poleward tip is suggestive of spindle fiber attachment. The knobless 3a fragment in K10 K10 plants does not pass rapidly to the pole but shows a delayed poleward movement and is drawn into the nucleus in about one half of the cells with fragments. Even in N10 N10 plants, acentric fragments of both types were included in some of the interphase and quartet nuclei. This behavior was not anticipated and cannot be attributed to attachment of the fragments to centric chromosomes in AI, since the frequency of attached fragments was low.

During second division the knobbed 7a fragment in K10 K10 plants is found at the pole of the spindle as early as MII. About half of the knobless fragments in K10 K10 plants are also found at the pole at MII and these may represent fragments which had been included in the interphase nucleus. In neither case did the fragment show any indication of spindle fiber attachment. We believe that the movement of the fragment at second division is passive, resembling the poleward movement of acentric fragments and other particles in mitotic cells of the endosperm described by Ostergren, Molè-Bajer, and Bajer (1960). Thus, any acentric fragment incorporated into the nucleus at the end of the first division rapidly moves to the pole in the second division, with the exception of attached fragments which may be released into a dead zone at the equatorial plane of the spindle.

The question remains whether or not the fragment persists through additional mitotic divisions. Genetic tests of the transmission of deficient bridge chromatids by pollen grains in which the vegetative nucleus contains an acentric fragment are in progress and mitotic divisions following fertilization will also be examined for presence of the fragment.

Ellen Dempsey
M. M. Rhoades

4. Evidence for an effect of the elongate gene on crossing over in chromosome 5.

The elongate gene has a number of effects when homozygous. These include, among others, the production of unreduced eggs in varying proportions with haploid eggs, pollen and ovule abortion, uncoiling of the

Table 1

Comparison of recombination in El el and el el sibs: family 713

Used as:	El el plants				el el plants			
	No. of progeny	% Recombination			No. of progeny	% Recombination		
		A-Bt	Bt-Pr	Total		A-Bt	Bt-Pr	Total
♀	458	3.5	15.7	19.2	336	10.1	30.1	40.2
	459	4.8	14.7	19.5	137	13.1	27.1	40.2
	522	1.3	18.5	19.8	114	10.5	30.6	41.1
	488	2.7	19.8	22.5	279	13.3	32.2	45.5
	339	7.7	20.5	28.2	202	8.4	37.9	46.3
	439	6.4	22.5	28.9	207	7.7	40.3	48.0*
	464	5.0	25.4	30.4	100	11.0	37.8	48.8
	422	6.2	24.8	31.0				
	546	3.3	30.6	33.9				
	481	6.7	32.8	39.5				
	427	5.4	35.5	40.9				
Wt. mean		4.6	23.8	28.4		10.5	33.6	44.1
♂	288	4.2	22.3	26.5	290	10.7	28.2	38.9
	396	7.1	23.4	30.5	387	14.7	31.9	46.6
	418	5.5	27.4	32.9	328	13.7	33.8	47.5
	344	3.8	30.7	34.5	364	20.6	29.7	50.3
	240	2.5	32.4	34.9	328	16.8	34.2	51.0
	341	5.0	31.4	36.4	326	15.3	37.1	52.4
	250	6.8	33.6	40.4	418	17.9	36.1	54.0
Wt. mean		5.1	28.4	33.5		15.9	33.1	49.0

*Combined data of 3 ears.

chromonemata at both meiotic anaphases and telophases, sporadic neocentromere formation at M II and occasional misdivision of the centromere at M II (Rhoades & Dempsey, Genetics 54:505-522, 1966). That this mutant may also influence crossing over is indicated by the following experiments.

Plants of two families which were of the genotype $\underline{A_2}$ $\underline{Bt_1}$ $\underline{pr}$/ $\underline{a_2}$ $\underline{bt_1}$ $\underline{Pr}$ and segregating for $\underline{El}$ $\underline{el}$ and $\underline{el}$ $\underline{el}$ were backcrossed as males and as females to $\underline{a_2}$ $\underline{bt_1}$ $\underline{pr}$ testers. The elongate plants were identified on the basis of pollen abortion and the presence of both plump and shriveled kernels on the ears. Where these plants were used as females, the recombination values were derived from the plump kernels, i.e. those which had developed from haploid eggs. All recombination percentages for the $\underline{Bt_1}$-$\underline{Pr}$ region were calculated from the $\underline{A_2}$ classes only, since $\underline{a_2}$ kernels lack aleurone color and cannot be directly classified for $\underline{Pr}$ and $\underline{pr}$. The results are given in Tables 1 and 2.

It is clear that the recombination percentages for the elongate plants are higher than for their $\underline{El}$ $\underline{el}$ sibs and that the effect is particularly striking in the case of the $\underline{A_2}$-$\underline{Bt_1}$ region, where the increase is approximately two- to threefold.

Possible explanations of these differences in recombination are:

1. A factor linked to the elongate locus affects crossing over. If this is the case, the linkage is close because an examination of the $\underline{A_2}$-$\underline{Bt_1}$ recombination values for male flowers, which show the greatest differences, reveals that there is no overlap between the figures for $\underline{El}$ $\underline{el}$ and $\underline{el}$ $\underline{el}$ plants. With loose linkage, some overlap would be expected among the 30 plants tested, due to crossing over between the elongate locus and the site of the "crossover factor" in the $\underline{El}$ $\underline{el}$ parent of each of the two families which were backcrossed.

2. The elongate gene itself affects crossing over. Since elongate is known to affect the behavior and appearance of meiotic chromosomes, this would seem to be the more likely possibility.

In an experiment similar to those described above, $\underline{Sh_1}$, $\underline{Bz_1}$, and $\underline{Wx}$, which are located distally on the short arm of chromosome 9, were used as markers. Progeny sizes were as follows:

Table 2

Comparison of recombination in El el and el el sibs: family 717

Used as:	El el plants				el el plants			
	No. of progeny	% Recombination			No. of progeny	% Recombination		
		A-Bt	Bt-Pr	Total		A-Bt	Bt-Pr	Total
♀	542	4.2	20.9	25.1	157	7.0	18.7	25.7
	472	3.6	22.0	25.6	129	5.4	29.7	35.1
	334	4.2	21.4	25.6	147	4.8	36.0	40.8
	428	3.3	22.3	25.6	165	8.5	33.8	42.3*
	353	2.8	25.4	28.2	134	10.4	32.8	43.2
	483	4.8	24.3	29.1	143	10.5	37.9	48.4
	456	4.2	27.6	31.8				
	464	4.3	27.6	31.9				
	323	4.6	30.4	35.0				
Wt. mean		4.0	24.6	28.6		7.8	31.4	39.2
♂	299	7.4	15.8	23.2	319	11.3	27.7	39.0
	274	4.0	20.8	24.8	208	12.5	27.9	40.4
	437	3.2	24.6	27.8	337	13.6	33.8	47.4
	248	7.3	22.8	30.1	396	14.4	38.6	53.0
	457	4.2	26.0	30.2	318	13.2	40.8	54.0
	326	7.4	24.7	32.1	429	15.4	40.3	55.7
	270	6.3	26.5	32.8	362	17.1	39.8	56.9
	435	8.3	26.4	34.7	234	20.9	39.8	60.7
Wt. mean		5.9	23.8	29.7		14.8	36.6	51.4

*Combined data of 4 ears.

El el ♀♀ = 4968	El el ♂♂ = 3914
el el ♀♀ = 2165	el el ♂♂ = 3472

Little or no differences in recombination between elongate plants and their normal sibs were detected. This is in agreement with the finding of Rhoades & Dempsey that crossing over between Sh_1 and Wx and also between the distal Lg_2 and A_1 markers of chromosome 3 in elongate plants corresponds well with the standard values.

While the lack of an effect on recombination in these two regions could be due to differences in genetic background or to the absence of a "crossover factor" linked to el, it is suggested that the effect of elongate, or the linked factor as the case may be, on crossing over differs in different portions of the genome. The A_2-Pr region spans the centromere of chromosome 5 with Bt_1 marking the centromere, and is known to be very sensitive to certain other genetic factors which influence crossing over. The fact that the differences in recombination are greater in the shorter, and therefore more proximal, A_2-Bt_1 region than in the longer Bt_1-Pr region could be an indication that the effect is more pronounced closer to the centromere.

A further point of interest which may be noted here is the variable way in which recombination in chromosome 5 is influenced by sex. Rhoades (J. Am. Soc. Agron. 33:603-615, 1941) reported that crossing over in the A_2-Pr region is higher in male than in female sporocytes. Most structurally normal stocks tested have shown this sex difference, which may vary from large to small, while in a few cases (Phillips, Genetics 61:117-127, 1969) it has not been found. Examples of extremes in the range of variation are illustrated in Table 2, where the male and female values for El el plants are very similar, and in Table 1 on page 67 of this Newsletter, where recombination is very much higher in male than in female flowers of both the normal and As as classes.

Paul M. Nel