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The effect of B chromosomes on chiasmata

Last year I reported on the influence of K10 on the total chiasmata at metaphase I and the distribution of the exchanges. It was indicated that K10 increased the total number of chiasmata and that proximal exchanges increased at the expense of distal exchanges.

The same procedure was used to determine the effect of B chromosomes on chiasma distribution. Sporocytes were taken from a line with mainly 0B and 1B plants, and chiasma counts were made on ten cells in seven plants of each of 0B and 1B groups. A chart was constructed with schematic representations of tetrads having various numbers of proximal and distal exchanges, and a count made of the number of each of the tetrad types; an average was obtained for the number of distal, proximal and total chiasmata for each plant. Statistical analyses were by means of t tests (Table 1).

Table 1. Effect of B's on chiasmata.

	Average chiasmata per cell			Total number of chiasmata		
	distal	proximal	total	distal	proximal	total
0B	9.41	9.54	19.0	659	668	1327
1B	7.50	12.50	20.0	526	873	1399
P	<.01	<.001	<.001			

U. W. Ayonoadu and H. Rees (Genetica 39:75, 1968) were the first to report the enhancement effect of B chromosomes on chiasma frequency in maize. Their results have been repeated here and extended to demonstrate a shift of exchanges from distal to more proximal regions. These observations are not unexpected, as they agree with recombination data. However, only a few regions have been tested genetically, and different responses could occur throughout the genome. The individual tetrads remain unidentified; but, as with the K10 results, it is suggested that all chromosomes are affected by the presence of the B's.

Thus, both B chromosomes and K10 increase chiasma frequency and redistribute chiasmata from distal to more proximal regions.

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Previously unreported wx heteroalleles

Since the last reported map of the wx locus (Genetics 60:507, 1968), some previously unreported mutations have been mapped. These are the mutations K, L, M, BL2, Stonor and B3. In addition, more extensive data are available for mutations B2, B4, B7, C31 and C34.

The mutations K, L and M occurred as spontaneous mutations in inbred lines of the Bear Hybrid Corn Company of Decatur, Illinois. The BL2 mutation is a presumptive EMS-induced mutation detected by R. W. Briggs, who was then at Brookhaven National Laboratory. The Stonor mutation was found in maize collected in Assam and was received from Edgar Anderson. The B3 mutation, obtained from R. A. Brink, is an autonomous mutable allele that resulted from the association of Mp (Ac) with a functional allele at the wx locus; the rate of germinal reversion is sufficiently

low that its position can be mapped. It cannot be mapped with respect to the Ds-controlled mutations m-1 and m-6, since it induces a high frequency of somatic and germinal reversions to Wx in these mutants; it was this observation which first drew attention to the fact that B3 was carrying Mp (Ac). B3 also induces a high rate of reversion in B4, which was thereby identified as a Ds-controlled mutant.

The frequencies of Wx pollen grains in crosses between wx heteroalleles are given in Table 1. The total population of pollen grains scanned is not given, although the number of plants sampled is noted. There were a minimum of 35,000 and a maximum of about 75,000 pollen grains per slide. A revised map of the wx locus based on these data plus those given in the 1968 Genetics paper is presented in Figure 1; the map is constructed as previously. The knowledge from conventional genetic experiments that the site of C is distal to the site of 90 and proximal to the site of H21 forms the starting point for construction. The pertinent datum for the F_1 between two heteroalleles is whether or not recombination is observed. A Wx frequency of less than 1.5×10^{-5} is interpreted as evidence that two alleles do not recombine. As previously, the map is constructed as a complementation map to emphasize the apparent length of many of the mutants. If the lines depicting the locations of two mutations overlap, the mutations do not recombine; if not, recombination takes place.

The revised map of the locus is not much different than that presented in 1968. It is still not clear whether m-6 is located proximal or distal to C.

The mutations B7 and C34, which appear to cover virtually all other mutations, have now been tested with a number of other mutations. Only B7 and C31 recombine (and at a low frequency); neither B7 nor C34 recombines with any other mutant against which it has been tested.

The paucity of lines in the area of the map subtending C1 may indicate a misplacement of this allele. It shows recombination with every allele with which it has been tested except B7 and C34. It was placed in its present position because such a position best fitted the Wx frequencies observed in heteroallelic combinations with various other wx alleles. It will not be certain that C1 is correctly placed until an allele is found that is non-recombining with both R and C1 or with both C1 and F. If it is correctly placed, there is an interesting discontinuity in this area.

In addition to the controlling element alleles m-1, m-6 and m-8, which were placed on the 1968 map, two more controlling element alleles, B3 and B4, have been placed.

In an effort to make the map as complete as possible, the mutation BL2 has been placed tentatively on the basis of preliminary crosses. It should be pointed out that BL2 has not been crossed by m-6R. It is known to recombine with B but has not been tested with the other alleles that do not recombine with B. Two other mutants, BL1 and BL3, isolated by Briggs, have also been investigated. BL1 is apparently a slightly leaky mutant (synthesizes some amylose) and produces pollen grains that stain more deeply than the usual waxy pollen. It is therefore difficult to use in pollen analysis and has been set aside. BL3 is non-recombining with B but does recombine with BL2, C, F, R and H21.

M recombines at a low frequency with F, but has not been tested against C or BL2. For this reason its distal terminus is indicated by a dotted line indicating uncertainty.

Table 2 presents data for crosses between heteroalleles that have been made for the second time. Overall the results show generally good agreement, but in two crosses, B x B8 and B6 x B8, it would have been estimated from the original cross that there was a low rate of recombination between the alleles. The second time that these crosses were made and sampled, the results would have indicated no recombination between B8 and either B or B6.

Table 1. The mean Wx frequency (per 10^5) in the pollen of crosses between wx heteroalleles.

Hybrid	Year	Wx frequency ± $s_{\bar{x}}$	Plants No.
K/			
R	68GH	0	4
	68F	0	6
F	68F	5.7 ± 1.5	6
B	68GH	40.0 ± 11.2	5
	68F	31.0 ± 5.8	7
H	69F	0.4 ± 0.8	7
C1	69F	11.0 ± 1.3	6
J	69F	0	6
L	69F	31.0 ± 4.3	7
M	69F	4.3 ± 0.8	6
m-8	70F	0	9
I	70F	0.4 ± 0.2	10
H21	70F	0.5 ± 0.3	8
m-1	70F	19.0 ± 2.1	6
F	70F	25.0 ± 3.9	7
B7/			
C31	69GH	3.0 ± 0.8	5
	69F	1.3 ± 0.5	6
B	69GH	0.3 ± 0.3	6
90	69GH	0	2
B1	69GH	0	4
B6	69GH	0.3 ± 0.3	6
C	69F	0	4
C1	71F	0	9
H21	71F	0.6 ± 0.3	8
B4/			
C2	69F	1.2 ± 0.5	8
C3	69F	5.3 ± 0.9	6
m-8	69F	1.6 ± 0.5	8
M/			
R	68GH	15.0 ± 3.9	6
F	68GH	1.6 ± 1.0	5
	71F	2.2 ± 0.7	7
	72F	2.8 ± 0.9	7
B	68GH	0	4
C1	72F	2.7 ± 1.4	7
B1	69F	0.3 ± 0.3	7
B6	69F	0	7
B8	69F	0.6 ± 0.3	8
90	70F	0	9
m-6R	70F	4.6 ± 1.1	8
	71F	1.4 ± 0.6	7
	72F	2.7 ± 0.9	7
C4	71F	1.8 ± 0.7	5
C31	71F	0	10
m-1	71F	5.1 ± 1.1	7
L/			
R	68GH	20.0 ± 3.4	6
	68F	8.0 ± 2.7	7
F	68GH	1.0 ± 0.7	7
	68F	1.8 ± 0.7	7
B	68GH	0	5
90	69F	0.3 ± 0.3	6
m-6R	69F	4.6 ± 0.8	8
B1	69F	0.5 ± 0.4	6
C1	70F	23.0 ± 1.7	7
B6	70F	1.1 ± 0.3	8
C4	71F	0	3
C	71F	28.0 ± 5.6	8
C31	71F	3.6 ± 1.2	10
B8	71F	6.3 ± 1.3	10
B7	70F	0.5 ± 0.3	8
C31/			
m-6NR	68F	22.0 ± 8.8	7
	69GH	16.0 ± 3.6	6
B	68GH	1.0 ± 0.9	5
	69GH	0.8 ± 0.5	6
90	68GH	1.1 ± 0.7	6
	69GH	0	11
B1	68F	5.7 ± 0.4	7
	71F	5.5 ± 1.3	8
B6	69GH	0	9
B8	68F	2.3 ± 0.6	7
	69GH	2.5 ± 1.2	6
	71F	2.9 ± 0.5	10
C4	71F	20.0 ± 4.2	8
B2/			
J	69F	1.3 ± 0.7	7
H	69F	2.0 ± 1.1	3
B4	69F	10.0 ± 2.4	6
C2	69F	1.3 ± 0.5	8
C3	69F	0	7
m-8	69F	0	8
B3/			
H21	71F	3.9 ± 1.2	8
R	71F	0.9 ± 0.5	9
m-8	71F	1.6 ± 0.5	9
C2	71F	1.6 ± 0.4	7
C3	71F	0.1	10
B2	71F	6.6 ± 2.3	10
H	71F	8.7 ± 2.0	9
	72F	8.0	6
I	71F	1.1 ± 0.4	9

Table 1.--continued

Hybrid	Year	Wx frequency ± $s_{\bar{x}}$	Plants No.
C34/			
B2	68GH	0.3 ± 0.3	6
	68F	0.9 ± 0.6	7
B4	68GH	0.3 ± 0.3	6
	68F	0.2 ± 0.2	7
I	68GH	0.8 ± 0.4	6
F	68GH	0	5
	68F	0.2 ± 0.3	7
B1	69GH	0.7 ± 0.5	6
B6	69GH	0	10
B8	69GH	0	7
C1	69GH	0.1 ± 0.1	5
90	69GH	0	7
B7	69GH	0	6
C31	69GH	1.7 ± 0.5	5
	69F	0	9
BL3/			
H21	71F	39.0 ± 5.5	7
C	71F	38.0 ± 7.3	7
R	71F	18.0 ± 2.7	10
B	71F	0.9 ± 0.4	7
	72F	0.6 ± 0.4	7
F	71F	29.0 ± 4.5	9
Stonor/			
C31	71F	10.7 ± 1.7	9
C34	69GH	0.1 ± 0.1	6
C1	69GH	2.9 ± 1.5	5
	69F	5.1 ± 1.2	6
90	69GH	6.4 ± 2.1	5
B	69GH	0.4 ± 0.4	5
B1	69GH	10.0 ± 2.9	6
B7	69GH	0.2 ± 0.2	6
C4	71F	7.0 ± 2.4	5
C	71F	0	8
m-6R	71F	0.8 ± 0.5	7
BL2/			
BL3	68F	33.0 ± 2.9	6
	71F	46.0 ± 10.4	5
C	71F	0	7
H21	71F	74.0 ± 12.5	5
R	71F	29.0 ± 2.6	10
F	72F	2.1 ± 0.9	7
B	72F	22.0 ± 4.1	7

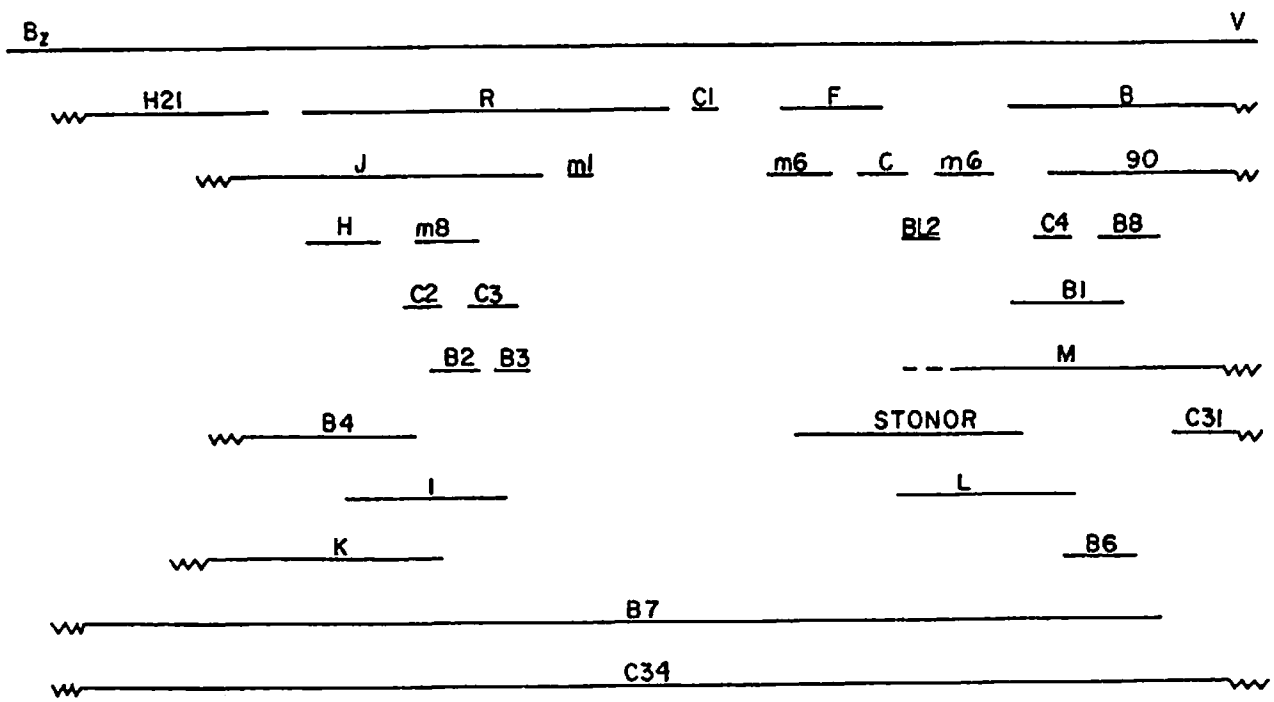

Table 2. The mean Wx frequency (per 10^5) of the pollen of crosses between wx heteroalleles made and sampled for the second time.

Hybrid	Year	Wx frequency ± s_x	Plants No.	Hybrid	Year	Wx frequency ± s_x	Plants No.
m-6R/				B6/			
m-8	Prev.	26.0 ± 2.5	3	B8	Prev.	3.1	3
	69F	13.0 ± 5.2	7		69H	0.8	1
90/				B/			
B	Prev.	1.4	4	B1	Prev.	1.7	2
	69GH	0	6		69GH	0	5
B1	Prev.	0	4	B6	Prev.	1	2
	69GH	0.8 ± 0.4	6		69GH	0	6
B6	Prev.	0	2	B8	Prev.	3.2	2
	69GH	0	6		69GH	0.3 ± 0.3	4
I/				C2/			
J	Prev.	0	3	I	Prev.	0	3
	69F	0	7		69F	1.1 ± 0.5	10
H	Prev.	0.4 ± 0.2	3	C3	Prev.	3.7 ± 1.8	3
	69F	0.4 ± 0.4	7		69F	3.4 ± 1.1	6
B4	Prev.	2.0	1	m-8	Prev.	0.7 ± 0.2	3
	69F	0	6		69F	1.4 ± 0.7	6
C3/				m-8/			
I	Prev.	0	3	I	Prev.	0.4 ± 0.5	3
	69F	1.9 ± 0.7	7		69F	0	6
J	Prev.	0.1 ± 0.1	3	J	Prev.	0	3
	69F	0	7		69F	0	8
m-8	Prev.	1.0 ± 0.5	3	H	Prev.	13.0 ± 1.5	3
	69F	1.3 ± 0.4	6		69F	9.1 ± 1.2	7
B1/				H/			
B6	Prev.	0	2	C2	Prev.	15.0 ± 4.8	4
	69GH	0	3		69F	24.0 ± 1.5	6
B8	Prev.	1.4	2	C3	Prev.	21.0 ± 5.9	3
	69GH	0	3		69F	23.0 ± 2.8	9
J/				B2/			
H	Prev.	0	3	B4	Prev.	21.0	2
	69F	0.5 ± 0.2	7		69F	10.0 ± 2.4	6
B2	Prev.	None	None	C3	Prev.	None	None
	69F	0.8 ± 0.5	7		69F	0.3 ± 0.2	7
B4	Prev.	None	None				
	69F	0	6	B4/			
C2	Prev.	0	3	C3	Prev.	None	None
	69F	0.3 ± 0.4	5		69F	5.3 ± 0.9	6

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