----- INHERITANCE IN STIZOLOBIUM -----

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Thesis presented

For the Associateship

Of The

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

by

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CONTENTS.

---- INTRODUCTION.----

Very little previous work has been done upon the genetics of Stizolobium.

J. Belling has investigated the inheritance of semi-sterility in the genus.

It was decided at the Imperial College of Tropical Agriculture to undertake an investigation with a twofold object.

1. To find out whether the inheritance of certain characters is determined by Mendelian rules.

2. To select suitable homozygous strains that turn up in the work, with a view to improving the plant when used as a cover crop.

The work was started in 1924 by Mc Kinstry who made the following crosses:-

1. Chinese Velvet x Bengal bean
2. Chinese Velvet x Yokohama Velvet
3. Chinese Velvet x Tracy Velvet
4. Chinese velvet x Osceola
5. Florida Velvet x Tracy velvet
6. Bengal bean x Bush velvet.

Crosses No. 3, 5, and 6 were carried on into F2.

The work was taken over at this stage by the writers.

It was decided to investigate the inheritance of the following characters:-

No. 3 cross. Chinese x Tracy.

Flower colour

Colour of hairs on growing point.

Character of pod hairs; whether "stinging" or "velvet"

Colour of hairs on pod.

Presence or absence of a pattern on the cotyledons.

No. 5. Cross. Florida x Tracy.

Presence or absence of a pattern on the cotyledons.

No. 6. Cross. Bengal x Bush.

Habit, whether determinate or indeterminate.

Colour of hairs on growing point.

Character of pod hairs.

Colour of hairs on pod.

Owing to the limited amount of labour and land it was decided to carry on into F.3 a large number of families from the Chinese x Tracy cross, very few of Florida x Tracy and very few Bengal x Bush.

The choice fell upon Chinese x Tracy as the main cross upon which to work for several reasons.

1. There were only three families in F.2

2. The sterility was less than in the Bengal x Bush cross.

3. Another easily observed ~~cross~~ CHARACTER was available, namely, flower colour.

This thesis is based upon the work done upon the Chinese x Tracy and Florida x Tracy crosses. It was not thought advisable to incorporate the results obtained from the Bush and Bengal cross as so few families could be taken into F.3. The recorded results are available to assist in future work and are presented in the form of a short appendix.

The following abbreviations will be used throughout the paper:-

C.T	equals	Chinese	x Tracy
F.T	"	Florida	x Tracy
B.V	"	Bush	x Bengal

Recording and Management of plots.

The characters named above were recorded in the F.2 families of which there were the following numbers:-

F.T.	6
C.T.	3
B.V.	5

An individual record was kept so that the characters of any one plant could immediately be found if desired.

Some recording had already been done by Haigh, Lochrie, and

Liebenburg, but it was found desirable to repeat the work throughout owing to several of the numbering pegs having been lost or shifted.

The recording being finished the plants were individually harvested, the seeds being put into paperbags marked with the number of the plant.

The F.2 families were numbered:

F.T.	1	2	3	etc.
C.T.	1	2	3	etc.
B.V.	1	2	3	etc.

The individual plants were numbered in order along the rows and were described by two numbers, the family number and the plant number.

Thus C.T. 1.60 would be the 60th plant in the first F.2 family of the Chinese x Tracy cross.

The F.3 family took the number of the plant from which it was grown.

Thus family F.T. 2.46 meant an F.3 family grown from an F.2 plant having this number.

Great care was taken during harvesting that no error should take place, the native labourers being personally supervised the whole time.

As soon as the land was cleared it was heavily manured and ridged in preparation for sowing out the F.3 families.

At first the plants were sown one yard apart in order to avoid the branches intermingling. Later it was found that plants would flower and fruit on a short stake if the growing point was frequently cut back. This enabled the spacing to be brought down to two feet apart. About four feet was left between the rows to allow of easy recording.

The seed was sown one inch deep, specially shifted soil being placed for each seed. Watering was resorted to in very dry weather. Germination was good but much trouble was experienced through ants eating off the young shoots. This was stopped by an organised blowing up of all nests in the neighbourhood.

When a seed failed to germinate or when a young plant died the gap was filled up when enough seed remained in each bag for this purpose.

The number of plants in each family varied between about 70 to 130 (with the exception of a few small families of about 20-30 plants put in to fill up gaps).

This number is not sufficiently high but with the majority of plants all the seed was used.

Twenty-nine C.T. F.3 families were planted.

Six F.T F.3 families were planted.

The latter were uprooted as soon as they had been observed for Cotyledonary pattern and the land was used for C.T.

The plants were very carefully numbered, a peg being placed at every fifth plant.

Selection of Plants to Take on into F.3.

In selecting plants for growing on into F.3 two points were considered.

1. The genetic constitution of the plant, with reference to the characters observed.

2. The vigour of the plant.

It was found possible to grow on examples of nearly every theoretical F.2 combination. The plants were selected in as representative a manner as possible. In some cases with special genetical constitution the plant did not bear sufficient seed to merit growing on.

F.3.

The plants were all recorded for cotyledonary pattern, and for the colour of the hairs on the growing point, in their early stages and were then tied to bamboo stakes. The plots were kept carefully weeded during the initial stages of growth.

The plants were recorded and very carefully observed throughout the growth period, anthesis and maturing. Field notes were kept throughout the year.

Several types were noted that were of interest from the economic point of view. These plants were harvested seperately A few plants from each family were harvested seperately so as to enable them being carried on into F.4. The remainder were harvested in bulk.

Laboratory work upon matters of cytological and microscopical interest was carried out during the investigation the results of which will be discussed later.

It will be convenient to divide the paper into five sections.

1. The characters discussed seperately in detail.
2. Possible relations between characters.
3. Sterility
4. Conclusions from the genetic point of view
5. The economic aspect.

COTYLEDONARY PATTERN.

The cotyledonary pattern consists of an uneven yellowish patch spreading outward from the midrib of each cotyledon.

Chinese x Tracy Cross

F.1. The presence of cotyledonary pattern is completely dominant over its absence.

F.2. Three families were grown.

If P represents the presence of cotyledonary pattern p represents its absence.

It will be noticed that there is a slight excess of P in each family on the assumption that P:p should segregate in a 3:1 ratio.

F.3. Twenty-eight families were recorded in F3 of which:

5 families bred true to P
7 " " " " p
16 " segregated into P and p.

Of the segregating families there are three significantly aberrant from a 3:1 ratio, namely:-

C.T. 1.1) showing an excess of P
2.11)
C.T. 1.6 showing a deficiency of P.

Provisionally it can be assumed that the inheritance of cotyledonary pattern depends upon the action of a simple pair of allelomorph characters. A hypothesis should be formulated to account for the aberrant nature of certain families.

Florida x Tracy Cross

F.2. Five families were grown in which:

2 segregated giving P:p equals 3:1
2 " showing an excess of P
1 " showing a deficiency of P.

F.3. Six families were grown of which:

2 bred true to P
1 " " " p
3 segregated giving P and p.

Of the 3 families segregating into P and p

2 gave P:p equals 3:1
1 " a deficiency of P.

To account for the aberrant nature of certain families, assume a lethal factor Lp linked with P on a 1.8 : 1 : 1 : 1.8 basis.

N.B. If x ; 1 : 1 : x is the gametic ratio of a linkage between A and B, the proportions of the phenotypes AB : aB : Ab : ab will be as follows:-

1.	Linkage.	$3x^2 + 4x + 2$	AB
		$2x + 1$	aB
		$2x + 1$	Ab
		x^2	ab
2.	Repulsion	$2x^2 + 4x + 3$	AB
		$x^2 + 2x$	aB
		$x^2 + 2x$	Ab
		1	ab

With a lethal factor linked with P the only phenotypes that live are PL and pL. From the above formula it is possible to calculate the ratio P:p when P is linked with a lethal on a 1.8 : 1 : 1 : 1.8 basis.

The following genotypes can occur:-

1 (PL) (PL) breeding true to P
2 (PL) (pl) segregating P:p equals 4.1 : 1
3 (Pl) (pL) segregating P:p " 2.5 : 1
4 (pL) (pL) breeding true to p
5 (Pl) (PL) breeding true to P
6 (pL)(PL) (pL) (pl) segregating P:p equals 3:1
7 (pL) (pl) breeding true to p.

EFFECT OF HYPOTHESIS UPON RESULTS.

Chinese x Tracy Cross.

F.1. would have the constitution (PL) (pl)

F.2. families can segregate giving P:p

4.1 : 1
2.5 : 1
3 : 1

If the 4.1 : 1 expectation is applied to the families the fit is improved in C.T. 1 and 2, and very little altered for the worse in C.T.3.

F.3. The 4.1 : 1 expectation improves the fit in the following families:-

C.T. 1.1 1.19 2.11 2.50 3.1 3.30 3.60.

The 2.5 : 1 expectation improves the fit in:

C.T. 1.6 1.7 2.10 3.39.

The 3:1 expectation improves the fit in:

C.T. 1.34 2.2 2.56 3.15.

C.T. 2.11 still remains aberrant and should be taken on into F.4.

Florida x Tracy Cross

F.1. would have the constitution (PL) (pl)

F.2. families can segregate giving P:p

4.1 : 1
2.5 : 1
3 : 1

If these expectations are applied to the families

4.1 : 1 expectation improves the fit in F.T. 3 and 5
2.5 : 1 " " " " " F.T 4
3 : 1 " fits in F.T. 1 and 2.

F.3. Of the three families segregating into P and p a 3 : 1 expectation fits in.

F.T. 1.55 2.23.

A 2.6 : 1 expectation improves the fit in

F.T. 2.6.

Tabulated results showing the inheritance of the presence or absence of cotyledonary pattern.

CHINESE x TRACY.

1. The following families segregate giving P and p.

Family	Constitution	Observed P	Observed p	Expected P	Expected p
C.T. 1	(PL)(pl)	47	12	47	12
2	(PL) (pl)	47	12	47	12
3	(PL (pl)	58	18	61	15
C.T. 1.1	(PL) (pl)	62	11	59	14
1.6	(Pl) (pL)	68	34	70	32
1.7	(Pl) (pL)	49	19	49	19
1.19	(PL) (pl)	48	10	47	11
1.34	Pp	108	38	109	37
2.2	Pp	63	22	64	21
2.10	(Pl) (pL)	30	13	31	12
2.11	(PL) (pl)	60	7	54	13
2.50	(PL) (pl)	52	12	51	13
3.56	Pp	92	28	90	30
3.1	Pp	63	18	61	20
3.15	Pp	68	23	68	23
3.30	Pp	93	27	90	30
3.39	(Pl) (pL)	45	17	44	18
3. 60	(PL) (pl)	67	14	65	16

2. The following families are homozygous PP:-

1.43 1.50 2.46 3.61 3 66

3. The following families are homozygous pp.

1.8 1.14 1.17 1.32 1.45 2.5 3.17.

Tabulated results showing the inheritance of the presence or absence of cotyledonary pattern.

FLORIDA x TRACY.

1. The following families segregate giving P and p.

Family	Constitution	Observed P	Observed p	Expected P	Expected p
F.T. 1	Pp	47	15	46.5	15.5
2	Pp	45	15	45	15
3	(PL) (pl)	48	13	49	12
4	(Pl) (pL)	42	16	41	17
5	(PL) (pl)	47	11	47	11
F.T. 1.55	Pp	61	21	61.5	20.5
2.23	Pp	50	19	53	17
4.16	(Pl) (pL)	45	19	46	18

2. The following families are homozygous PP:-

F.T. 1.1 2.49.

3. The following families are homozygous pp.

F.T. 3.5.

FLOWER COLOUR.

The factor R.

Chinese x Tracy.

The chinese parent had white flowers, the tracy parent purple.

If R represents purple flowers
r " white "

F.1. Purple is completely dominant over white

F.2. The families segregated into R and r approximately in a 3:1 ratio.

F.3. Twenty-eight families were recorded of which:-

7 were homozygous R
5 " " r
16 segregated giving R and r

		Obs.	Expt. (3:1)
C.T. 1.6(		95:17	84:28
2.10(	are aberrant	41;7	36:12
2.46(		46:25	53:18

Postulate a lethal factor $L._1$ on a 2.7 : 1 : 1 : 2.7 basis linked with R in $C.T._1$ and C.T.2.

In linkage this will give R:r equals 5.6 : 1

In repulsion this will give R:r equals 2.2 : 1

When the lethal does not operate R:r equals 3.0 : 1.

On this assumption $C.T._1$ and 2 will have to fit a 2.2 : 1 ratio.

The fit is improved in C.T.2 but made worse in $C.T._1$.

The 3:1 ratio fits the following families:-

C.T. 1.1 1.7 1.45 2.5 2.11.

The 2.2:1 ratio fits

C.T. 2.46 C.T. 1 C.T.2.

The 5.6:1 ratio fits:

C.T. 1.6 2.10.

No families from C.T.3 are significantly aberrant from a 3:1 ratio R:r.

Five families are somewhat aberrant namely:-

C.T. 3.1 3.59 3.66 giving an excess of R
C.T. 3.15 3.60 " " " " r

If a lethal factor L.2, linked with R on a 1.4 : 1 : 1 : 1.4 basis, is postulated, it will give the following segregation R:r.

In linkage R : r equals 3.5 : 1
In repulsion R : r " 2.6 : 1
When not acting R : r " 3.0 : 1

The 3.5 : 1 ratio improves the fit in C.T. 3.1, 3.59, 3.66 C.T 3.
" 2.6 : 1 " " " " " C.T 3.15 3.60 3.17
" 3.0 : 1 " " " " " C.T. 3.61.

For this hypothesis to be true it is necessary for L.2 to be homozygous in C.T.1 and 2 and to segregate in C.T. 3; and for L_1 to be homozygous in C.T.3 and to segregate in C.T. 1 and 2.

The constitutions of the F.1 plants were therefore as follows:-

C.T. 1 (Rl_1 L 2)(rL_1 L 2)
C.T. 2 (Rl_1 L 2)(rL_1 L 2)
C.T. 3 (RL_1 L 2)(rL_1 l 2)

Tabulated results showing the inheritance of flower colour.

1. The following families segregate giving R and r.

Family	Constitution	Observation R	Observation r	Expectation R	Expectation r
C.T. 1	$(Rl_1)\ (rL_1)$	26	9	24	11
2	$(Rl_1)\ (rL_1)$	22	12	23	11
3	$(RL_2)\ (rl_2)$	38	11	38	11
C.T. 1.1	Rr $[(Rl_1)\ (rL_1)]$	53	19	54	18
1.6	$(RL_1)\ (rl_1)$	95	17	95	17
1.7	Rr	52	16	51	17
1.45	Rr	72	23	71	24
1.50	Rr	44	13	43	14
2.5	Rr	22	8	22.5	7.5
2.10	$(RL_1)\ (rl_1)$	41	7	41	7
2.11	Rr	48	18	49	17
2.46	$(Rl_1)\ (rL_1)$	46	25	49	22
3.1	$(RL_2)\ (rl_2)$	64	17	63	18
3.15	$(Rl_2)\ (rL_2)$	67	26	67	26
3.17	$(Rl_2)\ (rL_2)$	72	26	71	27
3.59	$(RL_2)\ (rl_2)$	55	15	54	16
3.60	$(Rl_2)\ (rL_2)$	57	21	56	22
3.61	Rr	59	21	60	20
3.66	$(RL_2)\ (rl_2)$	70	20	70	20

2. The following families are RR and are homozygous coloured:-

C.T. 1.2 1.14 1.17 1.32 1.34 2.2 2.56.

3. The following families are rr and are homozygous white:-

C.T. 1.8 1.19 1.43 2.50 3.30.

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THE COLOUR OF THE HAIRS ON THE GROWING POINT.

The factor N.

Chinese x Tracy

Absence of black hairs equals N
Presence of " " " n.

F.1. There were no black hairs on the growing point N being completely dominant

F.2. The segregation in F.2 is obviously not dependant upon a simple pair of factors.

F.3. Twenty-nine families were recorded of which

14 bred true to N
1 " " " n
14 segregated giving N and n

Two types of segregation took place.

1. white apparently dominant
2. black " "

This suggests an inhibiting factor.

The factors postulated are:-

B producing black hairs on the growing point
A inhibiting the action of B.

The F.1 would have the constitution Bb Aa (white)

In F.2 the expectation is:-

9 BA	3 Ba	3 bA	1 ab
white	black	white	white

giving 13 white : 3 black.

Supposing that A:a and B;b are independant and that they segregate giving A:a equals B:b equals 3:1.

In F.3 the following families segregate giving an excess of black growing point

C.T. 1.6 1.43 2.2 2.50 3.15

In these families, being homozygous aa the segregation N:n depends upon b:B.

There is a significant deviation from the 1:3 ratio in:

C.T.	1.6	(1 : 1.9)
	2.2	(1 : 5)
	2.50	(1 : 1.6)

This suggests the presence of a lethal factor linked with B.

Postulate a lethal Lb linked with B on a 2.3 : 1 : 1 : 2.3 basis.

The following phenotypes are possible:-

			n		N	
(BL)(bl)	giving B:b equals		4.8	:	1	fitting C.T. 2.2
(Bl)(bL)	" B:b	-	2.3	:	1	" C.T 1.6 and 2.50
(BL)(bL)	" -	-	3	:	1	" C.T 1.43 and 3.1

Assuming A : a to be 3 : 1.

Aa(BL)(bl) will segregate giving N:n 3.8 : 1
Aa(Bl)(bL) " " " " 4.7 : 1 fitting C.T. 1.7.

The above possible ratios will not satisfy all the segregating families, the following remaining aberrant.

C.T. 1 and 2.
C.T. 1.9 1.14 1.45 2.5 2.11 3.17 3.30 3.39 3.60 3.66

Families C.T 1.45 3.30 and 3.66 together give an average ratio N:n equal to 2.3 : 1.

This ratio can be obtained if A is linked with a lethal M on a 2.3 : 1 : 1 : 2.3 basis the F.2 plants having one of the following constitutions:

(BL)(Bl)(Am)(aM) or (BL)(BL)(Am)(aM).

If this lethal is postulated the following segregating phenotypes can exist.

Constitution	Ratio N n	Fitting
(BL)(BL)(AM)(aM) -	3 : 1	
(BL)(BL)(AM)(am)	4.8 : 1	C.T. 1.14
(BL)(BL)(Am)(aM)	2.3 : 1	C.T 1.45 3.30 3.66.
(BL)(bl)(AM)(am)	6.0 : 1	C.T .
(BL)(bl)(Am)(aM)	5.1 : 1	
(BL)(bl)(AM)(aM) -	3.8 : 1	
(Bl)(bL)(AM)(am)	7.3 : 1	C.T. 3 1.8
(Bl)(bL)(Am)(aM)	3.9 : 1	C.T. 2
(Bl)(bL)(AM)(aM) -	4.7 : 1	C.T 1.7
(BL)(bL)(AM)(am)	6.7 : 1	C.T. 3.39
(BL)(bL)(Am)(aM)	3.4 : 1	C.T. 3.60
(BL)(bL)(AM)(aM) -	4.3 : 1	C. 3.59
with aa. BL bL	1 : 3	
BL bl	1 : 4.8	C.T. 2.2
Bl bL	1 : 2.3	C.T. 1.6 2.50

Tabulated results showing the inheritance of the presence or absence of black hairs on the growing point.

1. Families segregating into N and n.

Family	Constitution	Observed N	Observed n	Expected N	Expected n
C.T. 1	(AM) (am) (BL) (bl)	48	10	50	8
2	(Am) (aM)(Bl) (bL)	44	15	47	12
3	(AM) (am) Bb	69	7	66	10
C.T 1.6	aa (Bl) (bL)	38	79	35	82
1.7	Aa (Bl) (bL)	58	13	59	12
1.8	(AM) (am) (Bl) (bL)	70	10	70	10
1.14	(AM) (am) BB	63	12	62	13
1.43	aa Bb	14	40	14	40
1.45	(Am) (aM) BB	66	30	67	29
2.2	aa (BL) (bl)	16	72	15	73
2.50	aa (Bl) (bL)	26	41	20	47
3.15	aa Bb	27	67	24	70
3.30	(Am) (aM) BB	88	33	84	37
3.39	(AM) (am) Bb	56	8	56	8
3.59	(AM) (am) BB	62	15	64	13
3.60	Aa BB	60	19	60	19
3.66	(Am)(aM) BB	71	33	72	32

2. Families having either AA or bb will be homozygous N

(a) The following families are AA:-
C.T. 1.1 1.2 1.19 1.50 2.46 3.1 3.61.

(b) The following families are bb:-
C.T. 1.17 1.32 1.34 1.43 2.11 2.56 3.17

3. Families having aa BB will be homozygous n.

C.T. 2.10.

THE COLOUR OF THE POD HAIRS.

The factor W.

Chinese x Tracy.

If white pod hairs equals W

Black " " " w

F.1. All plants had white hairs W being completely dominant over w.

F.2. The segregation is obviously not determined by a simple pair of factors.

F.3. Twenty nine families were recorded in F.3 of which:-

7 families bred true to W
9 " " " " w
13 " segregated giving W and w.

The majority of families segregate giving an excess of W. C. 2.2 however, has an excess of W.

Upon examination of the results for N and W it is clear that there is a definite connection between the two characters. It is also clear that W is not identical with A or B.

The inheritance of W can be determined by:-

1. A second pigment factor inhibited by A.
2. A second inhibitor of B
3. A distinct factor closely linked with A or B.

Families homozygous aa are:-

C.T.	1.6	B:b	equals	72	:	37	ww
	1.43	B:b	"	37	:	13	ww
	2.2	B:b	"	66	:	13	W:w equals 13:66
	2.10	BB					ww
	2.50	B:b	equals	41	:	26	ww
	3.15	B:b	"	66	:	24	ww

Therefore B cannot be the pigment factor concerned. Prevalence of coloured pod hairs in the above suggests a second pigment factor inhibited by A.

Postulate a factor K giving coloured pod hairs in the absence of A.

In the families breeding true to NN which are AA the hypothesis demands WW.

This is true in the following families.

C.T. 1.2 1.19 1.50 2.46 3.1 3.61.

That is, 7 out of 14 families homozygous for N . Families breeding true to N may be bb.

These may have three constitutions, namely:-

1. bb AA
2. bb Aa
3. bb aa

1. would be WW

2 would segregate due to the action of A and K giving an excess of W.

3. would segregate due to K only and give an excess of w.

B and K are closely linked (see Association between W and N) so that K will be affected by the lethal Lb. It is assumed that the gametic ratio of the linkage between K and L is the same as that between B and L.

The possible ratios for W : w are the same as those for N : n.

The following phenotypes actually occur:-

(KL)(KL)(AM)(aM) giving W : w equals	3:1	C.T. 1.7 and 3.60
(KL)(KL)(AM)(am) " " "	4.8:1	C.T. 1 and 3 C.T. 1.8 1.14 2.11 3.17 3.39 3. 3.59.
(KL)(KL)(Am)(aM) " " "	2.3:1	C.T. 1.45 2.5 3.30 3.66
(Kl)(kL)(Am)(aM) " " "	3.9:1	C.T. 2 (over)
(KL)(kl) aa	1:4.8	C.T. 2.2

The F.1 plants C.T. 1 and 3 were homozygous KK.

Tabulated results showing the inheritance of the colour of pod hairs.

1. Families segregating into W and w.

Family	Constitution	Observed W	Observed w	Expected W	Expected w
C.T. 1	(AM) (am) KK	39	11	41	9
2	(Am) (aM) (Kl) (kL)	38	15	37	16
3	(AM) (am) KK	58	8	55	11
C.T. 1.7		52	16	51	17
1.8		62	15	64	13
1.14		57	13	58	12
1.45		66	29	66	29
2.2	aa (KL) (kl)	14	67	14	67
2.5		21	10	22	9
2.11		53	11	53	11
3.17		75	20	79	16
3.30		77	31	75	33
3.39		51	7	48	10
3.59		62	14	63	13
3.60		60	19	60	19
3.66		71	33	72	32

2. Families having either AA or Kk will be homozygous W.

(a) The following families are AA:-
C.T. 1.1 1.2 1.19 1.50 2.46 3.1 3.61.

(b) No families are kk.

3. Families having aa KK will be homozygous ~~W~~ w

C.T. 1.6 1.17 1.32 1.34 1.43 2.10 2.50 2.56 3.15

N.B. When the constitution is omitted the family is KK and the segregation depends upon the AM group.

THE TYPE OF HAIR ON THE POD.

The factor F.

Chinese x Tracy.

Throughout this section the terms "stinging" and "Velvet" will be used. The word "stinging" represents pod hairs that are stiff and easily detachable which have an extremely irritant action upon the skin. "Velvet" hairs are soft and not usually so easily detached. There is no irritant action caused by this type.

Presence of "stinging" hairs equals F
" " "velvet" " " f.

Neither of the parents possess "stinging" hairs which indicates that the factor F is produced by two or more complementary characters, both of which must be present before the stinging character is produced.

The factor F is intimately concerned with the factors N and W. This was made clear when it was observed that no "stinging" plant had either pigmented pod hairs or pigmented hairs on the growing point.

This suggests that the factor A is involved in the production of F. Postulate a factor G which with A gives "stinging hairs.

Therefore AG equals F.

F.1 All plants had stinging hairs, having the composition Aa Gg.

F.2. Segregates giving an excess of "stinging" plants

F.3. 2 families bred true to F
18 " " " " f
10 " segregated giving F and f.

The segregation of F:f can depend upon:-

1. The segregation of A:a G being homozygous
2. " " " G:g A being homozygous
3. " " " both G:g and A:a.

The following families being AA and segregating F:f depend upon the segregation G:g and should give F:f 3 : 1.

Family C.T. 1.1 gives F:f 4.5 : 1
1.50 " 3.4 : 1

This suggests a lethal factor Lg linked with G upon a 2 : 1 : 1 : 2 basis

The postulation of this lethal gives the following possible phenotypes: -

		Segregating F : f	Fitting
	(AM)(am)(GL)(gl)	2.0 : 1	C.T. 1
	(AM)(am)(Gl)(gL)	1.4 : 1	
	(AM)(am)(GL)(gL)	1.6 : 1	C.T. 3 1.8
	(AM)(aM)(GL)(gl)	1.6 : 1	C.T. 1.7
	(AM)(aM)(Gl)(gL)	1:1 : 1	
	(AM)(aM)(GL)(gL)	1.3 : 1	
	(Am)(aM)(GL)(gl)	1.3 : 1	
	(Am)(aM)(Gl)(gL)	1.0 : 1	
	(Am)(aM)(GL)(gL)	1.1 : 1	C.T. 3.30
with AA	(GL)(gl)	4.4 : 1	C.T. 1.1
	(Gl)(gL)	2.4 : 1	
	(GL)(gL)	3.0 : 1	C.T. 1.50
with GG	(AM)(am)	4.8 : 1	
	(Am)(aM)	2.3 : 1	C.T. 2. 2.5 3.17 3.66
	(AM)(aM)	3.0 : 1	C.T. 2.11.

Note:
It was noted that the amount of "stinging" was very variable. The division into F and f was difficult but with practice the dividing line could be easily decided.

Several distinct types of hairs were observed.

1. "Stinging" with long highly irritant hairs.
2. A type approaching this but not so highly irritant and with shorter hairs.
3. A type intermediate between 2 and 4.
4. "Velvet with soft easily detachable hairs and no stinging.

An attempt was made to classify certain families according to these types. Great difficulty was experienced through grading of types. The following figures were obtained.

Family	Type2	Type 3	Type 4	Ratio of Type2: Types 3 4
C.T. 1.14	17	17	24	1 : 2.4
3.1	25	23	33	1 : 2.2
3.59	15	9	38	1 : 3.0

Families were found with only type 1, others with only 3 and 4. In the latter case it was found impossible to distinguish the types by inspection.

Among the plants with black pod hairs, (all of which are type 4) a further division can be made.

A. Black hairs not easily detachable, of medium length.

B. Short detachable hairs when young. When maturity is reached the pod is practically smooth. A is usually characteristic of whole families while B is found characteristic of certain plants.

It is suggested that as the following combinations all give velvet:-

Ag, aG, ag, some variation among the plants classified as f is to be expected.

Plants having combinations:

AG, aG, Ag, ag, should be taken into F.4 to elucidate the hypothesis further.

Tabulated results showing the inheritance of "Stinging" Hairs on the Pods.

1. The following families segregate giving F. and f.

Family	Constitution	Observed F	Observed f	Expected F	Expected f
C.T. 1	(AM) (am) (GL) (gl)	33	17	33	17
2	(Am) (aM) GG	36	17	37	16
3	(AM) (am) Gg	50	15	40	25
C.T. 1.1	AA (GL) (gl)	59	13	59	13
1.7	Aa (GL) (gl)	44	24	41	27
1.8	(AM) (am) (GL) (gl)	53	24	51	26
1.50	AA Gg	44	13	43	14
2.5	(Am) (aM) GG	21	10	22	9
2.11	(AM) (am) GG	53	11	53	11
3.17	(AM) (am) GG	75	20	79	16
3.30	(Am) (aM) Gg	59	49	57	51
3.66	(Am) (aM) GG	71	33	72	32

2. When the constitution is AA GG the family is homozygous FF. This occurs in the following families:-

C.T. 1.2 2.46.

3. When the constitution is aa or gg the family is homozygous ff.

(a) The following families have the constitution aa:-

C.T. 1.6 1.17 1.32 1.34 1.43 2.2 2.10 2.50 2.56 3.15.

(b) The following families have the constitution gg:-

C.T. 1.14 1.19 1.45 3.1 3.39 3.59 3.60 3.61.

CHINESE x TRACY.

Collected Results From F.2 and F.3 Families.

Family	P : p	N : n	W : w	F : f	R : r
F.2 C.T. 1	47 12 (3.9 : 1)	48 10 (4.8 : 1)	39 11 (3.5 : 1)	33 17 (1.9 : 1)	26 9 (3.0 : 1)
2	47 12 (3.9 : 1)	44 15 (2.9 : 1)	38 15 (2.5 : 1)	36 17 (2.1 : 1)	22 12 (1.8 : 1)
3	58 18 (3.2 : 1)	69 7 (9.8 : 1)	58 8 (7.3 : 1)	50 15 (3.3 : 1)	35 11 (3.5 : 1)
F.3 C.T. 1.1	62 11 (5.6 : 1)	73 0 (-)	72 0 (-)	59 13 (4.5 : 1)	53 19 (2.8 : 1)
1.2	- -	81 0 (-)	81 0 (-)	81 0 (-)	81 0 (-)
1.6	68 34 (2.0 : 1)	38 79 (1 : 2.1)	0 112 (-)	0 112 (-)	95 17 (5.6 : 1)
1.7	49 19 (2.6 : 1)	58 13 (4.5 : 1)	52 16 (3.2 : 1)	44 24 (1.8 : 1)	52 16 (3.2 : 1)
1.8	0 80 (-)	70 10 (7.0 : 1)	62 15 (4.1 : 1)	53 24 (2.3 : 1)	0 77 (-)
1.14	0 75 (-)	63 12 (5.3 : 1)	57 13 (4.3 : 1)	0 71 (-)	70 0 (-)
1.17	0 19 (-)	19 0 (-)	0 20 (-)	0 20 (-)	20 0 (-)
1.19	48 10 (4.8 : 1)	58 0 (-)	54 0 (-)	0 54 (-)	0 54 (-)
1.32	0 35 (-)	42 0 (-)	0 42 (-)	0 42 (-)	42 0 (-)
1.34	108 38 (2.9 : 1)	177 0 (-)	0 175 (-)	0 175 (-)	175 0 (-)
1.43	54 0 (-)	14 40 (1:2.8)	0 50 (-)	0 50 (-)	0 50 (-)
1.45	0 96 (-)	66 30 (2.2 : 1)	66 29 (2.3 : 1)	0 95 (-)	72 23 (3.1 : 1)
1.50	57 0 (-)	57 0 (-)	57 0 (-)	44 13 (3.4 : 1)	44 13 (3.4 : 1)
C.T. 2.2	63 22 (2.9 : 1)	16 72 (1 : 4.8)	14 67 (1 : 4.8)	0 81 (-)	82 0 (-)

Family	P : p	N : n	W : w	F : f	R : r
C.T. 2.5	0 29 (-)	29 0 (-)	21 10 (2.1:1)	21 10 (2.1 :1)	22 8 (2.8 :1)
2.10	30 13 (2.3 :1)	0 49 (-)	0 48 (-)	0 48 (-)	41 7 (5.9 : 1)
2.11	60 7 (5.6: 1)	67 0 (-)	53 11 (4.8 : 1)	54 11 (4.8:1)	48 18 (2.7:1)
2.46	79 0 (-)	79 0 (-)	71 0 (-)	71 0 (-)	46 25 (1.8: 1)
2.50	52 12 (4.3:1)	26 41 (1:1.6)	0 68 (-)	0 68 (-)	0 68 (-)
2.56	92 28 (3.2:1)	120 0 (-)	0 115 (-)	0 115 (-)	115 0 (-)
C.T. 3.1	63 18 (3.5:1)	81 0 (-)	81 0 (-)	0 81 (-)	64 17 3.7: 1
3.15	68 23 (3.0: 1)	27 67 (1:2.5)	0 93 (-)	0 93 (-)	67 26 (2.6:1)
3.17	0 112 (-)	112 0 (-)	75 20 (3.8:1)	75 20 (3.8:1)	72 26 (2.8:1)
3.30	93 27 (3.4 :1)	88 33 (2.7:1)	77 31 (2.4:1)	59 49 (1.2: 1)	0 110 (-)
3.39	45 17 (2.7:1)	56 8 (7.0:1)	51 7 (7.3:1)	0 58 (-)	-
3.59	-	62 15 (4.1:1)	62 14 (4.4:1)	0 76 (-)	55 15 (3.6 : 1)
3.60	67 : 14 (4.8:1)	61 19 (3.2:1)	60 19 (3.1:1)	0 79 (-)	57 21 (2.7 : 1)
3.61	116 0 (-)	117 0	110 0 (-)	0 110 (-)	59 21 (2.8: 1)
3.66	103 0 (-)	73 36 (2.0 : 1)	71 33 (2.2:1)	71 33 (2.2:1)	70 20 (3.5:1)

ASSOCIATION BETWEEN CHARACTERS.

N and W.

It has been shown that the combination BA determines the production of N and that KA determines the production of W.

It remains to see if the hypothesis will account for the observed ratios WN : Wn : wN : wn.

In family C.T. 2.2 the constitution is as follows:-

aa (BL)(bl)(KL)(kl)

That is B:b 4.8 : 1.

K:k 4.8 : 1

Therefore BK : Bk : bK : bk equals 23.0 : 4.8 : 4.8 : 1

(wn : wN : Wn : WN)

This gives an expectation as follows:-

	WN	wN	Wn	wn
	2	12	12	54
Observed	13	0	0	66

This aberration indicates a very close linkage between B and K.

When K and B are both homozygous the expectation is WN : wn equals A : a.

This is so in every case where BB and KK exist.

On the assumption tha B and K are closely linked the expectation will exclude the presence of Wn and wN except when there is crossing over between B and L

The totals for F.2 and F.3 are:-

WN	Wn	wN	wn
629	6	16	248

Showing a small % crossing over.

Note: The combination Wn cannot theoretically exist when K is homozygous. Five plants having KK have been so recorded. This is probably due to error in recording the colour of hairs on the growing point being often very doubtful.

N and F.

It has been shown that the combination BA determines the production of N

GA determines the production of F.

A however, inhibits the production of the pigment B and acts as a complementary factor with G to produce F.

The ratio NF : Nf : nF : nf can be calculated if the ratios A : a, B ; b, and G : g are known.

It is obvious that the combination nF cannot exist because n cannot appear in the presence of A which is essential for the production of F.

The following combinations are possible:-

BAG	equals	NF
BAg	"	Nf
BaG	"	nf
Bag	"	nf
bAG	"	NF
bAg	"	Nf
baG	"	Nf
bag	"	Nf

When BB and GG are present together Nf is not possible and NF : nf equals A : a (family 3.66)

Note: In C.T.3 two plants are recorded nF. This is due to a mistake in recording. The amount of stinging exhibited by differnet pods was very variable and great difficulty was experienced in the classification of F.

W and F.

The association of W and F is directly comparable with the association of N and F.

The combination AG determines the production of F

AK " " " " W.

Owing to the fact that A is essential for the production of "stinging", and that it inhibits the production of colour in the pod hairs, "black stingers" are theoretically impossible. None were recorded throughout the work.

Families homozygous for GG and KK will segregate WF : wf equals A : a.

Families having this constitution are:-

C.T 2.5 2.11 3.17 3.66.

Association between R and N, R and W, R and F, P and R etc. were worked out and complete independence was found between P and all other characters and between R and all other characters.

In family C.T. 1.6 it was noticed that the plants having black hairs on the growing point flowered considerably later than the plants having white growing points.

This family had the factor A lacking and so it appears that the combination BL has some direct connection with the process determining the time of flowering.

The accompanying table shows the numerical results.

Unfortunately no other families were observed from this point of view. It is suggested that plants lacking the inhibitor A and and segregating for B should be grown on into F.4 to determine the exact relation between the BL combination and time of flowering.

----TABLE SHOWING ASSOCIATION BETWEEN----

Colour of Pod Hairs and Type of Hair

(expectation bracketed)

Family	WN	Wn	wN	wn
F.2 C.T. 1	26 (27)	- -	2 -	5 (6)
2	22 (23)	1 -	1 -	6 (7)
3	38 (39)	2 -	1 -	3 (5)
F.3 C.T.1.7	52 (55)	- -	6 -	10 (13)
1.8	62 (64)	- -	4 -	11 (13)
1.14	58 (58)	- -	- -	12 (12)
1.45	63 (66)	3 -	2 -	27 (29)
2.2	13 (14)	- -	- -	66 (65)
2.30	78 (75)	- -	- -	30 (33)
3.39	48 (46)	- -	- -	7 (9)
3.59	55 (56)	- -	- -	13 (12)
3.60	60 (59)	- -	- -	18 (19)
3.66n	54 (58)	- -	- -	29 (25)

--- TABLE SHOWING ASSOCIATION BETWEEN ---

Colour of Hairs On Growing Point And Type of Hair.

(expectation)
(bracketed)

	Family	NF	Nf	nF	nf
F.2	C.T. 1	22	6	-	5
		(22)	(6)	-	(5)
	2	20	3	-	7
		(21)	(3)	-	(6)
	3	33	6	2	3
		(30)	(8)	-	(6)
F.3	C.T. 1.7	44	14	-	10
		(42)	(15)	-	(11)
	1.8	53	13	-	11
		(52)	(16)	-	(9)
	3.30	57	21	-	30
		(57)	(19)	-	(32)
	3.66	54	-	-	29
		(58)	-	-	(25)

--- TABLE SHOWING ASSOCIATION BETWEEN ---

Type of Hair and Colour of Hair on Pod.

(Expectation bracketed)

Family	WF	Wf	wF	wf
F.2 C.T. 1	22	4	-	7
	(22.7)	(4.7)	-	(5.6)
2	20	3	-	7
	(21)	(2.7)	-	(6.2)
3	35	5	-	4
	(27)	(10)	-	(6)
F.3 C.T.1.7	44	8	-	16
	(42)	(10)	-	(16)
1.8	53	9	-	15
	(52)	(11)	-	(14)
2.5	20	-	-	10
	(21)	-	-	(9)
2.11	52	-	-	10
	(51)	-	-	(11)
3.17	75	-	-	19
	(78)	-	-	(16)
3.30	57	21	-	30
	(57)	(19)	-	(32)
3.66	54	-	-	29
	(58)	-	-	(25)

<u>TABLE</u> showing connection between the presence or absence of black hairs on the growing point and the date of flowering in an F_3 family of the <u>CHINESE TRACY CROSS</u>.

C.T.1.6. <u>Sown 10.11.26</u>.

Description of type	plants not flowering	plants flowering	Plants setting pods	Date
Plants having white hairs on growing point	7 (19%)	9 (24%)	21 (57%)	30. 1. 27
Plants having black hairs on growing point	59 (77.6%)	15 (19.8%)	2 (2.6%)	
Plants having white hairs on growing point	0 (0%)	3 (8.8%)	34 (91.2%)	15. 2. 27
Plants having black hairs on growing point	8 (10.6%)	48 (63.1%)	20 (26.3%)	

STERILITY.

Among the F.2 and F.3 families in the Chinese x Tracy cross certain plants exhibited marked sterility combined with peculiar vegetative structure.

The amount of sterility exhibited varies considerably, some plants being nearly completely, others slightly sterile.

The plants have the following characters:-

1. Black hairs on the growing point.

2. Pods always have black hairs of the very short easily detachable type and hence when fully developed appear to be smooth skinned.

3. "Stinging" hairs are never present.

4. The vegetative character of the plant is changed (see photographs)

   (a) The plants often have a top-heavy appearance as all the foliage is concentrated near the top. (see fig. 1)

   (b) A large number of flowers are formed in dense characters, most of these fall three to seven days after anthesis, thus giving the plant a peculiar appearance. (see fig. 2).

   (c) The leaf shape is very variable and often quite distinctive, a very common form being a smaller more rounded leaf.

5. The pods when formed are often very large and peculiar in shape.
   The seeds are large and often malformed, being very thin skinned and wrinkled.
   These seeds have no germinating power and often rot in the pod.

6. The plants are generally very late in setting pods which later ripen very slowly.

7. Vegetatively the plants are often excellent with a large quantity of dark green foliage and with a thick well developed root system.

8. Pollen from many plants was examined microscopically and in all cases the C.T. cross appeared to be sound. In pollen taken from semi sterile plants occurring in the B.V. cross a certain amount of defectiveness was observed.

9. Pods from all the families were examined and apart from the sterile type only an insignificant number of ill-formed seeds was observed, except in one family (C.T. 2.50) where one or two aborted seeds were found in many of the pods in several plants.

10. In the B.V. cross all plants with abnormal leaf ratios (see reference 2) were completely sterile.

The existence of sterility and semi-sterility within the C.T. cross suggests the presence of lethal factors and the peculiar characteristics of these plants indicate a disturbed genetic system and possibly chromosome incompatibility. Lethal factors can be broadly defined as factors altering metabolism in some way so as to cause the death of zygotes or gametes.

An attempt was made to investigate the cytology of the plants. Sections of root tips were cut and the somatic number of chromosomes was found to be over 24 which made the chance of discovering chromosome incompatibility too small to merit the continuation of the work.

I.

Sterile type showing vegetative characters

II.

Sterile type showing peculiar flowering shoots.

III.

(same as II.).

IV.

Normal type.

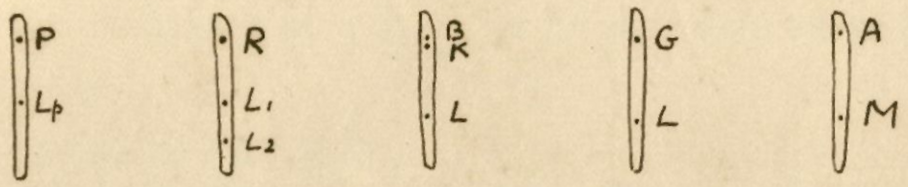
CONCLUSION FROM THE GENETIC POINT OF VIEW.

From an examination of the results of each character observed in the F.2 and F.3 families it is quite apparent that the genetic problem is not a simple one. Individual characters segregate in many families giving statistically significant deviations from the three to one ratio that is expected from a single pair of allelomorph characters. The observed association between certain characters is entirely different from expectation on a 9 : 3 : 3 : 1 basis. The hypotheses put forward in this paper to account for these aberrations are suggested by these results and give theoretical fits for each family very closely approximating to the observed results. The genetics of the Chinese by Tracy cross will be much further elucidated by making certain back crosses and by carrying certain plants on into F.4. In this way the hypothesis put forward in this paper will be checked.

Of the characters observed the inheritance of flower colour and of cotyledonary pattern apparently depends upon simple pairs of allelomorph characters complicated by the lethals which serve to improve the fit in certain aberrant families. Many families slightly but not significantly aberrant from a 3 : 1 ratio are improved by the postulation of these lethals.

The inheritance of colour of pod hairs, the colour of the hairs on the growing point and of the development of stinging hairs is further complicated by the fact that there is an obvious connection between the three characters. The hypothesis involving the factor A inhibiting the two pigment factors B and K and acting as a complementary character with G to produce stinging hairs, explains the inheritance of these characters. The linkage between B and K is made clear by the association between the characters W and N. The hypothesis also explains the total absence of "black stinging" pod hairs and of plants having black hairs on the growing point and "stinging" hairs. The hypothesis as summarised above will not explain the ratios obtained in certain families. The introduction of lethal factors linked with BK, A and G will improve the fit between expectation and observation in these families.

In the Chinese x Tracy cross five chromosomes are apparently concerned in the inheritance of the characters observed (see diagram)



The presence of lethal factors is strongly suggested by the sterility and semi sterility. This incompatibility may be due to the relationship of the parents being too distinct.

THE ECONOMIC ASPECT.

One of the main objects of this investigation was to establish, by crossing, one or more types of Stizolobium suitable for use as a cover crop.

The main qualities of a plant to be used as a cover crop are as follows:-

1. The seeds must germinate rapidly and easily; the percentage germination must be high. The initial stages of growth must be rapid, in order to keep down weed growth.

2. This shading should be maintained until maturity and should not be lost while the pods are maturing. This will prevent the necessity of growing a seperate crop for seed.

3. The pods must be easily harvested and therefore plants bearing pods with "stinging" hairs should be eliminated.

There are several excellent varieties which are used and it is hoped to produce a type, better in quality and yielding capacity.

The foliage should be thick and luxurious so as to act both as a smother crop and as a green manure.

In the F.3 families of the Chinese x Tracy cross several promising types have appeared. Families homozygous for important characters have been carefully observed.

The most promising family is C.T. 2.56 in which the plants have the following characteristics:

1. The family is segregating for cotyledonary pattern. This impurity can be removed by growing on the patternless form which is recessive.

2. All plants have white hairs on the growing point.

3. All plants have purple flowers.

4. All plants have "black velvet" pods. The hairs on these pods are not readily detached.

5. The plants segregate for seed shape and seed colour. Purification by seed selection in F.4 should yield a form with seed uniform in shape and colour.

6. The foliage is luxuriamt and the yield of seed is high.

7. The root system is strong and vigorous.

8. No sterility was observed in this family.

9. Germination was good and the plants flowered and matured evenly. A rapid growth took place in the early stages.

10. The growing period is comparatively short (about $4\frac{1}{2}$ months).

It is suggested that progeny rows be grown out next season from 16 plants that have been specially selected as representing the type.

With careful selection, within two years a type could be obtained breeding true to every character.

When this plant is obtained it should be tested against several varieties already on the market.

Several other interesting types have been harvested separately, particulars of which will be found in the field notes (Appendix 2).

As regards the Bush x Bengal cross the intermediate (determinate) type appears to be always heterozygous. A few F.3 families were sown and it was noted that many of the "bush" types appeared very vigorous. Attention should be paid to these types as they may be extremely useful, when the climbing habit of the other varieties would prove unsatisfactory, for example, as a cover crop for use in orchards.

The climbing varieties of Stizolobium when unstaked produce a thick tangle of vegetation and can be ploughed in as a valuable green manure at any stage in their growth. This practice has already found a place in the agronomy of many sugar cane estates and the future of Stizolobium as a cover crop and as a valuable fodder plant is of considerable agricultural and economic importance.

SUMMARY.

1. An account has been given of the mode of inheritance of factors affecting: Cotyledonary pattern, flower colour, the production of black hairs on the growing point, the colour of the pod hairs and the production of "stinging" pod hairs, in a cross between Chinese and Tracy varieties of Stizolobium.

The factors involved are as follows:-

P. A factor producing a pattern in the cotyledons.
Lp A lethal factor linked with P.

R A pigment factor producing coloured flowers.
L1 and L2 lethals linked with R.

B. A pigment factor producing colour in the hairs on the growing point.
K. A pigment factor producing colour in the pod hairs.
L. A lethal factor linked with B and K.
B and K are very closely linked.

A A factor inhibiting the action of B and K and when acting as a complementary character with G producing "stinging" hairs.
M.A lethal factor linked with A.

G. A factor which with A produces stinging hairs.
Lg. A lethal factor linked with G.

BA equals N
KA " W
GA " F

2. Association between characters is discussed. Independence exists between P and all other characters and between R and all other characters. N, W, and F are connected as A is common to all.

A possible connection between the factor B and the time of flowering is discussed.

3. Sterility is discussed in detail and a hypothesis is put forward to account for it.

4. Types that have arisen in the work are discussed from the Economic stand point, and suggestions are put forward for continuation of this side of the problem.

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----- A C K N O W L E D G M E N T S. -----

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APPENDIX I.

Bush x Bengal cross.

The characters N, W and F were observed as with the Chinese x Tracy cross.

A new character was observed in F.2. namely habit, whether the plant was indeterminate in growth, determinate or "bush".

These characters were represented as follows:-

V equals indeterminate growth
I " determinate "
O " bush "

The accompanying table shows the numerical results in F.2.

Sterility in this cross was higher than in C.T.

The ratio worked out for habit is

V : 1 and O.

F.3. families could not be grown on in sufficient quantity to merit recording.

APPENDIX II.

Field notes are to be found in the field note book which is left in charge of the Botany Department.

BUSH VELVET x BENGAL.

F.2. Family	V	I	O	N : n	F : f	W : w
B.V.1	39 2.4 :	13 1	3	43 : 12 (3.6: 1)	26 : 14 (1.8 : 1)	34 : 6 (5.7: 1)
B.V.2	45 2.8 :	15 1	1	47 : 14 (3.4: 1)	25 : 13 (1.9 : 1)	31 : 7 (4.4 : 1)
B.V. 3	42 2.6 :	11 1	5	46 : 12 (3.8: 1)	27 : 21 (1.3 : 1)	42 : 6 (7 : 1)
B.V. 4	46 2.9 :	15 1	1	45 : 17 (2.6 : 1)	31 : 14 (2.2: 1)	38 : 7 (5.4: 1)
B.V.5	47 5.2 :	7 1	2	46 : 10 (4.6 : 1)	35 : 9 (3.9 : 1)	40 : 4 (10 : 1)
B.V. 6	49 5.4 :	7 1	2	43 : 15 (2.9 : 1)	30 : 13 (2.3 : 1)	38 : 5 (7.6 : 1)
	268 3.3	: 1	82	270 : 80 (3.4 : 1)	174 : 84 (2.1 : 1)	223 : 35 (6.4 : 1)