

between the centromere and the locus in question and the crossover chromosomes at first division must segregate to the same interphase nucleus. The segregation of crossover chromosomes to the same interphase nucleus has been designated as genetic non-disjunction in the literature. Genetic non-disjunction, if it occurs at random, will occur 1/3 of the time.

The formula for computing the coefficient of double reduction is: $\alpha = ae$, where a equals the frequency of genetic non-disjunction and e is the frequency of crossing-over between the centromere and the locus in question. By solving this formula for e we can obtain the frequency of crossing-over, $e = \alpha/a$.

Mather has presented formulas for the solution of alpha by combining the backcross and F_2 data into maximum log likelihood equations. Presently, this backcross and F_2 data is being obtained for marker genes on chromosomes 2, 3, 4, 5, 6, 9, and 10. From this data estimates of alpha value will be obtained and subsequently the amount of crossing-over between marker gene and the centromere will be ascertained. The value of e (i.e. the cross-overs between the centromere and the marker locus) represents the map units between the centromere and the gene in question. Hence it will be possible to genetically locate many of the centromeres of maize.

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1. Colorless components of the $A^b:Ec$ and $A^b:P$ complexes in maize.

It has been reported earlier (MNL 33) that when alpha derivatives of crossover stable, crossover mutable and noncrossover classes from $A^b:Ec$ and $A^b:P$ are compounded with A^b and A alleles, colorless cases (a^*) of both crossover and noncrossover origins are recovered from all three classes of alphas from $A^b:Ec$ and from the crossover mutable alphas of the $A^b:P$ source; the crossover stable and noncrossover pale isolates from $A^b:P$ do not yield any colorless cases of recombinant origin. On the basis of similarity in frequencies of a^* cases of crossover origin in case of crossover stable and noncrossover alpha isolates from $A^b:Ec$, and the complete absence of a^* derivatives of crossover origin from noncrossover and crossover stable pale cases from the $A^b:P$ source, it was concluded that the non-crossover alpha isolates are not a result of the mutation of the β element of the respective A^b complexes. The two classes of alpha

occurrences, crossover stable and noncrossover, are thus structurally similar and there is no indication of a separable element at the site of β . In the process of production of pale derivatives as noncross-overs, β thus appears to be eliminated from the complex.

The noncrossover a^* cases from heterozygotes involving the three classes of alphas from each source represent isolates from the α -bearing strand; one exceptional case, however, turned out to be a single-step change of $A^b:Ec$ to a colorless state. The crossover a^* cases from alphas of the $A^b:P$ source (designated $\alpha:P$) where only crossover mutable alpha cases yield such derivatives, represent recombination for the proximal marker (T) of the α -carrying strand and the distal marker (sh or et) of the homologue. The crossover a^* cases from alphas of the $A^b:Ec$ source ($\alpha:Ec$), where all three classes of pale derivatives yield such cases, are found to be recombinants between the distal marker of the alpha-bearing chromosome and the proximal marker of the homologous strand. The direction of the recombination leading to the isolation of a^* cases of crossover origin shows that, in case of $\alpha:P$, the colorless component or components are situated at the left of the α element and, in case of $\alpha:Ec$, at the right.

Data on frequencies of recovery of colorless cases from the various sources have been presented earlier. Some of the a^* cases obtained have not been tested for the mutability in presence of Dt and the dominant or recessive brown nature of the pericarp in the presence of P. A summary of results of the tested cases is presented below and the discussion that follows is restricted to these a^* cases.

Table I

Tests on a^* cases

Description of a^* cases	No. of a^* cases from			
	$\alpha:Ec$		$\alpha:P$	
	Co	Nco	Co	Nco
<u>From crossover stable</u>				
Mutable, recessive brown ..	0	0	0	1
Stable, " ..	4	5	0	1
" , dominant brown ..	0	2	0	0
Indecisive, " ..	0	1**	0	1
<u>From crossover mutable</u>				
Mutable, recessive brown ..	3	8+1**	2**	0
" , dominant brown ..	0	3	1	4+1**
Indecisive, recessive brown ..	0	1	0	0
<u>From noncrossover</u>				
Stable, recessive brown ..	5	7	0	1
" , dominant brown ..	0	7	0	3
Indecisive, " ..	0	1	0	0

Co- crossover, Nco- noncrossover.

**From heterozygotes lacking distal marking in $\alpha:Ec$ and proximal marking in $\alpha:P$. In these α itself serves as a marker.

Recovery of crossover a^* cases from the crossover stable $\alpha:Ec$ shows that such alpha isolates are often associated with a separable, null level element which is stable under the action of Dt and is associated with recessive brown pericarp. Of the 13 crossover stable $\alpha:Ec$ cases used in the experiment, four gave stable, recessive brown a^* isolates of crossover origin and of the 12 noncrossover $\alpha:Ec$ cases tested, five appeared to be associated with such a separable element. The direction of recombination isolating the a^* cases indicates that the colorless, stable, recessive brown-acting element is situated at the right of the component in $A^D:Ec$. Colorless cases of crossover origin from the crossover mutable $\alpha:Ec$ source, of which 10 cases were included in the study, are all mutable and recessive brown. As the mutability of a crossover mutable α has been shown by Dr. Laughnan to be dependent on the association of α with the a :standard, which is itself mutable and recessive brown-acting, the a^* cases of crossover origin from this source may represent the a :standard element either singly or in association with the stable, recessive brown element recognized in case of the crossover stable and noncrossover α cases. The newly identified element, situated between α and β in $A^D:Ec$ complexes and predicted by Dr. Stadler in 1951, is tentatively designated a^{rb} .

The similarity of structure between the crossover stable and noncrossover α isolates shows that the noncrossover process is an aberrant type of crossing over, which isolates the existing components of a complex and is not connected with intragenic mutation. As such, the characteristics of the noncrossover a^* cases can be used to identify the colorless elements in the $A^D:Ec$ complex. All noncrossover a^* cases from crossover stable and noncrossover $\alpha:Ec$ sources are stable and are either recessive or dominant brown-acting. From the crossover mutable $\alpha:Ec$, the noncrossover a^* cases are recessive or dominant brown, but are mutable. Since crossovers have so far separated only the a^{rb} element, the dominant brown element, designated a^{db} and recovered among noncrossovers, seems to be situated in such a position that it can be excluded in a crossover. This is possible when it is closer to the α component than is the a^{rb} element. The evidence presented suggests that the $A^D:Ec$ complex consists of four elements, α , a^{db} , a^{rb} , and β , arranged in that order.

Four crossover stable, six crossover mutable and seven noncrossover α cases from the $A^D:P$ source were used in the present experiment. The crossover stables and noncrossovers did not yield any a^* cases of recombinant nature. Two of the crossover mutable $\alpha:P$ cases gave three colorless derivatives of crossover origin, one producing one and the other, two; the latter are mutable and recessive brown as is the a :standard. The single a^* case of crossover origin, deriving from a heterozygote marked on both sides, proved to be mutable but showed dominant, instead of the recessive brown pericarp character normally associated with the a :standard element. As such, the two

mutable, recessive brown cases are held to represent the \underline{a} :standard element either singly or in association with a colorless, recessive brown element, not so far identified through crossovers. Since the single crossover \underline{a}^* case is mutable, but dominant brown, the \underline{a} :standard element of the mutable $\alpha:P$ is located in such a manner with respect to the dominant brown-acting element, that a crossover event can either include or exclude the latter. As in the case of the \underline{a}^{db} element of the $\underline{A}^b:Ec$, this element, which also may be designated \underline{a}^{db} , is thus situated closer to α than is the \underline{a} :standard element of the crossover mutable $\alpha:P$.

Tests on the noncrossover \underline{a}^* cases from crossover stable and noncrossover $\alpha:P$ isolates show that all such colorless cases, except one, are stable but recessive or dominant brown. This exceptional case is mutable and recessive brown.

Noncrossover \underline{a}^* cases which are stable and dominant brown may or may not include the recessive brown null element, but the stable recessive brown cases clearly lack the dominant brown element. As noncrossover \underline{a}^* cases, which are either dominant or recessive brown but stable, are recovered from crossover stable and noncrossover $\alpha:P$ cases, both colorless elements, one dominant brown (\underline{a}^{db}) and one recessive brown (\underline{a}^{rb}) appear to be associated with $\underline{A}^b:P$.

Since crossover \underline{a}^* cases from crossover mutable $\alpha:P$ are mutable but recessive or dominant brown-acting, the \underline{a} :standard element in mutable alphas may be located at one of three positions-- β , \underline{a}^{rb} , or \underline{a}^{db} . The direction of recombination and the fact that the \underline{a}^{db} may or may not be included in a crossover show that this element is closer to α than is the \underline{a}^{rb} . Thus the $\underline{A}^b:P$ complex, as is the $\underline{A}^b:Ec$ complex, is composed of at least four elements arranged in the order $\beta:\underline{a}^{rb}:\underline{a}^{db}:\alpha$. With respect to the centromere, the two complexes thus represent inversions of a locus consisting of at least four elements, the two median elements showing colorless nature; one of them is recessive brown-acting (\underline{a}^{rb}) and the other, dominant brown-acting (\underline{a}^{db}) but both are stable under the action of \underline{Dt} .

No explanation is at present possible for the mutability of a recessive brown colorless case of noncrossover origin from the crossover stable $\alpha:P$ source.

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