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Chromosomal Drift, a New Phenomenon in Plants

Abstract. *A seasonal shift in chromosome number of reproductive cells of* Claytonia virginica, *which coincided with near-drought conditions, resulted in a chromosome complement new to the population. The number reappeared 2 years later, the minimum time required for plants of that generation to produce flowers. Moreover, the chromosome number of root cells commonly differed from aerial organs of the same plant.*

Diversity of chromosome number is widespread within certain plants. Its frequency is becoming more apparent, especially among annuals and herbaceous perennials, as more than one individual from each of several populations is studied. One example of such diversity is found in spring beauty *Claytonia virginica* L. in which 50 known cytotypes for the species range in diploid chromosome number from 12 to about 191 (*1*).

Although infraspecific aneuploidy and polyploidy are well recognized, no long-range study has included the relation of the effects of time on chromosomal variability within a single population. A micropopulation of *C. virginica* from the vicinity of Carthage, Panola County, Texas (*2*), was studied during four annual flowering seasons over a span of 8 years. The locality is about 20 m^2 with a gradual rise of 2 m near the middle. On this knoll, plants flower first at the top in late February and gradually flower down the slopes until the population completes flowering by the end of March or early in April. The population consists of perhaps 150 plants with about one-half in flower at any one time. From an underground stem (corm), one to several floral shoots emerge over a period of roughly 3 weeks depending on age and the environment. Plants grow largely during warm periods from autumn through winter and die back to the corm shortly after flowering. Results are based on samples averaging one-third of plants in flower at the time of sampling. Cells examined were those in meiosis in anthers unless noted otherwise.

In 1961, 1968, and 1969 chromosome numbers of these plants were similar (Table 1). In 1961 the study extended beyond the knoll population to include six other populations in the immediate area.

Yet in 1967 the chromosome number of these plants was different. In over two-thirds of them $2n$ was less than 28 and in 42 percent of these $2n$ was 24. I call this shift in chromosome number chromosomal drift (Fig. 1).

There is no ready explanation for this temporary change in 1967, but coincidentally one climatic factor varied during that season only. For the critical 6-month growing period roughly from November through April, rainfall was only 39.25 cm in the Carthage area, whereas, for the other 3 years, it varied from 76.25 to 97 cm which was about normal for a 20-year period. Is a precipitation of less than one-half the expected amount during a time of maximum growth and development responsible in some way for this marked chromosomal loss? Inasmuch as 42 per-

Table 1. Chromosome numbers of *Claytonia virginica* from the knoll population, vicinity of Carthage, Panola County, Texas.

Year	Plants (No.)	Chromosome number (as $2n$)																Chromosomes (av. No.)
		24	25	26	27	28	29	30	31	32	33	34	35	36	38	39	> 39	
1961	15		1	1		1	4	3	2	2	1							29.6
1961*	61		2	1		21	18	5	5	3	3			2		1		29.6
1967	19	8	1	4		3	2			1								26.1
1967†	22					19	2	1										28.2
1968	23					6	7	7	2	1								29.4
1968†	7					6	1											28.1
1969‡	94	5			2	23	16	11	12	7	4	5	2	2	1	1	3§	30.6

* Plus data from six micropopulations in the vicinity of the knoll. † Mitosis from roots after transplanting to greenhouse. ‡ Based on three samples taken at 2-week intervals. § $2n = 41$, 52, 58.

Table 2. Chromosome numbers of root tips and microsporocytes of *Claytonia virginica* from the vicinity of Carthage, Texas. The subscripts I and II designate univalents and bivalents, respectively.

Chromosome number			
Roots ($2n$)	Microsporocytes (as $2n$)	Plants (No.)	Meiotic configuration
14	14	1	7_{II}
27	27	1	$13_{II} + 1_{I}$
28	28	2	14_{II}
28	29	2	$14_{II} + 1_{I}$
28	30	2	15_{II}
28	31	3	$15_{II} + 1_{I}$*
28	31,33	1	$15_{II} + 1_{I}$, $16_{II} + 1_{I}$
35	35	1	†

* Fifty percent plus 14_{II} + 31 (7%), $14_{II} + 1_{III}$ (7%), $13_{II} + 5_{I}$ (22%), $13_{II} + 1_{IV} + 1_{I}$ (7%), $12_{II} + 1_{III} + 4_{I}$ (7%). † No dominance of $17_{II} + 1_{I}$, $16_{II} + 3_{I}$, $15_{II} + 5_{I}$, $14_{II} + 7_{I}$.

cent of microsporocytes had $n = 12$ (meiosis was regular, male gametes appeared normal, and seed set was high) in 1967, I expected that plants with this reduced number would reappear with time in the population. A minimum of 2 years is required for *C. virginica* to flower. As anticipated, five plants with $n = 12$ were found in 1969 (Table 1). Although this is the only instance, except in 1967, that I observed plants with this number in the area, it is perhaps premature to suggest that one result of chromosomal drift is a permanent alteration in the chromosomal composition of the population.

Almost all reports of chromosome number in *C. virginica* are based on meiotic material. Meiosis is readily observed because of the gradual maturation of the raceme. In addition, there are reasons for not studying somatic cells, notably that the stem is underground, the roots are fibrous and small, and the corm often dies after it is transplanted. Nevertheless, a sample from root tips is reported for plants transplanted in 1967 from the knoll population. Twenty-two plants survived; root cells were primarily with $2n = 28$ or rarely with $2n = 29$ and 30 for different plants (Table 1).

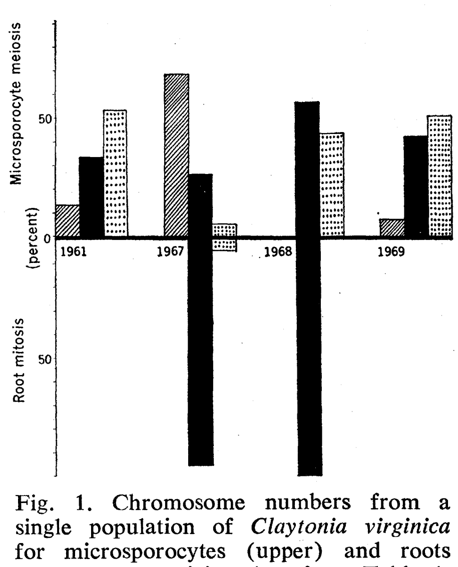

Fig. 1. Chromosome numbers from a single population of *Claytonia virginica* for microsporocytes (upper) and roots (lower) summarizing data from Table 1. Note dramatic but temporary shift in chromosome numbers during 1967. Hachured blocks, $2n = 24$ to 27; solid blocks, $2n = 28$ or 29; dotted blocks, $2n = 30$ to 58.

The $2n = 28$ number probably represents the basic polyploid for the area. It is the most common one throughout the south-central states (*3*); together with the derived $n = 14_{II} + 1_{I}$, it is the most frequent polyploid in the Carthage area, and the only known diploid from here is $2n = 14$. Yet the chromosome number of root cells is at variance with that of the aerial portions of plants from the same population. During the year that these individuals were transplanted, the average chromosome number of microsporocytes was $2n = 26.1$ with 42 percent having $2n = 24$. Yet no root cell was found with a number less than 28, even though sampled from exactly the same locality on the same day. The sample the following year was small, with only 7 surviving, but it showed precisely the same predominance of $2n = 28$ and absence of lower numbers as in 1967. Again, however, the chromosome number of microsporocytes differed, but these averaged higher, not lower. Both results illustrate a shift of the chromosome number of aboveground parts away from a basic number of $2n = 28$ that is characteristic of roots. Furthermore, the data suggest that in some individuals chromosome number in cells belowground differs from that of cells aboveground.

Of the numerous plants cultivated from the Carthage area only 13 survived to develop roots and to reach sexual maturity (Table 2). Five plants had similar chromosome numbers in their microsporocytes and roots, but for eight plants these were different. Two individuals had one supernumerary chromosome, two had two extra chromosomes, three had an additional three chromosomes and one plant had two numbers in its floral parts, that is, $2n = 31$ in one raceme and $2n = 33$ in another. Numbers were consistent in cells for each raceme and in the several roots examined for each plant.

The presence of one to five supernumerary chromosomes at meiosis did not affect greatly the meiotic behavior of the plants. Pairing was usual and what abnormality did exist consisted mostly of univalent formation (Table 2). It was impossible to distinguish the basic 14 bivalents from the bivalents formed from supernumerary chromosomes. Of seven plants studied from other populations in Texas and in Arkansas (*4*), no variation in chromosome number between root and aerial cells was observed.

A different chromosome number for distinct organs of the same individual is known for one unrelated species, *Xanthisma texanum* DC. (*5*). In this species chromosomes of root cells are lost during early embryonic development leaving a higher number in cells above ground than below. But as *C. virginica* may have several chromosome numbers in each of several different floral shoots as well as in its roots, elimination of chromosomes during root development will not account wholly for this variability. Perhaps the specialized corm is a reservoir for chromosomal variation in *C. virginica* which allows, under particular conditions of stress or in the presence of mutagenic agents, the generation of different chromosome numbers during the growth of organs. Stability within organs is likely a result of genetic control during morphogenesis.

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