FAILURE TO TRANSMIT MUTANT PLASTIDS IN A PELARGONIUM CROSS

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1. INTRODUCTION

Reciprocal crosses between *Pelargonium zonale* cultivars with green germ layers and cultivars with white germ layers produce green, variegated and white offspring in proportions related to the individual plastid contributions of the two parents. Intercultivar crosses involving five different white-over-green chimeras with white germ layers agreed with this principle, but a sixth W-o-G chimera, Kathleen Harrop, when crossed with the wholly green cultivar Paul Crampel, gave only green offspring (table 1A). I suggested (1963*a* and 1963*b*) that this would be the expected result if K. Harrop is not a plastid- but a gene-differential chimera. The green seedlings would therefore be the F_1 heterozygotes of a cross between a homozygous dominant with green phenotype, and a homozygous recessive with white phenotype.

TABLE 1A

Results of selfing and reciprocal crosses between the Pelargonium chimera, Kathleen Harrop, with a white germ layer and the wholly green variety, Paul Crampel

Self or cross	Total Nos. and percentages						Offspring		
	Ovules pollnd.	Seeds				T. fertility (per cent.)			
		Full	Full (per cent.)	Germd.	Germd. (per cent.)		G	V	W
G self	490	116	23·6	97	83·6	19·8	97	—	—
G×W	*	—	—	—	—	—	3	—	—
W×G	520	70	13·5	63	90·0	12·1	63	—	—
W self	*	—	—	—	—	—	—	—	—

* K. Harrop is male sterile; it has only once produced good pollen which was used in the cross with Paul Crampel.

2. TESTING THE HYPOTHESIS

To test the hypothesis that K. Harrop is a gene-differential chimera, I potted-up eighteen of the green F_1 seedlings and flowered all but one in the following summer, 1963. Eight of these were hermaphrodite and nine male sterile. I selfed the hermaphrodites and crossed the females with pollen from the hermaphrodites. The seeds were sown in J.I. Seed Compost as soon as they were ripe, placed in a frame at 25° C. and kept well watered. All the germinating seeds were green (table 1B).

TABLE 1B

Results of selfing and intercrossing the green F_1 seedlings obtained from crossing Kathleen Harrop and Paul Crampel (table 1A)

Self or cross	Total Nos. and percentages						Offspring		
	Ovules pollnd.	Seeds				T. fertility (per cent.)			
		Full	Full (per cent.)	Germd.	Germd. (per cent.)		G	V	W
G ♂ self	1870	278	14·9	243	87·4	13·0	243	—	—
G ♀×G ♂	1400	266	19·0	245	92·1	17·5	245	—	—
Totals .	3270	544	16·6	488	89·7	14·9	488	—	—

3. FAILURE TO TRANSMIT MUTANT WHITE PLASTIDS

The F_2 offspring showed no Mendelian segregation into green and white seedlings but were entirely green (table 1B). Moreover, the total fertility for the F_2 generation is slightly higher than for the F_1 so there is no reason to argue that the absence of the expected segregation is due to the inviability of numerous potentially white seedlings. My hypothesis that K. Harrop is a gene-differential chimera is therefore no longer tenable. The vegetative parts of two confirmed plastid-differential chimeras with white germ layers, Flower of Spring and J. C. Mapping, are indistinguishable from K. Harrop. The only apparent justification for separating the three as distinct cultivars is that they differ in flower colour and size and in the male sterility of K. Harrop. I believe that these two kinds of observation constitute reasonable grounds for considering that K. Harrop is, after all, a plastid-differential chimera similar to the five other *Pelargonium* chimeras, including Flower of Spring and J. C. Mapping, with which I made breeding experiments (1963*b*).

When F. of Spring was crossed with P. Crampel about one-third of the offspring were variegated or white showing that white plastids had been successfully transmitted. Whereas, within the limits of the number of seedlings produced by the crosses, the mutant white plastids from K. Harrop completely failed to be transmitted. This resulted in the exceptional, purely paternal inheritance of green plastids in the W×G cross as opposed to the maternal inheritance of the same green plastids in the reciprocal, G×W cross. The behaviour of the two kinds of plastid is evidently more important than the direction of the cross. I do not know exactly what happens to the white plastids but I suggest that one or other or both of the following reasons could explain their failure to be transmitted:

1. Far fewer white than green plastids are contributed to the fertilised egg so that during subsequent embryo development the white plastids are completely swamped by the green.
2. The green plastids multiply more rapidly than the white. This would be particularly important in the zygote and in the first few divisions of the embryo when the two kinds of plastid are together in the same, mixed cell.

Under these circumstances, with each successive cell division there could be so rapid an increase of green plastids over white that the white plastids would be overwhelmed without ever having sorted-out to give any pure white cells. Similarly, mixed cells would rapidly be outnumbered by pure green cells.

No doubt other explanations can also be given but we need to know much more about these little studied mutant plastids before we can draw any firm conclusions relating to such peculiarities of plastid transmission.

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4. REFERENCES

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