CYTOTAXONOMIC STUDIES IN MICHIGAN ASTERS

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ABSTRACT

CYTOTAXONOMIC STUDIES IN MICHIGAN ASTERS

by Paul Van Faasen

Chromosome counts of 18 species of Aster were obtained using the iron-acetocarmine squash technique on anthers and root tips. Three counts are reported for the first time (A. divaricatus $n = 9$, A. junciformis $2n = 32$, and A. lateriflorus $n = 8$, $n = 16$, $n = 24$). Numbers differing from previously reported counts were obtained from A. ericoides ($2n = 10$), A. laevis ($n = 24$), A. lowrieanus ? ($n = 9$), A. sagittifolius ? ($n = 16$), and A. simplex ($n = 16$, $n = 32$). Other counts include A. azureus ($n = 18$), A. ciliolatus ($2n = 72$), A. cordifolius ($n = 9$, $n = 18$), A. macrophyllus ($n = 36$), A. novae-angliae ($n = 5$), A. pilosus ($n = 24$), A. ptarmicoides ($n = 9$), A. sagittifolius ($n = 9$, $n = 18$), A. shortii ($n = 9$) and A. umbellatus ($n = 9$).

CYTOTAXONOMIC STUDIES IN

MICHIGAN ASTERS

By

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INTRODUCTION

A majority of the 200-250 species of the large and taxonomically complex genus *Aster* occur in North and Central America. About 33 species are native to Michigan. Chromosome counts have been made in approximately 80 species including 23 which occur in Michigan. This investigation has been based on Michigan material because of the need for study of the species in this area and because of the availability of plant material. The ultimate solution to the taxonomic problems in *Aster* will be based on many lines of evidence including chromosome numbers. It is with the latter that this paper deals.

As presently defined, the genus *Aster* includes a heterogeneous assemblage of species. Several segregate genera have been proposed, the most recent being a reconstitution of the genus *Machaeranthera* by Cronquist and Keck (1957). Other genera which have been segregated and submerged include *Amellastrum*, *Biotia*, *Eucephalus*, *Heleastrum*, *Ionactis*, *Oreastrum*, and *Sericocarpus*. Shinners (1953) considers *Doellingeria* to be a separate genus, and several authors, especially Shinners (1946), recognize *Leucelene* as a distinct genus. According to Cronquist and Keck (1957) the satellite genera except for *Machaeranthera* have no important characters by which they may be recognized, but rather are distinguished by a series of trivial characters which grade into Aster proper. In addition to vague generic limits of Aster, many species are also problematical. Specific circumscriptions often overlap, and species are recognized on the basis of unimportant and inconstant characters. In many cases it is not difficult to recognize most plants of a species, but determinations may often be only tentative for specimens near the extremes of variation.

MATERIALS AND METHODS

Buds, living plants, and voucher specimens were collected in central Michigan in 1960 and 1961. Voucher specimens are filed in the Herbarium of Michigan State University. A complete list of material upon which chromosome counts are based is given in table 1.

Buds were fixed in Carnoy's 6:3:1 (absolute alcohol, chloroform, glacial acetic acid), refrigerated at about 5° C, and kept refrigerated until examined. Squash preparations were made of anthers in iron-acetocarmine.

A modification of the process of Tjio and Levan (1950) was used for mitotic counts. Root tips were collected in water from plants growing in the greenhouse and transferred to a 0.002 mole/liter aqueous solution of 8-oxyquinoline. They were treated in the 8-oxyquinoline at 15° C for three hours, washed in distilled water, and fixed in Carnoy's 3:1 (95% ethyl alcohol, glacial acetic acid) for 15 minutes. The root tips were then transferred to a solution of 10 parts iron-acetocarmine : 1 part N HCl and heated gently 3 or 4 times for 5-10 seconds per heating with about one minute between heatings. The darkly stained tips were excised in a drop of iron-acetocarmine on a microscope slide and the cells teased apart with dissecting needles, a coverslip was added and pressure applied with the thumb

in order to flatten the cells.

The chromosomes were observed with a Zeiss WL microscope at an original magnification of 1280 X and drawn with a Zeiss drawing apparatus at 2400 X.

Distributions of species were determined from specimens in the herbaria of Michigan State University, the University of Michigan, Cranbrook Institute of Science, and Western Michigan University.

TABLE 1.

Chromosome numbers of Aster species occurring in Michigan

Species	Section	Collection data or reference. a/	Chromosome number n	2n	Figure
Aster amethystinus Nutt.	Aster	Wetmore and Delisle 1939.		10	
A. azureus Lindl.	Aster	MECOSTA CO.: 5 mi. W of Morley; 333.	18		1
		NEWAYGO CO.: 6 mi. SE of White Cloud; 352.	18		
		Avers 1953a. b/	18		
A. ciliolatus Lindl.	Aster	CHIPPEWA CO.: Sugar Island; Hiltunen in 1962.		72	2
		Avers 1953a.	36		
A. cordifolius L.	Aster	MUSKEGON CO.: 1 mi. S of Bailey; 354.	9		3
		KALAMAZOO CO.: Gull Lake, 2 mi. SW of Hickory Corners; 107, 109.	18		
		CLINTON CO.: St. Johns; 113, 120, 121, 359.	18		4 (120)
		Avers 1953a.	9,18		
		Avers 1957.	9		
A. divaricatus L.	Biotia	INGHAM CO.: Botanic Garden, Mich. State Univ.; 271	9		5

TABLE 1. Continued.

Species	Section	Collection data or reference.	Chromosome number n	2n	Figure
A. ericoides L.	Aster	JACKSON CO.: 2 mi. S of Waterloo; 279.		10	8
		Delisle 1937. c/.	5		
		Wetmore and Delisle 1939. c/.	5	10	
		Huziwara 1962.		32	
A. junciformis Rydb.	Aster	CLINTON CO.: Rose Lake, 9 mi. NE of Lansing; 216.		32	7
A. laevis L.	Aster	JACKSON CO.: 5 mi. N of town of Grass Lake; 273.	24		
		BARRY CO.: Kilpatrick Lake, 3 mi. E of Woodland; 322.	24		
		CLINTON CO.: 12 mi. NE of Lansing; 330.	24		
		NEWAYGO CO.: 6 mi. E of White Cloud; 339.	24		
		NEWAYGO CO.: 6 mi. SE of White Cloud; 350.	24		6
		IONIA CO.: 5 mi. E of Ionia; 365.	24		
		Revell 1955.		54	

TABLE 1. Continued.

Species	Section	Collection data or reference	Chromosome number n	$2n$	Figure
A. lateriflorus (L) Britt.	Aster	KALAMAZOO CO.: Gull Lake, 2 mi. SW of Hickory Corners; 108.	8		
		NEWAYGO CO.: 4 mi. E of White Cloud; 344.	8		9
		CLINTON CO.: St. Johns; 116.	16		10
		GRATIOT CO.: 7 mi. NE of Ashley; 128.	16		
		BARRY CO.: 3 mi. N of Woodland, near Jordan Lake; 325.	24		
		CLINTON CO.: 12 mi. NE of Lansing; 329.	24		11
A. lowrieanus Porter	Aster	Avers 1953a.	18		
A. lowrieanus ? Porter	Aster	MUSKEGON CO.: 1 mi. S of Bailey; 355.	9		12
A. macrophyllus L.	Biotia	CLINTON CO.: St. Johns; 117, 213.	36		
		INGHAM CO.: East Lansing; 226.	36		
		CLINTON CO.: 14 mi. NE of Lansing; 247, 248.	36		
		CLINTON CO.: 5 mi. E of Bath; 332.	36		

TABLE 1. Continued.

Species	Section	Collection data or reference	Chromosome number n	2n	Figure
A. macrophyllus cont.	Biotia	BARRY CO.: 2 mi. SE of Woodland; 324.	36		
		IONIA CO.: 2 mi. S of Portland; 327.	36		
		MUSKEGON CO.: 1 mi. S of Bailey; 356.	36		14
		Huziwara 1941.		72	
A. modestus Lindl.	Aster	Huziwara 1958.		18	
A. novae-angliae L.	Aster	INGHAM CO.: 3 mi. W of Haslett; 133.	5		
		INGHAM CO.: Lansing; 260.	5		
		CLINTON CO.: 7 mi. NE of Lansing; 238	5		
		CLINTON CO.: 5 mi. E of Bath; 331.	5		
		SHIAWASSEE CO.: 0.5 mi. E of Ovid; 251.	5		13
		Carano 1921.	5		
		Morinaga and Fukushima 1931.	5		
		Delisle 1937.	5		
		Wetmore and Delisle 1939.	5		

TABLE 1. Continued.

Species	Section	Collection data or reference	Chromosome number n	2n	Figure
A. novae-angliae L. cont.	Aster	Annen 1945.	5		
		Huziwara 1941, 1953, 1958.		10	
		Avers 1954b.	10		
A. patens Ait.	Aster	Huziwara 1941.		20	
		Avers 1954b.	10		
A. pilosus Willd.	Aster	INGHAM CO.: 3 mi. W of Haslett; 133.	24		
		CLINTON CO.: Park Lake, 7 mi. NE of Lansing; 180.	24		
		CLINTON CO.: St. Johns; 361.	24		
		SHIAWASSEE CO.: 1 mi. SE of Ovid; 182.	24		
		IONIA CO.: 3 mi. W of Ionia; 364.	24		15
		Avers 1954b.	24		
		Huziwara 1958.		48	
A. ptarmicoides (Nees) T. & G.	Orthomeris	MECOSTA CO.: 5 mi. W of Morley; 337.	9		
		Huziwara 1941, 1956, 1958.		18	

TABLE 1. Continued.

Species	Section	Collection data or reference	Chromosome number n	2n	Figure
A. puniceus L.	Aster	CLINTON CO.: Rose Lake, 3 mi. SE of Bath; 137.	8		
		INGHAM CO.: 4 mi. E of Leslie; 290.	8		17
		GRATIOT CO.: 3 mi. NE of Ashley; 299.	8		
		EATON CO.: 2 mi. E of Eaton Rapids; 307.	8		
		NEWAYGO CO.: 4 mi. E of White Cloud; 341.	8		
		MUSKEGON CO.: 1 mi. S of Bailey; 358.	8		
		IONIA CO.: 3 mi. W of Ionia; 362.	8		
		Huziwara 1958.		16	
A. sagittifolius Wedem.	Aster	GRATIOT CO.: 1 mi. NW of Sumner; 310.	9		
		CLINTON CO.: 12 mi. NE of Lansing; 328.	9		19
		NEWAYGO CO.: 4 mi. E of White Cloud; 345.	9		
		EATON CO.: 2 mi. E of Eaton Rapids; 305.	18		

TABLE 1. Continued.

Species	Section	Collection data or reference	Chromosome number n	2n	Figure
A. sagittifolius Wedem. cont.	Aster	MONTCALM CO.: Long Lake, 6 mi. SE of Greenville; 321.	18		
		BARRY CO.: Kilpatrick Lake, 3 mi. E of Woodland; 323.	18		20
		Avers 1953a.	9, 18		
A. sagittifolius var. drummondii (Lindl) Shinners	Aster	Avers 1953a. d/	18		
A. sagittifolius? Wedem.	Aster	IONIA CO.: 3 mi. W of Ionia; 363.	16		21
A. sericeus Vent.	Aster	Annen 1945.		10	
A. shortii Lindl.	Aster	IONIA CO.: Pewamo; 367.	9		18
		Avers 1953a.	9, 18		
A. simplex Willd.	Aster	EATON CO.: 2 mi. E of Eaton Rapids; 306.	16		22
		CLINTON CO.: St. Johns; 112, 114.	32		
		CLINTON CO.: 5 mi. N of Bath; 146.	32		
		IONIA CO.: 4 mi. E of Lake Odessa; 326.	32		

TABLE 1. Continued.

Species	Section	Collection data or reference	Chromosome number n	2n	Figure
A. simplex Willd. cont.	Aster	NEWAYGO CO.: 4 mi. E of White Cloud; 343.	32		
		MUSKEGON CO.: 1 mi. S of Bailey; 357.	32		24
		Avers 1954b.	36		
		Huziwara 1958.		64	
A. subulatus Michx.	Oxytripolium	Huziwara 1941.	9		
		Wetmore and Delisle 1939.		10	
		Huziwara 1953, 1958.		18	
		Huziwara 1958. e/		10	
		Turner *et al.* 1961.	5		
		De Jong and Longpre (unpubl.).	5		
A. umbellatus Mill.	Doellingeria	GRATIOT CO.: 3 mi. S of Edgewood; 303.	9		
		SAGINAW CO.: 1.5 mi. W of Marion Springs; 302.	9		
		NEWAYGO CO.: 4 mi. E of White Cloud; 342.	9		23

TABLE 1. Continued.

Species	Section	Collection data or reference	Chromosome number n	2n	Figure
A. umbellatus Mill. cont.	Doellingeria	INGHAM CO.: Botanic Garden, Mich. State Univ.; 271.	9		
		Huziwara 1962.		18	

a/ Collection numbers are by Van Faasen except where otherwise indicated, and all specimens were obtained in Michigan. Additional counts cited from the literature are not based on material from Michigan.

b/ as *A. shortii* ssp. *azureus* (Lindl.) Avers.

c/ as *A. multiflorus* Ait.

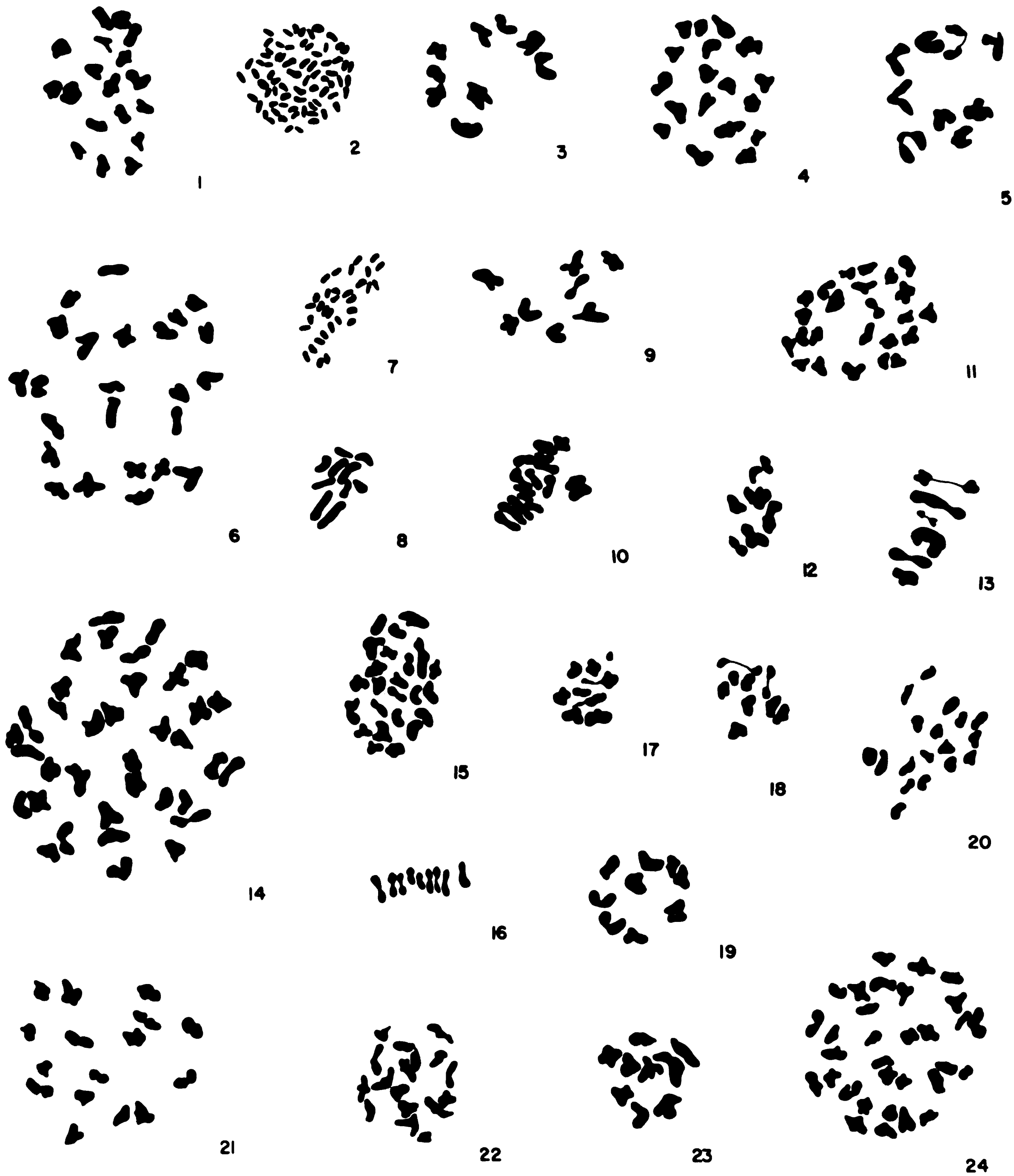
d/ as *A. drummondii* Lindl.

e/ as *A. exilis* Ell.

EXPLANATION OF FIGURES

Figures 1-24. Camera-lucida drawings of chromosomes of Michigan Aster species, all ca. X 960.

1. *A. azureus*, *n* = 18.
2. *A. ciliolatus*, 2*n* = 72.
3. *A. cordifolius*, *n* = 9.
4. *A. cordifolius*, *n* = 18.
5. *A. divaricatus*, *n* = 9.
6. *A. laevis*, *n* = 24.
7. *A. junciformis*, 2*n* = 32.
8. *A. ericoides*, 2*n* = 10.
9. *A. lateriflorus*, *n* = 8.
10. *A. lateriflorus*, *n* = 16.
11. *A. lateriflorus*, *n* = 24.
12. *A. lowrieanus*?, *n* = 9.
13. *A. novae-angliae*, *n* = 5.
14. *A. macrophyllus*, *n* = 36.
15. *A. pilosus*, *n* = 24.
16. *A. ptarmicoides*, *n* = 9.
17. *A. puniceus*, *n* = 8.
18. *A. shortii*, *n* = 9.
19. *A. sagittifolius*, *n* = 9.
20. *A. sagittifolius*, *n* = 18.
21. *A. sagittifolius*?, *n* = 16.
22. *A. simplex*, *n* = 16.
23. *A. umbellatus*, *n* = 9.
24. *A. simplex*, *n* = 32.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OBSERVATIONS

Aster azureus ($n = 18$). This number agrees with Avers' (1953a) count of the taxon which she recognized (1953c) as a subspecies, *A. shortii* ssp. *azureus* (Lindl.) Avers.

Aster ciliolatus ($2n = 72$). Avers (1953a) reported the same chromosome number for this species.

Aster cordifolius ($n = 9$, $n = 18$). Both diploid and tetraploid plants were also found by Avers (1953a). The diploid population (354) varied from plants with smooth leaves with winged petioles, characteristic of *A. lowrieanus*, to plants with scabrous leaves and narrow petioles, typical of *A. cordifolius*.

Aster divaricatus ($n = 9$). This is the first count for the species and the first diploid number reported in section Biotia. It is doubtful whether *A. divaricatus* occurs naturally in Michigan. The material studied was of cultivated origin. All Michigan collections which had been labeled *A. divaricatus* in the major herbaria in Michigan were found to be white-rayed forms of *A. macrophyllus*.

Aster ericoides ($2n = 10$). The chromosome number of this species (as A. multiflorus Ait.) was first reported by Delisle (1937). His count and a one subsequently reported by Wetmore and Delisle (1939) were $n = 5$. Huziwara (1962) reported $2n = 32$.

Aster junciformis ($2n = 32$). This is the first count reported for the species. A. junciformis is morphologically similar to A. adscendens Lindl. which has $n = 8$ and $n = 16$ (Clausen, Keck, and Heisey 1940), and to A. chilensis Nees with $2n = 64$ (Huziwara 1958). Cronquist recognized A. adscendens as a subspecies of A. chilensis.

Aster laevis ($n = 24$). A count of $2n = 54$ was reported by Revell (1955). In Michigan this species is morphologically variable, but no irregularities were noted in meiotic figures of the six collections studied.

Aster lateriflorus ($n = 8$, $n = 16$, $n = 24$). Chromosome counts for A. lateriflorus have not been previously reported, and this is also the first time that three ploidy levels have been found in one species of Aster. Collections 108 and 344 have $n = 8$ and the plants are morphologically typical for A. lateriflorus. Collections 116 and 128 have $n = 16$ and the lower surface of the leaf is slightly more pubescent than in typical material. Short stolons are also present on some of these specimens. Collections 325 and 329 with $n = 24$ are plants with extensive stolons and still more pubescence on the undersurface of the leaf. The pubescence on the undersurface of the leaf and the presence of stolons are characters of _A. ontarionis_ Wieg.

After the three chromosome numbers were detected and the correlation between the presence of stolons and polyploidy noted, the pollen quality was checked. This was determined by crushing unopened florets in iron-acetocarmine, counting 200 pollen grains, and considering those which did not stain darkly to be aborted. A high percentage of aborted pollen grains might suggest that the plants were not reproducing by sexual methods.

Nearly every one of the 78 herbarium specimens of _A. lateriflorus_ examined contained some aborted pollen grains and 29 specimens had more than 10 per cent aborted grains. There was little or no correlation, however, between the presence of stolons and aborted pollen. One plant (_329_) with _n_ = 24 and with extensive stolons had 88 per cent aborted grains, while another (_325_) had two per cent aborted grains. Of the plants with _n_ = 8, one (_118_) had three per cent and another (_108_) 44 per cent aborted grains. Other herbarium specimens contained from 2 to 70 per cent aborted pollen.

Aster lowrieanus ? (_n_ = 9). Collection _355_ fits the description of _A. lowrieanus_ as given by Fernald (1950), but plants with smooth leaves and winged petioles are one extreme of a highly variable population with typical _A. cordifolius_ at the other extreme, both with *n* = 9. Possibly the part of the population fitting the description of *A. lowrieanus* might better be considered variant forms of *A. cordifolius*.

Aster macrophyllus (*n* = 36). All collections studied had *n* = 36 and meiosis was regular. The species is morphologically variable, and populations have been observed which included as many as three forms which have been described at the varietal level.

Aster novae-angliae (*n* = 5). Some pollen mother cells of collection 251 contained one or two chromosome fragments in addition to the normal chromosome complement. This population included plants with rays varying from rose-violet to deep blue-violet. In one metaphase configuration (fig. 13), it appeared that a fragment was dividing and acting as a sixth chromosome. Avers (1954b) reported a tetraploid population of *A. novae-angliae*. None was encountered in this study and several other investigators (see table 1) also have found only diploid plants.

Aster pilosus (*n* = 24). No meiotic irregularities were found although the species is morphologically variable.

Aster ptarmicoides (*n* = 9). One collection was studied and no meiotic irregularities were noted.

Aster puniceus ($n = 8$). Specimens which could be determined as *A. lucidulus* (Gray) Wieg. are included under this species. Most pollen mother cells in collection 290 contained one to three chromosome fragments (fig. 17), but no irregularities were found in other collections.

Aster sagittifolius ($n = 9$, $n = 18$). Both diploid and tetraploid populations were also found by Avers (1953a). Although the species is morphologically variable, no correlation was noted between the chromosome number and the mode of variation.

Aster sagittifolius ? ($n = 16$). This collection, 363, with the anomalous chromosome number has both white- and blue-rayed plants, and the inflorescence is a little looser than in typical *A. sagittifolius*. The buds, however, are nearly cylindrical as are buds of *A. sagittifolius*. Morphologically the plants resemble *A. sagittifolius* more closely than any other species. A hybrid origin for this population might be possible, but is difficult to explain since all species related to *A. sagittifolius* have a basic number of $x = 9$. The only other species of *Aster* found nearby were *A. pilosus* which grew among these plants, and *A. puniceus* which was found about 100 yards away. A hybrid of the latter two species, both sessile-leaved, would hardly be expected to have long, winged petioles as does this population, and a hybrid of either of them with *A. sagittifolius* or a species related to *A. sagittifolius* would not likely produce a population with *n* = 16.

Aster shortii (*n* = 9). Avers (1953a) found *n* = 9 in one plant from Iowa, but all other material of this species she examined was tetraploid.

Aster simplex (*n* = 16, *n* = 32). All material studied has *n* = 32 except collection *306* with *n* = 16. Previously published counts for this species differ. Avers (1954b) found *n* = 36, while Huziwara (1958) reported 2*n* = 64.

Aster umbellatus (*n* = 9). This count agrees with one by Huziwara (1962) for the species.

DISCUSSION

Three basic chromosome numbers, *x* = 5, *x* = 8, and *x* = 9 occur in *Aster*. A controversy concerning the ancestral basic number of the genus has recently appeared in the literature. Huziwara (1958, 1959) and Raven *et al*. (1960) state that since the majority of the species studied have *x* = 9, this is an indication that the ancestral basic number of the genus is *x* = 9. They consider species based on *x* = 5 and *x* = 8 to be derived through aneuploid loss from ancestral stock with *x* = 9. Turner *et al*. (1961) argue that since there are no species of *Aster* with *x* = 6 and *x* = 7, it is more likely that the ancestral basic number was *x* = 5 and/or *x* = 4, and that the numbers *x* = 8 and *x* = 9 are of allopolyploid origin. They believe that the numbers *x* = 6 and *x* = 7 never existed rather than having been selected against and eliminated as suggested by Raven *et al*.

Only the basic number *x* = 9 is now known in sections Alpigenia, Biotia, Doellingeria, Orthomeris, Pseudocalimeris, Teretrachenium, and Tripolium. Two sections, Aster (*x* = 5, *x* = 8, and *x* = 9) and Oxytripolium *x* = 5 have other basic numbers. 1/ All Aster species with basic numbers other than

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1/ Correspondence with Drs. Raven and Solbrig indicate the probalility of error in indicating *Leucelene* as a section of *Aster* by Raven *et al*. (1960). Apparently *Leucelene* has not been made a section of *Aster*, and no other reference to it as a section of *Aster* has been found in the

$\underline{x} = 9$ are North American.

Some patterns are evident in the distribution of the commoner species of section Aster in Michigan according to their basic chromosome numbers. Species with $\underline{x} = 9$ are found primarily in the southern two-thirds of the Lower Peninsula with a few collections to the north of this area. One species (A. ciliolatus, $\underline{n} = 36$) is restricted to the Upper Peninsula and the extreme northern tip of the Lower Peninsula. With one exception, species having $\underline{x} = 5$ are found south of the hinge line running approximately from Bay City to Frankfort in the Lower Peninsula. The few collections of A. ericoides ($\underline{n} = 5$) from Menominee County in the Upper Peninsula are likely extensions of the species from Wisconsin. A. sericeus ($\underline{n} = 5$) is restricted to the relict prairie areas in the southwestern part of the Lower Peninsula. All species with the basic number $\underline{x} = 8$ are widely distributed throughout the State. Three species of other sections, A. macrophyllus (Biotia), A. ptarmicoides (Orthomeris), and A. umbellatus (Doellingeria) are widespread throughout the State.

Chromosome counts differ for A. subulatus and A. exilis, which has been referred to A. subulatus by Shinners (1953). Huziwara (1941, 1953, 1958) reported $\underline{n} = 9$ for A. subulatus and $\underline{n} = 5$ for A. exilis (1958), while Wetmore and

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literature. It seems best to recognize Leucelene as a distinct genus with one species, L. ericoides (cf. Shinners 1946). The count of $\underline{n} = 16$ for Aster hirtifolius (Raven et al., 1960) should be referred to Leucelene ericoides.

Delisle (1939), Turner et al. (1961), and De Jong and Longpre (unpubl.) found n = 5 for A. subulatus. The problem here appears to be taxonomic rather than cytological.

On the basis of morphology, species of section Aster with the basic number x = 5 do not appear to be closely related. However, A. novae-angliae and A. ericoides hybridize freely in the laboratory and frequently in nature forming X A. amethystinus. Other species apparently not closely related, but with the basic number x = 5, include A. turbinellus (n = 50, Avers 1957), A. sericeus (n = 5) and A. patens (n = 10).

Most of the taxonomic difficulties in section Aster in Michigan are found in species with the basic number x = 8. Among these are A. laevis and A. puniceus, both of which have been subdivided by some authors. Rydberg (1931) split A. laeviformis from A. laevis and stated that the new species belonged to the A. puniceus group. A. laeviformis has subsequently been submerged in A. laevis by Shinners (1941). The count for A. laevis in this study shows that A. laevis and A. puniceus have the same basic number, x = 8. Morphologically these two species are more similar to each other than are other groups of species which apparently are related. A. lucidulus (Gray) Wieg. was segregated from A. puniceus and is recognized by a number of authors. A. simplex (x = 8) as presently recognized includes a number of forms which at one time were considered separate species and varieties. Most individuals of A. simplex are not difficult to recognize, but extreme variants of the species are difficult to determine. Wiegand (1928) has discussed the problems connected with this species complex.

Another taxonomic difficulty concerns _A. lateriflorus_ ($\underline{x}$ = 8) which has a diversity of forms. The disk corolla seems to be the most dependable character for identification of _A. lateriflorus_. The corolla lobes are 50 to 75 per cent of the total length of the limb and may be easily observed in the field with an ordinary hand lens. Attempts to identify this species by other gross morphological characters are often frustrating. As suggested in the observations of _A. lateriflorus_. polyploidy may contribute to the taxonomic difficulties in the species. _A. pilosus_ ($\underline{x}$ = 8) may often be confused with _A. simplex_ and _A. lateriflorus_. Most specimens of _A. pilosus_ are not difficult to recognize, but some varieties and forms approaching the extremes of variation are very difficult to determine. Hybridization among _A. simplex_, _A. pilosus_, and _A. lateriflorus_ and other species undoubtedly contributes to the confusion.

While hybridization and polyploidy complicate the understanding of _Aster_ in Michigan, the most important factor, however, appears to involve the sensitivity of the species to fluctuations of environmental factors. Differences in type of soil, soil moisture, amount of shade, and direction of exposure may all affect the morphology of the plants. (In _A. junciformis_, for example, individuals growing on sandy lake shores, vary considerably from those growing in bogs, the usual habitat of the species.) Some confusion in species with $\underline{x} = 8$ results from the enormous number of these plants in Michigan. Although the percent of plants at the extremes of variation of the species may not be greater than in other groups, numerically there are more individuals at the extremes and an exaggerated idea of the difficulty of the group may result. Disturbance of the original pre-settlement vegetation has also reduced the rigor of former selective pressures and permitted formerly less-fit combinations to be preserved. Mechanical or insect injury may cause bizarre forms of some species. Clarification of all taxonomic problems in the genus is not imminent, but employment of the many new techniques available to the taxonomist should eventually resolve the difficulties.

SUMMARY

Chromosome numbers were determined in 18 of the approximately 33 species of *Aster* which occur in Michigan. Counts in three species (*A. divaricatus*, *A. junciformis*, and *A. lateriflorus*) are reported for the first time. Counts differing from previous counts were obtained in *A. ericoides*, *A. laevis*, *A. lowrieanus* ?, *A. sagittifolius* ?, and *A. simplex*. Four species were found with more than one ploidy level; diploid and tetraploid populations occurred in *A. cordifolius* and *A. sagittifolius*, diploids, tetraploids, and hexaploids in *A. lateriflorus*, and tetraploids and octaploids in *A. simplex*. Taxonomic problems apparently result from hybridization, polyploidy, and phenotypic plasticity.

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