THE SEGREGATION OF ALBESCENT SEEDLINGS AND THE MUTATION TO DEFECTIVE SEEDS IN A PEDIGREE OF THE JAPANESE MORNING GLORY

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MISS YASUI (1920) obtained albino seedlings of the Japanese morning glory, *Pharbitis Nil,* as a simple recessive in its heterozygous pedigree. Later, this form appeared spontaneously in the writer's own culture (Imai, 1924, 1927). In a pedigree of unknown origin, he also observed the segregation of "albescent" seedlings, which appeared to be almost if not quite viable by themselves. The diagnosis of the albescent seedling is as follows: It has cotyledons with a white or whitish smear, which varies in quantity as well as intensity of whiteness, from nearly normal green to almost pure white. The stalks of the cotyledons are generally pale in color, especially on the upper side, which is nearly white. The buds of young leaves appearing between the two cotyledons are distinctly white. The albescent seedling can be detected on inspection from above by observing the color of the bud and stalks of the cotyledons. The white smear on the cotyledons is so variable that it can not always be relied upon for diagnosis. The first evolved leaves of albescent seedlings are usually whitish in color or white-smeared, but those developed later are not diagnostic. The grown-up plants that develop from albescent seedlings are apparently green. The capsules, however, are whitish in color when the seeds are ripening. They are a pale green in color in the normal.

THE SEGREGATION OF ALBESCENT SEEDLINGS

The mother plant, from which these albescent seedlings segregated, developed from a normally green seedling, and had green stems, cordate leaves and white flowers with slightly colored tubes. The progeny were homogeneous in their characteristics, aside from the segregation of the chlorophyll deficient seedlings as shown in Table 1.

TABLE 1

THE DATA OBTAINED IN 1925

The record of the seedling bed

	Green seedling	Albescent seedling	Total	Percentage of albescent seedlings
Observed	112	26	138	18.84

TABLE 2

THE OFFSPRING OF THE NON-ALBESCENTS, RAISED IN 1926

The record of the seedling bed

Family number	Green seedling	Albescent seedling	Total	Percentage of albescent seedlings
11 families	353	—	353	0.00
1	7	3	10	30.00
2	42	9	51	17.65
3	38	6	44	13.64
4	7	3	10	30.00
5	27	10	37	27.03
10	11	2	13	15.38
11	17	2	19	15.26
14	3	1	4	25.00
15	26	8	34	23.53
18	27	5	32	15.63
21	4	4	5	20.00
22	42	10	52	19.23
23	42	8	50	16.00
24	10	2	12	16.67
25	5	1	9	44.44
26	7	1	8	12.50
Total	315	75	390	19.23

TABLE 3

THE DATA OBTAINED IN 1927

Character of mother plant	Family number in the first segregating generation	Family number in the second segregating generation	Green seedling	Albescent seedling	Total	Percentage of albescent seedlings
Green seedling	2	5 families	288	—	288	0.00
		12	89	14	103	13.59
		13	21	5	26	19.23
		14	131	32	163	19.63
		16	45	3	48	6.25
		18	96	21	117	17.95
		20	43	11	54	20.37
		21	60	9	69	13.04
		22	69	17	86	19.77
		23	66	8	74	10.81
		25	126	25	151	16.56
		Total	746	145	891	16.27
	3	4 families	310	—	310	0.00
		5	27	8	35	22.86
		7	72	12	84	14.29
		8	80	15	95	15.79
		9	24	6	30	20.00
		11	15	2	17	11.76
		12	57	8	65	12.31
		Total	275	51	326	15.64
	6	5 families	341	—	341	0.00
	8	8 families	346	—	346	0.00
	22	2 families	48	—	48	0.00
		9	8	1	9	11.11
		10	24	8	32	25.00
		11	21	2	23	8.70
		12	13	3	16	18.75
		Total	66	14	80	17.50
Albescent seedling	2	9 families	—	232	232	100.00
	2	4 families	—	33	33	100.00
	22	8 families	—	169	169	100.00

The proportion of the albescent segregates is only 18.84 per cent. Some of these green and albescent seedlings were transplanted on the field to allow their later growth, but the unfavorable weather damaged all albescents, therefore the data of the next generation are confined to the greens, as shown in Table 2.

The average proportion of the albescent segregates in this generation is 19.23 per cent., which is very close to that of the foregoing generation, though both are conspicuously behind the normal expectation of 3 to 1. The same deficit appeared also in the third segregating generation, the data of which are indicated in Table 3.

In this generation the writer obtained the progenies of albescent segregates and found them constant to type. In the twenty-one families examined, 434 seedlings were recorded, all being albescent. Tables 1 to 3 will show the recessive Mendelian nature of the albescent seedling. The deficiency in the proportion of recessives seems to be constant in each generation. Actually we had:

Year of cultivation	Number of families	Total individuals observed	Average percentage of segregating albescent seedlings
1925	1	138	18.84
1926	16	390	19.23
1927	20	1,297	16.19
Average	37	1,825	17.04

In Table 4 the segregating families through three generations are arranged according to the magnitudes of the deviations in terms of probable errors.

The goodness of fit is high, being $P = 0.781$, and this indicates the fact that the variation exhibited in the proportion of segregating albescent seedlings is due to a chance deviation from an average, 17 per cent. The cause of the deficiency seems to be simple, working either directly or indirectly upon the recessive segregates, which are expected to be produced in a monohybrid recessive ratio. The albescent seedlings are compara-

TABLE 4

A MATHEMATICAL TREATMENT ON THE VARIABILITY EXHIBITED IN THE PROPORTION OF SEGREGATING ALBESCENT SEEDLINGS

Deviations are calculated from the average of 17 per cent.

Dev./Prob. error	−4	−3	−2	−1	0	+1	+2	+3	+4	Total
Observed	0	2	4	12	9	8	1	1		37
Expected	0.79	2.48	5.98	9.25	9.25	5.98	2.48	0.79		37

$\chi^2 = 3.984$ $P = 0.781$

tively less vigorous and they frequently die in their early development after transplantation in the field. The data for the point at issue, as collected in 1927, are indicated in Table 6 and may be summarized as follows:

Type of family	Number of families	Seedlings transplanted on field	Grown-up plants	Percentage of mortality	
				in green seedlings	in albescent seedlings
Normal { true-breeding	5	153	131	14.38	——
Normal { segregating	9	427	359	9.86	45.83
Albescent	7	217	130	——	40.09

The discrepancy in albescent plants seems to be due to their conspicuously weak constitution.

THE APPEARANCE OF ABNORMAL SEEDS

In the second segregating generation of this albescent-segregating pedigree the writer recorded the spontaneous occurrence of abnormal seeds. A number of plants from families Nos. 2, 3, 6, 8 and 22 were transplanted for later growth. The exceptions occurred only in family No. 2. The others gave normal black seeds. At seed-harvest of the plants of this family the abnormal seeds were found in Table 5.

The abnormal seeds are segregated in a simple recessive proportion. The seeds are very thin and deformed

TABLE 5

THE DATA FOR THE MUTATIVE APPEARANCE OF THE DEFECTIVE SEEDS IN FAMILY NO. 2, COLLECTED IN 1926

Family number	Green with normal seed	Albescent with normal seed	Green with defective seed	Albescent with defective seed	Total
2	20	8	7	1	36
	28		8		
Expected	27		9		36

and rusty tan in color. From their form the writer calls them "defective" seeds. The defective seed is a novel character in our morning glory. No description of it occurs in our literature.

The spontaneous segregation of the defective seeds apparently is due to the heterozygosity of the mother plant of this family, presumably being derived through the union of a normal gamete by an abnormal one which had mutated from the normal. The mutation, therefore, occurred from dominant to recessive.

The data for the simple recessiveness of the defective seed obtained in the next generation are given in Table 6.

The data on the segregation of the defective seeds are summarized in Table 7.

The simple recessiveness of the defective seed to the normal is proved to be correct by the data. Table 6 also shows the free assortment of the albescent seedling and defective seed in their simultaneous segregation.

THE DEFECTIVE SEED

Owing to their deformity air-dried, defective seeds weigh only 2.632 grams per 100 grains, on an average, as compared with the normal seeds which attain 4.785 grams. The seedlings from the defective seeds are thin and deformed. They have a higher death-rate, before recovering their vitality after transplantation, as compared with the normals (see Table 6). The grown-up

TABLE 6

THE DATA OF FAMILY NO. 2 FOR THE SEGREGATION OF THE ALBESCENT SEEDLINGS AND DEFECTIVE SEEDS, COLLECTED IN 1927

Character of mother plant	Number of families	Number of plants transplanted into field			Observed number of plants at seed harvest					Percentage of mortality	
		green seedling	albescent seedling	total	green with normal seed	green with defective seed	albescent with normal seed	albescent with defective seed	total	in green seedlings	in albescent seedlings
Green with normal seed	3	91	—	91	64	16	—	—	80	12.09	——
	3	155	32	187	147	—	17	—	164	5.16	46.88
	2	73	23	96	51	13	12	4	80	12.37	30.43
Green with defective seed	2	62	—	62	—	51	—	—	51	17.74	——
	4	127	17	144	—	109	—	6	115	14.17	64.71
Albescent with normal seed	3	—	82	82	—	—	39	—	39	——	52.44
	3	—	123	123	—	—	69	19	88	——	28.46
Albescent with defective seed	1	—	12	12	—	—	—	3	3	——	75.00

TABLE 7

THE SUMMARIZED DATA FOR THE SEGREGATION OF THE DEFECTIVE SEED, IN 1927

Character of mother plant	Number of families	Normal seed	Defective seed	Total
Normal seed	6	203	—	203
	8	196	52	248
Defective seed	7	—	169	169

plants bear generally more numerous capsules than the normals. They grow vigorously and remain comparatively young later in the season. The deformity of the defective seeds occurs at the drying-up period of their maturation. Prior to this the capsules are filled with swollen seeds. The capsule of the Japanese morning glory is tri-parted, each part containing two seeds. The abortiveness of the ovules is rather commonly found in various varieties of this plant. A statistical survey showed a slight abortiveness of the defective-seeded plants, as indicated in the comparison with the normal in Table 8.

TABLE 8

SHOWING THE VARIATION IN THE SEED NUMBER PER CAPSULE OF THE NORMAL AND DEFECTIVE PLANTS RAISED IN 1927

Number of seeds per capsule	1	2	3	4	5	6	Average
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Normal-seeded	2.53	10.00	16.58	26.08	28.48	16.33	4.17
Defective-seeded ...	8.24	20.86	26.91	23.93	15.69	4.37	3.31

Their modes are 3 and 5, respectively, indicating the difference in their most common seed number per capsule, and the average seed numbers are 3.31 and 4.17. The low fertility of the defective seed is a zygotic characteristic, and not gametic, as the recessive segregates occur in a proportion approximately regular.

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