



An inheritance and cytological study of the rabbit-eared rogue or Tare of garden peas, *Pisum sativum* L.

by William L Marchant

A THESIS Submitted to the Graduate Division in partial fulfillment of the requirements for the degree of Master of Science in Agronomy at Montana State College

Montana State University

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Abstract:

The "rabbit-eared" rogue or Tare of garden peas *Pisum sativum* L. is a recurring mutation which appears in certain varieties. Four varieties with different rates of Tare expectancy were studied. These were Laxton's Superb, with a Tare expectancy of one Tare in 200 plants; Thomas Laxton, with one Tare in 250 plants; Teton, with one Tare in 670,000 plants and Perfection which throws no Tares. A pure-line Tare strain originally taken from Thomas Laxton was also studied.

Plantings were made in the greenhouse at Montana State College during the winter of 1948-49. Crosses were made with the varieties using the Tare as male parent. Young flowers in the bud stage were taken from the plants for cytological study.

Seed obtained from the crosses was planted in comparison with the parent in randomised plots and measurements were made of the plant stipules and internodes.

The Ferric-acetocarmine squash technique was used to stain the chromosomes of the tapetal tissue of the anthers. Irregular mitotic divisions were noted and consisted of chromosome bridges, laggards and fragments. The percentage of irregular mitotic cell divisions was as follows: Laxton's Superb 26.2, Tare 20.0, Thomas Laxton 19.1, Teton 7.7 and Perfection 7.37.

A definite correlation between the amount of Tares produced in a variety and the percentage of mitotic irregularities in a variety was noted.

The stipule ratio, length over width, increased in all the varieties, except in Perfection, and even Tare and plants showed an increase as the plants matured. There was a greater correlation between the stipule ratios of the plants and the Tare parents than between the F₁ and the Type parents.

There was a correlated increase in the internode length of all the varieties and the plants. The correlation, however, was stronger between the Tare and the than between the Type and the plant internodes.

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79 J. J. Graduate Committee 204

TABLE OF CONTENTS

	Page
LISTING OF TABLES, GRAPHS AND FIGURES	4
ABSTRACT	6
INTRODUCTION	8
REVIEW OF LITERATURE	10
MATERIALS AND METHODS.	14
EXPERIMENTAL RESULTS	21
DISCUSSION	33
SUMMARY.	37
LITERATURE CITED	38

LIST OF TABLES

	Page
Table I Observations of mitotic divisions of the anther tapetal cells of Laxton's Superb, Thomas Laxton Tare, Thomas Laxton, Teton and Perfection.	27
Table II Stipule ratio and internode length averages of F_1 and parent plants	28
Table III Calculated correlations of parent and F_1 populations for stipule ratio and internode length.	29

LIST OF GRAPHS

Graph I Average percentages of mitotic irregularities occurring in the mitotic cell division of the anther tapetal cells in Thomas Laxton, Tare, Laxton's Superb, Teton and Perfection.	30
Graph II Average stipule ratios plotted to show the correlation between the F_1 and its parents.	31
Graph III Average internode lengths plotted to show the correlation between the F_1 and its parents.	32

LIST OF FIGURES

Figure 1. A. Plants of the Thomas Laxton variety. B. Plants of the Teton variety. C. Plants of the Thomas Laxton Tare. The pictures show the broad, blunt stipules of Thomas Laxton and Teton in contrast to the narrow pointed stipules of the Tare plants.	17
Figure 2. A. Plants of the Perfection variety. B. Plants of the Laxton's Superb variety. C. Plants of Thomas Laxton Tare. The pictures show the broad, blunt stipules and short internodes of Perfection and Laxton's Superb compared to the narrow, pointed stipules and long internodes of the Tare plants.	18

LIST OF FIGURES cont'd

Page

- Figure 3. A - Thomas Laxton X Tare(left) and Thomas Laxton (right) showing narrow stipules of F_1 plant in contrast to broad stipules of Thomas Laxton. . . 19
- B - Photograph of Teton (left) and Teton X Tare showing narrow stipule of F_1 19
- Figure 4. A - Photograph of Perfection (left) and F_1 (right) showing broad stipule and short internodes of Perfection compared to narrow stipule and long internodes of Tare. 20
- B - Photograph showing short broad-leaved Laxton's Superb plants compared to tall narrow stipuled F_1 plants 20
- Figure 5. A - Photomicrograph of mitosis at anaphase showing a chromosome gridge and fragment. 22
- B - Photomicrograph of mitosis at anaphase showing a chromosome bridge 22
- Figure 6. Mitotic cell division at anaphase
- A - Normal separation of chromosomes.
- B - C- D- Irregular division with chromosome bridge formed across the equatorial plate.
- C - Shows two chromosomes, in addition to the bridge, lagging behind the majority of chromosomes. 23
- Drawings made with the aid of a camera lucida.

ABSTRACT

The "rabbit-eared" rogue or Tare of garden peas Pisum sativum L. is a recurring mutation which appears in certain varieties. Four varieties with different rates of Tare expectancy were studied. These were Laxton's Superb, with a Tare expectancy of one Tare in 200 plants; Thomas Laxton, with one Tare in 250 plants; Teton, with one Tare in 670,000 plants and Perfection which throws no Tares. A pure-line Tare strain originally taken from Thomas Laxton was also studied.

Plantings were made in the greenhouse at Montana State College during the winter of 1948-49. Crosses were made with the varieties using the Tare as male parent. Young flowers in the bud stage were taken from the plants for cytological study.

Seed obtained from the crosses was planted in comparison with the parent in randomized plots and measurements were made of the plant stipules and internodes.

The Ferric-acetocarmine squash technique was used to stain the chromosomes of the tapetal tissue of the anthers. Irregular mitotic divisions were noted and consisted of chromosome bridges, laggards and fragments. The percentage of irregular mitotic cell divisions was as follows: Laxton's Superb 26.2, Tare 20.0, Thomas Laxton 19.1, Teton 7.7 and Perfection 7.37.

A definite correlation between the amount of Tares produced in a variety and the percentage of mitotic irregularities in a variety was noted.

The stipule ratio, length over width, increased in all the varieties, except in Perfection, and even Tare and F_1 plants showed an increase as

the plants matured. There was a greater correlation between the stipule ratios of the F_1 plants and the Tare parents than between the F_1 and the Type parents.

There was a correlated increase in the internode length of all the varieties and the F_1 plants. The correlation, however, was stronger between the Tare and the F_1 than between the Type and the F_1 plant internodes.

AN INHERITANCE AND CYTOLOGICAL STUDY
OF THE "RABBIT-EARED" ROGUE OR TARE
OF GARDEN PEAS Pisum sativum L.

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INTRODUCTION

The "Rabbit-eared" Rogue or Tare of garden peas is an off-type plant which occurs in many varieties of garden peas Pisum sativum L. These plants are distinguished from the Type plants of the varieties in which they originated by being darker in color, having more narrow stipules, maturing slightly earlier and by being as tall or slightly taller than the Type plants. There is little, if any, difference between the number of nodes of the Tare and the Type. Any difference between the two in plant height is due to internode length.

Because Tares are considered undesirable by commercial canners and freezers of peas, the seed-producers must take measures to insure there being as few Tare plants as possible present in their seed crops. At present two practices are used by companies producing quality pea seed to cut down the number of Tares present in their stocks.

In the first method the Tares are removed from production fields by crews of men handpulling the undesirable plants. This is, of course, an extremely expensive procedure.

In the second method early generation lines of new material are discarded if an abnormally high percentage of Tare is present. Some success has been obtained in producing relatively Tare-free varieties by outcrossing to varieties which do not throw Tares.

This study was initiated in the hope that means could be found to enable plant breeders to cytologically screen breeding material and eliminate lines which might be potential Tare producers.

The varieties chosen for this work had wide range of Tare expectancy, or mutation rate, varying from one Tare expected in two hundred plants to a variety which throws no Tares.

Because of the generally confused situation regarding the naming of pea varieties, it is very difficult to trace the parentage to the original source. There does not appear to be a common source for varieties producing Tares.

REVIEW OF LITERATURE

The narrow, pointed stipuled mutation or "rabbit-eared" rogue in garden peas, Pisum sativum L., has been studied genetically by many workers. In 1915 Bateson and Pellew(1)^{1/} reported that in crosses with the parent or broad, obtusely stipuled type, the rogue character is dominant, and that in the F_2 and succeeding generations only rogues appear. They(2) later noted intermediate forms which on self-fertilization gave varying proportions of rogues, intermediates and Types in their progenies. The intermediates, showing a high percentage of rogues among their offspring, displayed a progressive increase in the percentage of rogues to non-rogues among their progeny when comparing plants derived from the lower nodes with offspring from the upper nodes of the same intermediate plant. This change in ratio between the two classes of plants was accounted for by a corresponding increase among the male gametes of those bearing the factor for rogues.

Brotherton(3), in 1923, reported segregation in the F_2 generation of crosses between Gradus rogue and typical plants of Mummy, a non-rogue producing pea variety. However this segregation of rogue and Type plants in the F_2 and F_3 generations did not follow any known Mendelian ratio. The rogues greatly outnumbered the non-rogues. The F_1 generation plants resembled those described by Bateson and Pellew as intermediates.

In order to obtain a more exact comparison of the rogues and Types, and the F_1 and F_2 generations of hybrids between the two, Brotherton

^{1/} Numbers in parentheses refer to literature cited on page

measured the length and width of the stipules from the fourth to the ninth node of the various plants he was working with. The ratio of width to length of stipule was then calculated. He states, "The F_1 hybrids up to the seventh node are like the type, or intermediate between the type and rogue; above the seventh node the plants become rapidly more roguelike".

He further states, "The influence of the type parent, in crosses between the Types and rogue is apparent only in the F_1 plant and at only the lower nodes".

Brotherton advanced the hypothesis that rogues arise de novo from the parent type by mutation of a single factor, x to X , and that the heterozygous Xx combination is very unstable. The factor x in the presence of X readily mutating to X during somatic development so that at gametogenesis the F_1 hybrid of Type with rogue is homozygous for the rogue factor XX .

He calls the allelomorph of X in Mummy x' and states that it differs from x of the rogue-producing variety in being more stable, rarely, if ever, mutating to X when in the homozygous $x'x'$ condition. In the heterozygous Xx' combination (F_1 and succeeding generations of rogue X Mummy), however, the combination, while being more stable than the Xx germ plasm of rogue x Type, nevertheless is fairly unstable, and x' mutates frequently to X . The frequent change of x or x' to X during the development of the plant is called "mass somatic mutation" and the unequal proportion of the two kinds of gametes formed, x or $x':X$, results in masking the true Mendelian inheritance.

Miss Pellow(8) states, " F_1 rogues, ex type X rogue, and reciprocal, crossed back with Type, give rogues and an occasional Type and intermediate

plant. The exceptional plants have come from F_1 x Type, and not from the reciprocal cross. The F_1 rogue appears to differ only in degree from those intermediate plants which arise spontaneously in the variety Early Giant, and which give a mixture of Types, intermediates and rogues. A higher proportion of Types and intermediates come from the female gametes than from the male, and from the lower nodes than from the upper".

Bunten, (4) in 1930, reported the diploid chromosome number of Gradus peas, whether Type or rogue, to be 14. This confirms the observations of Matsuura (6) and Winge (12). Miss Bunten states, "If Brotherton's hypothesis concerning mass somatic mutation is to be applied here, it must be based, as Brotherton assumes, on some change other than chromosome number".

The occurrence of somatic mutations has been reported by Emerson (5) in corn. He studied a variegated variety of maize that had a white pericarp with numerous red spots of varying size. Genetically these plants were homozygous for the recessive gene for white. He considered this gene to be unstable, mutating spontaneously into the dominant allele for red. Consequently each red spot on the kernel was made up of cells which came from one cell in which such a mutation had occurred.

Somatic mutations occur frequently in the buds of some plants. These are known as bud sports, or bud mutations. The Naval orange is an example of a fruiting body produced on a shoot developed from a bud mutation (9). In many instances men working with peas have noted side shoots, from a Type plant, which were roguelike and which produced seed which in turn bred Tare plants while the main part of the plant produced seed breeding true to Type.

The lack of segregation in a cross between Tare and Type plants in the F_2 generation may be attributed to differential pollination. The pollen grains carrying the Tare gamet may be able to affect fertilization ahead of the pollen grains carrying the Type gamete. Because the Tare character is dominant, the recessive Type characters would, therefore, never appear.

Many cases of variable pollen vigor, such as is postulated above, have been reported. Stadler (11) has reported a chromosome segment deficiency in maize. The pollen grains carrying the deficiencies were smaller than normal and, except in rare cases, failed to produce a pollen tube, consequently being unable to fertilize an ovule. Muntzing (7) working with orchard grass, found that pollen grains carrying the haploid and diploid chromosome numbers were highly fertile, while those with intermediate chromosome numbers were very low in fertility.

MATERIALS AND METHODS

The varieties used in this study were Laxton's Superb H43611, ^{1/}(Fig.2B); Perfection H46876, (Fig.2A); Teton H47912, (Fig. 1B); Thomas Laxton H451201, (Fig.1A) and Thomas Laxton Tare H481045, (Fig.1C). The Thomas Laxton Tare line originated as a single plant selection in Thomas Laxton H451201 and was grown for three seasons (1946-1948) as an individual line. It is a true Tare and showed no segregation during the three seasons grown.

According to unpublished data recorded by Associated Seed Growers, Inc., workers and given to the author by Dr. W. H. Pierce, the following rates of Tare expectancy have been determined for the varieties under consideration:

Laxton's Superb	H43671	1 Tare in 200 plants
Thomas Laxton	H451201	1 Tare in 250 plants
Teton	H47912	1 Tare in 670,000 plants
Perfection	H46876	No Tares

Approximately 25 seeds of each of the varieties and Tare were planted on November 27, 1948 in the greenhouse at Montana State College. The seeds were spaced one inch apart in rows 20 inches apart. The soil was fumigated with a formaldehyde solution two weeks previous to the planting to reduce the danger from soil-borne plant pathogens.

The varieties Thomas Laxton, Laxton's Superb and Tare began blossoming on December 28, 1948, Teton on the 30th and Perfection on January 7, 1949. Crosses were made with the varieties, using the Tare as the male parent.

A second planting of the varieties and Tare was made on February 2, 1949 in order that buds could be secured for cytological study.

^{1/} Refers to Associated Seed Growers, Inc. line number.

The F_1 seed from the Tare crosses and parents was planted on February 25th for comparison. The seeds were planted in groups as follows: F_1 Thomas Laxton X Tare, Thomas Laxton, and Tare; F_1 Teton X Tare, Teton, and Tare; F_1 Laxton's Superb X Tare, Laxton's Superb, and Tare; F_1 Perfection X Tare, Perfection, and Tare. Four seeds of each F_1 and variety were planted four inches apart in rows eight inches apart. The varieties were randomized within groups and the groups within replications. Two replications were planted. Figures 3 and 4 show F_1 plants.

Stipule length and width was measured in centimeters at the first through the sixth node above the soil surface. The second internodes through the fifth above the soil surface were also measured.

The greenhouse temperature was maintained at 75°F. This is a little higher than is considered desirable for Pisum, but this temperature reduced the time required for flowering and made it possible to grow two crops during the winter months of 1948-49.

The relative humidity was held as close to 60 percent as was possible, and the day length was kept at 16 hours by using artificial light.

It was found that the blossom bud cells underwent the maximum number of mitotic divisions when they were approximately 1.5 to 3 mm. in length.

Considerable difficulty was encountered in obtaining pollen mother cells in division and consequently meiotic observations are not included in this report.

In order to study chromosome behavior the buds were plucked and immediately immersed in Carnoy's solution (6:3:1) and held at room temperature for a minimum of three days or until slides were prepared. The

Ferric-aceto-carmines squash method of slide preparation was used as follows:

1. The bud was removed from the Carnoy solution and the anthers dissected from the bud.
2. The anthers were immersed in 10% HCl for approximately one-half minute on an over-turned beaker.
3. The HCl was then blotted away and 2 to 4 drops of aceto-carmines stain ($\frac{1}{2}$ gm. carmine per 100 cc. acetic acid) were used to cover the anthers.
4. One drop of Ferric-acetate was added and stirred into the stain with a dissecting needle. The anthers were left to stain for one-half hour.
5. After staining the anthers were mounted in Aceto-carmines on a slide, covered, squashed by pressing the cover slip with the handle of a dissecting needle then heated for a few seconds over an alcohol lamp.
6. The cover slips were sealed with a temporary seal suggested by Smith (10) and held in place with a clothes-pin. The seal usually dried within a half-hour, but the clothes-pin was left in place over night.

Chromosome drawings were made free hand and also with the aid of a camera-lucida. Photomicrographs were taken with a 35mm. camera.



A



B



C

Figure 1. A. Plants of the Thomas Laxton variety. B. Plants of the Teton variety. C. Plants of the Thomas Laxton Tare. The pictures show the broad, blunt stipules of Thomas Laxton and Teton in contrast to the narrow pointed stipules of the Tare plants.



A



B



C

Figure 2. A. Plants of the Perfection variety. B. Plants of the Laxton's Superb variety. C. Plants of Thomas Laxton Tare. The pictures show the broad, blunt stipules and short internodes of Perfection and Laxton's Superb compared to the narrow, pointed stipules and long internodes of the Tare plants.



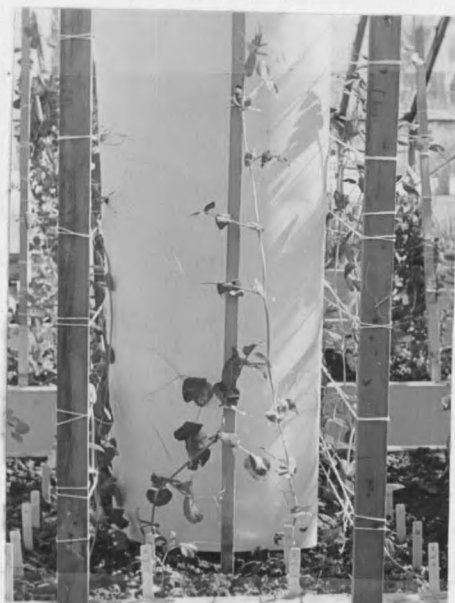
A



B

Figure 3. A - Thomas Laxton X Tare(left) and Thomas Laxton (right) showing narrow stipules of F_1 plant in contrast to broad stipules of Thomas Laxton.

B - Photograph of Teton (left) and Teton X Tare (right) showing narrow stipule of F_1 .



A



B

Figure 4. A.- Photograph of Perfection (left) and F_1 (right) showing broad stipule and short internodes of Perfection compared to narrow stipule and long internodes of Tare.
B.- Photograph showing short broad-leaved Laxton's Superb plants compared to tall narrow stipuled F_1 plants.

EXPERIMENTAL RESULTS

Mitotic observations were made of the tapetal tissue of the anthers of Thomas Laxton, Thomas Laxton Tare, Laxton's Superb, Teton and Perfection.

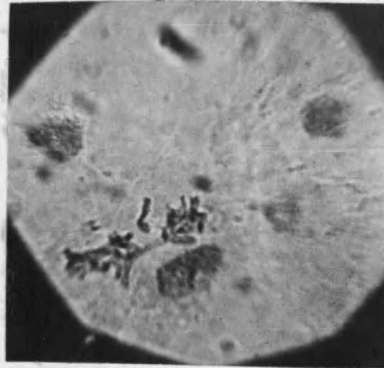
Irregularities of three types, bridges, laggards and fragments, were observed. The number of these aberrations present in each cell were noted and are recorded in Table 1.

A bridge was considered to be present in a cell when at anaphase there was noted a definite stretching across the equatorial plate of one or more chromosomes. Figures 5 and 6 illustrate the type of configurations considered as bridges.

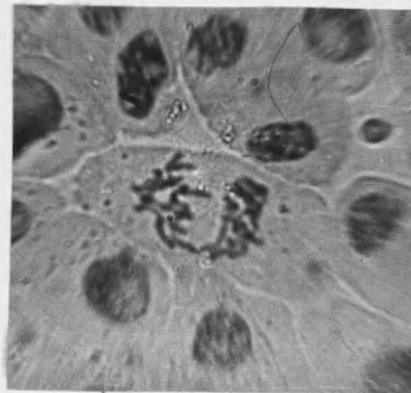
A laggard was considered to be present in a cell when at anaphase there was noted a chromosome which definitely lagged behind the majority of chromosomes in separating and moving to the poles of the daughter cells. These chromosomes looked as though they may have been part of a bridge which had broken, for in most cases there was a pair present, one moving to each of the poles, and in Figure 6C two chromosome laggards are shown.

A fragment was considered to be present when at anaphase or telephase there was noted a chromosome or piece of a chromosome which had failed to move to the daughter cell and remained unattached near the equatorial plate. There were only three cases of this type of aberration noted. Figure 5A illustrates one of these fragments.

In the varieties Laxton's Superb, Thomas Laxton and Teton the percentage of laggards was higher than the percentage of bridges. In Thomas Laxton Tare and Perfection the percentage of bridges was higher than the percentage of laggards.



A



B

Figure 5. A - Photomicrograph of mitosis at anaphase showing a chromosome bridge and fragment.

B - Photomicrograph of mitosis at anaphase showing a chromosome bridge.

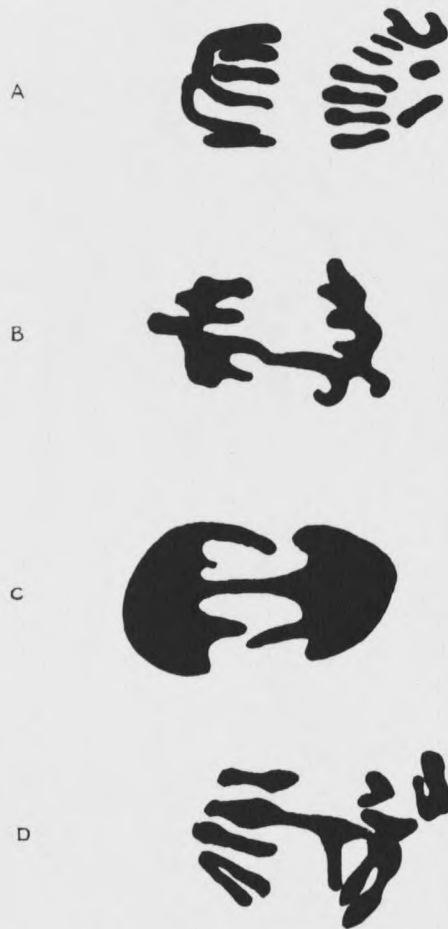


Figure 6. Mitotic cell division at anaphase.

A - Normal separation of chromosomes.

B - C- D- Irregular division with chromosome bridge formed across the equatorial plate.

C - Shows two chromosomes, in addition to the bridge, lagging behind the majority of chromosomes.

Drawings made with the aid of a camera lucida.

The percentage of irregular mitotic divisions is given in the right hand column of Table I. These figures were computed by dividing the number of cells undergoing irregular mitotic divisions by the number of cells observed undergoing mitosis. This figure does not take into account that in some of the cells observed there was more than one bridge or laggard.

The percentage of irregularities observed very closely corresponds to the mutation rate, or tare expectancy figures, noted in the section on Materials and Methods, (Laxton's Superb 1 Tare in 200 plants, Thomas Laxton 1 Tare in 250 plants, Teton 1 Tare in 670,000 plants and Perfection no Tares). The mitotic irregularities observed are shown in Graph I.

Measurements of stipule width and length were made and from these figures the stipule ratio (Length over width) was computed. Table II is a compilation of the stipule ratios. Correlation coefficients were calculated for the stipule ratios at the various nodes and are listed in Table III.

Because of the small numbers used in these calculations the significance of the "r" values is doubtful. They do, however, indicate the trend.

In order to obtain a measurement of the correlation between the stipule ratios of Tare and Type, F_1 and Tare and F_1 and Type correlation coefficients were calculated grouping all the plants into the following categories Tare, Type, and F_1 . The resulting "r" values are:

Type and Tare correlation coefficient	0.276	<u>1/</u>
F_1 and Tare	"	0.745**
F_1 and Type	"	0.490*

1/ *.05 Level of significance
 **.01 Level of significance

These figures indicate that there is no significant correlation between Type and Tare plant stipule ratios and that although there is some correlation between the F_1 and Type plant stipule ratios there is a much stronger correlation between the stipule ratios of the F_1 and Tare plants. This is to be expected as Bateson and Pellew (1,2), Pellew (8) and Brotherton (3) determined that the tare character is dominant. There did not appear to be any striking transition from Type-resemblance to Tare-resemblance as the plants matured as observed by Brotherton (3). With the exception of Perfection there was a definite increase in the stipule ratio of all the plants as they matured. This is contradictory to Brotherton's Type plants which maintained a constant stipule ratio throughout their growth.

The second, third, fourth and fifth internodes of all the plants under consideration were measured and the results are given in Table II and in Graph III.

Correlation coefficients were calculated for the internode lengths and are included in Table III. Considering the small number of plants sampled there is a good correlation between all of the internode lengths of plants compared, with the exception of the Teton group. These high correlation coefficients indicate that the internode lengths increased proportionally for all the plants as they matured.

The internode length figures were grouped in the same manner as for the stipule ratios and the following correlation coefficients were determined:

Type and Tare	correlation coefficient	.659**
F_1 and Tare	" "	.879**
F_1 and Type	" "	.5910*

Highly significant correlations exist between the Type and Tare, and between the F_1 and Tare plants. The correlation between F_1 and Type is significant, but is not as strong as that between the other plants.

Table I Observations of Mitotic Divisions of the Anther Tapetal Cells of Laxton's Superb, Thomas Laxton Tare, Thomas Laxton, Teton and Perfection.

Variety	Plant No.	No. Cells Observed	Bridges		Laggards		Fragments		Irregular Cells	
			No.	%	No.	%	No.	%	No.	%
Laxton's	2	28	5	17.8	7	25.0	0	0	5	17.7
Superb	3	28	8	28.6	10	35.8	0	0	7	25.0
	9	28	9	32.1	11	39.3	2	7.15	10	35.7
Av.				26.2		33.4		2.38		26.2
Thomas	2	24	6	25.0	3	12.5	1	4.16	5	20.8
Laxton	II-29	3	0	0	0	0	0	0	0	0
Tare	5	13	1	7.7	0	0	0	0	1	7.70
	6	11	1	9.1	1	9.1	0	0	2	18.2
	II-30	10	1	10.0	4	40.0	0	0	3	30.0
	3	4	1	25.0	1	25.0	0	0	2	50.0
Av.				15.4		13.8		1.54		20.0
Thomas	2	17	4	23.5	10	58.8	0	0	5	29.4
Laxton	3	6	0	0	0	0	0	0	0	0
	9	15	2	13.3	2	13.3	0	0	3	20.0
	10	9	1	11.1	5	55.5	0	0	2	22.2
	11	26	7	26.9	4	15.4	0	0	7	26.9
	13	16	0	0	0	0	0	0	0	0
Av.				15.8		23.6				19.1
Teton	2	4	0	0	0	0	0	0	0	0
	3	31	0	0	2	6.5	0	0	1	3.23
	6	15	1	6.7	2	13.3	0	0	2	13.3
	7	13	1	7.7	1	7.7	0	0	2	15.4
	8	1	0	0	0	0	0	0	0	0
	9	14	0	0	1	7.2	0	0	1	7.15
Av.				2.6		7.7				7.70
Per-fection	1	13	5	38.5	0	0	0	0	2	15.4
	2	25	1	4.0	2	8.0	0	0	2	8.0
	3	22	0	0	1	4.5	0	0	1	4.55
	4	25	1	4.0	2	8.0	0	0	2	8.0
	5	9	0	0	0	0	0	0	0	0
	6	28	3	10.7	0	0	0	0	2	7.15
Av.				8.2		4.1				7.37

Table II. Stipule Ratio and Internode Length Averages of F_1 and Parent Plants.

		STIPULE RATIO AVERAGES*							INTERNODE LENGTH*			
		No.	Node						Node			
		REP Pl.	1	2	3	4	5	6	2	3	4	5
Thomas	I	4	1.73	1.68	1.63	1.58	1.75	1.83	28	55	61	81
Laxton	II	4	1.60	1.78	1.47	1.67	1.70	1.78	15	25	47	70
	Av.		1.67	1.73	1.55	1.63	1.73	1.81	22	40	54	76
Tare	I	4	1.95	2.28	1.85	1.95	1.78	2.22	27	51	91	88
	II	3	1.77	2.06	2.00	1.93	2.00	2.20	28	54	60	78
	Av.		1.86	2.17	1.93	1.94	1.89	2.21	28	53	76	83
T.L.x	I	2	2.20	2.05	2.05	2.05	2.15	--	20	27	47	34
Tare	II	3	1.53	1.70	1.73	1.80	1.80	2.00	29	38	57	80
	Av.		1.87	1.88	1.89	1.93	1.98	2.00	25	33	53	60
Teton	I	4	1.80	1.75	1.55	1.63	1.75	1.75	32	52	63	86
	II	4	1.43	1.55	1.53	2.60	1.80	1.88	26	43	56	66
	Av.		1.62	1.65	1.54	1.82	1.78	1.82	29	40	60	76
Tare	I	4	1.73	2.20	1.93	1.95	2.18	2.28	29	21	53	96
	II	3	1.50	1.70	1.77	1.83	2.10	2.16	28	52	65	87
	Av.		1.62	1.95	1.85	1.89	2.14	2.22	29	36	62	92
Tet.x	I	4	1.50	1.88	1.70	1.70	1.93	2.10	21	35	54	60
Tare	II	4	1.37	1.63	1.65	1.65	1.93	2.35	30	56	68	84
	Ave.		1.44	1.77	1.68	1.68	1.93	2.25	26	46	61	72
Lext.	I	3	1.30	1.43	1.40	1.60	1.43	1.70	21	26	32	46
Superb	II	3	--	1.63	1.66	1.50	1.70	1.70	21	39	44	51
	Av.		1.30	1.53	1.53	1.58	1.56	1.70	21	33	39	49
Tare	I	3	1.40	1.90	1.86	2.00	2.07	2.13	26	52	79	88
	II	4	1.70	1.92	2.00	2.60	2.15	2.16	29	56	61	98
	Av.		1.55	1.91	1.93	2.30	2.11	2.15	28	54	70	93
L.S.x	I	2	1.40	1.80	1.80	1.80	2.05	2.05	34	52	67	112
Tare	II	0	--	--	--	--	--	--	--	--	--	--
	Av.		1.40	1.80	1.80	1.80	2.05	2.05	34	52	67	112
Perf- ection	I	4	1.80	1.73	1.52	1.72	1.45	1.75	111	16	33	21
	II	3	--	1.67	1.67	1.80	1.57	1.37	12	19	37	36
	Av.		1.80	1.70	1.59	1.76	1.51	1.56	12	18	35	29
Tare	I	4	1.75	2.00	1.35	2.08	2.08	2.20	28	47	61	85
	II	4	1.65	1.95	1.80	1.95	2.18	2.30	32	60	65	102
	Av.		1.70	1.98	1.58	2.02	2.13	2.25	30	54	63	94
Perf.x	I	0	--	--	--	--	--	--	--	--	--	--
Tare	II	2	1.75	1.65	1.70	1.70	1.70	2.05	23	39	52	72
	Av.		1.75	1.65	1.70	1.70	1.70	2.05	23	39	52	72

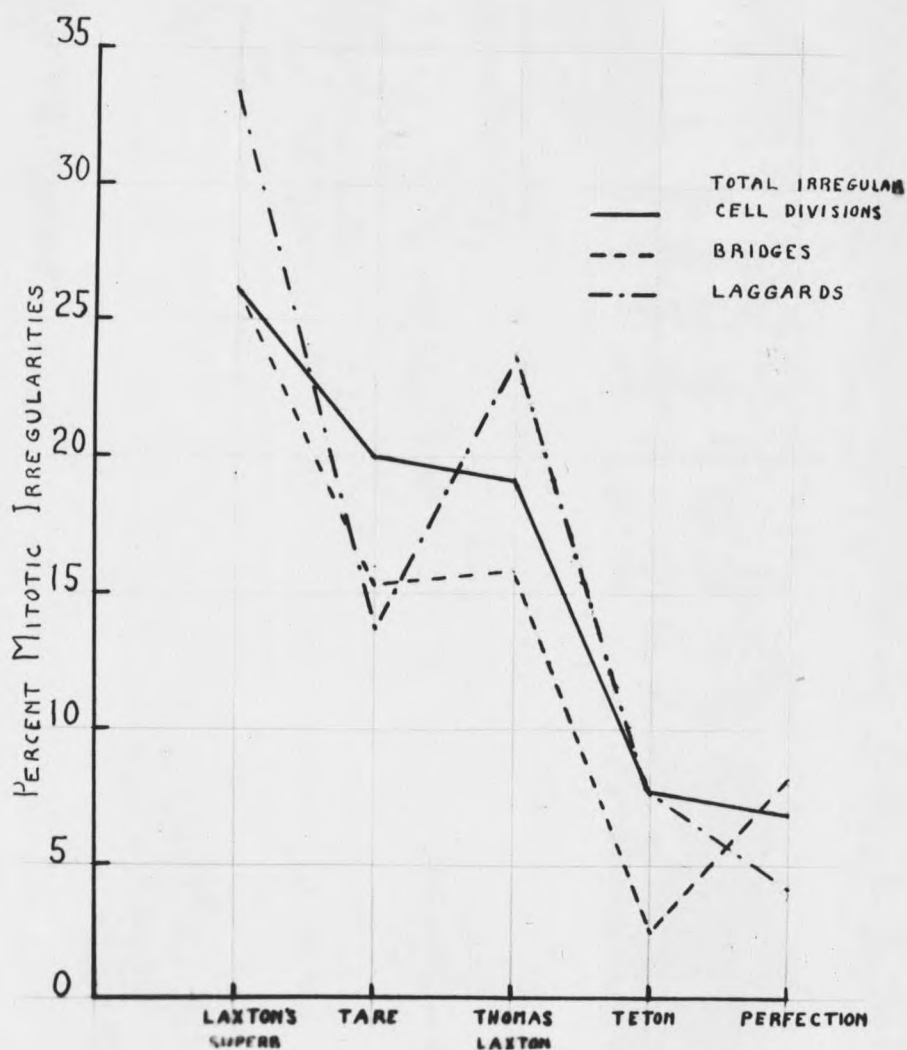
* Measurements in centimeters

Table III. Calculated Correlation of Parent and F_1 Populations for Stipule Ratio and Internode Length.

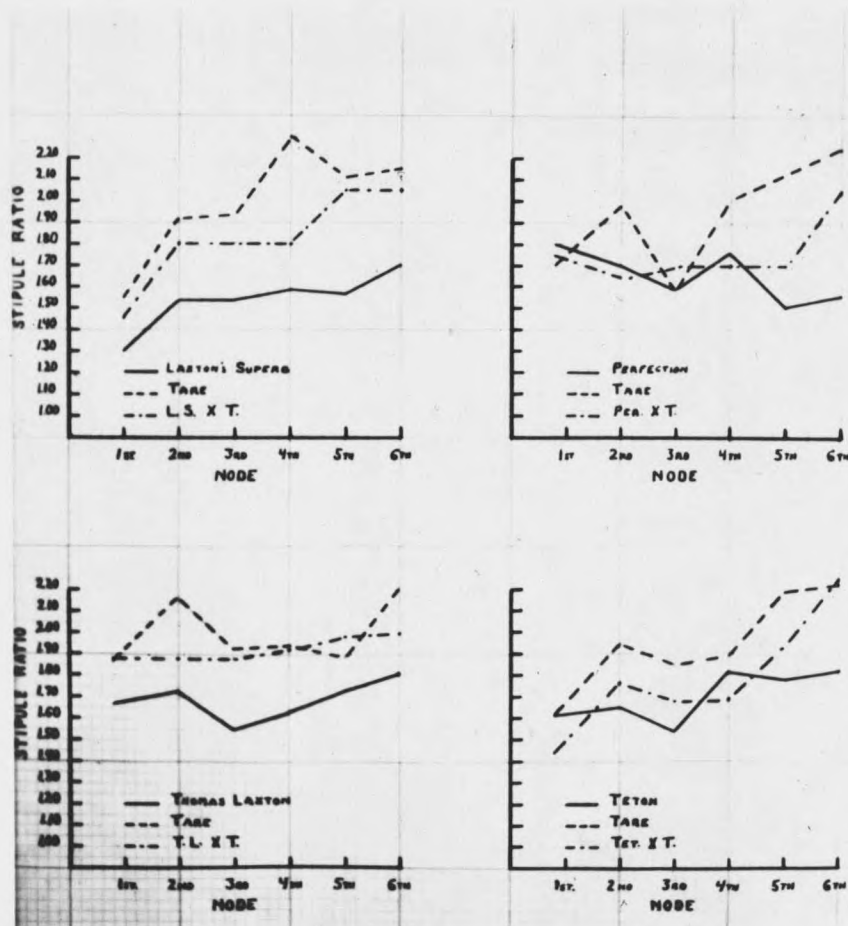
Populations Correlated	Correlation Coefficients	
	Stipule Ratio	Internode Length
Thomas Laxton X Tare	.191	.957* ^{1/}
F_1 X Tare	.709	.974*
F_1 X Thomas Laxton	.455	.963*
Teton X Tare	.630	.861
F_1 X Tare	.950	.932
F_1 X Teton	.667	.903
Laxton Superb X Tare	.263	.993**
F_1 X Tare	.947**	.964*
F_1 X Laxton Superb	.274	.985*
Perfection X Tare	-.526	.723
F_1 X Tare	-.406	.993**
F_1 X Perfection	.532	.7997

^{1/} *Significant to the .05 point

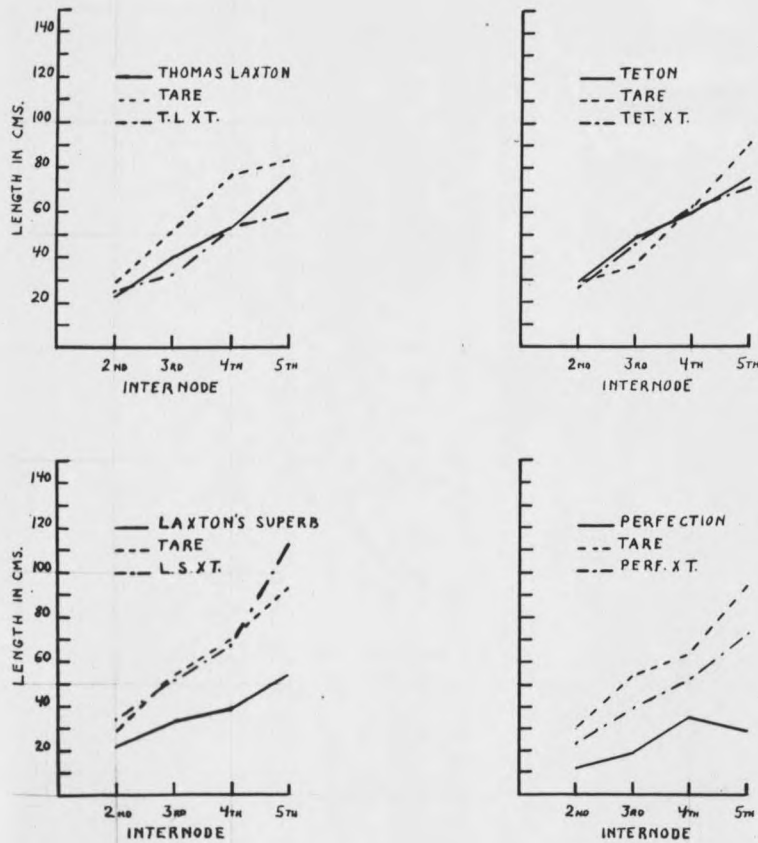
**Significant to the .01 point



Graph I. Average percentages of mitotic irregularities occurring in the mitotic cell divisions of the anther tapetal cells in Thomas Laxton, Tare, Laxton's Superb, Teton and Perfection.



Graph II. Average stipule ratios plotted to show the correlation between the F_1 and parents.



Graph III. Average internode lengths plotted to show the correlation between the F_1 and parents.

DISCUSSION

There appears to be a definite correlation between the Tare expectancy and the percentage of mitotic cell irregularities observed. Laxton's Superb had 26.6 per cent mitotic irregularities and a Tare expectancy of one Tare in 200 plants. As illustrated in Graph I this is the highest percentage of irregularities observed and also the highest mutation rate. Thomas Laxton was second in mutation rate with one Tare expected in 250 plants and a mitotic irregularity of 19.1 per cent. Teton has a Tare expectancy of one plant in 670,000 and a mitotic irregularity of 7.7 per cent. Perfection throws no Tares and had an observed mitotic irregularity of 7.37 per cent.

The fact that Perfection showed a mitotic irregularity of 7.37 per cent and throws no Tares seems to indicate that all mitotic irregularities do not lead to Tares.

All bridges and laggards obviously do not lead to irregular chromosome distribution in the daughter cells. The presence of these bridges and laggards, however, would lead to the assumption that should the chromosomes break apart at any point other than at the original terminals of the chromosomes that duplication of a segment of one chromosome would take place in one daughter cell and the other daughter cell would have a deletion of the same section of the chromosome. It is quite possible that the daughter cells could carry on division with this duplication and deletion, one cell leading to the creation of tare characteristics in a manner described by Brotherton as "Mass Somatic Mutations".

It is a peculiar fact that when a Tare is crossed with a normal

plant there is no segregation of the normal type taking place in the F_2 nor is there an expression of sterility exhibited in any of the progeny.

A possible explanation of the above phenomenon may be made by postulating that the pollen grains carrying the irregularity (probably the duplication) are capable of producing a germ tube more vigorous than the other type pollen grains (the ones carrying the deletion) and consequently they always fertilize the ovule.

In a case of this sort the pollen grains carrying the Tare character would always affect the fertilization and since this character is dominant the recessive character would never appear. In other words, there would be no segregation of Tare and Type characters, which is exactly what happens in crosses of Tare with Type plants.

The author has no proof that pollen grains carrying the Tare character are more vigorous than those of the Type character, but this is a possible explanation of the cause of lack of segregation.

Brotherton's conjecture that the Tare is caused by a point mutation is open to debate. The fact that the Tare plants are so drastically different from the Type plants would indicate that not a minute point is involved in this mutation, but rather that a segment of a chromosome carrying several genes, is responsible.

Ordinarily segmental interchange is not to be expected in mitosis. The chromosomes do not exhibit the attraction between homologous pairs which occurs in meiosis, but here incomplete separation of a part of the daughter chromosomes appears to take place. There must have been some force which caused part of the chromosomes to adhere and lead to the bridges previously

described.

The heterochromatin material composing the pea chromosomes must be weak, accounting for the instability of pea plants in general.

If this heterochromatin material composing the backbone of the chromosome is as weak as it appears to be, the end of one chromosome attached to another chromosome could be broken off by the force of the chromosomes moving to the poles of the dividing cell. This action would lead to the duplication or deletion of a segment of the chromosome as suggested.

In crosses of Type plants with the Tare the Tare character was found to be dominant. This substantiates the findings of Bateson and Pellew (1) and Brotherton (3). The stipule ratio of the F_1 plants of crosses of Tare times Thomas Laxton, Laxton's Superb, Teton and Perfection was definitely of Tare type.

Brotherton reported a transition from Type-like stipule to Tare-like stipule as the F_1 plant matured.

There was noted a definite increase in the stipule ratio of all the plants, Type, Tare and F_1 except those of the Perfection variety, considered in this study. This is somewhat contradictory to Brotherton's findings as his Type plants maintained a fairly uniform stipule ratio throughout their growth.

A definite positive correlation existed between the internode lengths of all the plants measured. Although the correlation coefficients listed in Table III are not all significant, the internode lengths of all the plants, except Perfection, increased quite consistently from node to node.

The correlation coefficients calculated for the internode length of Type

and Tare, F_1 and Tare, and F_1 and Type were significant. There was a higher correlation between F_1 and Tare than between F_1 and Type plants. This is to be expected as the Tare characters are considered to be dominant over the Type characters.

SUMMARY

1. Four varieties of garden peas Pisum sativum L. with the following rate of Tare expectancy were studied:

Laxton's Superb	1 Tare in 200 plants
Thomas Laxton	1 Tare in 250 plants
Teton	1 Tare in 670,000 plants
Perfection	No Tares

2. Chromosome irregularities consisting of bridges, laggards and fragments were noted in the mitotic cell divisions, and the following percentages of irregular cell divisions were recorded:

Laxton's Superb	26.2	Tare	20.0
Thomas Laxton	19.1	Teton	7.7
Perfection	7.37		

There appears to be a correlation between the number of mutations in a variety with number of irregularities in mitosis.

3. The stipule ratio, length over width, increased in all the varieties and the Tare and F_1 plants, except Perfection, as they matured. There was a greater correlation between the stipule ratios of the F_1 plants and the Tare parent than of the F_1 plants and the Type parent.
4. The internode length of all the plants increased in a proportional amount as they matured. There was a greater correlation between the internode lengths of the F_1 and Tare parent than between the F_1 and Type parent.

LITERATURE CITED

1. BATESON, W. and PELLEW, C. On the genetics of "rogues" among culinary peas Pisum sativum. Jour. Genetics 5:13-36. 1915.
2. _____ . The genetics of "rogues" among culinary peas Pisum sativum. Proc. Roy. Soc. (London) (B) 91:186-195. 1920.
3. BROTHERTON, S.E., Jr. Further studies of the inheritance of rogue types in garden peas Pisum sativum L. Jour. Agr. Res. 24:815-952. 1923.
4. BUNTEN, ISABEL. A preliminary report on the chromosome complement of "rabbit-eared rogues" in culinary peas Pisum sativum L. Amer. Jour. Bot. 17:139-142. 1930.
5. EMERSON, R.A. The inheritance of a recurring somatic variation in variegated ears of maize. Amer. Natur. 48:87-115. 1914.
6. MATSUURA, H. A bibliographical monograph of plant genetics. 1900-1929 Ed2, rev. and enl., 787 pp. Sapporo, Japon. 1933.
7. MUNTZING, A. The effects of chromosomal variation in dactylis. Hereditas 23:113-235. 1937.
8. PELLEW, C. Further data on the genetics of "rogues" among culinary peas Pisum sativum. 5 Internat. Kongress Vererbung. Berlin Verhandlungen. 2. 1927.
9. SHAMEL, A.D., SCOTT, L.B. and POMEROY, S.C. A study of bud variation in the naval orange. U.S.D.A. Bul. 623:1-146. 1918.
10. SMITH, LUTHER. The aceto-carmin smear technique. Stain Tech. 22, Jan. 1947.
11. STADLER, L.J. On the genetic nature of induced mutations in plants. II. A haplo-viable deficiency in maize. Mo. Res. Bul. 204:1-29. 1933.
12. WINGE, O. Contributions to the knowledge of chromosome numbers in plants. Cellule 35:306-324. 1925.



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