

CANNA CROSSES

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GIGAS A VEGETATIVE MUTATION

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CANNA CROSSES

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III. PLASMATIC INFLUENCES

THE RED LEAF MARGIN

The variability of segregation into plants with and without a red leaf margin after crossing *Canna glauca* by *indica* was demonstrated and shortly discussed in „Canna crosses I” (1923). The experiments on Sumatra led to a suggestion of periodicity in so far as the seeds obtained after pollination and ripening in a dry period segregate according to 1 : 1 and those won during the rainy season according to 9 : 7. For the back cross of F_1 and *glauca* the results were less variable.

When a small quantity of pollen is brought upon the stigma there is theoretically a better chance of effecting an aequation-fertilization than when the pollination is abundant, in which case a certation-fertilization is more likely, the style being a rather long one. As the terms large and small quantity of pollen go by comparison, I begged some of the students to make the same experiments in order to check a personal equation. The results of our work in 1923 diverge considerably (table I). From the seeds obtained after plentiful pollination by both Miss Joustra and Miss Roodenburg I got a shortage of red-edged plants, whereas after pollination by Mr. Oppenheim and myself I always found an excess of plants with anthocyanin, a smaller one if the pollination had been abundant, a trifle larger one after scanty pollination, but always too high a percentage.

The number of seeds per fruit can be used to verify to some extent the exactness of the pollination. As a rule the number of seeds after scanty is somewhat smaller than after abundant pollination, but the difference is not large and there exist exceptions; this is not very surprising considering the always small number of seeds per capsule, a small percentage only of the number contained by *Oenothera* or *Nicotiana* fruits (table II).

As all seeds are sown out and all plants counted by myself, and as it is not very probable that personal errors should diverge in a female and a male direction, I thought the difference in time of pollination a possible cause of the irregularities. The ladies had pollinated in July, Mr. Oppenheim partly in July partly in August and I myself from the beginning of flowering in June to September. The next year control-experiments have been made by Mr. Ramaer and Mr. Rümke and the results proved the supposition to be true. In the beginning

of summer there is a shortage of red-edged plants that passes into an excess till at last at the end of August it diminishes again (0.82 : 1 to 2.67 : 1 and again 1.68 : 1 as extremes, table III). As interesting as this result may be, seen from a physiological point of view, so disagreeable it is for a genetist who aims at a factorial analysis.

But there was still another peculiarity. The largest difference between the percentages of plants with red leaf margin after plentiful and scanty pollination was 23.6%, the smallest 0.1% (that is not a difference), the others varying between 0.9 and 7.8%. The difference between every two sets, if there is any, lies in the same direction: more red-edged plants after a small quantity of pollen, which is the reverse of what was expected.

A cross with a type more related to *C. indica* and differing from it in a number of factors far smaller than *glauca* does, might give more constant results, at least there was a chance it would. For that purpose I chose a *C. aureo-vittata* received from the botanical gardens in Montevideo, which could be designated as a red patched yellow-flowering *indica* with green leaves. It has two staminodes of the same size as those of my *indica*, no wax and small round dark seeds, the rhizome is not creeping and the first flowers appear within 3 or 4 months after sowing, all characteristics it has in common with *indica*. The style is much shorter than that of *glauca* and its F_1 hybrid, which may be an advantage in view of certation.

The reciprocal F_1 consisting of 45 and 39 plants, was uniform; the flowers of a slightly paler red than those of the pure *indica* (Oberthür, strawberry red 110-2 to 3), but with the same broad, red leaf-margin.

The F_2 of *indica* × *aureo-vittata* pale yellow consisted of 975 individuals from 9 F_1 mothers, 561 with red leaf margin and 414 with green leaves (theory 548.4 : 426.6), so a small surplus of red ones. The F_2 from 10 reciprocal F_1 mothers contained 851 plants of which 520 red-margined and 331 green (theory 478.7 : 372.3); the excess of reds is here somewhat larger (table IV).

The back crosses (*indica* × *aureo-vittata* p. y.¹⁾ F_1) × *aureo-vittata* p. y. on 10 F_1 plants resulted in 134 red margin plants and 363 green leaved ones (theory 124.25 : 372.75), so undeniably a 1 : 3 ratio, but with a small surplus of the double dominant type (table V).

From the back crosses (*aureo-vittata* p. y. × *indica* F_1) × *aureo-vittata* p. y. I got 325 plants, 72 red and 253 green ones (expectation 81.25 : 243.75); there is a shortage of the double dominant type in this case.

The two series together show a clean-cut Mendelian ratio, viz. 206 red as against 616 green, a deviation from theory of less than a single individual (205,5 : 616,5).

¹⁾ pale yellow henceforth indicated as p.y., deep yellow as d.y.

The difference between the iterative and the sesquireciprocal crossing is here a difference in plasma. In the first case the plasma is that of *indica* and the double dominants with the *indica* characteristic are present in a number that is 7,8% higher than it should theoretically be. In the second cross the plasma is that of the *aureo-vittata* and the number of double dominants is 11,4% less than theory requires (on the basis of 82 Ab and 164 aB + ab plants the shortage is 18,3%, see table VIII).

As we have to do with back crosses in which the double recessive type is pollen parent, that is with aequation crosses in both cases, the idea of an explanation by differences in rate of growth for the pollentubes is excluded. The *indica* plasma offers a slightly better chance for the combinations in which the two *indica* chromosomes with the factors A and B are present, just as the *aureo-vittata* plasma favours the zygotes with the chromosome combinations in which at least one of the two indicated *indica* chromosomes is replaced by its *aureo-vittata* homologous one.

The favouring or opposing action of the plasma is of moderate strength and of less consequence than the certation. This is evident from the results of the F_2 *aureo-vittata* \times *indica* that has *aureo-vittata* plasma; there the surplus of double dominants is even greater than in the F_2 from the reciprocal cross with *indica* as the ovule and plasma parent. It is also clear from the results of the certation back cross *aureo-vittata* \times (*aureo-vittata* \times *indica* F_1), when compared with the reciprocal aequation back cross (*aureo-vittata* \times *indica* F_1) \times *aureo-vittata*, the nos. 1136 and 1101-1109 in table V.

Whether there exists a connection between the facts that the surplus of reds in the nos. 1090-1100 is smaller than the shortage in the back crosses of the reciprocal F_1 hybrids and the larger number of not germinated seeds, 7,6% as against 3,3% in the nos. 1101-1109, remains uncertain.

When one compares the tables VIII (*indica* with *aureo-vittata* pale yellow) and IX (*humilis* with *aureo-vittata* pale and deep yellow), it is evident that as to leaf colour there exists a monofactorial difference between *indica* and *humilis*. This conclusion drawn from back crosses was not suggested by a direct *humilis* \times *indica* cross. The total number of red-margined plants like *indica* (BB or Bb) was in F_2 279 as against 226 with green leaves like *humilis* (bb). These figures are in better agreement with a segregation according to 9:7 than with a 3:1 ratio (expectation: on a 9:7 basis 284:221 and in case of a monofactorial difference 379:126, table VI).

It seems that the *humilis* plasma does not favour the B zygotes. Besides this conclusion (which has to be controlled by F_2 from the reciprocal cross and by backcrossing reciprocal F_1 plants) there is

also visible some influence due to the time of pollination: self pollination in the end of August yields relatively more green-leaved specimens than selfing two weeks earlier, which was also exhibited by the *glauca* × *indica* F_1 after selfing in the same year.

RED FLOWER COLOUR

That in the F_2 of *indica* × *aureo-vittata* and reciprocally the excess of AB types is not caused by coupling of the factors A and B, is evident from the ratios red-flowering plants (A) to yellow-flowering ones (a). As all AB plants with red leaf margin have red flowers, there is a surplus of red-flowering-plants, but the ratio red: yellow among the green-leaved specimens agrees exactly with the expectation Ab: (aB + ab) on a 3 : 3 : 1 basis (table VII). For *indica* × *aureo-vittata* F_2 we have Ab : (aB + ab) = 172 : 232 (theory 173 : 231), for *aureo-vittata* × *indica* F_2 it is 141 : 188 (expectation 141 : 188). In case of coupling between A and B with a surplus of AB types, there should have been a shortage of the red-flowering green-leaved type Ab, but there is no deficit of Ab. Thus A and B must be thought localised in different chromosomes.

That the gametic ratios are those of Mendelian segregation is confirmed in only one of the back crosses, viz. (*aureo-vittata* × *indica* F_1) × *aureo-vittata*, where the number of Ab plants is exactly half the sum of the aB and ab ones (82 : 164). The (*indica* × *aureo-vittata* F_1) × *aureo-vittata* descendants with a surplus of AB, however, show a noticeable shortage of Ab, viz. 133 AB : 107 Ab : 247 (aB + ab).

A second series for red flower colour is represented by the crosses of *C. humilis* with *aureo-vittata*. *C. humilis*, also received from the botanical gardens of Montevideo, has 2 short and narrow staminodes (red between Oberthür cardinal red 112-4 and vermilion red 87-4), no anthocyanin in the leaves and a non-creeping rhizome. It could be a green-leaved *indica* variety. The following crosses are made:

1. *humilis* × *aureo-vittata* p. y., F_1 Oberthür scarlet 85-3; 2. *aureo-vittata* p. y. × *humilis*, F_1 Oberthür scarlet 85-3 and 3. *aureo-vittata* d. y. × *humilis*, F_1 cochineal red no. 83-3. The three F_1 sets consisted of 18, 28 and 77 individuals; each of them was uniform.

The F_2 of *humilis* × *aureo-vittata* p. y. contained in the 347 plants, 264 with red and 83 with yellow red-patched flowers. The deviation from a 3 : 1 ratio is small ($260\frac{1}{2} : 86\frac{1}{2}$ expectation).

The F_2 of the reciprocal cross of 378 individuals also showed a small surplus of red-flowering plants, viz. 292 : 86 (theory $283\frac{1}{2} : 94\frac{1}{2}$).

Only the 707 *aureo-vittata* d. y. × *humilis* F_2 apparently contained too many reds, 557 reds as against 150 yellows (theory $530\frac{1}{2} : 176\frac{1}{2}$).

The back crosses (*humilis* × *aureo-vittata* p. y. F_1) × *aureo-vittata*

p. y. and (*aureo-vittata* p. y. \times *humilis* F₁) \times *aureo-vittata* p. y., both aequation-crosses, remind us of those between *indica* and *aureo-vittata*. In the first back cross with *humilis* plasma there is a small surplus of reds (34 : 31), in the second with *aureo-vittata* plasma a somewhat larger one of yellows (79 reds : 91 yellows). Yet from the 514 plants from the back cross (*aureo-vittata* deep y. \times *humilis* F₁) \times *aureo-vittata* pale y. 265 were red and 249 yellow (table IX). It is here the same F₁ combination in *aureo-vittata* deep y. plasma of which the F₂ also showed the largest surplus of reds (table X).

INTENSIFICATION FACTORS

From the cross *C. glauca* \times *indica* was concluded to the existence of three intensification factors for the red colour caused by factor A, while one of them was coupled to a high degree to the factor B. As the patches scattered over the staminodes in *aureo-vittata* are of a much deeper red than the pink ones on the centre of the *glauca* staminodes, it is no wonder that as to intensity of the red colour the back crosses of F₁ *indica* \times *aureo-vittata* and the reciprocal F₁ by *aureo-vittata* show only two groups. The numbers of these groups square very well with the 1 : 1 ratio that is to be expected, if *indica* and *aureo-vittata* differ in one intensification factor, viz. 67 : 66, 53 : 54, 34 : 33 and 40 : 42 (table VIII). In both series, the red-margined plants with factor B as well as the green-leaved red-flowering ones that are bb, this 1 : 1 ratio appears. Therefore it is not factor E (in *indica* coupled to B) that makes a point of difference between *indica* and *aureo-vittata*; it must be either D or F.

Also the fact that the back cross (*glauca* \times *indica* F₁) \times *glauca* shows 8 shades of reds and the back crosses with *aureo-vittata* p. y. only four or five at the utmost, proves more similarity of *indica* and *aureo-vittata* in intensification factors. And the extreme intensities, shades 10 and 6 in the *aureo-vittata* back crosses are present in most cases in a single individual, not necessarily, but possibly extreme variates of the neighbouring groups. It is sometimes rather difficult to judge the intensity of the red that is influenced by the many shades of yellow.

Just as for the cross *glauca* \times *indica* it was the back crosses that gave understandable segregations for the intensification factors and not the F₂, it is also the case with the *indica* \times *aureo-vittata* cross and its reciprocal one. Using the same limitline between the groups as used for the back crosses, we find in F₂ ratios that do not correspond with those of the back crosses. For the red-edged F₂ plants with *indica* plasma the ratio 356 : 187 or 1,92 : 1 reminds us of the 2 : 1 ratio for factor D, discussed in part I pages 38-40 and of the lethal factor Q.

But in the F_2 of the reciprocal cross with *aureo-vittata* plasma the ratio is rather deviating, viz. 295: 222 or 1,33: 1. That the reciprocal F_1 sets of *indica* and *aureo-vittata*, consisting of 45 and 39, together 84 individuals, are uniformly of the same shade of red, is not a difficulty theoretically. The difficulty arises in the F_2 . Therefore it is a great pity that the F_1 and the F_2 hybrids of *aureo-vittata* with a pure yellow type, evidently a cross-over in an F_3 plant from the cross *glauca* Montevideo \times *glauca* Java, are of scanty fertility, so that the A-D-relation cannot very well be investigated with the aid of this recessive type.

THE YELLOW COLOURS

The difference between pale and deep yellow in *aureo-vittata* is, as concluded from back crosses, a bifactorial one, if „smaller” modifying factors are neglected for the present.

Table XI shows that there are 22 pale yellows, shade 2, out of 87 or 25.3% in (p. y. \times d. y. F_1) \times p. y. In the same way 52 p. y. out of 222 or 23.4% in (d. y. \times p. y. F_1) \times p. y. and 113 p. y. out of 457 or 24.7% in p. y. \times (d. y. \times p. y. F_1). Departing is the segregation in p. y. \times (p. y. \times d. y. F_1), where only 26 p. y. out of 176 or 14.8% appeared.

As the same deep yellow is present in the chromatophores of *indica* and becomes visible separated from the red sap colour in part of F_2 after crossing *indica* with *aureo-vittata* p. y., the difference will be caused by the factors H and I, already discussed in the report on the *glauca-indica* cross (although the tint of yellow in *glauca* is brighter than in *aureo-vittata* p. y.).

In both aequation-crosses (nos. 1124-25 and 1127-28) the shades of deep yellow 3-7 are present in nearly half the total number of plants, 42 out of 87 and 110 out of 222. This group HhIi + Hhii is in the absence of shade 2, sharply separated from the rest, just as pale yellow shade 2, hhii, is in the absence of pale yellow shade 3. But then the class deep yellow shade 1, phaenotypically classed with the deep yellow series, should genotypically be joined to the hhIi group, which for the rest is bright yellow. Otherwise the figures are incomprehensible.

This supposition is corroborated by the fact that among 85 F_3 plants (no. 1177) of which the mother was a selfed p. y. \times d. y. F_2 specimen with bright yellow flowers shade 1, there were 9 of the type deep yellow shade 1 and one was even looked upon as shade 2. The other 75 plants consisted of 54 bright yellow shade 1 like the mother, 9 pale yellow shade 3 and 12 pale yellow shade 2.

That outer circumstances have noticeable influences on the type

of yellow and on the classification, is taught by the back crosses nos. 1129-33 which flowered in September and October, while those of the reciprocal F_1 (nos. 1134-35) bloomed in June simultaneously with the aequation back crosses. In the nos. 1129-33 the deep yellows are somewhat paler: shade 7 is absent and shade 2, which did not occur in the earlier flowering nos., is present in each of the five that bloomed later. Bright yellow shade 2, present in the nos. 1124, 1128, 1134 and 1135, was not found in the later flowering plants and, on the other hand, pale yellow shade 3, found in each of the five later sowings, was not seen before.

The number of pale yellows in F_2 of reciprocal crosses chimes fairly well with what may be expected from the back cross results, i. e. 6.25% pale yellows. In p. y. \times d. y. F_1 with pale yellow plasma we find 7.6% (14 out of 185) while in d. y. \times p. y. F_1 with d. y. plasma they are on the other hand a little too few in number, 37 out of 725 or 5.1%.

These percentages found in 1930 and being nearly the same as those of 1929, i. e. 5.6% (78 out of 1394 yellows), differ considerably from the figures obtained in 1925 (2.8% of 846 and 1.9% of 315 yellows). Yet I cannot believe that the class of pale yellows should have been estimated too low as at that time the classification was not so precise as of late years. There was one group of pale yellows instead of three shades. If such a departing percentage had been found in aequation back crosses, I should think it owing to false judging of tints, but now that it occurs in F_2 sowings, it is only a new proof to me of the inappropriateness of F_2 for genetic analysis in *Canna*.

The relatively plain ratios of pale yellow as against the deeper tints are not found back unaltered in the crosses of *aureo-vittata* with *humilis*. The back cross (*humilis* \times *aureo-vittata* p. y. F_1) \times *aureo-vittata* p. y. shows 10 pale yellows among a total of 31 yellows or 32.3%. The reciprocal F_1 backcrossed by *aureo-vittata* p. y. yields 39 out of 91 or 42.8%, that is considerably more than 25% (table IX, nos. 1110-1113). In accordance with these higher numbers of pale yellows the percentages in F_2 are also above the theoretical 6.25%, expected from the *aureo-vittata* p. y. and d. y. crosses, viz. 11 out of 83 yellows or 13.3% and 9 out of 86 or 10.5%.

The results are understandable when one assumes that *humilis* is HHI and I is coupled to A, the factor for the difference between red and yellow flowers. As in the back cross with *humilis* plasma there is perhaps a small surplus of red-flowering plants and with *aureo-vittata* plasma a small surplus of yellows, and as the numbers 65 and 170 are small, it is impossible to determine the crossing over percentage for AaIi with exactness. The ratio 3 AI: 1 Ai: 1 aI: 3 ai, giving 37.5% pale ones among the yellows, if H behaves independently from A

and I, will probably be not far from the reality (the figures actually found are 32.3 and 42.8%).

This coupling ratio will produce in F_2 9 pales out of 64 yellows or 14.1%. The percentages found are 13.3 and 10.5, the lowest in the series with *aureo-vittata* plasma, which was not expected. With a view to the large number of phaenotypes the F_2 , consisting of 347 and 378 plants, is also too small.

The same phenomenon, too many pale yellows, would result, if H instead of I was coupled to A. And then there would be a shortage of deep yellows, which indeed exists, only it is too small to explain the surplus of pale yellows. Furthermore coupling of H to A and free mendelian segregation for I would lead to equal numbers of bright and pale yellows; 11 Ii: 39 ii in the nos. 1112-1113 for instance differs too much from a 1: 1 ratio to be looked upon as a chance deviation, while the figures are in better agreement with the 1: 3 ratio that follows if I, and not H, is coupled to A. At least, if H should be coupled to A, this coupling must be weaker than the coupling of I to A and with a crossing-over percentage not far below 50%.

That the assumption of *humilis* being HHII is correct, is proved by F_2 and by back crosses of *aureo-vittata* deep yellow \times *humilis* F_1 . Neither in F_2 (249 yellows) nor in the back cross by *aureo-vittata* pale yellow (150 yellows) there appeared a single pale or bright yellow specimen. For the back cross with p. y. I expected deep yellow shade 5, indeed the most numerous class of the five, but there are 52 plants with deeper and 61 with paler tints. Tracing the limitline between the classes 5 and 4 we find 188 deeper and 61 paler shade plants. For the present it remains an open question whether this 3: 1 ratio has any importance. (For instance there is the possibility that in the back cross both parents, the *aureo-vittata* and its hybrid with *humilis*, are heterozygous for an intensification factor for deep yellow).

In the crosses of *aureo-vittata* with *indica* the deviation from the 25% pale yellows in the deep and pale yellow crosses is still greater than in the *humilis* crosses. Back crossing the F_1 of *indica* and *aureo-vittata* p. y. by *aureo-vittata* pale yellow produces in *indica* plasma pale yellows to an amount of 40.5% of the total number of yellows (100 out of 247). In *aureo-vittata* plasma it is as much as 45.1% (72 out of 164). For the F_2 the percentages of pale yellows are in *indica* plasma 21.1 (49 out of 232) and in *aureo-vittata* plasma 24.5 (46 out of 188).

In trying to find an explanation one has to consider three possibilities: 1. the coupling between A and I may be stronger in *indica* than in *humilis*; 2. the factor for deep yellow H may be coupled to a factor present in the red-flowering plants or part of them, and 3. the ratios are disturbed either by plasmatic influences or by differences in viability of zygotic combinations.

If A and I had a higher degree of coupling in *indica* than in *humilis* the consequence would be a lower percentage of bright yellows (aahhII and aahhIi). Counting in the class deep yellow shade 1 as aahhII or aahhIi we find of these constitutions 19 out of 122 or 15.6% in the *humilis* hybrids after backcrossing by *aureo-vittata* p. y. and 72 out of 411 or 17.5% in the back crosses of *indica* hybrids. Thus the crossing-over value must be nearly the same and it is in the *indica* hybrids certainly not smaller than in the *humilis* ones.

It is evident that the percentages of deep yellows, theoretically 50% of all yellows in the back crosses, are too small in the two series, in the *humilis* one it is 54 out of 122 or 44.3% and in that of *indica* 165 out of 411 or 40.1%. When this shortage of deep yellows is compensated by a surplus in the reds, there would be an indication of linkage between H and A. Coupling of H with B would produce more AB plants which have at the same time the factor for deep yellow H than AB plants with the recessive factor h which contain bright or pale yellow only, and, on the other hand, less green-leaved red-flowering plants with deep yellow than with bright or pale yellow. Among the yellows, however, it would make no difference; half of them would be deep yellow just as in the case of free segregation of B and H.

Now for part of the reds it is to some extent possible to class them according to their being H or hh. I made three groups: 1. the bright reds, which are HH or Hh; 2. those being slightly influenced by the yellow colours and 3. those without visible effect of the yellow. Most dubious is the second group, because it is impossible to distinguish with certainty in a deep red sap colour whether the yellow is of the palest shades of deep yellow due to H or a brighter yellow due to I. Therefore, considering only as hh the third group and counting the rest as HH or Hh, I shall surely make mistakes to an unknown extent. But although the figures have no absolute value, I can use them for comparing the two classes of reds, those with and those without red leaf margin.

For judging coupling of H to either A or B we have the following data (of comparative value!):

Back crosses:

Out of 133 AB plants with	<i>indica</i>	plasma 59.4%	should have H
„ „ 107 Ab	„ „ „	51.5%	„ „ „
„ „ 67 AB	„ „ <i>aur.-vit.</i>	53.7%	„ „ „
„ „ 82 Ab	„ „ „	51.2%	„ „ „
„ „ 34 Ab	„ „ <i>humilis</i>	61.8%	„ „ „
„ „ 79 Ab	„ „ <i>aur.-vit.</i>	51.9%	„ „ „

F₂:

Out of	543 AB plants with	<i>indica</i>	plasma	82,7%	should have H
" "	172 Ab	" "	" "	74,4%	" " "
" "	517 AB	" "	<i>aur.-vit.</i>	84,1%	" " "
" "	141 Ab	" "	" "	80,9%	" " "
" "	264 Ab	" "	<i>humilis</i>	78,0%	" " "
" "	292 Ab	" "	<i>aur.-vit.</i>	74,7%	" " "

The percentage of AB plants assumed to be deep yellow is higher than that in the Ab group of the same sowing in all four cases. But in these Ab plants it was never lower than 50% in back crosses as it would be, if the assumption were true that the surplus in the AB plants was due to linkage between H and B. The shortages of 0,6 and 0,3% from 75% in F₂ are too small to be considered. For the rest free segregation is as probable as a weak coupling to A, the 61,8% AH in *humilis* plasma being of not much importance in view of the small number of plants. This uncertainty is a meagre result for an F₂ of 2518 individuals and 1035 descendants after back crossing, but it is not to be wondered at, seeing there occur under plasmatic influence even in aequation back crosses shortages to an extent of 18,3%.

IV. CANNA AUREO-VITTATA GIGAS A VEGETATIVE MUTATION

In Canna crosses II a table shows the origin of some *gigas* types of *C. aureo-vittata*, all being descendants of one F₁ plant after crossing a deep yellow with a pale yellow-flowering plant.

The 14 *gigas* forms that appeared in 1930 out of more than 2000 *aureo-vittatae* taught me that there is no reason to emphasize the descent of the 7 giants in 1926 and 1927 from one special F₁ plant, since they are now present in lines in which they had been absent among 1018 individuals three and four years before.

For the rest these newly arisen *gigas* plants would not be of much importance, if not two of them had originated as bud-variations in normal plants. The first was an F₆ *aureo-vittata* pale yellow specimen no. 1163-9 which had already been flowering quite normally for more than a month, when there appeared two stalks with the extra broad and flat leaves of the *gigas* which afterwards exhibited the larger *gigas* flowers. Selfing the flowers of a spike resulted in one fruit with one seed. When this meagre harvest was gathered, the rhizome was dug out and cleaned with the aid of a jet of water to decide whether the two types belonged to one single rhizome. This proved to be the fact.

The second instance of vegetative origin was yielded by no. 1133-63, an initially normal plant with deep yellow flowers shade 3, from the back cross *aureo-vittata* p. y. \times (*aureo-vittata* d. y. \times p. y. F₁) Here too some of the later appearing stalks at one side were of the *gigas* type.

In all these cases with hybrids it is not possible to say which parent, the pale one or the deep yellow one, is responsible for the doubling of chromosomes. In six generations of selfed pure types it was only the pale one that once produced a *gigas* rhizome. The only red-flowering *gigas*, arisen from *aureo-vittata* d. y. \times *humilis* F₁ back crossed by *aureo-vittata* p. y. also leaves this question unanswered.

When one is certain that 2 out of 21 *gigas* plants have arisen vegetatively, one is inclined to assume the same origin for the other 19, but this cannot be proved. It is the old problem about the origin of mutations: before or after fertilization? But with respect to the phenomenon of bud-variation, there are as a rule no means to decide about time and mode of mutation in seedlings. Restricting the question to the mutations of doubling of chromosomes, we see that there are cases in which changed pollen-cells combined with normal egg-cells produce triploid individuals, as for instance W. E. DE MOL obtained in tulips. But conversely, triploidy alone is no proof of a mutation of one of the generative cells since BREMER's cytological study on sugar cane hybrids. F₁ plants after crossing *Saccharum officinarum* by *S. spontaneum* do not possess 40 + 56 chromosomes, but 2 \times 40 + 56 and the splitting must have occurred after fertilization. Whether these heterotriploids are to be considered as arisen generatively or vegetatively depends on definition. The first vegetative cell-division is the division of a heterotriploid cell. When the doubling of one or both sets of chromosomes takes place somewhat later, but yet rather early in the development of the embryo, the resulting seedling may be a hetero- or a homozygous *gigas*, undistinguishable from a giant originated from combination of two germcells, one or both of which are doubled. Only if it occurs much later, during the independent life of the seedling, as in two of the *aureo-vittata* plants, it is a proof of vegetative mutation.

SUMMARY (III and IV)

1. Selfing *C. glauca* × *indica* F₁ in the first half of July partly produced more plants with green than with red margined leaves. Later the percentage of red edged plants increased, the maximum being found after pollination in the beginning of August; afterwards it diminished again. The ratios red-margined: green-leaved varied from 0,82:1, increasing to 2,67:1 and decreasing again to 1,68:1 as extremes.

2. Two *C. humilis* × *indica* F₁ plants also showed a lower percentage of red edged plants after selfing at the end of August than after pollination two weeks earlier.

3. A small quantity of pollen on the stigma sometimes gives a higher percentage of plants with red leaf margin than rich pollination does; in one case a difference of 23,6% was found. The reverse was not observed.

4. When the reciprocal F₁ of *indica* (AABBHHII) and *aureo-vittata* pale yellow (aabbhiii) are backcrossed by *aureo-vittata* as an aequation cross, that is without certation, there is a surplus of red margined plants AB in *indica* plasma and a deficit of AB in *aureo-vittata* plasma.

5. In F₂ the favouring or opposing plasmatic influence is covered by certation.

6. The same plasmatic influence is evident from the back crosses of *C. humilis* and *aureo-vittata* pale yellow F₁ by *aureo-vittata*, not, however, from that of *aureo-vittata* deep yellow × *humilis* F₁.

7. *C. indica* and *aureo-vittata* differ in one intensification factor for red sap colour, either D or F, not E which is linked to B.

8. The factor I for bright yellow flower colour, in *indica*, *humilis* and *aureo-vittata* deep yellow hypostatically covered by H and A, is coupled to the red flower colour factor A; coupling ratio ± 3 AI: 1 Ai: 1 aI: 3 ai.

9. It is not quite certain whether factor H for deep yellow, present in *indica*, *humilis* and *aureo-vittata* deep yellow, segregates free from A or is linked with a crossing over percentage not far below 50%.

10. In over 7000 *aureo-vittata* plants of several generations 21 *gigas* have appeared. Two of them have originated vegetatively as budvariations on initially normal diploid rhizomes.

OVERZICHT

1. Zelfbestuiving van *C. glauca* × *indica* F₁ in het begin van Juli deed gedeeltelijk meer planten met groene bladen ontstaan dan met rooden bladrand of anders van de laatsten weinig meer. Later nam het percentage roodrandige exemplaren toe met een maximum bij bestuiving in het begin van Augustus, terwijl het daarna weer afnam. De verhoudingen roodrand:groen variëerden van 0,82:1, toenemend tot 2,67:1 en weer dalend tot 1,68:1 als uitersten.

2. Twee F₁ exemplaren van *C. humilis* × *indica* vertoonden eveneens bij zelfbestuiving in het eind van Augustus een lager percentage roodrand planten dan bij bestuiving een paar weken vroeger.

3. Een kleine hoeveelheid stuifmeel op den stempel doet soms een hooger percentage roodrand ontstaan dan rijkelijke bestuiving, eens tot een verschil van 23,6%. Het tegengestelde werd niet waargenomen.

4. Wanneer de reciproke F₁ van *indica* (AABBHHII) en *aureo-vittata* bleek geel (aabbhiii) teruggekruist wordt met *aureo-vittata* als aequatie-kruising, dus zonder certatie, is er een overmaat van roodrand planten AB in *indica* plasma en een tekort aan AB in *aureo-vittata* plasma.

5. In F₂ is de begunstigende of nadeelige invloed van het plasma niet terug te vinden door de certatie.

6. *C. humilis* (AAbbHHII) en *aureo-vittata* bleek geel (aabbhiii) vertoonen bij terugkruisen van F₁ met den recessiven vorm denzelfden invloed op het aantal Ab combinaties, niet echter de F₁ van *aureo-vittata* donker geel (aabbHHII) × *humilis*.

7. *C. indica* en *aureo-vittata* bleek geel verschillen in één factor voor de intensiteit van de roode bloemkleur. Het is of factor D of F, niet E, die met B gekoppeld bleek te zijn in de *glauca-indica* kruising.

8. Factor I voor helder gele bloemkleur, aanwezig in *indica*, *humilis* en donker gele *aureo-vittata*, is gekoppeld met A, ± in de verhouding 3 AI: 1 Ai: 1 aI: 3 ai.

9. Factor H, die in *indica*, *humilis* en donker gele *aureo-vittata* factor I epistatisch overdekt, splitst vrij van A of zou er misschien een zwakke koppeling mee kunnen vertoonen.

10. Onder meer dan 7000 *aureo-vittata* planten van verschillende generaties kwamen 21 *gigas* exemplaren voor. Twee ervan zijn vegetatief ontstaan als knopvariaties aan oorspronkelijk normale diploide rhizomen.

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PLATES

- I. Broad flat leaves of *C. aureo-vittata gigas*; narrower and somewhat folded leaves of *C. aureo-vittata*.
- II. Rhizome of *C. aureo-vittata*, parts marked by × have *gigas* constitution.

PLATEN

- I. Breede vlakke bladen van *C. aureo-vittata gigas*, smaller en iets gevouwen bladen van *C. aureo-vittata*.
- II. Wortelstok van *C. aureo-vittata*, de gedeelten aangeduid met een × hebben *gigas* natuur.

*) So far as not cited in: Nucleus and plasma in the heredity of the need of light for germination in *Nicotiana* seeds. Genetica XII p. 441-468, 1930.

PLATE I

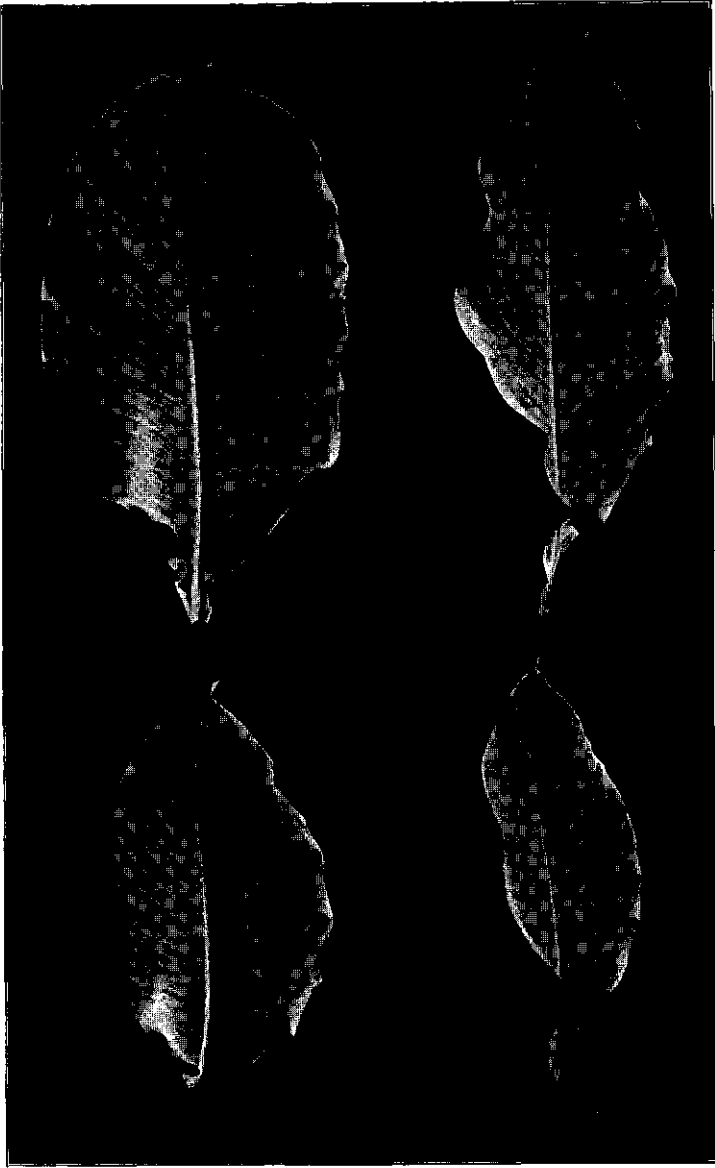


PLATE II



TABLE I SEGREGATION OF F₂ INTO INDIVIDUALS WITH AND WITHOUT A RED LEAF MARGIN

Pollinated by	Quantity of pollen	Number of		Percentage of plants		Deviation from theor. expected 56,25 % red margin
		seeds	seedlings	with red margin	green	
1923						
Miss Joustra	abundant	97	80	50	50	— 6,2
	small	132	109	57,8	42,2	+ 1,6
Miss Roodenburg	abundant	84	72	43,1	56,9	— 13,1
	small	100	81	66,7	33,3	+ 10,5
Mr. Oppenheim	abundant	87	76	57,9	42,1	+ 1,7
	small	59	51	58,8	41,2	+ 2,6
author	abundant	319	274	59,5	40,5	+ 3,3
	small	278	247	61,9	38,1	+ 5,7
1924						
Mr. Ramaer	abundant	415	359	63,0	37,0	+ 6,8
	small	292	252	63,1	36,9	+ 6,9
Mr. Rümke	abundant	289	257	61,5	38,5	+ 5,3
	small	240	201	64,7	35,3	+ 8,5
Total	abundant	1291	1118	59,2	40,8	+ 3,0
	small	1101	941	62,6	37,4	+ 6,4
		2392	2059	60,8	39,2	+ 4,6

TABLE II CONTROL ON THE EXACTNESS OF THE POLLINATION

Pollinated by	Quantity of pollen	Number of		
		fruits	seeds	seeds per fruit
Miss Joustra	plentiful	19	97	5,1
	small	23	132	5,7
Miss Roodenburg	plentiful	15	84	5,6
	small	18	100	5,6
Mr. Oppenheim	plentiful	16	87	5,4
	small	13	59	4,6
author	plentiful	56	319	5,7
	small	56	278	5,0
Mr. Ramaer	plentiful	67	415	6,2
	small	58	292	5,0
Mr. Rümke	plentiful	47	289	6,1
	small	45	240	5,3

TABLE III
 RATIOS OF PLANTS WITH AND WITHOUT RED LEAF MARGIN IN CONNECTION WITH THE TIME
 OF POLLINATION

Pollinated by	Quantity of pollen	Time of pollination															
		2-15 July				16-31 July				1-5 August				22-26 August			
		Number of plants		ratio	Number of plants		ratio	Number of plants		ratio	Number of plants		ratio	Number of plants		ratio	
with red margin	green	with red margin	green		with red margin	green		with red margin	green		with red margin	green					
Mr. Ramaer	abundant	49	46	1,07:1	135	64	2,11:1	—	—	—	—	42	23	1,83:1			
	small	28	19	1,47:1	62	33	1,88:1	—	—	—	—	69	41	1,68:1			
Mr. Rümke	abundant	14	17	0,82:1	87	58	1,50:1	57	24	2,37:1	—	—	—	—			
	small	15	16	0,94:1	67	37	1,81:1	48	18	2,67:1	—	—	—	—			
Total	abundant	63	63	1:1	222	122	1,82:1	—	—	—	—	—	—	—			
	small	43	35	1,23:1	129	70	1,84:1	—	—	—	—	—	—	—			

TABLE IV

PLANTS WITH AND WITHOUT RED LEAF MARGIN IN F₂ AFTER
CROSSING C. INDICA AND AUREO-VITTATA
PALE YELLOW RECIPROCALLY

No.	No. of F ₁ plant	number of		red margin	green	expectation
		seeds	plants			
C. indica × aureo-vittata pale yellow F ₂						
1065	1059-11	167	163	99	64	91,7 : 71,3
1066	-12	153	145	79	66	81,6 : 63,4
1067	-14	102	102	58	44	57,4 : 44,6
1068	-14	19	18	9	9	10,1 : 7,9
1069	-16	136	132	81	51	74,2 : 57,7
1070	-29	150	145	62	83	81,6 : 63,4
1071	-31	76	74	48	26	41,6 : 32,4
1141	-19	139	133	81	52	74,8 : 58,2
1142	-24	68	63	44	19	35,4 : 27,6
	Total	1010	975	561	414	548,4 : 426,6
C. aureo-vittata pale yellow × indica F ₂						
1072	1061- 7	78	77	42	35	43,3 : 33,7
1073	-10	66	63	43	20	35,4 : 27,6
1074	-15	92	78	43	35	43,9 : 34,1
1075	-17	164	158	96	62	88,9 : 69,1
1076	-22	75	75	49	26	42,2 : 32,8
1077	-30	100	98	60	38	55,1 : 42,9
1078	-32	111	111	63	48	62,4 : 48,6
1079	-34	96	93	63	30	52,3 : 40,7
1080	-37	56	54	34	20	30,4 : 23,6
1081	-39	46	44	27	17	24,7 : 19,2
	Total	884	851	520	331	478,7 : 372,3

TABLE VI

INFLUENCE OF THE TIME OF POLLINATION ON THE NUMBER OF
PLANTS WITH RED LEAF MARGIN IN C. HUMILIS × INDICA F₂

No.	F ₁ plant	date of pollination	number of		leaves		ratio red : green
			seeds	seed- lings	red margin	green	
668	599-1	16 Aug. 1924	118	114	60	54	1,11 : 1
668a	599-1	31 Aug. 1924	132	126	62	64	0,97 : 1
669	599-3	7-11 Aug. 1924	223	216	129	87	1,48 : 1
669a	599-3	25 Aug. 1924	51	49	28	21	1,33 : 1
Sum			524	505	279	226	
Expectation on 9 : 7 ratio					284	221	
" " 3 : 1 "					379	126	

TABLE V

PLANTS WITH AND WITHOUT RED LEAF MARGIN; RECIPROCAL
CROSSES OF C.INDICA AND AUREO-VITTATA PALE YELLOW
BACKCROSSED BY AUREO-VITTATA

No.	Back cross	number of		red margin	green
		seeds	plants		
	(ind. × aur.-vit. F ₁) × aur.-vit.				
1090	1059-14 × 901-2	23	23	6	17
1091	-16 × 901-2	46	40	7	33
1092	-19 × 901-2	99	91	25	66
1093	-22 × 792-6	39	37	8	29
1094	-29 × 901-2	94	87	26	61
1096	-35 × 901-2	88	82	23	59
1097	-42 × 970-8	14	13	4	9
1098	-42 × 901-2	67	62	17	45
1099	-44 × 1064-1	23	21	8	13
1100	-44 × 792-6	45	41	10	31
	Sum (expectation)	538	497	134 124½	363 372½
	(aur.-vit. × ind. F ₁) × aur.-vit.				
1101	1061-7 × 901-2	76	74	12	62
1102	-10 × 901-2	22	21	10	11
1103	-10 × 1064-1	8	8	2	6
1104	-19 × 901-2	57	56	14	42
1105	-22 × 1064-8	31	31	6	25
1106	-32 × 592-11	78	72	18	54
1107	-34 × 901-2	11	11	2	9
1108	-37 × 1064-1	40	39	6	33
1109	-39 × 969-5	14	13	2	11
	Sum (expectation)	337	325	72 81½	253 243½
	Both series together (expectation)	875	822	206 205½	616 616½
	Back cross (certation-) aur.-vit. × (aur.-vit. × ind. F ₁)				
1136	969-5 × 1061-30	54	53	20 13½	33 39½
	(expectation)				

TABLE VIII FLOWER COLOURS; RECIPROCAL CROSSES OF C. INDICA AND AUREO-VITTATA
PALE YELLOW BACKCROSSED BY AUREO-VITTATA PALE YELLOW

No.	Back cross	Plants with red edged leaves										Plants with green leaves										grand total yellow-lows					
		shades of red in flowers					shades of red in flowers					flowers deep yellow, shades					bright yellow, shades						pale yellow, shades				
		10	9	8	7	tot.	10	9	8	7	6	tot.	5	4	3	2	1	tot.	2	1	tot.		3	2	1	tot.	
(ind. × aur.-vit. F ₁) × aur.-vit. AaBbHhIi × aabbhhii; indica plasma																											
1090	1059-14 × 901-2	3	3	—	6	3	2	1	—	6	—	2	4	—	6	—	1	—	1	—	1	—	4	—	4	11	
1091	-16 × 901-2	3	4	—	7	4	6	3	—	13	—	2	4	—	6	—	1	—	1	—	1	—	8	—	8	20	
1092	-19 × 901-2	7	13	4	24	7	10	3	—	20	—	2	7	12	26	—	1	—	1	—	1	—	16	1	17	43	
1093	-22 × 792-6	4	4	—	8	7	4	—	—	11	5	2	—	—	7	4	11	—	1	—	1	—	6	—	6	18	
1094	-29 × 901-2	14	10	4	28	9	3	2	—	14	1	2	16	—	19	5	24	1	1	—	1	—	19	—	19	44	
1096	-35 × 901-2	17	5	—	22	6	6	3	1	17	—	3	1	—	4	5	23	1	2	3	—	—	16	—	16	42	
1097	-42 × 970-8	2	1	1	4	2	1	—	—	3	2	1	—	—	3	1	5	—	—	—	—	—	1	—	1	6	
1098	-42 × 901-2	8	6	3	17	7	5	1	—	13	2	6	5	—	13	2	15	—	1	—	1	—	15	—	15	31	
1099	-44 × 1064-1	—	6	2	8	—	1	—	—	1	—	1	—	—	1	—	7	—	—	—	—	—	3	—	3	10	
1100	-44 × 792-6	1	2	6	9	—	6	3	—	9	—	1	5	—	6	—	3	9	—	—	1	—	12	—	12	22	
Sum		1	66	54	12	133	1	52	40	13	1	107	6	35	60	1	35	137	3	7	10	—	99	1	100	247	
(Expectation 121½)																											
(aur.-vit. × ind. F ₁) × aur.-vit. AaBbHhIi × aabbhhii; aureo-vittata plasma																											
1101	1061-7 × 901-2	7	3	1	11	—	9	6	4	—	19	—	3	10	—	5	18	1	4	5	—	15	1	16	39		
1102	-10 × 901-2	6	3	1	10	—	2	1	—	3	—	1	—	—	2	—	2	—	1	—	1	—	3	1	4	8	
1103	-10 × 1064-1	—	1	1	—	2	2	—	—	2	—	2	—	—	2	—	2	—	1	—	1	—	1	—	1	4	
1104	-19 × 592-11	—	9	4	—	13	8	7	1	—	16	—	4	10	—	—	14	1	—	—	—	10	—	10	25		
1105	-22 × 1064-8	—	3	2	1	6	4	5	2	—	11	—	4	1	—	—	5	—	—	1	—	8	—	8	14		
1106	-32 × 592-11	—	2	10	3	15	8	7	3	—	18	2	7	5	—	—	19	—	—	2	—	14	—	14	35		
1107	-34 × 901-2	—	1	1	—	2	2	—	—	—	—	4	—	—	—	—	1	5	—	—	—	—	4	—	4	9	
1108	-37 × 1064-1	1	3	2	—	6	—	3	1	—	7	—	7	—	—	—	—	2	9	—	—	16	—	16	25		
1109	-39 × 969-5	—	1	1	—	2	—	4	1	—	6	1	1	—	—	—	—	1	4	—	—	1	—	1	5		
Sum		1	33	27	6	67	—	40	30	11	1	82	3	19	41	—	16	79	3	8	11	—	72	2	74	164	
(Expectation 78½)																											
(aur.-vit. × (aur.-vit. × ind. F ₁) aabbhhii × AaBbHhIi; aureo-vittata plasma																											
1136	969-5 × 1061-30	3	8	4	1	16	—	6	6	3	—	15	—	2	3	—	3	8	—	1	1	1	5	—	6	15	

TABLE IX

FLOWER COLOURS; CROSSES OF *C. HUMILIS* AND *AUREO-VITTATA*
PALE YELLOW OR DEEP YELLOW, BACKCROSSED BY *AUREO-VITTATA*
PALE YELLOW (*AabbHhii* × *aabbhhii* AND *AabbHHII* × *aabbhhii*)

No.	Flowers red, shades						Flowers deep yellow, shades						Flowers bright yellow, shade	Flowers pale yellow, shade	grand total yellows		
	10	9	8	7	6	tot.	7	6	5	4	3	2	1	tot.	1	2	
(<i>humilis</i> × <i>aureo-vittata</i> p.y. F_1) × <i>aureo-vittata</i> p.y.																	
1110	-	9	10	3	2	24	-	-	-	4	4	1	3	12	5	7	24
1111	-	3	3	4	-	10	-	-	1	1	2	-	-	4	-	3	7
Sum	-	12	13	7	2	34	-	-	1	5	6	1	3	16	5	10	31
(<i>aureo-vittata</i> p.y. × <i>humilis</i> F_1) × <i>aureo-vittata</i> p.y.																	
1112	1	26	23	12	3	65	-	-	4	13	11	2	-	30	5	33	68
1113	-	9	4	1	-	14	-	-	1	7	3	-	-	11	6	6	23
Sum	1	35	27	13	3	79	-	-	5	20	14	2	-	41	11	39	91
(<i>aureo-vittata</i> d.y. × <i>humilis</i> F_1) × <i>aureo-vittata</i> p.y.																	
1114	6	25	8	4	2	45	1	9	29	5	3			47			
1115	-	17	7	4	-	28	-	7	20	5	2			34			
1116	1	16	7	3	-	27	-	5	14	2	-			21			
1117	2	14	4	2	-	22	1	5	8	-	1			15			
1118	1	11	4	-	-	16	-	3	4	2	2			11			
1119	1	14	2	1	-	18	1	2	3	-	1			7			
1120	2	26	11	1	-	40	-	2	24	13	7			46			
1121	2	11	17	1	-	31	-	6	14	9	2			31			
1122	2	7	7	6	-	22	-	7	13	-	4			24			
1123	1	9	3	3	-	16	-	3	7	2	1			13			
Sum	18	150	70	25	2	265	3	49	136	38	23			249			

TABLE X

FLOWER COLOURS; F₂ OF C. HUMILIS AND AUREO-VITTATA PALE OR DEEP YELLOW

No.	Flowers red, shades										Flowers deep yellow, shades							Flowers bright yellow, shades			Flowers pale yellow, shade		grand total yellows			
	11	10	9	8	7	6	5	4	3	2	1	tot.	7	6	5	4	3	2	1	tot.	2	1		tot.	2	1
humilis × aureo-vittata pale yellow F ₂ , AabbHhIi selfed																										
1082	-	6	17	20	15	-	-	-	-	-	58	-	-	12	3	3	-	1	19	1	1	2	1	1	22	
1083	-	4	24	29	11	-	-	-	-	-	68	-	-	13	3	6	-	1	23	-	1	1	4	1	28	
1147	-	2	1	10	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	1	1	1	
1148	-	6	47	47	21	3	1	125	-	-	3	9	3	5	1	6	27	-	-	-	-	-	5	32		
Sum	-	18	89	106	47	3	1	264	-	-	3	34	9	14	1	8	69	1	2	3	11	83	87)			
(Expectation 260)																										
aureo-vittata pale yellow × humilis F ₂ , AabbHhIi selfed																										
1084	-	8	61	63	26	1	-	159	-	1	17	4	16	-	5	43	-	-	5	5	2	2	50			
1085	-	-	35	37	15	1	-	88	-	-	1	2	7	-	1	11	-	-	2	2	3	16	16			
1143	-	4	18	19	4	-	-	45	-	1	5	3	2	-	1	12	2	2	4	4	4	20	20			
Sum	-	12	114	119	45	2	-	292	-	2	23	9	25	-	7	66	2	9	11	9	86	94)				
(Expectation 284)																										
aureo-vittata deep yellow × humilis F ₂ , AabbHHIi selfed																										
1086	-	5	41	18	7	-	-	71	14	2	3	-	-	-	-	19	-	-	-	-	-	-	-	-		
1087	-	6	36	28	5	2	-	77	2	11	9	1	-	-	-	23	-	-	-	-	-	-	-	-		
1088	4	3	13	32	18	2	-	72	3	5	10	-	-	-	18	-	-	-	-	-	-	-	-	-		
1089	1	-	18	17	5	-	-	41	4	5	6	1	-	-	16	-	-	-	-	-	-	-	-	-		
1144	1	6	56	52	10	-	-	125	8	13	10	4	-	-	35	-	-	-	-	-	-	-	-	-		
1145	-	7	42	17	6	-	-	72	2	2	12	-	-	-	16	-	-	-	-	-	-	-	-	-		
1146	1	9	52	28	9	-	-	99	2	8	12	1	-	-	23	-	-	-	-	-	-	-	-	-		
Sum	7	36	258	192	60	4	-	557	35	46	62	7	-	-	150	-	-	-	-	-	-	-	-	-		
(Expectation 530)																										

TABLE XI

RECIPROCAL F_1 OF C. AUREO-VITTATA DEEP AND PALE YELLOW,
BACKCROSSED BY PALE YELLOW

No.	Flowers deep yellow, shades								Flowers bright yellow, shades			Flowers pale yellow, shades			grand total yellows
	7	6	5	4	3	2	1	tot.	2	1	tot.	3	2	tot.	
(pale \times deep F_1) \times pale															
1124	-	4	15	4	4	-	5	32	1	11	12	-	20	20	64
1125	1	5	3	2	4	-	3	18	-	3	3	-	2	2	23
Sum	1	9	18	6	8	-	8	50	1	14	15	-	22	22	87
(deep \times pale F_1) \times pale															
1127	5	9	32	10	18	-	11	85	-	34	34	-	40	40	159
1128	3	6	15	9	3	-	9	45	2	4	6	-	12	12	63
Sum	8	15	47	19	21	-	20	130	2	38	40	-	52	52	222
pale \times (deep \times pale F_1)															
1129	-	2	12	7	10	4	14	49	-	10	10	1	21	22	81
1130	-	5	28	27	16	10	21	107	-	27	27	5	43	48	182
1131	-	4	13	4	7	3	9	40	-	18	18	1	25	26	84
1132	-	1	2	1	1	4	1	10	-	3	3	1	5	6	19
1133	-	4	13	11	9	5	10	52	-	17	17	3	19	22	91
Sum	-	16	68	50	43	26	55	258	-	75	75	11	113	124	457
pale \times (pale \times deep F_1)															
1134	3	15	21	21	7	-	18	85	1	12	13	-	13	13	111
1135	5	4	9	7	4	-	10	39	2	11	13	-	13	13	65
Sum	8	19	30	28	11	-	28	124	3	23	26	-	26	26	176

TABLE XII

FLOWER COLOUR IN F₂ AFTER CROSSING C. AUREO-VITTATA
DEEP AND PALE YELLOW RECIPROCALLY

No.	Flowers deep yellow, shades								Flowers bright yellow, shades			Flowers pale yellow, shades			grand total yellows
	7	6	5	4	3	2	1	tot.	2	1	tot.	3	2	tot.	
pale × deep F ₂ 1930															
1175	30	20	34	15	4	5	10	118	-	17	17	2	10	12	147
1176	2	8	7	9	2	-	2	30	-	4	4	-	4	4	38
Sum	32	28	41	24	6	5	12	148	-	21	21	2	14	16	185
deep × pale F ₂ 1930															
1178	26	56	73	21	22	14	15	227	-	35	35	5	10	15	277
1179	21	41	77	37	17	13	19	225	1	34	35	4	16	20	280
1180	15	29	33	14	16	13	11	131	-	24	24	2	11	13	168
Sum	62	126	183	72	55	40	45	583	1	93	94	11	37	48	725
pale × deep F ₂ 1929															
1044	74	91	84	6	78	-	23	356	12	78	90	-	26		472
1045	37	9	11	1	8	3	3	72	5	13	18	-	5		95
1046	91	9	9	1	11	12	8	141	27	17	44	-	11		196
1047	43	23	58	3	30	2	18	177	9	31	40	-	18		235
1048	1	7	3	1	3	-	2	17	2	2	4	-	2		23
1049	23	9	12	1	8	2	3	58	2	8	10	-	1		69
1050	25	8	17	-	10	-	6	66	9	12	21	-	4		91
1051	15	45	42	2	43	-	13	160	12	30	42	-	11		213
Sum	309	201	236	15	191	19	76	1047	78	191	269	-	78		1394