9. Pachytene chromosome morphology and meiosis in tetraploid species of Tripsacum.

In a program aimed at studying the chromosome morphology and meiosis in tetraploid species of Tripsacum, it has become possible to make a detailed study of the chromosome morphology and the behavior of the 'associations of four' chromosomes in T. laxum. The pachytene chromosomes of T. laxum are differentiated into eu- and heterochromatic regions much the same way as in the diploid species. The longest chromosome in the complement measures on an average 68.04 microns while the shortest is 15.08 microns long. Altogether seven knob positions have been observed on the 18 sets of chromosomes. Some of the knobs were found to be in a heterozygous condition. The details on the relative lengths of the chromosomes, their arm ratios and the knob positions are presented in Table 4. Chromosome 10 is the nucleolus organizing chromosome.

A total of 218 pachytene associations have been studied in T. laxum to obtain data on the frequency and the position of exchange of partners, the relative distribution of exchanges in the eu- and heterochromatic regions and the mean number and mean length of pairing blocks. Such a study showed the maximum and the minimum numbers of exchanges ranged from three to none. There was observed a positive correlation between the physical length of the arm and the distribution of exchanges. Besides the 'two by two' pairing, 16.4 per cent of the associations showed an association of the four centromeres with or without partner exchanges elsewhere on the chromosome. In the long chromosomes, chromosomes 4 and 8 showed a low frequency of 'two by two' pairing while chromosome 2 almost always showed exchange of partners.

The initial points of pairing, as inferred by the position of exchange of partners, seem to lie at random along the length of the chromosomes. However, in the case of chromosomes 5 and 14 a clustering of exchanges was observed in a particular region of the long arms.

The frequency distribution of exchanges in the eu- and heterochromatic regions showed that such exchanges are rare in the heterochromatic regions. The mean number of pairing blocks increased with increase in length of the chromosome up to a certain limit beyond which it decreased. Thus, the mean number of pairing blocks for chromosome 1 is lower than for chromosome 2. The mean length of the pairing block increased with increase in length of the chromosome. These observations are in general agreement with the inferences drawn by Darlington and Mather (1932) and Stone and Mather (1932) on the basis of a diakinesis study of triploid tulips and hyacinths.

Detailed studies have been made at diakinesis in all five tetraploid species of Tripsacum to obtain data on the types and frequencies of multivalents so that the data can be used to compare the meiotic behavior among the five species. This study showed that all the tetraploids are characterized by few multivalents and many bivalents. The frequencies (percentages) of various types of associations are presented in Table 5. The highest quadrivalent frequency is found in T. dactyloides and the lowest in T. laxum. Quadrivalent types 11 (chain of four) and 17 (ring

Table 4

Table showing the relative lengths and arm ratios of the haploid complement of 18 pachytene chromosomes of tetraploid T. laxum. (All measurements are in microns.)

Chromosome number	Total length	Length of the long arm	Length of the short arm	Arm ratio
1	68.04	45.24	18.20(k)	2.7:1.0
2	54.60	41.60	13.00(K)	3.1:1.0
3	52.00	35.88	13.00(k)	2.7:1.0
4	50.96	34.32	15.08	2.3:1.0
5	44.20	27.56	15.08	1.8:1.0
6	41.60	28.60	11.44	2.5:1.0
7	37.44	23.40	13.00	1.8:1.0
8	33.80	28.60	5.20	5.3:1.0
9	33.80	21.84	10.40	2.5:1.0
10	32.24	16.12	15.60	1.0:1.0
11	28.60	16.64(k)	10.40	1.6:1.0
12	27.56	20.80	5.20(K)	4.0:1.0
13	27.04	17.68	7.80	2.2:1.0
14	22.36	16.12	5.20	3.1:1.0
15	21.32	13.00	5.72	2.3:1.0
16	18.20	12.48(K)	4.68	2.6:1.0
17	17.68	13.00(K)	2.60	4.5:1.0
18	15.08	8.84	5.72	1.5:1.0

(K) indicates the presence of a terminal knob in the arm.
(k) indicates the presence of a heterozygous terminal knob in the arm.

Table 5

Table showing the relative frequency distribution of various types of associations (quadrivalents, trivalents, bivalents and univalents) observed at diakinesis in the tetraploid (2n = 72) species of Tripsacum

Species	Types of associations					
	Quadrivalents	Trivalents	Bivalents			Univalents
			Ring	Rod	Total	
T. dactyloides (Florida)	22.8	--	39.1	36.9	76.0	1.2
T. lanceolatum (27294; 65-1251) Mexico	17.6	3.2	58.2	17.7	75.9	3.3
T. pilosum (26488; 65-1240) Mexico	19.3	2.8	51.6	21.7	73.3	4.6
T. laxum (44179; 65-1245) Guatemala	15.7	--	52.5	29.6	82.1	2.2
T. latifolium (44116; 65-1269) Guatemala	21.3	--	40.0	36.9	76.9	1.8

of four) are the two most frequent types observed in all the species. T lanceolatum and T. pilosum had a low trivalent frequency.

On the basis of the meiotic behavior, distribution patterns and segregation of morphological characters, it is suggested that all the polyploid species of Tripsacum are segmental allopolyploids. T. laxum, T. latifolium and T. dactyloides are stabilized segmental allopolyploids; T. lanceolatum and T. pilosum are relatively young and are at an active stage of segregation.

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10. Heterosis: Kernel weight, ovules per ear row, and rows per ear.

The following data, gathered at DeKalb several seasons ago, may be of interest in regard to heterosis of 'yield components' of the maize ear, i.e., kernel weight, ovules per ear row and row number. The HD prefix indicates doubled haploid lines. L indicates a low value of the attribute in the parental line, M indicates a median value, and H a high value. Line averages are indicated in the columns to the right of each 2 x 2 table. Central values in these tables are those of the various single cross hybrids measured. Crosses were made one way only.

a. Kernel weight (grams per 100 kernels):

		L HD907	L HD82	L HD159	H HD2380	H HD1464	H HD1344	Lines per se
L	HD907	----	25.8	21.9	27.6	28.5	29.9	17.1
L	HD82	25.8	----	26.6	31.2	34.0	30.3	17.5
L	HD159	21.9	26.6	----	30.3	31.7	29.2	18.5
H	HD2380	27.6	31.2	30.3	----	37.9	35.2	30.0
H	HD1464	28.5	34.0	31.7	37.9	----	36.7	34.5
H	HD1344	29.9	30.3	29.2	35.2	36.7	----	37.0
Averages:		26.7	29.6	27.9	32.4	33.8	32.3	25.7

Summary:	L	H	Lines
L	24.8	30.3	17.7
H	30.3	36.6	33.8
Averages:	27.6	33.5	25.7

*Heterosis:
L x L = 40.9%
L x H = 17.9%
H x H = 8.3%

*Heterosis given as % increase of hybrids over average of parents.