk, └S & Hd 8688┘ (TRIBCNTS-3 [= published by Semple et al., 1989], to sp. [= published to species level only, subspecies identification not determined at the time of publication])
2. └A. glaucodes┘ 2n=9II US WY. Albany Co.: Snowy Range, 3 mi NW of Centennial, └Hartman 3045┘ (RM) (Hartman'77)
3. └A. pilosus┘ var. └pilo.┘ [epithets sometimes abbreviated] 2n=32 US AL. Cleburne-Calhoun count line; SE of Anniston, └S & Ch 6305┘ [= collectors, *Semple & Chmielewski*] (PILOGEO-2 [= published by Semple & Chmielewski, 1985], as var. └priceae┘; corrected S, Ch & Lane 1989 [= Semple et al. 1989 noted that the collection on which the 1985 report was based was reidentified as var. *pilosus*])
4. └Sol. rigida┘ ssp. └glabrata┘ cf. 2n=18 US TN. Coffee Co.: Manchester, └JRB [= *J.R. Beaudry*] & DeSelm 57-472┘ (Beaudry'63, as └Sol. jacksonii┘ var. └hum.┘ [= var. *humilis*, which is not a synonym of *S. rigida* ssp. *glabrata*]) UNMAPPED [= location has not been added to unpublished cytogeography map on species because identification was uncertain at time record was added to file]
5. └Sol. simplex┘ ssp. └randii┘ var. └monticola┘ 2n=36 CDN PQ. Mégantic Co.: Black Lake, └JRB [= J.R. Beaudry] & Cinq-Mars 56-433┘ (Beaudry & Chabot'59, as └S. randii┘; R&S'87, as └S. glut. ran.┘ var. └ran.┘ [= *Solidago glutinosa* subsp. *randii* var. *randii*, which is a synonym of *S. simplex* var. *monticola*])

The symbols "└" and "┘" (keyboard characters alt-192 and alt-217, respectively) were inserted to replace non-ASCII printer codes indicating that the enclosed word(s) should be italicized. These conveniently allow specific letters or words to be converted to italics when shifting text between *askSam* and *Wordperfect*. The two symbols can be used as query characters in searching data bases.

Any of the information in a data file can be retrieved using the Query subroutine in *askSam*, and any individual report can be edited at any time. The Query subroutine also can be used to obtain a tally of the reports containing designated search fields (e.g., "└A. lanceolatus┘ {PRINT}"). Boulean searches can also be made (e.g., "└A. lanceolatus┘ var. └lanceolatus┘ {AND} 2n=48 {NOT} CDN ON {TAL}"). Any or all of the data can be transferred directly or indirectly to a word-processing program file (in this case *Wordperfect* version 5.1; Wordperfect Corp., Orem, Utah 84057, U.S.A.) using either a subroutine in *askSam* by saving the results of a Query operation as a new ASCII text file or by using the screen capture option in *DESQview* and performing a direct transfer to an existing file being edited in *Wordperfect*. It is this convenience in searching files and exchanging information between data base programs and word-processing files that makes the system being discussed useful for systematists.

Totals for the number of reports for each taxon obtained from Query operations in *askSam* were entered into a matrix (taxon by political region) prepared using the spreadsheet program *Quattro* (Borland International, Scotts Valley, California 95066, U.S.A.). The total number of counts for each taxon, the total number of counts per political region (country; province, territory, or state), the number of taxa and the number of counted and uncounted taxa for each political region, and a grand total for all count reports were calculated as part of the matrix of 28,890 data fields. The process of filling and editing the *Quattro* matrix was facilitated using the Video and Switch options available in *DESQview*. A 50-lines-of-text screen allowed *askSam* and *Quattro* to be viewed simultaneously. A compiler program could not be used with *askSam*.

Also frequently consulted were *askSam* files on aster and goldenrod nomenclature (approximately 345 kilobytes (Kb) and 200 Kb, respectively) and a literature file. These were necessary for chromosome numbers reported under infrequently used synonyms. Each nomenclature file includes ASCII text data on basionyms, synonyms, types, phylogenetic relationships, excluded taxa, and miscellaneous comments.

DATA BASE

Data on chromosome number reports were obtained from the literature and nearly 600 unpublished reports from studies on certain species complexes being investigated by my laboratory. Data were taken from 121 publications (see references in Semple & Brouillet, 1980b and Semple et al., 1984; and Morinaga & Fukashima, 1931; Higinbotham, 1936; Smith, 1965; Johnson & Packer, 1968; Packer, 1968; Mulligan & Cody, 1971; Kapoor, 1972; Mulligan et al., 1972; Andreasen & Eshbaugh, 1973; Witherspoon et al., 1974; Keil & Stuessy, 1975; Keil & Pinkava, 1976; Hartman, 1977; Kapoor, 1977; Keil & Pinkava, 1977; Jones, 1978; Powell & Powell, 1978; Dawe & Murray, 1979; Morton, 1979; Keil & Pinkava, 1979; Pringle, 1979; Dawe & Murray, 1980; Semple, 1980; Weedin & Powell, 1980; Brouillet & Semple, 1981; Dawe & Murray, 1981; Keil & Pinkava, 1981; Parfitt & Harriman, 1981; Semple, 1981; Semple et al., 1981; Kapoor & Gervais, 1982; Löve & Löve, 1982a, b; Semple, 1982; Semple & Brammall, 1982; Brouillet, 1983; Chmielewski & Semple, 1983; Dean & Chambers, 1983; Hill, 1983; Sherif et al., 1983; Semple et al., 1983a, b; Strother, 1983; Ward, 1983; Windham & Schaack, 1983; Allen, 1984; Hill, 1984; Jones, 1983; Morton, 1984; Mulligan, 1984; Sanderson et al., 1984; Semple, 1984; Allen, 1985; Houle & Brouillet, 1985; Chmielewski & Semple, 1985a, b; Semple, 1985; Semple & Chmielewski, 1985; Chmielewski, 1986; Sundberg, 1986; Sundberg & Dillon, 1986; Ward & Spellenberg, 1986; Brouillet & Labrecque, 1987; Chinnappa & Chmielewski, 1987; Chmielewski, 1987; Chmielewski et al., 1987; Lamboy, 1987; Ringius & Semple, 1987; Semple & Chmielewski, 1987; Vahidy et al., 1987; Heard & Semple, 1988; Lamboy, 1988; Semple, 1988; Campbell & Medley, 1989; Legault & Brouillet, 1989; Nesom, 1989; Semple et al., 1989; Brammall & Semple, 1990; Chmielewski & Semple, 1990; Semple et al., 1990; Semple & Chmielewski, 1991). These data were entered under the taxon name used in the source publication unless the name was known to be a synonym for another name included in the data files. The file on asters had 4,884 records and was about 553 Kb in size at the time of writing, and the goldenrods file had 2,099 records (including non-North American reports) and was about 257 Kb. In some cases, corrections found in later publications were incorporated into the original data base record. The vouchers for the majority of the reports not published by my laboratory were not seen as part of this study. Therefore, the data base may have some biases due to misidentifications. Also, no vouchers are known for some reports, and the original identifications had to be accepted on faith or the reports rejected as unconfirmable.

For certain taxa, a corrected chromosome count and a comment noting this adjustment were included in the data file record. For example, prior to 1978 reports for all members of *Aster* sect. *Dumosi* subsect. *Heterophylli* were published reflecting an assumed chromosomal base number of $x = 9$. Jones (1978) demonstrated that the chromosomal base number for subsect. *Heterophylli* is $x = 8$. Therefore, older published counts of $n = 9$ were entered as "2n=8II cf." in the data matrix, with "as n=9" appended to the publication data. These corrections did not affect the summaries presented in this paper, but could influence other manipulations of the matrix.

In other cases, an "unusual" chromosome number report for a taxa was entered as published, with a comment that further investigation is required. By "unusual" I mean, for example, the one count out of 40 or more that was not in agreement with the other counts for the taxon.

GRAPHICS AND STATISTICS

Maps were prepared using the graphics program *Coreldraw* Version 1.02 (Corel Systems Corporation, 1600 Carling Ave., Ottawa, Ontario K1Z 8R7, Canada), which must be run under *Windows* Version 2 or higher (Microsoft Inc., Redmond, Washington 98073, U.S.A.). Maps were printed using a QMS-PS 810 postscript laser printer.

Pearson correlations were calculated using *SYSTAT* Version 5.0 (SYSTAT, Inc., 1800 Sherman Ave., Evanston, Illinois 60201, U.S.A.).

RESULTS AND DISCUSSION

A total of 6,908 chromosome number reports for asters and goldenrods from Canada, the United States, and Mexico were included in the study (Table 1). The results of the analyses of the data matrix on chromosome number reports and numbers of taxa per political region are presented pictorially in Figures 1–4. The total numbers of reports for each province and territory in Canada, each state in the United States, and all of Mexico are given in Table 1 and Figures 1 and 3 for *Aster* sens. lat. and *Solidago*, respectively. A total of 4,844 reports was entered into the *askSam* data file on asters. Of these, 1,520 were for plants native to Ontario. The next largest numbers of reports were for Oregon, Québec, and Michigan with 194, 144, and 133 reports, respectively. There were more than 100 reports each for California, Colorado, Florida, New York, North Carolina, and Virginia. The lowest number of counts in the United States was from Delaware with only two reports. No count reports were included in the data files for asters from Newfoundland and Labrador, and there was only one report from Prince Edward Island. Two thousand sixty-four reports were entered into the *askSam* data file on goldenrods. Of these, 590 were for plants native to Ontario. The next largest numbers of reports were from Québec, New York, California, and Colorado with 144, 75, 73, and 58 reports, respectively. No other state in the United States had more than 50 reports. No count reports were included in the data files for goldenrods from Prince Edward Island. Only 30 reports for asters and six for goldenrods from Mexico were entered into the files.

Tentative estimates were made of the total number of taxa down to varietal level for each province and territory in Canada, each state in the United States, and for Mexico (Table 1). These are presented graphically for asters and goldenrods in Figures 2 and 4, respectively. Overall, the number of aster taxa and the number of goldenrod taxa for each area correlate rather highly ($r = 0.7$), but the majority of the regions (86%) have more aster than goldenrod taxa (Table 1). The diversity of taxa for asters and goldenrods is greatest in the eastern United States; previously, Cronquist (1955) noted this to be the case for goldenrods. The greatest numbers of species, subspecies, and varieties for both asters and goldenrods occur in North Carolina (56 and 51 estimated, respectively). The fewest taxa occur in Alaska and the far northern areas across Canada. The western part of North America has far fewer goldenrod taxa than the eastern part. However, the pattern for asters is different because several taxon-rich sections and subsections of asters achieve their greatest diversity in the west, unlike any group of goldenrods. The number of taxa along the Pacific coast is high primarily because of the presence of *Aster* sect. *Eucephalus* and *Aster* sect. *Dumosi* subsect. *Foliacei*. Without these two groups, the general pattern of diversity in asters would be quite similar to that in goldenrods.

There was a great range (0% to 90%) among geopolitical regions in the percentage of taxa for which at least one individual's chromosome number had been determined (Table 1; Figs. 2, 4). The mean percentages of taxa from Canada, the United States, and Mexico sampled cytologically were 49.1% for asters and 45.1% for goldenrods. The highest percentages of taxa that were counted were for Manitoba and Ontario: 90% and 75% in the former, and 80% and 83% in the latter for aster and goldenrod taxa, respectively. Percentages were lower in all other provinces and states. In Canada, the numbers of counts and the percentages of taxa counted were lowest in Newfoundland and Prince Edward Island. Thirty-four out of 62 provinces, territories, states, and Mexico (54.8%) had more aster taxa counted than goldenrod taxa, but on average only 4% more aster than goldenrod taxa were counted per area. Generally, the percentages of aster and goldenrod taxa sampled in an area did not correlate strongly ($r = 0.49$). For example, five of the 23 estimated aster taxa for Nevada (22%) versus five of the seven goldenrod taxa

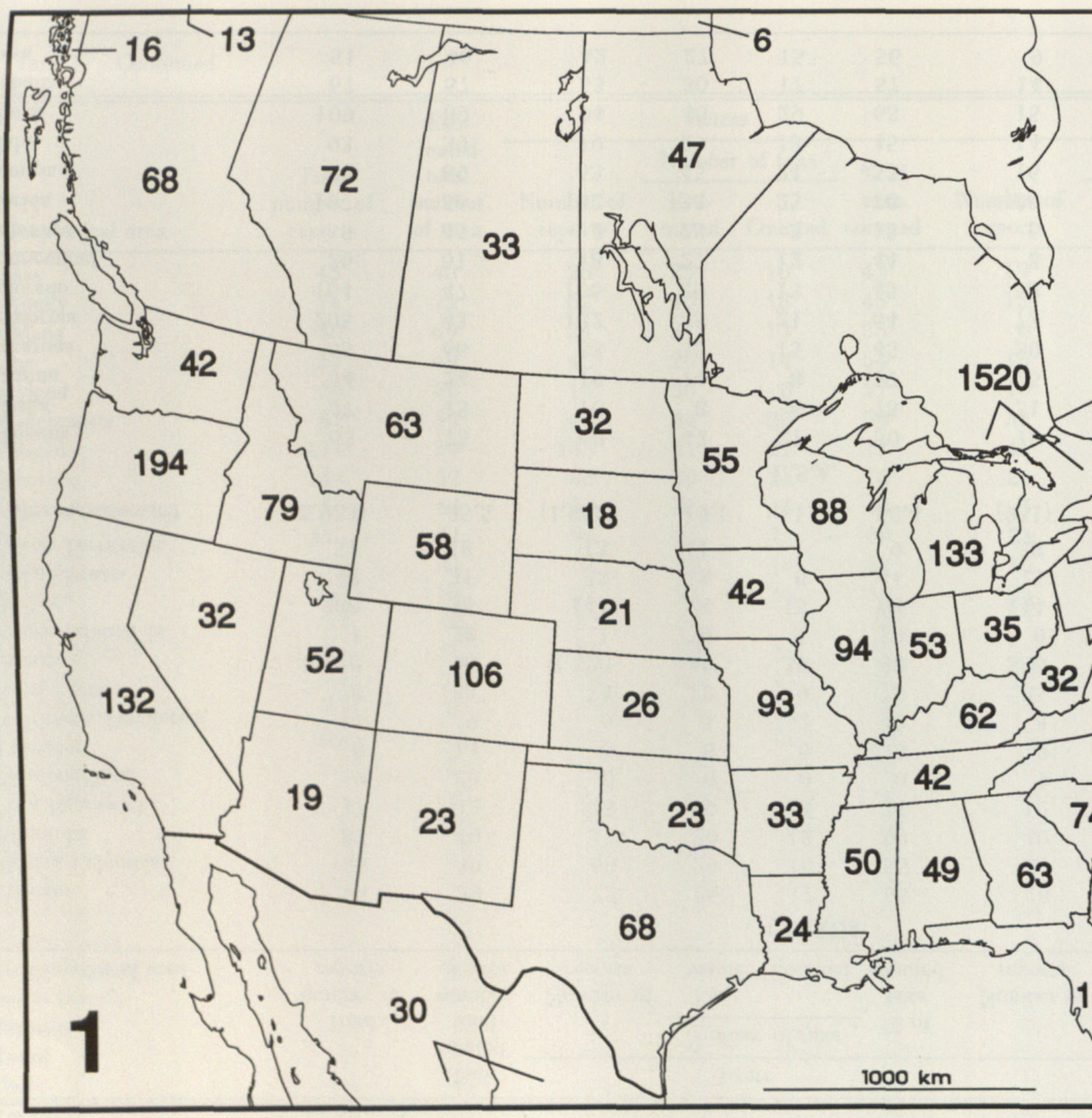

FIGURE 1. Numbers of chromosome number reports for *Aster* sens. lat. (*Aster*, *Virgulaster*, and *Virgulus*) in Canada
Alaska and the Northwest Territories are indicated at the top of the map; Yukon Territory is not included in the map.
Québec, and Mexico, respectively.

TABLE 1. Numbers of chromosome number reports, estimated numbers of taxa (species, subspecies, and varietie
taxa counted for the provinces and territories of Canada, states of the United States, and all of Mexico.

Geopolitical area	Total number of reports	Estimated total number of taxa	Asters: Number of reports	Asters: Number of taxa: Estimated	Asters: Number of taxa: Counted	Asters: % of taxa counted	Gol…: Number of reports	Gol…: Nu…: Est…mat…
			CANADA					
Alberta	95	39	72	26	17	65	23	13
British Columbia	95	39	68	29	16	55	27	10
Manitoba	87	40	47	20	18	90	40	20
New Brunswick	47	42	35	19	14	74	12	23
Newfoundland	9	20	0	6	0	0	9	14
Labrador*	0	14	0	0	0	0	0	0
Northwest Territories	14	9	6	5	2	40	8	4
Nova Scotia	78	33	53	12	9	75	25	21
Ontario	2,110	90	1,520	49	39	80	590	41
Prince Edward Is.	1	28	1	10	1	10	0	18
Québec	288	56	144	24	15	63	144	32
Saskatchewan	48	31	33	18	8	44	15	13
Yukon Territories	51	18	13	11	1	9	38	7
Means (subtotals)	(2,923)	35.5	(1,992)	19.1	11.7	50.4	(931)	18
			U.S.A.					
Alabama	63	75	49	42	21	50	15	33
Alaska	47	15	16	8	6	75	31	7
Arizona	44	24	19	14	8	57	25	10
Arkansas	63	66	33	33	15	45	30	33
California	205	43	132	33	21	64	73	10
Colorado	164	47	106	29	13	45	58	18
Connecticut	26	51	18	27	12	44	8	24
Delaware	8	45	2	23	3	13	6	22
Florida	167	56	132	33	25	76	35	23
Georgia	79	89	63	45	24	53	16	44
Idaho	93	39	79	29	13	45	14	10
Illinois	109	69	94	46	29	63	15	23
Indiana	67	57	53	30	17	57	14	27
Iowa	51	46	42	27	15	56	9	19

TABLE 1. Continued.

Geopolitical area	Total number of reports	Estimated total number of taxa	Asters				Gold	
			Number of reports	Number of taxa		% of taxa counted	Number of reports	Num
				Estimated	Counted			Est mat
Kansas	45	40	26	23	10	43	19	17
Kentucky	74	73	62	40	18	45	12	33
Louisiana	30	69	24	37	13	35	6	32
Maine	57	49	42	26	14	54	15	23
Maryland	24	60	14	30	8	27	10	30
Massachusetts	82	59	44	34	20	59	38	25
Michigan	174	59	133	31	22	71	41	28
Minnesota	114	52	88	30	21	70	26	22
Mississippi	55	64	50	35	15	43	5	29
Missouri	117	61	93	31	21	68	24	30
Montana	79	41	63	28	16	57	16	13
Nebraska	37	34	21	21	11	52	16	13
Nevada	39	30	32	23	5	22	7	7
New Hampshire	56	52	31	28	14	50	25	24
New Jersey	46	73	19	43	11	26	27	30
New Mexico	62	40	23	22	13	59	39	18
New York	181	80	106	51	22	43	75	31
North Carolina	171	107	124	56	30	54	47	51
North Dakota	51	29	32	16	7	44	19	13
Ohio	49	49	35	27	11	41	12	22
Oklahoma	38	55	23	28	17	61	15	27
Oregon	209	46	194	33	20	61	15	13
Pennsylvania	103	62	84	39	16	41	19	23
Rhode Island	11	46	6	25	5	20	5	21
South Carolina	99	84	74	44	24	55	25	40
South Dakota	35	26	18	14	7	50	17	12
Tennessee	92	78	42	40	18	45	50	38
Texas	83	67	68	29	20	69	15	38
Utah	69	35	52	24	9	38	17	11
Vermont	80	51	47	29	17	59	33	22
Virginia	154	80	127	38	27	71	27	42

Table 1. Continued.

Geopolitical area	Total number of reports	Estimated total number of taxa	Asters: Number of reports	Asters: Number of taxa: Estimated	Asters: Number of taxa: Counted	Asters: % of taxa counted	Gold…: Number of reports	Gold…: Num…: Esti-mat…
Washington	48	46	42	34	10	29	6	12
West Virginia	42	66	32	34	12	35	10	32
Wisconsin	116	68	86	40	27	68	27	28
Wyoming	76	54	58	35	15	43	18	19
Means (subtotals)	(3,949)	55.3	(2,822)	31.4	15.7	50.0	(1,127)	23.
Canada & U.S.A.								
Means (subtotals)	(6,872)	51.1	(4,818)	29.8	15.9	50.1	(2,058)	22.
MEXICO								
Mexico	36	41	30	14	5	36	6	27
Totals	6,908		4,844				2,064	
Means	111.4	50.9	78.1	28.7	14.7	49.9	33.3	22.

* Labrador is part of the Province of Newfoundland; data on the island and the mainland portions of the province

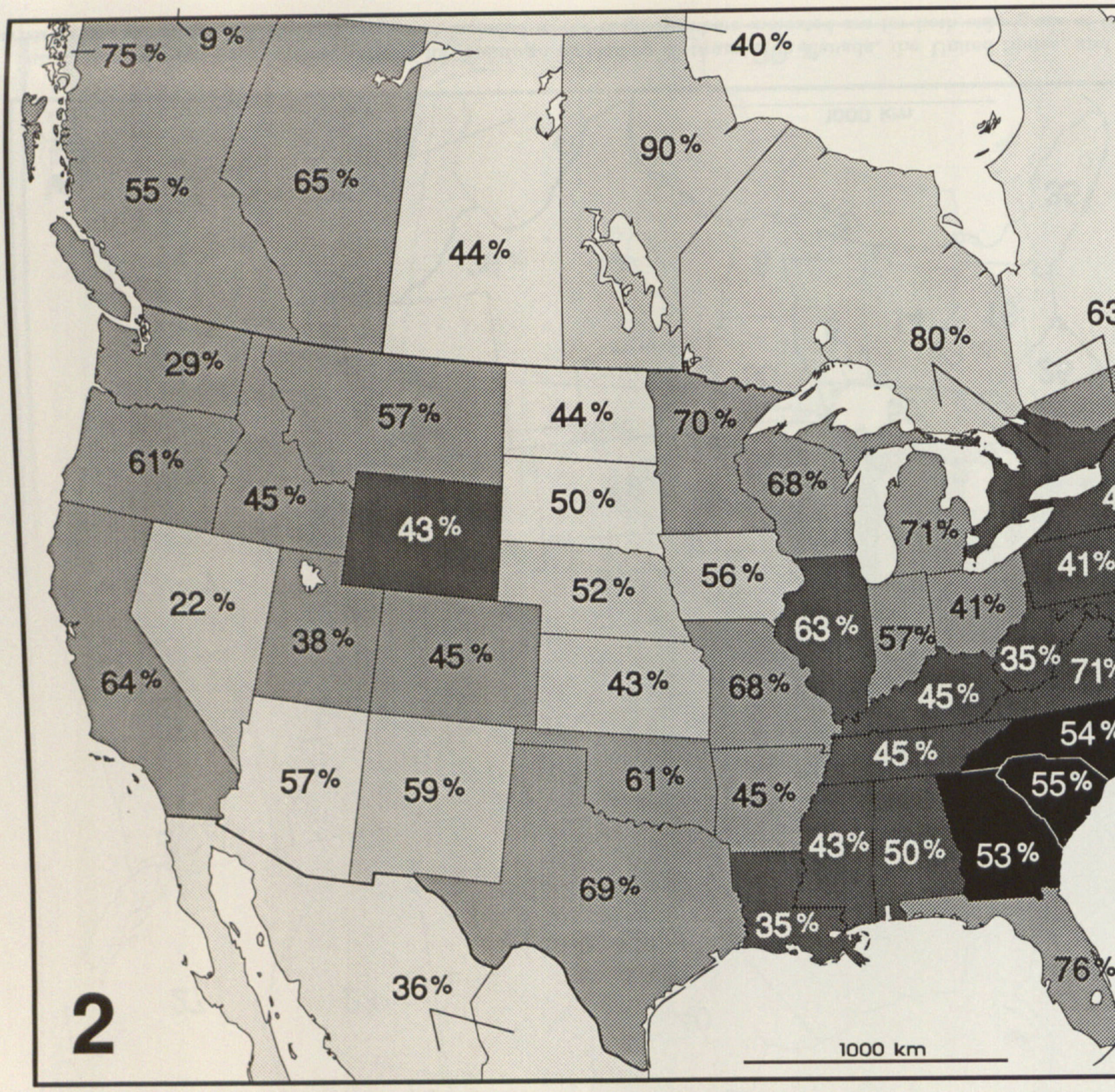

FIGURE 2. Estimated numbers of taxa (species, subspecies, and varieties; shading) in *Aster* sens. lat. (*Aster*, *Virgulaster*, a
chromosome number has been determined (numbers in the regions indicated). Numbers indicated are for both subregions of Or

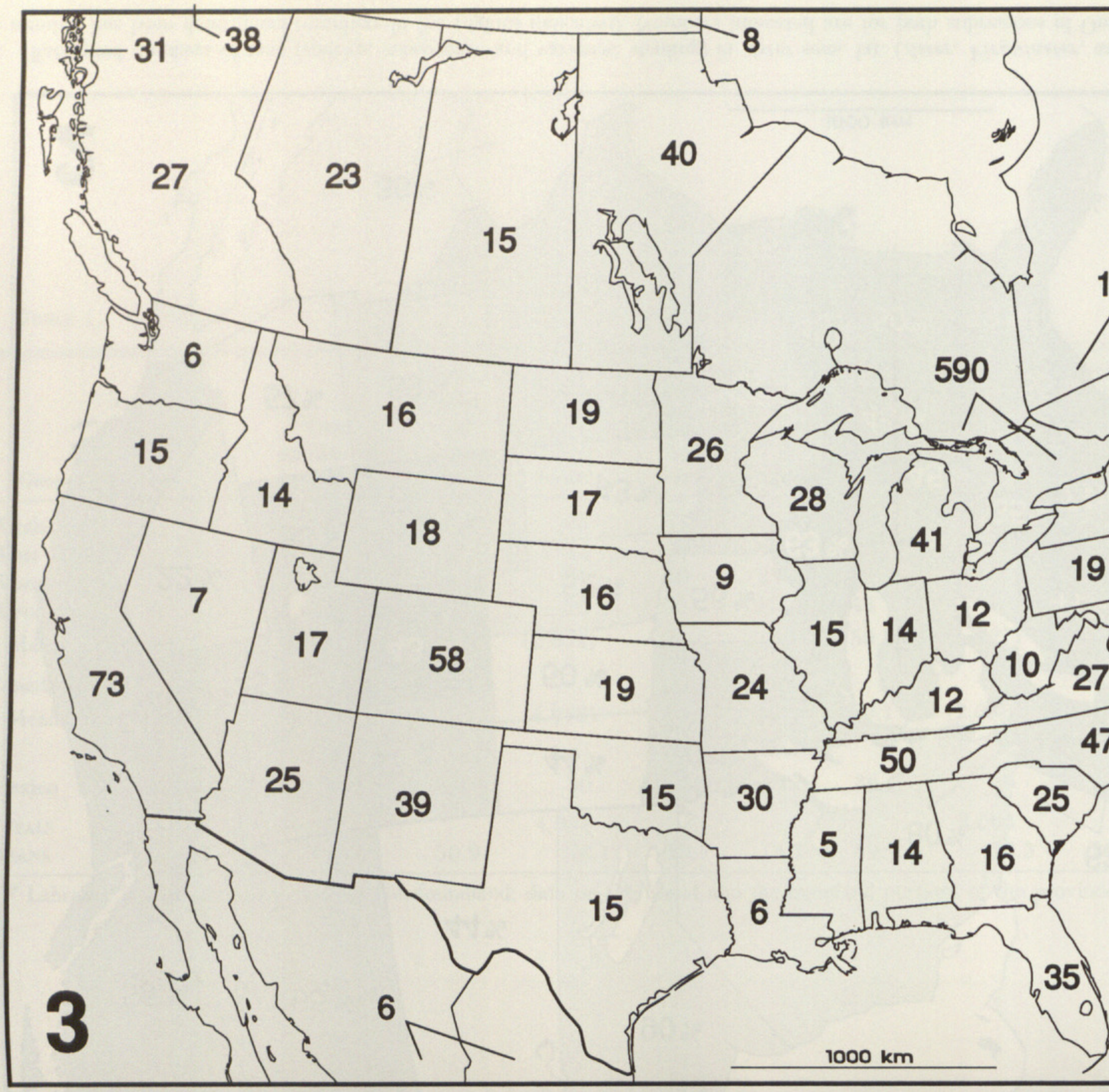

FIGURE 3. Numbers of chromosome number reports for *Solidago* (excluding *Euthamia*) in Canada, the United States, and
Northwest Territories are indicated; Yukon Territory is not included in the map. Numbers indicated are for both subregions of

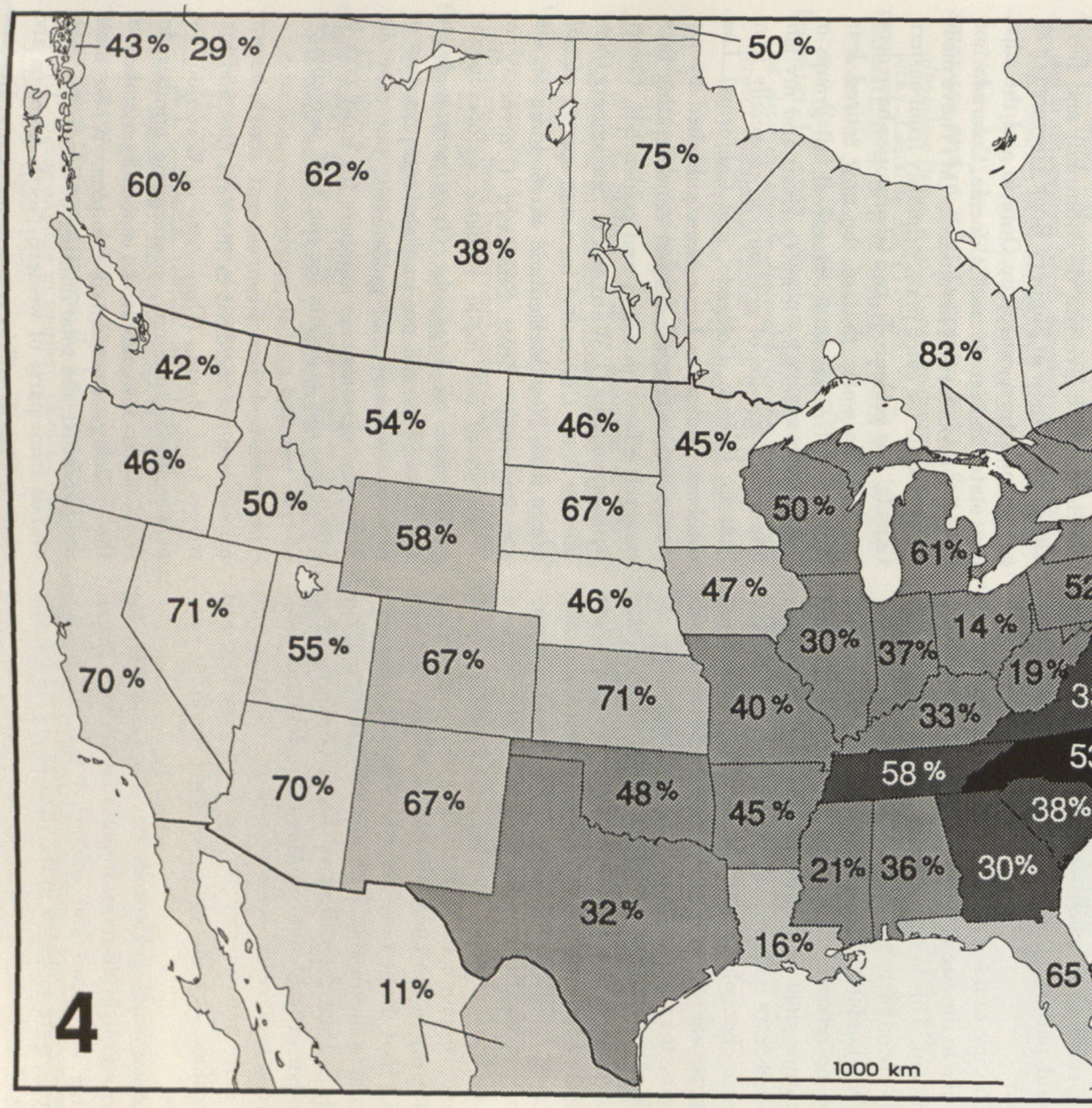

FIGURE 4. Estimated numbers of taxa (species, subspecies, and varieties; shading) in *Solidago* (excluding *Euthamia*) and p
has been determined (numbers in the regions indicated). Numbers indicated are for both subregions of Ontario, Québec, and

(71%) had been sampled, and 20 of the 29 estimated aster taxa for Texas (69%) versus 12 of the 38 goldenrod taxa (32%) had been sampled.

The numbers of taxa per geopolitical region (Table 1) were my estimates and should be viewed as preliminary. The numbers were based on numerous floras, revisions, and my work. Both over- and underestimates are likely because I have not examined all of the tens of thousands of herbarium specimens that need to be seen to fully document the distributions of the taxa in the aster and goldenrod genera. For this reason, ranges rather than actual numbers of taxa are presented in Figures 2 and 4. Of course, there will always be some disagreement on the number of taxa present in any given area because taxonomists are notorious for disagreeing about such matters. Nonetheless, the general patterns are presented with some confidence.

The size of the data base from Mexico was small relative to the size of the country, and this warrants comment. This low number of reports may be due to an incomplete search of literature not included in the standard chromosome number indices. Of note, no references in Spanish are included in the literature cited in this paper, although there was no deliberate ignoring of non-English publications. The numbers of taxa are in accord with those from neighboring states in the United States. For goldenrods, the sample size in most western states reflects the amount of work done in a particular state by my laboratory; to date we have not undertaken collecting expeditions into Mexico. This alone may account for the low number of reports in comparison to areas further north. Without the work of Scott Sundberg, the number of counts of asters would be much lower for Mexico. A number of collectors in the United States have provided material that allowed my laboratory to make the only chromosome number determination(s) for a number of taxa from the collectors' home territories. The number of collections of Mexican asters and goldenrods with viable achenes sent to my laboratory by more active collectors has been very low, and therefore, any specimens received would be valuable.

Asters and goldenrods have a reputation for frequent hybridization. Reports for 65 and 13 putative wild aster and goldenrod hybrids, respectively, were included in the data base (1.34% and 0.63%); these low values include both inter- and infraspecific crosses. Only eight of the 6,908 reports (0.12%) were triploid. For Ontario, 22 of the 2,110 reports were for interspecific hybrids, and none of the reports was triploid.

The most critical factor determining the total number of reports and the percentage of taxa sampled was the laboratories active in a particular region. For asters, the laboratories contributing the greatest number of reports were those of Kenton Chambers (Oregon State University with Michael Dean and Gerry Allen (now at the University of Victoria, B.C.); reports from the western United States), Almut Jones (University of Illinois; reports from all groups of asters), Ronald Jones (Eastern Kentucky University; reports on virguloid asters), Paul Van Faasen (Hope College; reports from Michigan and the northeastern United States), L. Michael Hill (Bridgewater College; reports from Virginia), and my lab (primarily with Luc Brouillet (now at the Institut de Recherche en Biologie Végétale de l'Université de Montréal) and Jerry Chmielewski (now at Slippery Rock University); all groups of asters, especially Ontario and the adjacent states and provinces, California, Colorado, and Florida). Brouillet and his students (MT) have made many counts for aster taxa, primarily from eastern Canada. For goldenrods, two laboratories have done most of the work: that of the now retired Jean Beaudry (l'Université de Montréal; all groups of goldenrods, especially from Québec) and my laboratory (all groups of goldenrods, especially from Ontario, Québec, Colorado, and California). Low numbers of reports have been published by numerous other laboratories not concentrating their research efforts on asters and goldenrods. Contributions made by D. Ward and D. Spellenberg (New Mexico State University) for some species of *Solidago* from New Mexico and surrounding regions are important. Scott Sundberg (University of Washington) has made valuable cytotaxonomic contributions on *Aster* subg. *Oxytripolium*. Askell and Doris Löve did not publish large numbers of reports for asters and goldenrods, but they did determine chromosome numbers for most taxa in Manitoba; this accounts for the high percentages of taxa counted in that province.

Unpublished data from several active laboratories were not included in the data files and matrices. John Morton (University of Waterloo) has accumulated numerous chromosome number determinations for goldenrods, especially members of the *Solidago canadensis* complex. When these are published, the total number of counts for goldenrods from parts of western North America and eastern Canada will increase significantly. Because most of the taxa involved have been sampled at least once in most provinces and states, the percentages of taxa sampled will not change greatly, with the exception of those from Newfoundland.

Brouillet is also known to have numerous unpublished counts for asters from eastern Canada, especially Québec, where at least 63% of the aster taxa have already been sampled. As noted above, more than 600 unpublished counts for particular species complexes of asters and goldenrods made by my laboratory were included in the data base.

Lastly, it should be noted that my laboratory will gratefully receive viable achenes of any taxon of aster or goldenrod, preferably with a voucher. These will facilitate continuing work on the cytogeography of asters and goldenrods from North America and elsewhere.

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