Lecture 6, January 25, 1954

Continuation of inheritance behavior of Ac.

I. Review of previous talk:

1. The inheritance of Ac -- progeny tests:
   - a). F_2 ratios: 1 AcAc : 2 Ac ac : 1 ac ac
   - b). Backcross tests: Ac ac x ac ac 1 Ac ac : 1 ac ac
   - c). Ac Ac x ac ac 95 Ac ac : 1 no ac.
   - d). The ears produced by Re c sh Wxds ac / Re c sh Wx ds ac x C Sh wx Ds, ac
     - (1). The regular pattern of variegation -- majority of kernels.
     - (2). The unusual types of kernels:

       No c spots or areas   Completely colored kernels
       Tiny specks of c   Late Ds breaks in development
       Areas only with few c specks
       Early losses or Ds breaks -- Like 1 Ac.

2. The effects of dosage of Ac: The higher the dose, the later in time of development that breaks occur at Ds.

3. The different isolates of Ac: In two doses:
   - a). All speckled with recessive spots: late but uniform pattern of breaks at Ds -- in certain cells, late in development.
   - b). Areas, distributed over kernel, in which breaks occur in some cells, often associated with areas where no breaks occur. Remainder of kernel has speckled pattern of Ds breaks
   - c). Kernels where changes occur early to give sectors: These resemble 0 Ac, 1 Ac, 2 Ac and 3 Ac in same kernel.

     Suggest that something is happening to Ac during early development that resembles somatic segregation.

II. The analysis of the unusual kernels on the ears produced by

Re c sh Wx Ac / Re c sh Wx Ac x C Sh wx Ds, no Ac   Photo of ear (1)

1. Initial experiment: selected kernels showing no c specks, that is, no evidence of presence of Ac and 2 kernels that showed very late losses or breaks at Ds.

2. Because material available was not great, first experiment was something of a trial to determine something of nature of events. Analysis made of 25 plants derived from aberrant kernels: 23 from kernels with no c specks, and 2 from kernels showing late losses of C.

3. Necessary to determine if Ac present or not, if Ds present in C chromosome and if transmissions of chromosomes 9 in next generation were normal -- that is that no alterations had occurred to effect inheritance of chromosomes.

4. The tests: Self pollination of each plant
   Each plant crossed to c ds/c ds, ac ac [illegible]
   Each plant crossed to c ds / c ds Ac Ac Do
   Each plant crossed by Ac-tester: I Sh wx Ds, no Ac. [illegible]

see fig 1 - on board.

III. Kernel types on ear from initial tests:

1. The plants showing no Ac:
   - a). Self-pollinated ear gave ratio of 3 Colored, non-var. : 1 colorles
   - b). Crossed by I Sh wx Ds: All kernels colorless in wx class
     No evidence of Ac.
   - c). Crossed to c ds / c ds, ac ac Ratio of 1 Colored, non-var : 1 c/c
   - d). Crossed to c ds / c ds, Ac Ac:

     25 Colored, non-variegated or not obviously variegated
     1159 Colored with areas of c produced by Ds breaks
     1244 colorless (c/c class)

     Shows that Ds in C Sh wx chromosome is active in presence of Ac.
   - e). Conclusions: No Ac is present in these 10 plants. (11 [illegible]

2. Plants derived from colored kernels that gave no evidence of Ds breaks: Ac present from tests. The Ac constitutions differed among the plants. 12 plants
   - a). 7 plants: tests showed that 2 Ac factors present. Not linked. (Progeny test on 5)
   - b). 2 plants: 1 Ac factor present but in action it resembles two doses of original Ac. (Progeny tests on 2)
   - c). 2 plants: either 1 Ac with double dose action or 2 Ac very closely linked; ~~or~~ marked change in action of a ~~single~~ Ac factors.
   - d). 1 plants: 2 Ac factors present, probably. ~~Either~~ linked. ~~or early changes occur, in sporogenous cells, affecting Ac locations.~~ Progeny test conducted [illegible]

→ 2 plants [illegible] affected: 1 [illegible]

3. The nature of the tests: The Ac ac; Ac ac plants.
   - a). Crossed to c ds/c ds, ac ac: Gave: (Example)

     67 C, non-variegated kernels
     266 Colored kernels with c areas: Two distinct classes of kernels; those with early losses of Ds, thus some large colorelss areas; those with late losses of C producing kernels with specks of c.
     342 colorless kernels : the c/c class.
   - b). Crossed to plants that were c ds/c ds, Ac Ac.

     256 Colored kernels; not obviously variegated. [illegible]
     6 Colored kernels ~~with area or~~ fully speckeld with c
     70 Colored kernels - obviously variegated for c areas
     461 colorless kernels (the c/c class)
   - c). Crossed by Ac tester stock This was Re C Sh Wx ds / I Sh wx Ds, ac/ac.

Kernel types on resulting ears in the I ~~xixxx~~ wx class

$\frac{N\ \ C\ Sh\ wx\ Ds}{Re\ c\ sh\ Wx\ ds}$ x $\frac{Re\ C\ Sh\ Wx\ ds}{N\ \ I\ Sh\ wx\ Ds}$ $\frac{ac}{ac}$

Only the I wx kernels can be considered:

253 I wx kernels with no obvious variegation for C areas
218 I wx kernels with heavily speckled pattern of C (color)

494 I Wx (the c Wx / I wx class; cant test Ac in these kernels)

Diagram of appearance of I wx kernels:

d). If we assumed plants being tested were Ac ac; Ac ac, the gametic ratios for Ac would be:

1 Ac^1 Ac^2 : 1 Ac^1 : 1 Ac^2 : 1 no Ac

Or: 1 Ac + Ac : 2 Ac : 1 no Ac.

Gametic ratio for Ac is 3 with Ac to 1 with no Ac

e). In cross to c ds/ c ds, no Ac would expect a ratio of 3 C - c variegated kernels to 1 with no variegation. Observed 266 variegated to 67 non-variegated. Two types of variegated kernels: 1 with 2 Ac and 1 with 1 Ac. Differences should be seen.

f). In cross to c ds/ c ds, Ac Ac plants would get:

From female:		From male: ratio		Ac constitution: dose
c ds Ac	c ds Ac	1 C Ds;	no Ac	2 Ac
		2 " ;	1 Ac	3 Ac
		1 " ;	2 Ac	4 Ac

In colored class would expect 1 with 2 Ac : 2 with 3 Ac : 1 with 4 Ac

1 AcAcAcAc : 2 Ac Ac Ac : 1 Ac Ac

If 4 Ac is too high a dose to give Ds breaks early enough in development of kernel, then this class would be non-variegated. This would give C Sh wx kernels. Ac tester stock used as female had an Ac that gives almost no effect in 3 doses. The small specks of c that might appear difficult to see. Thus, Ac Ac Ac class could appear non-variegated. The 4 doses and 3 doses of Ac would produce kernels that were not obviously variegated. Thus, ratio expected would be: 3 C kernels, not obviously variegated : 1 that was variegated, showing speckles of c.

Observed: 256 C, non-variegated : 70 C - c variegated and speckled. and 6 odd kernels -- only areas of specks of c:

Appearance of kernels:

g). In cross by I Sh wx Ds ac: C Sh wx Ds / C Sh wx Ds / I Sh wx Ds

The wx class of colorles kernels:

Female contribution

1 Ac Ac Ac Ac : 2 Ac Ac : 1 with no Ac

	4 Ac	2 Ac	no Ac	
Expect:	No obvious var.	I-C var.	No var.	Gives: 1 non-var 1 var.

Observed: 253 I wx, no certainly var. (some had few C specks)

218 I wx clearly var. for C specks

f). If this projected constitution is correct, then it should be possible to prove it by progeny tests: This was done for 4 of the 6 plants that gave ratios in these i itial tests indicating the presence of 2 Ac factors, independently located in chromosome complement and not linked to factors in short arm of chromosome 9.

IV. The progeny tests conducted with plants assummed to be Ac ac; Ac ac.

1. The Appearance of plants: Table on board.

2. The reason for the white streaks and their frequency:

a). Ds break could occur in either chromosome; If in W Ds chromosome, a white streak would appear. If a coincident Ds in both chromosomes, then cells homozygous deficient for 2/3 of short arm would be formed. These do not produce tissue that can be seen. They appear to be cells with enormous nuclei:

This seen in the examination of the glumes of such plants:

b). If Ac dose is high, then events occur very late. w streaks may not be seen in the green background. If 1 Ac present, Ds breaks occur early enough to produce a good streak, easily seen.

3. Tests of the plants in columns A and B for Ac inheritance. Two plants selected from both A and B of each culture in Fig. 2

a). Each plant crossed to a C sh bz wx ds, ac plant:

The cross:	Female	Male	
Column A	C sh bz ds, ac	I Sh Bz Ds C Sh Bz Ds	Ac ac; Ac ac
Column B	"	"	Ac ac

b). Expected ratio of kernel types from crosses of plants in column A:

(1) Gametes: 1 Ac Ac : 2 Ac : 1 no Ac

3 with Ac to 1 with no Ac

Kernels should be in both I and C classes: 3 variegated to 1 non-var.

(2). The observed ratio of kernel types: Figure 3 on board.

All ratios as expected except for 1 aberrant plant: This plant had new change of Ac. It was AcAc ac.

Reason why C Bz variegated kernels fewer than expected: - Can not see variegation in a purely speckled pattern.

The two types of variegated kernels: Late losses of Dominant: 2Ac
Early losses of " : 1 Ac

4. Tests of plants in column B for Ac inheritance. Two plants selected from each culture to be tested: The expected gametic ratio for Ac 1 with 1 Ac : 1 with no Ac.
The expected ratio of kernel types: I variegated to 1 non-varieg.

The observed types of kernels in cross: Figure 4, on board.

5. Conclusions:
1. Summary of procedure so far:
 a). Ac ac plants self-pollinated
 b). Found the expected 1 Ac Ac : 2 Ac ac : 1 ac ac in F_2
 (Allelic)
 c). Gametes of Ac Ac plants tested for Ac. by cross with ac. All should have 1 Ac
 Majority of kernels had expected pattern produced by Ac
 Few unexpected types of kernels. Among them, some with no evidence of Ac.
 23 such kernels removed from ears. Plants grown from them and tested for Ac.

 11 plants: No evidence for Ac. Ac not in gamete produced by Ac Ac plant.

 12 plants: Ac present. In 6 of them, constitution was apparently Ac ac; Ac ac. Two non-allelic, non-linked Ac factors from plant that was Ac Ac, allelic. All gametes should have had only 1 Ac.

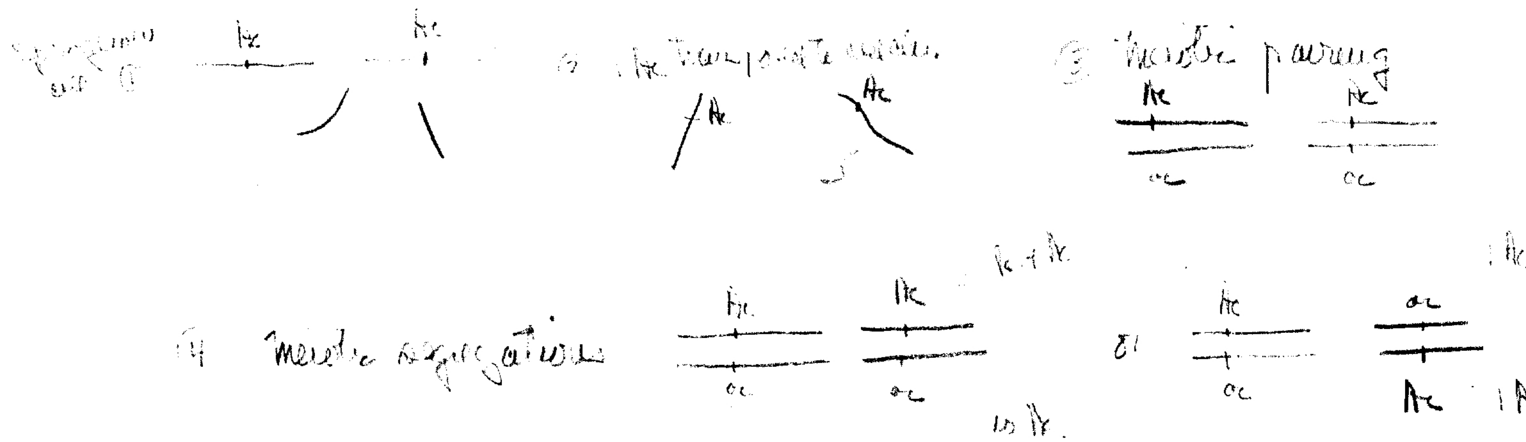
Progeny from 4 of the 6 plants assumed to have Ac ac; Ac ac tested. These tests confirmed the Ac ac; Ac ac co stitution in the 4 selected cases derived from C non-var. kern.

2. The reason that Ac not seen in original non-variegated kernel: The dose of Ac too high: 4 Ac present in the endosperm.
3. To see the Ac action, must use an Ac ac; Ac ac plant as a pollen parent. Then, kernels have either Ac Ac or Ac - 2 or 1 dose of Ac.

4. Evidence so far shows that Ac can be lost to a gamete in an Ac Ac plant (allelic positions of Ac). Or, an extra Ac factor can appear in some gametes.
7. The relationship between the two suspected. Ratios were 11 to 12.

8. Can suspect transposition of Ac from one location to another. Premature to consider this now, but better to have something in mind.

Diagram of possible origin of No Ac and 2 Ac.



9. This would fit with observations of the sectorial kernels. Photos; Somatic segregations of the Ac factor. would give these patterns. In many cases, associated with a break at Ds.

IV. The examination to present:

♀ x ♂

Rc c wx Ds
Rc c wx Ds

C Sh wx Ds ac

Typical var. kernels = majority of kernels. 20 tested. All Ac ac.

Few with no variegation - 23 tested - 11, no Ac
12, Ac present - 6 two Ac

late arising breaks - 2 " - Ac present.

with early arising breaks. 6 " most exp.

V. Tests of the AcAc ac plants: N C Sh wx Ds / Re c sh Wx ds   Plant (1):

1. Kernel types in crosses to c ds, ac females: Table

104 C to c variegated: late losses of C. Like Ac Ac type of original Ac

124 C, non-variegated

233 colorless (c/c kernels)

2. Kernel types in crosses to c ds/c ds. AcAc (allelic)

68 with no sharp variegation -- small specks of c in some or small areas of C to c.

71 with typical 2 Ac dose C to c variegation

146 colorless (c/c)

3. By w I Sh wx Ds / Re C Sh Wx ds, ac ac. The I kernels only: Table 46

88 I wx, ~~with~~ some with ~~only~~ few specks of C : 8 I wx, heavily speckled with C : 111 I Wx

4. 11 plants from these kernels Table 59 (These with few C spots).

All had few wd streaks

(Like 2 Ac action of original Ac)

2 plants from these kernels Table 59

Both had many wd streaks (1 Ac type of original Ac action)

5. 2 plants crossed to females: C sh bz, ds, ac (Table 52)

Both crossed to females: C sh bz ds, ac (Table 53)

	I, non-var.	I-Cbz	C Bz *	CBz-Cbz		I non var.	I-Cbz	CBz	CBz-bz
Plant 1	74	61	63	40	Plant 1	97	111	84	88
Plant 2	100	118	112	100	Plant 2	225	165	195	166

late loss of I Bz

early loss of I Bz

6. Test of 2nd case of AcAc/ac gave the same result -

Tables 54 + 55

6. Conclusions: Altered Ac acts like AcAc -- double dose of Ac action at a single locus or:
Two Ac loci present, closely linked.

VI. Although first experiment showed much, I was not satisfied with the tests in every case, especially the ones that appeared to show altered Ac action as well as altered numbers. Also, the tests were not large enough for any one plant; also, the Ac-tester stocks could have been better. Therefore, the second experiment conducted, and much more precisely with regard to details.

Summary of results of the combined experiments, I and II.

42 plants examined from C, non-variegated kernels:

19 - No Ac

16 - Ac ac; Ac ac Two non-linked Ac

1 AcAc ac; Ac ac Two non-linked Ac; one with double-dose action.

6 AcAc ac

8 plants from kernels showing only a few c specks

4 Ac ac; Ac ac Two non-linked Ac

1 AcAc ac; Ac ac Two non-linked Ac; one with double dose actio[n]

3 AcAc ac

8 plants from kernels showing a heavily speckled pattern of c dots. Late losses of C but uniform in pattern.

2 AcAc ac or two closely linked Ac. In one dose, very irregular patterns; Gametic ratios irregular; many altered types of patterns of var. Suggests early transpositions of Ac

4. Ac ac; One Ac but dosage action increased over that of original Ac but not doubled in action.

1 "AcAc" ac. The Ac action altered. Produces early sectorials in one dose.

1 Ac ac. One Ac. Could not discover any modification in action compared to original Ac.

VII. What happens = Best studies made in [illegible] [illegible]
Ac appeared in short arm of chr. 9.

On board.

♀			♂
Re c sh Wx ds / Re c sh Wx Ds	$\frac{Ac}{Ac}$ (callable)	×	C Sh wx Dsa.

Ears: majority of kernels show uniform pattern of variegation: Plants from 20 kernels tested.

Plants from kernels tested

Few kernels with no evidence of Ac action: Completely colored. Exp I 23 Exp. II 19

Ac constitutions: 11 no Ac. : 7 Ac oc; Ac → progeny tests on 5 : 2 Ac Ac oc → progeny tests on both : 1 Ac; Ac ... → progeny test : 2 Ac Ac ... of ... → progeny test on both.

Few kernels with specks of c. 2 14

1 Ac Ac oc → progeny test : 1 Ac ... progeny tested.

Early losses of C, like 1 Ac 0 C ...

Plants: 8;
6 Ac ac / Ac ac
2 Ac Ac / ac

Plants tested for Ac constitution: $\frac{M\ C\ Sh\ wx\ Ds}{Re\ c\ sh\ wx\ ds}$

Derived from C, non-var. kernels in cross of ~~Re~~ c sh wx (Re c sh wx) Ac/Ac ♀ by C Sh wx Ds ac ♂.

Projected Ac constitution	Self-pollinated	by I Sh wx Ds ac ♂ ($\frac{Re\ wd\ C\ Sh\ wx\ ds}{M\ wd\ I\ Sh\ wx\ Ds}$ ac/ac)	Used as ♂ to c ds/c ds ac/ac	Used as ♂ to c ds/c ds Ac Ac (high dose action Ac) (Ac Ac Ac = non-var.?)
No Ac	3 C non-var : 1 colorless ac ac ac	1 I wx non-var. : 1 I ~~wx~~ non-var. all ac ac ac	1 C non-var. : 1 c all ac ac ac	25 C non-var. 1159 C with specks of c 1244 colorless (c/c) 'all' Ac Ac ac
Ac ac ; Ac ac 6 plants.	reg. var. kernels.	Total = 965 253 I wx, not dv. var. 218 I wx; specks of C 494 I Wx (C Wx 9 x I wx ♂) 1 Ac Ac Ac : 2 Ac Ac ac : 1 ac ac ac	67 C, non-var. 266 C → c var. (2 classes of var.) 342 c/c = colorless 1 Ac Ac : 2 Ac ac : 1 ac ac ac	256 C, not dv. var. 6 C, areas with specks of c 70 C → c specks of c (Ac Ac type) 461 c/c = colorless 1 Ac Ac Ac : 2 Ac Ac Ac : 1 Ac Ac ac
2 plants Ac Ac / ac	reg. var. kernels.	48 I wx, non-var. or not certainly var. 8 I wx & specks of C. 111 I ~~Wx~~, (C Wx / I wx) 1 Ac Ac Ac Ac : 1 ac ac	124 C, non-var. 104 C → c var. (Ac Ac ac type) 233 colorless (c/c) 1 Ac Ac ac ac : 1 ac ac ac	68 C, non-variegated 71 C → c var. (Ac Ac type) 146 colorless (c/c) 1 Ac Ac ac ac : 1 ac ac ac

Figure 1 ~~Outcrossed~~

number of Plants	self-pollination	by I Sh wx Ds ac	to c ds/c ds $\frac{ac}{ac}$	to c ds/c ds $\frac{Ac}{Ac}$
10	no var. kernels.	no var. kernels.	no var. kernels.	variegated kernels.
14	var. kernels.	var. kernels.	var. kernels.	var. kernels
1	no var.	no. var.	no. var.	var. kernels — this [illegible] Ds. not transmitted through ♀

[illegible] with [illegible] ♀ Ds ♀

Total . 23 non-var. C Sh Wx kernels { 11 with no Ac / 12 with Ac

2 late spotting c = Both have Ac.

Fig. 12

on board

Appearance of plants derived from selected I wx kernels in cross of $\frac{M\ W\ C\ Sh\ wx\ Ds}{Re\ c\ sh\ W\ x\ ds}$ Ac a; Ac a ♀ × $\frac{M\ W\ I\ Sh\ wx\ Ds}{Re\ W\ C\ Sh\ Wx\ ds}$ $\frac{ac}{ac}$.

♀ Parent Plant	A: I wx with small area of C.			B: I wx; heavily speckled		
	Suspected Ac constitution of plant on basis of kernel appearance = Ac + Ac			Suspected Ac constitution of plant on basis of kernel type 1 Ac		
	occasional w streaks only	Relatively few small w streaks total	many w streaks	occasional w streak	relatively few w streaks	many w streaks Total 50 total
Plant 1 (4539A-1)	0	5 ^{2}	0	0	2	5 ^{2}
Plant 2 (4540A-2)	1 ^{1}	6 ^{2} (1 pr) Total 51	0	0	0	8 ^{2}
Plant 3 (4541B-1)	3	5 ^{2}	0	0	0	4 ^{2}
Plant 4 (4543-2)	0	6 ^{2}	0	0	0	4 ^{2}
Totals.	4	22	0	0	2	21

Plant Progeny

1 = 4935 A and B

2 4942 A + B

3 4946 B + C

4 4951 A + C

Table 50

Fig. 4 on board.

Crosses of plants in B column, figure 2. to C sh bz wx ac ac

♀ C sh bz wx ac ac × ♂ I Sh Bz wx Ds Ac ac / C Sh Bz wx Ds

♂ parent from Column B	✓	I wx kernels		C Bz kernels	
		I wx, non-var.	I- C bz var.	C Bz not obvious var.	C Bz - C bz variegated
original plant 1	1	147	107	161	113
	2	223	186	228	149
2	1	49	52	54	46
	2	104	88	91	74
3	1	133	144	132	138
	2	181	166	181	154
4	1	135	111	106	109
	2	178	127	136	91
Totals		1150	981	1089	874

Fig 3

Crosses of plants to Cnd by wt Ac ac

C nd by wt ac ac ♀ × wd I Sh Bz wt Ds / Wd C Sh Bz wt Ds

Ac ac ; Ac ac

Apparent parent from column A in Fig. 2		The I kernels.		The C kernels.	
		I, non-var.	I-Cb var.	C Bz not drawn in	C Bz with bz areas.
1	①	114	311	109	270
	②	37	106	39	98
2	①	74	245	86	210
	②	188	189	201	175
3	①	113	271	113	238
	②	74	96*	45	122
4	①	35	86	35	98
	②	47	145	63	143
Totals minus 2-②		494	1260	490	1176