A GENETIC LINKAGE IN *CICER ARIETINUM* L.

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THOUGH as many as seven pairs of chromosomes have been found in *Cicer* (Dombrowsky-Sludsky, 1927, and Rau, 1929), not a single genetic linkage has been reported so far. Pimplikar (1943) refers to the association observed between flower colour and seed coat colour as perfect linkage. However, from the results presented by him, it appears almost certain that it is a case of pleiotropy and not linkage. The association is obviously due to gene " P " which has been assumed to be common to both the pink-flowered and white-flowered parents, used in his cross. As the various colours of the flower and the seed coat are but the products of interaction of this gene with the other genes involved, pleiotropy has the semblance of linkage in the results that he obtained. It is proposed to give in this paper an account of a genetic linkage, not improbably a linkage group, discovered in the course of work done at the Crop Breeding Station, Bailhongal, State of Bombay.

In the year 1947, a cross was made between the mutant *alternifolia* (Argikar, 1950, *J. Ind. Bot. Soc.*, in press) and a plant of the " Dohad " type which possessed a normal, opposite leaflet arrangement. Incidentally, the cross involved also two other contrasting characters, namely (1) branching habit, and (2) period of maturity of which the former has been already reported to be monogenic (Ramanatha Aiyer *et al.*, 1937). The two parents possessed the characters in the following manner :—

Parent	Branching habit	Leaflet arrangement	Period of maturity
alternifolia	Umbrella-shaped (u) *	alternate (al)	Early (E) about 97 days
" Dohad " type	Basal (U)	Opposite (AL)	Late (e) about 113 days

* Letters within the brackets have been adopted as symbols for the characters, in this paper.

The F_1 plant had basal branching, opposite leaflet arrangement and was early to mature.

The F_2 progeny consisted, unfortunately, of only 69 plants resulting from the seed of only one F_1 plant. The phenotypic segregation was of the following kind :—

Parental types		Recombinant types						Total
U, Al, e	u, al, E	U, al, E	u, Al, e	U, Al, E	u, al, e	U, al, e	u, Al, E	
11	8	7	3	35	1	2	2	69

In spite of the small number, the segregation for the individual characters, which is in all cases monogenic, has been satisfactory as will be seen from the values of probabilities for goodness of fit.

Factor	χ^2	P
U-u	0·82	0·3-0·5
Al-al	0·13	0·7-0·8
E-e	0·014	0·9-0·95

The nature of the two-factor segregation is shown below :—

Factors taken together	χ^2_L	P
U-u and Al-al	11·63	0·01
Al-al and E-e	0·85	0·3-0·5
U-u and E-e	0·13	0·7-0·8

It will be seen from the statistics given above that the probabilities are high for the first pair of characters to be linked. In the case of the second pair, there are alternative possibilities of the factors being either very loosely linked or of their being independent of each other, a definite conclusion being impossible with such a small number of plants. The segregation of the third pair is such as to support either of the above alternatives, the view of loose linkage being admissible if the order of the three factors is assumed to be U-Al-E.

The percentage of recombination between the factors, U and Al, estimated by the Scoring Method (Fisher, 1946 ; Bhat, 1948) is 23·85. If the factor, E, be loosely linked to these two, the recombinations possible in the segments, Al-E and U-E would be of the order of 41·00 per cent. and 50·00 per cent. respectively, on the basis of segregation observed amongst the 69 plants. On making adjustments

with Kosambi's formula, which is applicable in this case, the possible estimates and map-lengths are as below :—

Segment	Recombination per cent.	Map-length in centimorgans	χ^2 for agreement with Kosambi's formula
U-Al	24·17	26·37	0·003
Al-E	43·07	64·93	0·044
U-E	47·47	91·30	0·373
		Total for (1 d.f.) . .	0·420

The perfect agreement of the data with Kosambi's formula shows that it is not improbable that all the three factors studied in this case are situated on the same chromosome.

Another possible method of testing whether the factor for flowering duration is or is not linked with the two other factors is to test the agreement of the observed frequencies of phenotypes with those to be expected on the basis of (1) loose linkage and (2) independence. This is done below :—

	Parental types		Types resulting from recombination in segments						Total χ^2 (7 d.f.)
			I		II		I and II		
	U, Al, e	u, Al, E	U, al, E	u, Al, e	U, Al, E	u, al, e	U, al, e	u, Al, E	
Observed	11	8	7	3	35	1	2	2	...
Expected on the basis of " E " being linked to U and Al	12·8	8·08	5·97	1·88	32·86	1·84	1·36	5·45	...
χ^2 for agreement .	0·114	0·001	0·178	0·667	0·139	0·383	0·301	2·184	3·967
Expected on the basis of independence of " E "	11·12	7·47	5·46	1·82	33·35	2·49	1·82	5·46	...
χ^2 for agreement	0·001	0·037	0·431	0·762	0·082	0·892	0·017	2·197	4·419

Even the above test leaves the question undecided, though the observed frequency of the critical triple recessive phenotype u, al, e, agrees better with that to be expected on the hypothesis of linkage rather than of independence. No definite conclusion can, therefore, be drawn until either about 2960 plants, required for discriminating the linkage between Al and E from independence, are bred or till a factor between the two is discovered.

SUMMARY

A linkage of 23·85 per cent. is reported between the factor for branching habit and that for leaflet arrangement in *Cicer arietinum* L.

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This is the first genetic linkage detected so far in the species.   It is not improbable that the factor for period of maturity is also linked to these two.

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