NOTE ON THE ORIGIN OF A MUTATION IN THE SWEET PEA

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(With One Text-figure.)

Many instances of the sudden appearance of new forms in plants and animals have been recorded in recent years, and speculation has been rife as to the moment at which they may be regarded as having originated. Perhaps the view most favoured is that the new form takes its origin from some abnormal division during the formation of the gametes. Nevertheless there are biologists who have placed on record their opinion that it may occur at some other stage in the life-history of the form that exhibits the new character[1]. The principal difficulty in coming to any decision on this point is that in almost all cases on record the new character has not been first observed in accurately pedigreed stock. After observation it has frequently been made the subject of careful experiments in order to test its genetic nature, but this of course does not help us with the problem of its origin. Even in *Drosophila*, with its century of mutants, there does not appear to be a case where the new form can be traced backwards through definite individuals for several generations. For this reason I have thought it worth placing on record the following facts in connection with the appearance of a new form of sweet pea in pedigree cultures. The form in question is the so-called "cretin," already described by Mr Bateson and myself in an earlier number of this Journal[2]. It is a monstrous form of which the chief characteristic is the straight stigma protruding through the

[1] See more especially Johannsen, *IV^e Conférence Internationale de Génétique*, Paris, 1911, and Emerson, *The American Naturalist*, June 1913. A good general discussion on the subject is to be found in Baur's *Einführung in die experimentelle Vererbungslehre*, 2 Auf. 1914, pp. 288 seq.

[2] *Journal of Genetics*, Vol. I. 1911.

cleft keel (cf. Fig. 1). The standard and wings are generally smaller than in the normal flower and fail to expand fully, but in these respects a good deal of variation is to be found. The cretin is however always characterised by one other feature; it is invariably sterile on the female side. The fact that this peculiar form appeared as a single individual in a pedigree culture has already been recorded. Data have also been given to shew that it behaves as a simple recessive to the normal form[1]. There arises the question whether the evidence is consonant with the view that the original mutation occurred in the maturation divisions of the germ cells, or at some other stage. To attempt to answer it involves a consideration of all the details connected with the coming of the

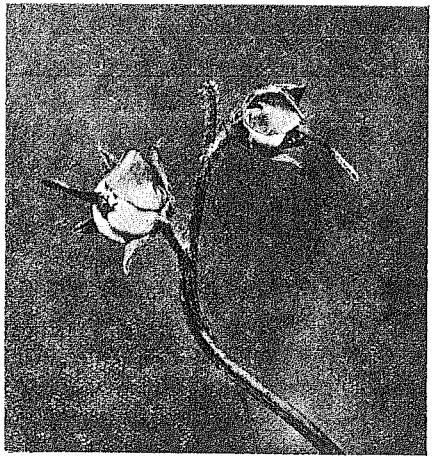

Fig. 1. Two flowers of the original cretin plant, No. 146[18]/1907. Flowers of other cretins are figured on Pl. XL, *Journ. Gen.* Vol. I. 1911.

cretin, in so far as they are known, together with those of its subsequent behaviour.

In 1903 a cross was made between two white sweet peas, Blanche Burpee (long pollen) and Emily Henderson (round pollen)[2]. From 3 purple F_1 plants three large F_2 families were raised in 1905. From one of these F_2 families, No. 309 containing 187 plants, the seed of 29 individuals was saved to give an F_3 generation. These 29 families were raised in 1906 and resulted in 2083 individuals all of which were normal

[1] *Journal of Genetics*, Vol. I. 1911; *ibid.* vol. III. 1913.

[2] Cf. *Rep. Evol. Comm. Roy. Soc.* IV. 1908, pp. 9 seq. where details will be found of the various characters entering into the cross.

(cf. Table I). From one of the F_3 families, No. 304 containing 181 plants, seed was saved from 14 individuals to give an F_4 generation. From these 14 plants there resulted an F_4 generation of 1118 individuals of which all were normal save one (cf. Table I). The exception was the original cretin which appeared in a family of 52 plants raised from the

TABLE I.

Record Nos. of F_2 plants 1905	Record Nos. of derived F_3 families 1906	No. of plants in family	Record Nos. of F_3 plants 1906	Record Nos. of derived F_4 families 1907	No. of plants in family	Record Nos. of F_4 plants 1907	Record Nos. of derived F_5 families	No. of plants in family
309 [1]	301	159	—	—	—	—	—	—
— [2]	302	121	—	—	—	—	—	—
— [4]	303	60	—	—	—	—	—	—
— [6]	362	64	—	—	—	—	—	—
—[7]	**304**	**181**	**304[6]**	**146**	**52***	146 [4]	144	1
— [8]	363	35	— [7]	147	46	— [5]	145	6
— [9]	305	126	— [8]	148	87	—[10]	146	26
—[10]	306	61	—[10]	149	83	— [11]	147	61
—[11]	307	67	—[11]	150)		—[12]	148	69
—[13]	365	68	—[12]	151)	128	—[13]	149	2
—[15]	308	59	—[14]	152	169	—[14]	150	2
—[16]	368	26	—[17]	153	242	—[15]	151	1
—[17]	369	82	—[18]	154	91	—[17]	152	27
—[18]	309	25	—[19]	155	30			
—[19]	370	21	—[20]	156	23		Total	195
—[20]	380	24	—[22]	157	90			
—[21]	310	54	—[25]	158	29			
—[22]	381	20	—[26]	159	48			
—[23]	371	62		Total	1118			
—[24]	311	20						
—[25]	372	196						
—[26]	373	25						
—[28]	374	193						
—[29]	375	57						
—[30]	313	75						
—[31]	382	39						
—[32]	376	49						
—[33]	377	57						
—[39]	386	57						
	Total	2083						

* Family in which the cretin appeared. The record number of the cretin was 146^{18}. Further details as to the nature of the F_2, F_3, and F_4 families will be found in *Report IV to the Evolution Committee of the Royal Society*, pp. 14, 15.

F_3 plant 304^6/1906. This family of 52 was numbered 146 in 1907. The appearance of the cretin led to the saving of seed from normal individuals of this family, but since many of them had been pulled up before

the cretin was discovered the numbers saved were fewer than could have been wished. For various reasons the sowing of these seeds was postponed until 1912. They germinated poorly and the F_5 families from 9 plants consisted of but 195 individuals (cf. Table I). No cretin however was found among them. Seed was collected from the four plants Nos. 145–148 and sown in 1913. The 135 plants which resulted were all normal. The series of experiments was not continued beyond the F_6 generation.

The cretin then had its origin in a single seed of the F_3 plant No. $304^6/1906$ and was the only case of its kind in a family of 52 plants. None of the 13 sister plants of 304^6 produced a cretin among a progeny of over 1000, nor did such a plant appear in the large F_3 generation of 2083 individuals of which 304^6 was a member. Though the F_5 generation raised from the sister plants of the cretin was not large, yet four of the families were certainly of sufficient size to have produced cretins had they been heterozygous for this simple recessive character. The evidence taken together renders it unlikely that the origin of the cretin was due to the meeting of two germ cells which had each lost the normal factor. Were the mutation of germinal origin we should be inclined to place its occurrence in the parent plant of 304^6, viz. in the F_2 plant 309^7, and we should have expected cretins to form about 25 % of the family in which they first appeared. Again we should have looked for their further appearance in some of the F_5 families grown from sister plants of the cretin itself. We are led therefore to suppose that the appearance of this peculiar form is due to a change in the individual at some stage *after* fertilisation whereby the factor for the normal flower was either dropped out or altered during the somatic divisions.

It has been assumed that the cretin always behaves as a simple recessive, and some evidence has already been published in support of this assumption. More extended experience during the past few years has served to confirm this view. Crosses between cretins and normals of various families have been carried to the F_2 and F_3 generations and in no case is there any reason for supposing that the cretin behaves otherwise than as a simple recessive. A brief summary of the results is given in Table II. Over a period of seven years 80 families have been bred in which cretins occurred. Out of 5520 plants recorded in these families 4198 were normal and 1322 were cretins—a proportion not far removed from the expected ratio 3 : 1. There is therefore no reason for supposing that the difference between the cretin and the normal is other

than that of a single factor, and this, taken in conjunction with the circumstances under which it made its appearance, supports the view that the original plant arose, not through the union of two germ cells which

TABLE II.

Year when grown	No. of plants	No. of normals	No. of cretins	No. of families
1910 [1]	640	486	154	9
1912 [2]	815	590	225	13
1913 [2]	1026	756	270	20
1914	711	562	149	2
1915	1455	1124	331	25
1916	873	680	193	11
Totals ...	5520	4198	1322	80
Expectation		*4140*	*1380*	

had lost the normal factor, but through some radical alteration in the zygote after union between two normal gametes had already taken place.

[1] Recorded in *Journal of Genetics*, Vol. I. 1911, p. 295.
[2] Recorded in *Journal of Genetics*, Vol. III. 1913, pp. 102, 103.