

Unstable Wrinkled and Stable Wrinkloid Flowers of the Japanese Morning Glory.

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With Plate XXVII and three Text-figures.

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Introduction.

According to IMAI (1934, 1936), so far twenty-two mutable genes have been discovered in the Japanese morning glory, *Pharbitis Nil*. Some of these mutable genes relate to anthocyanin and chlorophyll distribution, and others to the morphological characters that affect the leaves and flowers. Wrinkled (IMAI, 1927) belongs to the latter, with willow (IMAI, 1925, 1927; TABUCHI, 1935 b), contracted (IMAI, 1927, 1934), delicate (IMAI, 1927; TABUCHI, 1935 a), pine-inconstant (IMAI, 1927; U, 1930), lobeless (TERAO and U, 1930), miniature-inconstant (TERAO and U, 1930) and pipy (IMAI and KANNA, 1935).

The present writer has verified IMAI's result on unstable wrinkled, adding some further data. The inheritance of stable wrinkloid has also been elucidated, the characteristic of wrinkloid somewhat resembling that of wrinkled.

The investigation was conducted under the guidance of Prof. K. MIYAKE and Dr. Y. IMAI, to both of whom the writer wishes to express his sincere thanks.

Inheritance of Wrinkled and Wrinkloid Flowers.

As to the wrinkled (Pl. XXVII, fig. 1), IMAI (1934) wrote "Corollas wrinkled, somewhat star-shaped, fertility generally low, rarely reverting to normal". The wrinkled pedigree strain with which the experiments were made is numbered 220. It has been under cultivation by Dr. IMAI for the last 20 years or more. As will be seen from Table I, the fertility differed owing to different conditions. When the flowers were artificially pollinated, seed production was somewhat fair, but otherwise its fertility was generally low.

TABLE I.
Fertility of wrinkled strain.

Pollination		Number of flowers	Number of capsules	Number of seeds	Fertility (%)	Number of seeds per capsule
Unbagged	Natural	92	48	138	52.17	2.88
	Artificial	89	79	306	88.76	3.87
Bagged	Natural	159	41	91	25.79	2.22
	Artificial	266	198	611	74.44	3.09

Wrinkloid, a new sporadic mutant, was found by Dr. IMAI in his culture (Pl. XXVII, fig. 4). The wrinkloid mutant bears crêpe dragonfly leaves, and flecked corollas, which are slightly wrinkled. The fertility seems normal, and the character is very constant, no reversion to normal corolla having been observed.

In 1933, the writer received the F_2 from normal \times wrinkled from Dr. IMAI for the purpose of testing the segregation. As was expected, a monogenic ratio was obtained (Table II a), in which the wrinkled segregated as recessive.

In the same year, the writer made crosses, normal \times wrinkloid and wrinkled \times wrinkloid, their F_2 having been tested in 1935. The former cross gave normal F_1 , and resulted in a simple Mendelian segregation in F_2 with wrinkloid as recessive (Table II b). The F_1 from the latter cross bore normal flowers and segregated digenically in F_2 , namely, normal: wrinkled: wrinkloid to be 9:4:3, as shown in Table II c.

TABLE II.
Segregation data in F₂.
a. Normal × wrinkled.

Cross	Pedigree No.	Normal	Wrinkled	Total
Normal × Wrinkled	1	29	13	42
	2	14	4	18
Total		43	17	60
Expected		45.00	15.00	60

b. Normal × wrinkloid.

Cross	Pedigree No.	Normal	Wrinkloid	Total
Normal × Wrinkloid	1	40	10	50
	2	12	6	18
Reciprocal	1	37	13	50
	2	18	9	27
Total		107	38	145
Expected		108.75	36.25	145

c. Wrinkled × wrinkloid.

Cross	Pedigree No.	Normal	Wrinkled	Wrinkloid	Total
Wrinkled × Wrinkloid	1	9	7	3	19
	2	19	11	6	36
Reciprocal	1	19	7	7	33
	2	21	7	5	33
Total		68	32	21	121
Expected		68.06	30.25	22.69	121

From the foregoing results, it is concluded that the wrinkled and wrinkloid genes segregate independently of each other, both as simple recessive to normal, although their loci have not yet been determined.

Breeding Results of Wrinkled Pedigrees.

In 1934, the writer cultivated selfed 34 wrinkled pedigrees, the results of the observations made so far being contained in Table III.

TABLE III.
Pedigree cultures of wrinkled strain.

Pedigree No.	Normal	Wrinkled	Mosaic	Total
1	1	11	0	12
2	4	26	0	30
3	1	20	0	21
4	0	24	0	24
5	2	54	1	57
6	0	29	1	30
7	1	14	0	15
8	1	39	0	40
9	0	18	0	18
10	3	62	0	65
11	1	23	1	25
12	1	33	0	34
13	0	38	0	38
14	1	75	0	76
15	0	16	0	16
17	0	8	0	8
18	1	11	0	12
19	1	20	0	21
20	0	30	1	31
21	2	40	2	44
23	4	62	2	68
24	1	142	1	144
25	0	8	1	9
26	0	40	0	40
27	0	43	0	43
28	0	32	1	33
29	1	40	0	41
30	3	25	1	29
31	0	25	2	27
32	0	8	0	8
33	2	71*	3	76
34	0	28	0	28
35	0	33	0	33
36	0	35*	0	35
Total	31	1183	17	1231
Percentage	2.52	96.10	1.38	100

* Contains one haploid individual in each pedigree.

Normal (Pl. XXVII, fig. 2) and mosaic (Pl. XXVII, fig. 3) mutants in otherwise wrinkled individuals were occasionally observed. In totaling the individual and mosaic mutants, the frequency with which they occur was calculated to be 3.9 per cent.

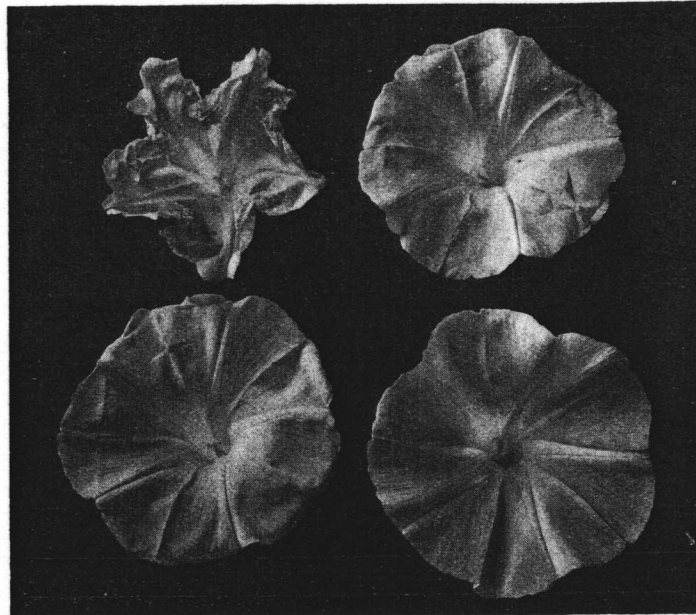
The normal mutants bore various flowers, ranging from exactly normal to somewhat crinkled (Text-fig. 1). In the mosaic plants, various flower types were also observed, including mosaic flowers (Text-fig. 2).

Normal Mutants and Mosaics in Wrinkled Pedigrees.

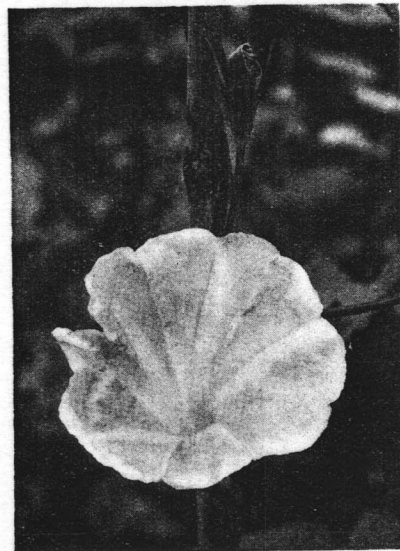
Normal mutants and mosaics were bagged in order to test their genetic behaviour. The data for the progenies of 23 out of 31 individual mutants are given in Table IV. There were two groups, (a)

TABLE IV.
Progeny of reverted normal individuals.

Pedigree No.	Normal	Wrinkled	Mosaic	Total
a. Group showing monogenic segregation.				
1-1	15	5	0	20
2-2	39	14	1	54
2-3	14	7	0	21
2-4	35	9	2	46
3-1	9	3	0	12
5-1	42	15	0	57
5-2	5	3	0	8
7-1	3	0	0	3
8-1	10	6	0	16
11-2	3	2	0	5
12-1	16	5	0	21
14-1	13	2	0	15
18-1	13	6	0	19
21-2	17	4	0	21
21-4	12	4	0	16
23-2	15	6	1	22
23-5	8	3	0	11
33-1	9	5	0	14
Total	278	99	4	381
Expected	285.75	103	95.25	381
b. Group breeding to wrinkled				
2-1	1	11	0	12
23-1	0	9	0	9
23-6	2	14	0	16
24-1	0	6	0	6
33-5	0	17	1	18
Total	3	57	1	61



Text-fig. 1. Wrinkled (upper left), normal (lower right), somewhat crinkled normal (upper right and lower left).



Text-fig. 2. Mosaic flower, $1/5$ wrinkled and $4/5$ normal.

which segregated, monogenically, normal and wrinkled and (b), which gave results similar to the progeny of wrinkled, that is, nearly every individual bore wrinkled flowers. These two normal flowers were difficult to identify with their phenotypes.

The progenies of 17 mosaic mutants were also tested with results as may be seen in Table V. From the results obtained by selfing normal flowers on mosaic plants, they may be divided into two groups;

TABLE V.
Progeny of mosaic individuals.

Pedigree No.	Normal	Wrinkled	Mosaic	Total
a. Segregating offspring from normal flowers.				
5-3	13	6	0	19
6-1	3	0	0	3
11-1	9	5	1	15
20-1	12	6	0	18
21-3	17	7	0	24
23-3	2	0	0	2
25-1	7	2	1	10
28-1	1	0	0	1
30-1	9	1	0	10
33-2	5	2	0	7
Total	78	29	2	109
Expected	81.75	31	27.25	109
b. Wrinkled offspring from normal flowers.				
21-1	0	7	0	7
23-4	3	50	1	54
24-2	1	3	0	4
31-1	0	18	1	19
31-2	0	7	0	7
33-3	0	6	0	6
33-4	0	1	0	1
Total	4	92	2	98
c. Offspring from wrinkled flowers.				
21-1	1	18	0	19
23-3	0	2	0	2
23-4	0	3	1	4
24-2	0	12	1	13
31-2	2	10	0	12
33-2	0	10	0	10
33-3	1	21	0	22
33-4	1	21	0	22
Total	5	97	2	104

the one which segregated, and the other which bred to wrinkled, just as in the case of the individual mutants. The wrinkled group, although it included a few normal and mosaic individuals, was substantially the same as the offspring from wrinkled flowers.

Mutable behaviour in connection with the mechanism of bud variation in the Japanese morning glory was discussed with a wealth of data by IMAI (1934), followed by KIHARA (1934), IMAI and KANNA (1935), and TABUCHI (1935a-b).

According to IMAI (1934), the plant body of the Japanese morning glory consists of three histogens. The morphological characters of the corollas are determined mainly by those of the ecto- and meso-histogens, mutation in the tissue of the latter bringing about a heritable change in the progeny.

From the results shown in Table IV, the so-called normal mutants contained some mosaic individuals in which vegetative mutation had occurred during very early ontogenic development. The false normal mutants may have normal tissues either in the ecto-histogens or in the meso-histogens, the former breeding to wrinkled, as shown in Table IVb, the latter segregating to normal and wrinkled, the results of which cannot be separated from those of the true individual mutants, being mixed together, as shown in Table IVa.

Because of the fact that the wrinkled flower is not accompanied by any foliar characters, its identification is possible only by observing the flower, in which case some mosaics that mutated vegetatively very early in its somatogenesis might not bear any wrinkled flowers, owing to predominant growth of the mutated normal parts. Such false individuals are recorded as normal mutants, without distinction from the true normal mutants.

The normal parts of the mosaic mutants exhibited the same features in their breeding aspects, that is, vegetative mutation occupied either the ecto-histogen or the meso-histogen (in the latter case homogeneous sports are also included) (Table Va-b), while the original wrinkled parts bred to wrinkled (Table Vc).

Other Mutants.

In the course of breeding experiments in 1934 with the wrinkled, haploids and light-coloured mutants appeared.

HAPLOID INDIVIDUALS. Two haploid plants (Text-fig. 3) occurred

in the wrinkled pedigree culture, besides one in the F_1 of a cross in which wrinkled was used as the female parent. A brief description of the haploids, with chromosomal observations, have already been reported (KATAYAMA, 1935).



Text-fig. 3. Diploid (left) and haploid (right) wrinkled.

MUTANTS WITH LIGHT-COLOURED FLOWERS. In a wrinkled pedigree, 8 out of 40 individuals bore light-coloured flowers. As the mutant character bred true to the later generation, the new character is believed to be a monogenic recessive. According to RIDGWAY'S "Color Standard and Color Nomenclature", the flower colour of wrinkled No. 220 is Amaranth Pink, while that of the mutant is Pale Amaranth Pink.

Summary.

1. The genes of unstable wrinkled and stable wrinkloid in the Japanese morning glory are monogenic recessives, which segregate independently of each other.

2. The wrinkled produces normal mutants and mosaics, their occurrence being 3.9 per cent.

3. Some of the normal mutants either segregated monogenically or bred exactly like the wrinkled, the former consisting of true and false individual mutants, while the latter is of mosaic origin. The normal parts of mosaics had either mutated heterozygous normal or wrinkled meso-histogens, the last-named having normal ecto-histogens.

4. Haploids and light-coloured mutants occurred in the wrinkled culture, the latter being a monogenic recessive to normal.

LITERATURE CITED.

- IMAI, Y. (1925): Genetic behaviour of the willow leaf in the Japanese morning glory. *Jour. Gen.* 16: 77-98.
- (1927): The vegetative and seminal variations observed in the Japanese morning glory, with special reference to its evolution under cultivation. *Jour. Coll. Agr., Tokyo Imp. Univ.* 9: 223-274.
- (1934): On the mutable genes of *Pharbitis*, with special reference to their bearing on the mechanism of bud-variation. *Jour. Coll. Agr., Tokyo Imp. Univ.* 12: 479-523.
- (1936): Chlorophyll variegations due to mutable genes and plastids. *Zeitschr. f. ind. Abst.- u. Vererbgs. l.* 71: 61-83.
- IMAI, Y. and KANNA, B. (1935): The pipy flower of *Pharbitis Nil* as a mutable character. *Jour. Gen.* 30: 107-114.
- KATAYAMA, Y. (1935): Haploid plants in the Japanese morning glory. *Japan. Jour. Gen.* 11: 279-281.
- KIHARA, H. (1934): Vererbungsstudien über eine "flecked"-Sippe bei *Pharbitis Nil*. I. *Botany and Zoology* 2: 1801-1814.
- TABUCHI, K. (1935a): The mutable behaviour of delicate genes in the Japanese morning glory. *Jour. Coll. Agr., Tokyo Imp. Univ.* 13: 373-395.
- (1935b): A study on the mutability of the willow leaf in the Japanese morning glory. *Jour. Coll. Agr., Tokyo Imp. Univ.* 13: 415-430.
- TERAO, H. and U, N. (1930): Studies on the appearance of mutation in the morning glory. (Japanese). *Japan. Jour. Gen.* 6: 195-198.
- U, N. (1930): On the recurring mutation of pine type of morning glory. (Japanese). *Japan. Jour. Gen.* 6: 199-202.

EXPLANATION OF PLATE XXVII.

- Fig. 1. Wrinkled.
- Fig. 2. Normal.
- Fig. 3. Wrinkled mutated vegetatively to bloom normal. The lower flower is wrinkled and the upper normal.
- Fig. 4. Wrinkloid.
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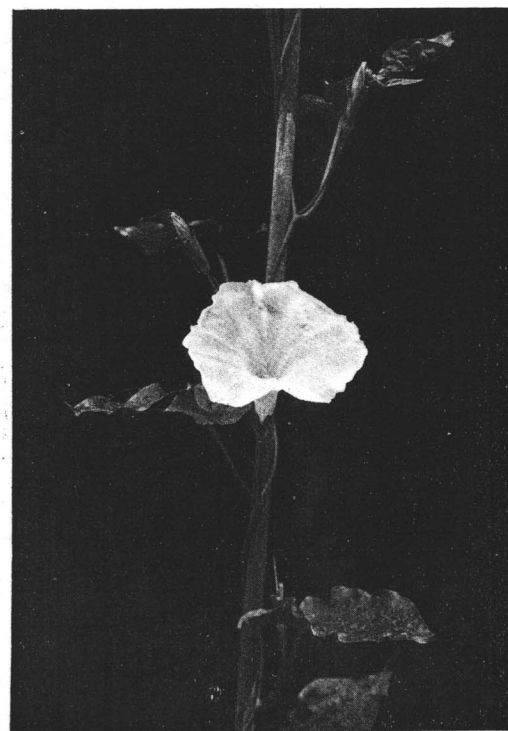
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2



3



4