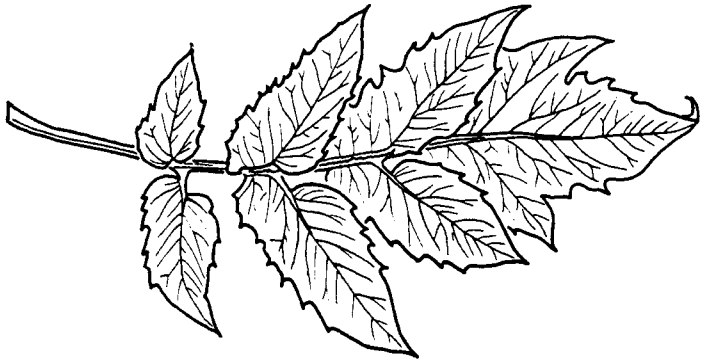
REPORT
of the
TOMATO GENETICS
COOPERATIVE



NUMBER 12 FEBRUARY 1962

DEPARTMENT OF VEGETABLE CROPS
UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

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Department of Vegetable Crops
University of California
Davis, California

Contents

Cover design was traced from a photograph of
a typical leaf of the entire (e) mutant.

FOREWORD

The Tomato Genetics Cooperative is a group of workers who have a common interest in tomato genetics and who are organized informally for the purpose of exchanging information and stocks. Participation is voluntary, and costs of activities are met by assessments to members.

TGC membership stood at 241 as of January 1, 1962, representing a slight increase over the 235 total of the preceding year. With a balance of $298.16, TGC finances are satisfactory. This figure is not excessively large, for the majority of members are paid up for the 1961-63 triennium and expenses for 1962 and 1963 will mostly be met by this balance plus dues of new members and sale of backnumbers.

The usual annual meeting was held at Purdue University in conjunction with the AIBS meetings in August, 1961. Minutes of the meeting appear on the next page. The meeting in 1962 is again scheduled at the AIBS sessions, thanks to the cooperation of that organization. If you are planning to attend the meetings in Corvallis, Oregon in August please put the TGC meeting on your list.

New tomato mutants are being reported at such a rate that the Coordinating Committee decided to instruct the Gene List Committee to prepare the third list for this report. This new list, together with a condensed list of all previously described mutants, has been completed and appears in the following pages. We owe a special vote of thanks to Dora Hunt for taking the major responsibility for this effort and to Dick Robinson for taking over the assignment of seed stock keepers.

We are grateful to the many workers who assisted in the preparation of this Report. Thanks are due to the many members who have shared their interesting findings. We are greatly indebted to Virginia Borelli for typing the stencils on her usual high standards. (This is the ninth TGC Report for Virginia.) The skillful editing and attention to many other details by Dora Hunt are gratefully acknowledged. Thanks also to many graduate students who assisted with various details.

Four hundred copies of this Report have been issued.

Minutes of the Purdue Meeting

August 30, 1961

The meeting took place at 12:00 noon in room 235 of the Student Union, and there was an overflow crowd present. While the orders were being taken for lunch, the chairman, L. Butler, asked each person to stand and introduce himself, and then neighbours exchanged the usual tomato gossip until after the meal had been eaten. The service was slow, and there were two tomato papers to be given at 1:00 and 1:10 in the A.S.H.S. meetings so several people had to leave right after lunch. The chairman read a report from C. M. Rick which showed that TGC has 230 members and a bank balance of $239.49. Also that the Coordinating Committee had made the following decisions:

1. A supplementary gene list will be issued in TGC 12, and members will be canvassed to see if they will still serve as seed sources for certain mutants.

2. In response to a suggestion that TGC meet with other groups for its annual meeting, it was decided that the current practice should be continued.

3. Exchange stock lists will not be issued in TGC 12.

4. A revised membership list will be issued in TGC 12.

5. The latest revised linkage map has been transmitted to the editor of the Handbook on Growth.

The chairman then asked for discussion on the decisions. Most comments were favourable, but it was pointed out that perhaps the seed stock of mutants could be looked after by a central government agency.

A communication from T. O. Graham was read which indicated that the pedigrees for the varieties Century, Epoch, Hertford Cross, Summer Sunrise, Swift, Tecumseh, VFI 36, VFI 45, and Ware Cross would be published soon. The meeting then adjourned so that we could get back to the meetings.

V. M. Butler,

Secretary, pro tem.

LIST OF TOMATO GENES AS OF JANUARY 1962

Two previous lists of genes have been issued in TGC 4 and 9. The former was published with a list of nomenclatorial rules in Journal of Heredity 46: 22-26, 1955, and the latter with supplementary rules in the same medium 51: 167-174, 1960. During the three-year interval since the last list was issued, numerous new genes have been reported and the need for an additional rule has risen.

Recent investigations have revealed the approximate position of genes on certain chromosome arms. The following rule was therefore formulated as a means of presenting this information in the chromosome maps. It is consistent with usage in the maize and Drosophila groups.

1. As soon as the arm location of a gene is known, the locus numbering should be revised to reflect that information. The small arm of each chromosome is designated as the left arm, and the zero position is the left end of the small arm.

Following the procedure of the second list, two tables have been prepared. Table I lists in condensed version all genes that appeared in previous lists. Table II lists new genes that have been described since the second list was issued. The inclusion of mutants of L. pimpinellifolium described in Stubbe's I list (Kulturpflanzen 8:110-137, 1960) has been deferred until certain nomenclatorial problems have been settled.

Table I. CONDENSED LIST OF GENES ISSUED IN TGC 4 & 9

(Asterisk signifies genes first listed in TGC 4.)

Symbol	Name	Seed Source		Symbol	Name	Seed Source	
* a_1(a)	anthocyaninless	Bur	Rob	* ap	apetalous	Bur	R
ac	apocarpous			ar	arrecta	St	B
* ad	Alternaria resistance	A	K	* as_1	asynaptic-1	Soost	C
				* as_2	asynaptic-2	Soost	C
ae (a_{332})	entirely anthocyaninless	Bur	Rob	* as_3	asynaptic-3	Soost	C
				* as_4	asynaptic-4	Soost	C
aeg	aegrota	St	R	* as_5	asynaptic-5	Soost	C
af (a_{325})	anthocyanin-free	Bur	K	as_6	asynaptic-6	Soost	C
* ag	anthocyanin gainer	B	R	* at	apricot	Jenkins	R
				atn (at)	attenuata	St	B
ah	Hoffman's anthocyaninless	Rob	WW	au_1 (au, brac)	aurea	Lesley	WW
ai (a_{342})	incomplete anthocyanin	Bur	Rob	* aw	without anthocyanin	NC	B
* al (a_2)	anthocyanin loser	B	R	* B	Beta-carotene	Tomes	NC
				bc (bi)	bicolor	St	B
* an^1_2 (an)	anantha	St		bg	bursting resistance of fruit		
* an^2 (ca)	cauliflower						
ang	angustifolia	St	B	bi	bifurcate inflorescence	Bur	C
ao (a_{337})	anthocyanin omitted	Bur	Rob	* bk	beaked	B	C

	Symbol	Name	Seed Source	
	bl	blind	R	WW
	bn	blunt	Brown	WW
*	br	brachytic	B	R
	Bt	Bursting sysceptibility of fruit		
	btl	brittle	A	Rob
	bul	bullata	St	B
*	c	potato leaf	B	Rob
	car	carinata	St	R
*	cb	cabbage		
*	Cf_1 (Cf_{sc})	resistance to Cladosporium fulvum-1	K	A
*	Cf_2 (Cf_{p1})	" -2	K	A
*	Cf_3 (Cf_{p2})	" -3	K	A
*	Cl_1	Cleistogamous-1	R	NC
*	cl_2	cleistogamous-2	R	NC
	clā	clara	St	R
	clau (ff)**	clausa	St	R
	cm	curly mottled	R	B
	cn (ca)	cana	St	B
	co	cochlearis	St	B
	con	convalescens	St	R
	cr	radial cracking resistance of fruit		
	cs	corollaless	K	
	Cu_1 (Cu)	Curl-1	R	PAY
	cv^{crisp} (rob^{crisp})	curvata robusta crispata	St	B R
	d_1			
*	d_1 (d, rob^{imm})	dwarf-1	B	Johnson
*	$d_1{}^x$ (d^x)	extreme dwarf-1	R	C
	d_2 (rob_2)	dwarf-2	St	NC
	d_5 (d_2, m-5)	dwarf-5	Bur	Rob
	dē	declinata	St	B
	deb	debilis	St	R
	def	deformis	St	R
	deli	deliquescens	St	B
	dep	deprimata	St	R
	depa	depauperata	St	B
	di	divergens	St	B
	dil	diluta	St	R
	dim	diminuta	St	B
	dis	discolor	St	B
*	dl	dialytic	R	NC
*	dm (d_2)	dwarf modifier	B	Rob
	ds	dwarf sterile	R	Bur
*	dv	dwarf virescent	R	C
*	e (b)	entire	B	R
	ec	exserted carpels	PAY	K
*	el (e)	elongate	B	Creech
	ele	elegans	St	R
	elu	eluta	St	R
	er	erecta		
*	ex	exserted	R	Creech

	Symbol	Name	Seed Source	
	exl (ex)	exilis	St	B
*	f	fasciated	B	Bur
	fir	firma	St	B
*	fl	fleshy	B	PAY
	fla	flavescens	St	R
	flav	flavida	St	B
*	fru^{abb} (bu^{abb})**	fruticosa abbreviata	B	PAY
	fru^{hem} (bu^{hem})**	fruticosa hemiglobosa	St	B
	fu	fusiformis	St	K
	ful	fulgens	St	R
	Fw	Furrowed	R	HWY
*	(G)	(interacts with r)		
*	g	grooved	C	WW
	gf	green flesh	K	R
	gh (ab)	ghost	R	Bur
	gil	gilva	St	
	glau	glaucescens	St	K
	glo	globosa	St	R
	gq	grotesque	R	K
	gr	green ripe	K	
	gra	gracilis	St	K
*	gs	green stripe	R	NC
*	H	Hairs absent	B	R
*	hl	hairless	B	Bur
	hp (hp_1, hp_2, bs, dr)	high pigment	Thompson	K
	ht	hastate	R	Abdel-Al
*	I	Immunity to Fusarium lycopersici	NC	Gilbert
	ig	ignava	St	K
	imb	imbecilla	St	R
	in	indiga	St	K
	inc	incurva	St	K
	inf	infirma	St	R
	int	integerrima	St	K
	intro	introflexa	St	K
	inv	invalida	St	R
	irr	irregularis	St	K
*	j_1 (j, lf)	jointless-1	Munger	Bur
	j_2	jointless-2	Reynard	K
	jug	jugata	St	R
*	(K)	(interacts with r)		
*	l_1 (l, g, rub)	lutescent-1	B	R
	l_2	lutescent-2	R	K
	Lā	Lanceolate	Jenkins	R
	lat	lata	St	R
*	Lc	Locule reduction	PAY	NC
*	(lc_1, lc_2, lc_3)	(control locule number)		
*	lg_1 (lg)	light green-1	B	PAY
	lo	locule number reduced		

**According to information received from Dr. Stubbe during preparation of TGC 12.

Symbol	Name	Seed Source
ls	lateral supressor	WW R
luc	lucida	St R
lut	lutea	St R
* m_1 (m)	mottled-1	B C
M_3 (M_{345})	Mottled-3	
marm	marmorata	St R
* mc	macrocalyx	HWY R
md (mo, m-2)	mottled-2	Bur R
Me	Mouse ears	R C
Mi	Meloidogyne incognita resistance	Gilbert NC
mn_+ (mi)	minuta	St K
mo_B (I^B)	modifier of B	Tomes NC
mon	monstrosa	St K
* ms_1	male-sterile-1	
* ms_2	male-sterile-2	R C
* ms_3	male-sterile-3	R Bur
* ms_4	male-sterile-4	R Creech
* ms_5	male-sterile-5	R C
* ms_6	male-sterile-6	R NC
* ms_7	male-sterile-7	R Bur
* ms_8	male-sterile-8	R NC
* ms_9	male-sterile-9	R Bohn
* ms_{10}	male-sterile-10	R NC
* ms_{11}	male-sterile-11	R Creech
* ms_{12}	male-sterile-12	R Bur
* ms_{13}	male-sterile-13	R NC
* ms_{14}	male-sterile-14	R NC
* ms_{15}	male-sterile-15	R C
* ms_{16}	male-sterile-16	R Creech
* ms_{17}	male-sterile-17	R NC
* ms_{18}	male-sterile-18	R NC
ms_{19}	male-sterile-19	
ms_{20}	male-sterile-20	
ms_{21}	male-sterile-21	
ms_{22}	male-sterile-22	
ms_{23}	male-sterile-23	R Creech
ms_{24}	male-sterile-24	R Creech
* mt	midget	
mult	multiflora	St R
* n (nt)	nipple	B HWY
na	nana	St R
* nc	narrow cotyledons	B K
nd (m-4)	netted	Bur WW
* ne_1 (ne)	necrotic-1	B PAY
neg	neglecta	St R
ni	nitida	St K
not	notabilis	St K
Nr	Never ripe	R K
nv	netted virescent	Soost C
* o	ovate	B C
* (O, O',o)	(Sperical, oblate, elongate)	
* O^1 (ol)	Oval	R
op	opaca	St K
* p	peach	B C
pal	pallida	St R
pau	pauper	Bohn K
pc	precocious chromosome division	C Rob
* pe	sticky epidermis	B PAY
per	perviridis	St R
pg_1 (pg, pg_{329})	pale-green-1	Bur Creech
Ph_1 (Pi_{T_1}, TR_1)	susceptibility to Phytophthora infestans race T_1	Gallegly A
* pi	pistillate	R NC
pic	picta	St NC
* pr	propellor	B R
pro	procera	St R
prun	prunoidea	St R
* ps (va)	positional sterile	B C
pt	petite	Bur Creech
pu	pulvinata	St NC
pum	pumila	St R
pur	purilla	St R
* r	yellow flesh	R Bohn
r_1^y (r^y, ry)	reddish yellow	PAY Bohn
ra	rava	St R
* rc	rolled	
re	reptans	St NC
rela	relaxata	St NC
rep	repens	St NC
* ri	ridged	NC Gilbert
rl (ra)	radial crack resistance of fruit	
* ro	rosette	B C
ru	ruptilis	St NC
rust	rustica	St R
* rv	reticulate virescent	R WW
* s	compound inflorescence	B C
sd	sun dwarf	R K
* Se	Septoria resistance	A Tomes
sf	solanifolia	R WW
sit	sitiens	St R
* sl^1 (sl)	stamenless-1	NC Lyall
sl^2(sl_2)	stamenless-2	WW
sl^3(sl_3)	stamenless-3	
sl^4(sl_4)	stamenless-4	
sl^5(sl_5)	stamenless-5	WW
* Sm	Stemphyllium resistance	A Gilbert

Symbol	Name	Seed Source
* sp	self-pruning	B Rob
squa	squarrosa	St NC
* st	sterile	
stri	stricta	St R
su	suffulta	St NC
sub	subtilis	St R
suf	sufflava	St R
$sulf^{pura}$ 5-100%	$sulfurea^{pura}$ alleles	St
$sulf^{vag}$ 5-100%	$sulfurea^{variegata}$ alleles	St
Sus_a	Subsistens	St
Sw_1	Spotted wilt resistance-1^a	NC Gilbert
Sw_1^b	Spotted wilt resistance-1^b	NC Gilbert
sw_2	spotted wilt resistance-2	NC Gilbert
sw_3	spotted wilt resistance-3	NC Gilbert
sw_4	spotted wilt resistance-4	NC Gilbert
sy	sunny	Bur Bohn
$*t_v$	tangerine	B R
t^v	virescent tangerine	Lesley R
tab	tabescens	St NC
ten	tenuis	St R
* tf (ct, tri)	trifoliate	Jenkins HWY
Tm_1	Tobacco-mosaic virus resistance-1	C NC
Tm_2	Tobacco-mosaic virus resistance-2	Soost C
* u (u_1)	uniform ripening	B R
* ug (u_2)	uniform grey-green	B PAY
um	umbrosa	St NC
uni	unicaulis	St R
* v_1 (v)	virescent	
va^{dec}	$varia^{decolorata}$	St R
va^{virg}	$varia^{virgata}$	St R
var	variabilis	St R
* Ve	Verticillium resistance	R Rob
vel	velutina	St NC
ven	venosa	St R
ver	versicolor	St NC
* vg	vegetative	R NC
* vi	villous	B K
vio	violacea	St NC
vir	viridis	St R
vit	vitiosa	St NC
* w_1 (w)	wiry-1	B Foskett
* w_2	wiry-2 (Lindstrom)	
* w_3 (w_2	wiry-3 (Lesley)	
* wd	wilty dwarf	Rob NC
* wf	white flower	R Bohn
* Wo_m	Wooly	B R
Wo_v	Morgan's wooly	R C
Wo	vanWert wooly	Soost C
* wt	wilty	B HWY
* x	modifier of I	Gilbert NC
* Xa	Xanthophyllic	B R
* y (y^1)	colorless fruit skin	B R
yg_1	yellow-green-1	Thompson
yg_2 (yg_{282}, yc)	yellow-green-2	Bur K
yg_3 (yg_{330}, ye)	yellow-green-3	Bur Gilbert
yg_4 (yg_{333}, yl)	yellow-green-4	Bur K
* ys	yellow seedling	
* yv	yellow virescent	R Gilbert

Table II. LIST OF GENES JANUARY 1959 - JANUARY 1962

Gene symbol	Reference	Seed Source	Character
aba (ab)(a_{179})	Burdick, TGC-10:8	B	anthocyaninless-base. A typical green stem mutant, similar to all the others; spontaneous in San Marzano.
acu	Stubbe, 1959	St Abdel-Al	accumbens. Leaves and pinnae shortly stalked; leaf surface furrowed; older leaves strongly bent downward. Condine Red.

Gene symbol	Reference	Seed Source	Character
adp	Stubbe, 1959	St Abdel-Al	adpressa. Leaves epinastic; shoots, internodes and leaflets shortened; upright habit. Condine Red.
afl (af)	Rick, TGC-11:18	R Creech	albifolium. Seedling very slow; cotyledons white; leaves becoming normal except for gray flecks; later growth nearly normal. XL Pearson.
afr (ap)	Yu & Yeager, 1960		anthocyaninless-fragile. Anthocyanin absent; small, brittle, fragile plants; leaves wilt in a day. Chatham.
am (a_{340})	Burdick, TGC-10:8	B Rob	anthocyanin-minus. A typical green stem mutant, similar to all the others; irradiation-induced.
apl	Stubbe, 1959	St Abdel-Al	applanata. Leaves elongate, laxly pinnate; fruit flatter, broader, larger; spreading habit. Lukullus.
be	Lesley, TGC-8:24	Lesley Verkerk	blue-green. Small plants with blue-green leaves; probably an irradiation-induced translocation. Canary Export.
bip	Stubbe, 1959	St Abdel-Al	bipinnata. Leaves highly divided, with smaller acute segments. Lukullus.
ch	Rick, TGC-10:31	R Foskett	chartreuse. Greenish-yellow corolla segments. Pearson.
chln	Böhme & Scholz, TGC-11:5		chloronerva. Upper leaves smaller and chlorotic interveinally; strong graft response. Bonner Beste.
com	Stubbe, 1959	St Thompson	complicata. Plants much reduced; stems upright, stiff. Condine Red.
cor	Stubbe, 1959	St Foskett	coriacea. Tiny unbranched plants; all parts reduced; short leaves with plicate segments. Condine Red.
cpt	Rick, TGC-12:37	R Rob	compact. Highly branched compact plant; lax stems; pale, smaller leaves. XL Pearson.
Cr_1	Butler, TGC-12:17	B	Crimson-1. Complementary gene effecting crimson fruit color. Philippine variety.

Gene symbol	Reference	Seed Source	Character
cr_2	Butler, TGC-12:17	B	crimson-2. Complementary gene effecting crimson fruit color. Philippine variety.
Cri	Stubbe, 1959	St HWY	Crispa. Cri/Cri inviable without grafting; minute in all parts; leaves bright olive-green, necrotic. Cri/+ whitish brown spots on the middle of the leaflets. Condine Red.
cu_2	Yu & Yeager, 1960		curly leaf-2. Small, downcurled leaves. Chatham.
cur	Stubbe, 1959	St HWY	curvifolia. Leaves twisted, yellow green; shortened internodes. Rheinlands Ruhm.
cva	Stubbe, 1959	St Foskett	conversa. Dense growth habit; older leaves lose pigment. Condine Red.
dec	Stubbe, 1959	St Thompson	decumbens. Leaves sparse; plant very prostrate and spreading. Lukullus.
det	Stubbe, 1959	St Verkerk	detrimentosa. Reduced branching; slower growth; tends to be virescent; base of young leaves tend to be yellowish. Rheinlands Ruhm.
div	Stubbe, 1959	St Rob	divaricata. Leaves concave; chlorotic between veins; anthocyanin in reverse. Condine Red.
dp	Yu & Yeager, 1960		drooping leaf. Leaf drooping, elongate, dark green; stems weak, slender, prostrate. Chatham.
fe	Stubbe, 1959	St Foskett	fertilis. Leaves roll ventrally; pendant. Lukullus.
flc	Stubbe, 1959	St Foskett	flacca. Leaves small, recurved dorsally, susceptible to overwilting. Rheinlands Ruhm.
fr	Stubbe, 1959	St Foskett	frugalis. All parts reduced; plant small, compact; leaves dark green, brittle. Condine Red.
Fs	Clayberg, TGC-12:22	C Rob	Fruit stripe. Dark green radial stripes on immature fruits opposite and equal in number to locules; unripe fruit highly pigmented. Backcross transfer from L. hirsutum f. glabratum.
gl	Stubbe, 1959	St Verkerk	glauca. Leaf segments narrow, acute; virescent at growing point. Condine Red.

Gene symbol	Reference	Seed Source	Character
glb	Stubbe, 1959	St Verkerk	globularis. Internodes and leaves shortened; leaves densely pinnate, yellow tinged. Rheinlands Ruhm.
glc	Stubbe, 1959	St Verkerk	glaucophylla. Leaves light yellow or gray-green, acuminate. Rheinlands Ruhm.
gri	Stubbe, 1959	St Thompson	griseifolia. Leaves small, strongly recurved dorsally, gray-green; trichomes longer. Rheinlands Ruhm.
he	Stubbe, 1959	St Foskett	heteroidea. Weak plant; internodes shortened; leaflets somewhat narrowed; older leaves glossy, brittle, pale green. Condine Red.
Hrt	Rick, TGC-12:38	R	Hirtum. Increased density of large trichomes; incompletely dominant. Peruvian tomato var.
ic	Stubbe, 1959	St Thompson	inclinata. Internodes and leaves shortened; older leaves epinastic; plant prostrate. Rheinlands Ruhm.
id	Stubbe, 1959	St HWY	indehiscens. Broad leaf segments; connate sepals; fruit irregularly cracked. Rheinlands Ruhm.
imp^{dia}	Stubbe, 1959	St Foskett	$\frac{impedita}{distincta}$. Plants short, weak; leaves chlorotic at margins; plants smaller than imp^{eg}. Condine Red.
imp^{eg}	Stubbe, 1959	St Foskett	$\frac{impedita}{exigua}$. Like imp^{dia} but plant larger. Condine Red.
j_2^{in}	Joubert, TGC-11:13	Joubert R	jointless-2 with incomplete action. Pedicel joints with normal form but do not separate when fruits ripen. ex. Riverside x Sunneva.
lae	Stubbe, 1959	St Foskett	laesa. Axillary sprouts later necrotic; primary leaves dainty. Rheinlands Rhum.
lg_2 (li)(pg_{392})	Burdick, TGC-10:9	B Verkerk	light green-2. Cotyledons light yellow (like ye); leaves pale green; leaf shape normal; classification sometimes difficult; irradiation-induced in seed of Red Cherry inbred.
lg_3 (lt)(pg_{483})	Burdick, TGC-10:9	B Verkerk	light green-3. Cotyledons and leaves light green; cotyledons fade to yellow; mature plant pale green; irradiation-induced in seed of Red Cherry inbred.

Gene symbol	Reference	Seed Source	Character
lg_4	Burdick, TGC-11:6	B Verkerk	light green-4. Yellow green cotyledons, light green leaves; seedling classification dependable; 10,000r X-ray-induced in pre-soaked seed of Red Cherry inbred.
lg_5	Kerr, TGC-12:30	K Verkerk	light green-5. Light-green foliage color. PI 126,954 L. pimpinellifolium.
lu	Stubbe, 1959	St	luteola. Dark yellow flowers. Lukullus.
ma	Stubbe, 1959	St	macrocarpa. Leaves distinctly lengthened; fruit large and smooth. Lukullus.
mar	Stubbe, 1959	St	marcescens. Plants small, erect; leaves dark green, lightly wilted. Lukullus.
mnx (min^{ex})	Persson TGC 10:27-28	Persson	extreme miniature. Severely stunted chlorina mutant with 1 cm. internodes; flowers only after grafting on +.
ms_{25}	Rick, TGC-10:35-37	R Rob	male-sterile-25. Stamens slender, fore-shortened, pale; stigmas mostly exposed. Red Top.
ms_{26}	Rick, TGC-10:35-37	R Rob	male-sterile-26. Stamens variable, greatly distorted; stigmas 100% exposed. Van's Early.
ms_{27}	Rick, TGC-10:35-37	R Rob	male-sterile-27. Stamens slender, diverging distally, pale; stigmas mostly not exposed. Van's Early.
ms_{28}	Rick, TGC-10:35-37	R Rob	male-sterile-28. Stamens very slender, slightly shorter, pale; stigmas mostly exposed. XL Pearson.
ms_{29}	Rick, TGC-10:35-37	R Rob	male-sterile-29. Stamens slender, often separate below, pale, often greenish; stigmas mostly exposed. CPC-2.
ms_{30}	Rick, TGC-10:35-37	R Rob	male-sterile-30. Stamens highly modified, very slender, free, twisted, pale or greenish yellow; stigmas 100% exposed. San Marzano.
ms_{31}	Rick, TGC-10:35-37	R Rob	male-sterile-31. Stamens smaller, very pale; stigmas 100% exposed. VF-6 Pearson.
ms_{32}	Rick, TGC-10:35-37	R Rob	male-sterile-32. Stamens greatly reduced and shrunken; very pale, often brown; stigmas 100% exposed. Primitive cultigen from Colombia.

Gene symbol	Reference	Seed Source	Character
ms_{33}	Rick, TGC-12:39	R	male-sterile-33. Anthers very irregular, yellow-green; no pollen; breakdown in early meiosis; stigmas exposed; VF-11 Pearson.
ms_{34}	Rick, TGC-12:39	R	male-sterile-34. Anthers short, pale; no pollen; meiosis normal, possibly delayed; stigmas exposed. VF-11 Pearson.
ms_{35}	Rick, TGC-12:39	R	male-sterile-35. Anthers small, slender, pale; empty PMC in locules; breakdown in different stages of meiosis; stigmas exposed. A-1.
mu	Stubbe, 1959	St	multinervis. Internodes and leaves somewhat shortened; foliage full pale green, veins normal green. Condine Red.
muf	Stubbe, 1959	St	multifolia. Leaves elongate, highly divided, gray-green; interveinal areas blistered. Rheinlands Ruhm.
ne_2	Yu & Yeager, 1960		necrotic-2. Leaves with many grayish necrotic spots; plant small, weak, killed by defoliation. Chatham.
Nec	Martin, 1961	Martin	Necrotic. Hypertrophic pustules along veins of leaves; followed by chlorosis, then necrosis. Backcross transfer from L. chilense.
ob	Stubbe, 1959	St	obscura. Small plants with reduced branching; early foliage dark green. Rheinlands Ruhm.
oc	Stubbe, 1959	St	ochroleuca. Leaves discolored, becoming white variegated. Exposed unripe fruit yellowish gray. Rheinlands Ruhm.
Od	Rick & Dempsey, TGC-10:37	R Bohn	Odorless. Herbage has little or no characteristic tomato odor. Galápagos accession. Primitive cultivated var.
og	Rick & Dempsey, TGC-11:21	R Gilbert	old gold. Corolla tawny orange. Mutant in L. chilense backcrossed to var. Pearson.
oli	Stubbe, 1959	St	olivacea. Leaves crinkled, malformed, spotted tan basally. Rheinlands Ruhm.

Gene symbol	Reference	Seed Source	Character
pen	Stubbe, 1959	St Abdel-Al	pendens. Leaves broad, convex, pendant, glossy. Condine Red.
pg_2 (pa) (pg_{390})	Burdick, TGC-10:8	B Creech	pale green-2. Cotyledons and leaves pale green; phenotype good; irradiation-induced in seed of Red Cherry inbred.
pg_3 (pl) (pg_{391})	Burdick, TGC-10:8	B Creech	pale green-3. Cotyledons pale gray-green and leaves seem to fade to a dull yellow color; easy classification; irradiation-induced in seed of Red Cherry inbred.
pla	Stubbe, 1959	St Verkerk	plana. Leaves gray-green with yellowish speckling. Condine Red.
pli	Stubbe, 1959	St Rob	plicata. Plant reduced; leaves plicate, narrow; strong anthocyanin. Lukullus.
pol	Stubbe, 1959	St Thompson	polylopha. Short internodes; leaves plicate and twisted; fruit flat, fasciated. Lukullus.
prc	Stubbe, 1959	St Thompson	procumbens. Internodes and leaves shortened; leaves blistered and lightly mottled yellow. Condine Red.
rig	Stubbe, 1959	St Verkerk	rigida. Leaves small, rigid, never pendant, yellowish green. Condine Red.
rot	Stubbe, 1959	St HWY	rotundifolia. Short internode; leaves short, broad, blistered. Rheinlands Ruhm.
Rs	Yu & Yeager, 1960		Suppressed root. Greatly restricted root development. Chatham.
sem	Stubbe, 1959	St HWY	semiglobosa. Small compact plant; very short internodes; small dark leaves. Condine Red.
si	Stubbe, 1959	St Foskett	sinuata. Reduced growth; leaves small, wavy, yellow-green. Rheinlands Ruhm.
sn	Lesley & Lesley, TGC-11:15		singed. Epidermal hairs smaller; trichomes crooked, curved, and otherwise distorted. Canary Export.
spa	Stubbe, 1959	St Foskett	sparsa. Small weak plants, leaves emerge yellow-green, later blotched whitish yellow-green. Condine Red.
sph	Stubbe, 1959	St Rob	sphaerica. Very short spherical plant; older leaves small, dark green. Condine Red.

Gene symbol	Reference	Seed Source	Character
sr (sm)	Yu & Yeager, 1960		slender stem. Stem slender, stiff, upright, with few branches; leaves elongate, blue-green, with few segments. Chatham.
ste	Stubbe, 1959	St Rob	sterilis. Leaves very densely pinnate, leaflets reduced, weakly pale green; many flower buds abort; low normal fruit set. Condine Red.
sua	Stubbe, 1959	St Verkerk	suffusa. Leaves broad, paler, prematurely yellowing. Rheinlands Ruhm.
suc	Stubbe, 1959	St Foskett	succedanea. Small delicate plants; leaves small, broad, dull green, prematurely yellowing. Condine Red.
ta	Stubbe, 1959	St Foskett	tarda. Small dainty plant; leaves reduced, glossy, gray-green. Condine Red.
tl	Langridge & Brock, 1961	Brock Rob	thiaminless. Cotyledons normal; leaves small, yellow, developing green veins, dying prematurely; lethal; viable and normal if fed thiamin.
to	Stubbe, 1959	St HWY	torosa. Reduced branching; determinate growth; flowers fasciated. Condine Red.
tp	Yu & Yeager, 1960		tripinnate leaf. Leaves tri-pinnately compound; retarded growth. Chatham.
tr_1 (tr)	Stubbe, 1959	St HWY	truncata. Small weak plants; leaves scanty, gray-green. Condine Red.
v_2	Kerr, TGC-12:30	K Rob	virescent-2. New leaves pale under greenhouse conditions; frequently undistinguishable in field. Breeding line.
w_4	Rick, TGC-11:18	R Foskett	wiry-4. Similar to previously-described wiry mutants; leaves progressively more reduced. Pearson.
wv	Rick, TGC-10:32	R Creech	white virescent. Plant retarded; cotyledons whitish yellow; leaves start chlorotic, always with white speckling. Peruvian domestic variety.

Gene symbol	Reference	Seed Source	Character
yg_5 (yw) (yg_{388})	Burdick, TGC-10:8	Bur HWY	yellow-green-5. Very yellow cotyledons and leaves; slow growing; good plant viability; irradiation-induced in Red Cherry inbred by seed treatment; the most yellow mutant we have.
yg_6 (yo) (yg_{389})	Burdick, TGC-10:8	Bur HWY	yellow-green-6. Bright yellow cotyledons and leaves; seedling etiolates; plant very vigorous; gametic and zygotic viability good; irradiation-induced in seed of Red Cherry inbred.
yv^{ms}	Hagemann, TGC-12:27	St	yellow-virescent masculosterilis. Male-sterile allele of yv; seedling yellow becoming yellow green (field) or light green (greenhouse). Condine Red.
yv^{mut}	Hagemann, TGC-12:27	St	yellow-virescent mutabilis. Male-sterile variegated allele of yv; green color frequently mutating to yv^{ms}. Condine Red.
(no symbol)	Gröber, TGC-11:12	lethal s	lethal seedling? Dies in seedling stage at low temperatures; survives and is nearly normal if grown above 26°C or grafted on +. Condine Red.

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KEY TO STOCK SOURCES IN TABLES I AND II

A	C.F. Andrus	K	E.A. Kerr	Rob	R.W. Robinson
B	L. Butler	NC	North Central Regional Station U.S.D.A. Ames, Iowa	St	H. Stubbe
Bur	A.B. Burdick			WW	W. Williams
C	C.D. Clayberg			HWY	H.W. Young
		R	C.M. Rick	PAY	P.A. Young

PART I

RESEARCH NOTES

Bills, R. W., and M. W. Martin
Embryo sacs in hybrids between L. esculentum and S. lycopersicoides.

The study reported herein was conducted to determine the feasibility of using a hybrid between Lycopersicon esculentum and Solanum lycopersicoides as a bridge for transferring into Lycopersicon the genes which control the apparent immunity from curly top virus infection that is expressed by certain species of Solanum.

Cuttings of the F_1 hybrid used in the study were obtained from C. M. Rick, who made the cross. The commercial tomato variety V. R. Moscow was used in reciprocal crosses with the hybrid and as the standard of comparison for the studies on the embryo sac and pollen-tube growth. Fruits for study were obtained from the following pollinations:

(a) selfing the hybrid
(b) crossing hybrid x V. R. Moscow
(c) crossing V. R. Moscow x hybrid
(d) no pollination of the hybrid or V. R. Moscow
(e) selfing of V. R. Moscow

To the pedicel of approximately half of the flowers in each of the pollination groups tested, the growth hormone parachlorophenoxyacetic acid at a concentration of 60 ppm was applied from immediately after pollination to 24 hours after. The other half of the flowers were left untreated. In all cases in the first four pollination groups those receiving no hormone treatment abscised; only those flowers receiving hormone treatment remained on the plant and developed fruit.

The intergeneric hybrid normally produces numerous small parthenocarpic fruits, but occasionally unusually large fruits which show some seed development are produced. The embryo sacs in these large naturally-occurring fruits were also studied.

Fruits were taken at intervals from the time of anthesis up to 30 days after pollination. In the case of the large naturally-occurring fruits, both young and mature fruits were collected. The fruits were killed and fixed, and the pericarps were removed. The locular contents were prepared for sectioning by the paraffin method. The sections were mounted serially and stained in safranin and fast green.

The development of the embryo sac and embryo in V. R. Moscow followed closely the pattern described by Cooper (1931, Am. J. Bot. 18:739-748) and Smith (1935, Cornell Univ. Ag. Exp. Sta. Mem. 184). In no case was embryo development observed in the hybrid pollinated with its own pollen or with the pollen of V. R. Moscow nor was embryo development observed in V. R. Moscow pollinated by the hybrid pollen. At anthesis the hybrid showed very few well-developed embryo sacs and those observed were not complete in their development. Within 8-10 days after pollination the embryo sac in the intergeneric hybrid was filled with a proliferation of cells. At ovule maturity this embryo sac area appeared as a brown area of dead oxidized cells in the aborted, nonviable seeds. The pattern of development follows that described

as the collapsed type by Rick (1946, Am. J. Bot. 33(4):250-256) in his work on sterile-ovule development in Lycopersicon esculentum.

A study also was made to determine whether any stigma or stylar incompatibilities were present in the Lycopersicon-Solanum hybrid. Stigmas and styles were collected from V. R. Moscow and the Lycopersicon-Solanum hybrid at 24-hour intervals from the time of pollination up to 72 hours after pollination. The hybrid pollen did not germinate either on its own stigma or on that of V. R. Moscow. The V. R. Moscow pollen germinated on both its own stigma and that of the hybrid. Pollen tubes of V. R. Moscow were observed throughout the length of the style of the hybrid.

Pollen from the intergeneric hybrid was stained with acetocarmine to determine by stainability the percentage of viable-appearing pollen grains produced by the hybrid. The results of this study were the same as the results reported by Rick (1951, P.N.A.S. 37:741-744). About 0.5 percent of the 1000 pollen grains counted stained darkly. Because of the small number of apparently-normal pollen grains from the hybrid, the chance of finding in vivo germination was rather small, even if it is assumed that all dark-staining pollen grains are viable. Therefore, even though observation of 70 stigmas pollinated with hybrid pollen failed to disclose any germination, there is still a question whether germination of hybrid pollen does occur on either its own stigma or that of V. R. Moscow.

The results of this study indicate that even though germination and tube growth of V. R. Moscow pollen occur normally on the hybrid pistil, fertilization and subsequent embryo development do not occur. Failure of fertilization is probably due to a lack of viable ovules which in turn is the result of the irregular meiotic behavior of the intergeneric hybrid. In pollen formation on the Lycopersicon-Solanum hybrid only a few normal-appearing pollen grains are produced and the same pattern would be expected in the formation of ovules.

Embryo sacs collapse in the Lycopersicon-Solanum hybrid at all stages of development from the megaspore to the mature embryo sac. Hypertrophy of the integumentary cells and proliferation of the cells within the embryo sac accompany the collapse.

The above results indicate that the chances of achieving successful crosses or selfs on the hybrid are quite small.

Boynton, J. E. The use of blenders to facilitate seed extraction. Recently the Waring Blendor has been successfully used to eliminate many of the laborious hand operations involved in tomato seed extraction. A model No. P B-5A Waring Blendor coupled to a Powerstat variable transformer model 3PF 116, which serves as a convenient speed reduction device, were employed.

Use of the blender to macerate whole tomatoes, followed by fermentation of the blended pulp, has proved to be a convenient and rapid method of seed extraction for moderate to large numbers of fruits. The blender jar is loaded with whole tomatoes, sufficient water added to cover the revolving blades, the Powerstat set at 60-80 volts, and the blending action allowed to continue very briefly, 30-45 seconds--just sufficient to chew the fruit into coarse segments releasing the seeds. The blended pulp, skins, and free seeds are then poured into cans and allowed to ferment for approximately two days--just long enough for the gelatinous matrix around the seed to break down. As the ferment is decanted, the skin and pulp rise to the top, while the seeds settle to the bottom in the usual fashion.

The glass blender jars of this model are adequate for fruit lots of as many as 12 moderate-size fruit or fewer of larger-size fruit. A larger Waring Blendor, model CB4, with a 4-quart stainless steel jar, is available and should have sufficient capacity to handle most large fruit lots.

An alternative procedure for use of the Waring Blendor for immediate extraction of seeds, without fermentation, appears to be practical in certain instances--particularly with very small-fruited L. esculentum types and with fruits of the wild species. Whole tomatoes are placed in the blender jar with sufficient water to cover the revolving blades. The voltage regulator of the Powerstat is set initially at 50-80 volts in order to break up the whole fruit. As soon as this is accomplished, the voltage is reduced to ± 30V, just sufficient to keep the blender blades in motion, and the blender allowed to run for 2-5 minutes, depending upon size and ripeness.

Small volumes of blended pulp can be decanted in the blender jar itself, or larger volumes transferred to another container. If an appropriate time and voltage combination is employed, the seeds will rapidly settle to the bottom, free of their gelatinous matrix. Since the skin segments usually float to the surface, they can be poured off with the finely blended pulp.

No significant damage to mature seeds--either visible effects or impairment of subsequent germination--results from this extended treatment provided a sufficiently low voltage (30-40 volts) is used. If several blender jars are used one can be loaded, another decanted, while a third lot of fruit is being blended.

A modification of the immediate extraction procedure has been found useful, particularly with the extremely large-fruited L. esculentum varieties, in which the separation of the skin segments from the seeds poses a problem. The tops of the whole tomatoes are sliced off and the entire contents--core, locules, and contents--are scooped out, using a tablespoon with sharpened edges. The foregoing procedure is then followed except that a slightly lower initial voltage is required to start the blender.

Butler, L. Crimson, a new fruit colour.

In 1953 we obtained seed of a Philippine variety which had fruits which were a distasteful muddy purple colour. Since this fruit colour looked like another good genetic factor, crosses were made to three tester stocks, and the following results were obtained:

P_1	X	P_1	F_1	F_2
Phil.	X	825	red	155 red: 47 crim.: 55 muddy: 3 muddy crim.
Phil.	X	902	red	50 red: 16 crim.: 6 muddy: 4 muddy crim.: 14 yellow
Phil.	X	e nc	crim.	55 red: 130 crim.: 40 muddy: 20 muddy crim.

It is obvious that muddy is a recessive, and the F_2 ratios show that it gives good monogenic segregation, and its linkage relationship will be discussed in another note. The fruit colour of the F_1's of the third cross was entirely unexpected, the fruits were bright red and the Hunter was 134 as compared with Improved Garden States 116 and John Baer 90. Many of these F_1 fruits were normal sized but seedless, indicating that the fruits will set under poor conditions (winter greenhouse). This lack of seeds may partly account for the very high Hunter reading, but the different shade of red was quite apparent and was easily classified in all three F_2's. From these data, providing we are willing to accept the proposition that muddy will conceal some of the

crimsons, the most simple explanation is the interaction of two genes, one dominant and the other recessive. This would give the following genotypes for the first two crosses:

$\underline{Cr_1}\underline{Cr_1}\ \underline{cr_2}\ \underline{cr_2}$ X $\underline{cr_1}\ \underline{cr_1}\ \underline{Cr_2}\ \underline{Cr_2}$ giving a red F_1 and 13 red to 3 crimson in the F_2, and the data fit this hypothesis. For the third cross the genotypes would be: $\underline{Cr_1}\ \underline{Cr_1}\ \underline{cr_2}\ \underline{cr_2}$ X $\underline{cr_1}\ \underline{cr_1}\ \underline{cr_2}\ \underline{cr_2}$ giving crimson F_1 and 3 crimson to 1 red in the F_2.

Following these observations the seed stocks were turned over to a student at one of the experimental farms, and in spite of the lapse of time, the above hypothesis has never been fully tested.

Butler, L. The cross-over values for chromosome 2.

	m	d	p	op	suf	dil	aw	ps	o	ro	Me	Cu	wv	bk	Wo	ms_{10}	s
dv	6.8	5.2	15.0				18.9	15.5	28.0	20.1		20.3		36.1	29.1	14.6	34.2
m		2.4	7.2	6.5			14.9		28.0	5.9	26.0	23.0		20.5	29.2	35.7	22.0
	d		3.0	13.5	14.0	14.4	18.2	11.8	15.8	23.4	25.0	27.0	27.8	27.9	33.2	30.0	31.6
		p			7.3	15.2	14.8	10.5	14.3					26.0	26.8	16.3	28.1
			op				28.7				12.7				17.6		
				suf			5.5		11.0	5.9		15.5		33.1	25.5		29.0
					dil		11.0		7.3	7.0	5.8			16.0	5.7		12.4
						aw		38.8	39.5	15.6	25.0	8.0	20.1	30.3	26.1	27.6	35.3
							ps		26.1		14.5			22.0		15.0	25.0
								o						18.2	23.4		23.5
									ro		25.5	20.3	14.2		25.6		
										Me		6.3		13.3		6.4	
											Cu			9.6		11.3	10.8
												wv					
													bk	22.5		22.7	9.2
														Wo		2.5	19.2
																ms_{10}	18.6

Backcrosses are being made and the chromosomes are being looked over for deficiencies in order to eliminate some of the inconsistencies which show up in the above values.

Butler, L. Muddy fruit, a phenotype of the gene gf.

The dirty brownish purple colour of the fruit of the Philippine variety was at first thought to be the expression of a new gene, and since the fruit in its early stages contained a lot of anthocyanin pigment, we thought this colour was the result of anthocyanins. Chemical analysis proved that it was not an anthocyanin, but probably a breakdown product of chlorophyll. In yellow-fruited segregates, the muddy colour did not develop, although the unripe fruits were often purple; instead the ripe fruits appeared to be similar to the ripe fruits of Staygreen caused by the gf gene. No crosses were made to check allelism but a large backcross made for another purpose shows close linkage with al. The data are:

Al red 36: Al muddy 856: al red 880: al muddy 34 or a cross-over of 3.8%.

This is much closer than the map shows but until a test is made for allelism it is better to consider muddy as the expression of the gf and R genes with the possible addition of an anthocyanin intensifier. It is interesting to note that 43 of the 58 muddy segregates had green seed, indicating plieotropic effect or linkage.

Butler, L. The linkage of divergens di.

The seed of this mutant was obtained from Stubbe, and while it is named for its habit of growth, it was found that the seedlings could be classified by their white stems. In many cases there is a deficiency of di plants, the data obtained so far being:

Test gene	++	+ t	di +	di t	chi square t	di	linkage
d_1	906	355	225	34	0.3	51.3	20.4
br	816	259	164	24	4.5	68.9	4.9
c	585	205	202	51	0.4	0.3	0.3
a	270	108	106	26	0.4	0.2	4.1
l	123	33	15	11	0.1	11.1	3.7
e	745	382	318	9	10.1	4.9	124.0**
Xa	266	83	68	40	8.5	0.2	2.4
au	1086	272	300	73	23.3	11.1	0.0
ao	364	133	131	26	0.3	0.3	6.4
tf	2255	801	631	226	2.0	0.3	0.0
ah	2474	804	748	240	0.6	7.7	0.0
rv	181	50	60	10	4.1	0.5	1.3
sl_1	97	36	41	0	1.8	0.2	11.5*

These data show that e and di are linked so this gene can be placed on chromosome 4. It also appears that sl_1 is probably linked with di and may also be on this chromosome, and a three point backcross is being prepared to check on this.

Butler, L. The tomato linkage map and the chromosomes.

Up to the present time the mapping of the linkage groups has proceeded on the proposition that the chromosomes are stable, and that the tomato is relatively free from inversions, deficiencies, and translocations. The map has also been built on the supposition that cross-overs are more or less equally frequent in all regions of the chromosome. Neither of these propositions seems to hold. Our studies of the chromosomes reveal many abnormalities in the standard tester

stocks, and the linkage data for chromosomes 2, 10, and 11 indicate that there are regions of frequent cross-over. One of these regions of frequent breaks is in the o region of chromosome 2.

Chiscon, J. A., and A. B. Burdick

Pleiotropism in three chlorophyll mutants.

A previous research note from this laboratory (TGC 11) stated that our chlorophyll mutants, when examined for chlorophyll content, fall into 3 groups with respect to chlorophyll ratio. The largest group retains the same proportion of chlorophyll a to b as the wild types. A second group contains proportionally less chlorophyll a than the wild types. The third group contains proportionally less chlorophyll b than the wild types. This third group consists of only the yg_2, yg_5, and yg_6 mutants.

These same 3 mutants were found to have a greater reduction from wild type of total chlorophyll content than any of the other mutants which were examined. We have recently found that the quantity of free glutamic acid found in leaf material from these mutants is considerably higher than in the wild types. A few other mutants were found to accumulate glutamic acid, but these increases were slight and did not really approach the degree of accumulation evidenced in the three yg mutants.

When two of the three mutant factors (yg_2 and yg_6) were placed homozygously together in the same genotype, the resulting effect on glutamic acid accumulation appeared to parallel the effect of the same genotype on the chlorophyll ratio. Glutamic acid accumulation became less than in either single mutant and approached wild type. The chlorophyll ratio deviated from wild type less than in either single mutant and also approached the wild type.

There is little likelihood that these three mutants are in any way allelic. The three possible heterozygotes among them are all wild-type, and they (at least yg_2 and yg_6) appear to recombine freely. It is possible, however, that yg_2, yg_5, and yg_6 may be duplicate pleiotropic genetic units, whose manifold effects upon the tomato include at least the following:

a. a severe reduction in total chlorophyll content
b. an alteration of the normal ratio of chlorophylls a and b, with chlorophyll b becoming proportionally reduced
c. an increased accumulation of free glutamic acid

The percentage of increase (I) or decrease (D) from wild type of optical density readings for glutamic acid.[1]

	LINE 018 MUTANTS	
af - I - 5.7	li_3 - D - 5.7	pg_3 - I - 8.6
li - D - 5.7	md^3 - D - 14.3	yg_5 - I - 40.0
li_2 - I - 11.4	pg_2 - D - 20.0	yg_6 - I - 17.1
	KOKOMO MUTANTS	
pg - D - 50.0	yg_3 - - - 0.0	$(328)^2$ - D - 41.2
sy - - - 0.0	yg_4 - D - 35.3	$(338)^2$ - D - 44.1
	MUTANTS OF LINES 215, 226	
nd - D - 34.5	yg_2 - I - 65.5	

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1. obtained by paper chromatographic separation of free amino acids present in tomato leaf material
2. no gene symbol as yet assigned

Chmielewski, T. M., and C. M. Rick

Lycopersicon minutum. Several accessions have been received of a new entity among wild tomatoes, which we provisionally label L. minutum. This name was selected because this form is diminutive in most respects. All collections conform to the following description: Stems slender, copiously branched. Internodes rather elongate. In keeping with other tomato species, the foliage has a distinctive odor, in this instance suggesting burnt cheese. Leaves interrupted pinnate, but much less divided than those of most spp., in the size range of L. peruvianum var. humifusum, pseudostipules lacking. Leaf segments long petiolate, their margins serrate or undulate. Racemes simple without basal bracts. Pedicels often subtended by bracts, especially the basal one. Flowers small and inconspicuous, corolla 12 mm. or less broad. Style scarcely exserted. Fruit spherical, about 8 mm. diameter, minutely puberulent, whitish green at maturity with two darker green, sometimes purplish, radial stripes. Seeds small, about 1.5 - 2.0 mm. x 1.0 mm., broadly oblanceolate, hairy. All parts puberulent and glandular, but without large trichomes. The plants are highly self-fertile and set fruit abundantly in the greenhouse. In the field, and to some extent in the greenhouse, the plants are subject to severe wilting and collapse as if highly susceptible to vascular wilt diseases.

L. minutum is known from few localities: San Rafael and Chavinillo (Huánuco), Abancay (Apurimac), PERU. That these sites lie on the eastern slopes of the Andes is of special interest, for all other green-fruited tomato species occur west of the continental divide.

In two separate series of tests conducted in the greenhouse in different seasons of the year, crosses were attempted between L. minutum and representative forms of all other available tomato species and closely related species of nightshade. The only successful combinations were the following: L. minutum x L. esculentum and reciprocal; L. esculentum var. minor, L. pimpinellifolium, and L. hirsutum f. glabratum, all x L. minutum but not reciprocals; and L. minutum x S. pennellii, but not reciprocal. Seed yields were nearly normal in the first listed cross, but considerably reduced in the other combinations. Crosses with L. peruvianum, chilense, and hirsutum typ. failed, although combinations with L. minutum as female parent often yielded fully developed fruits with aborted ovules.

Hybrids with L. esculentum, L. esculentum var. minor, and L. pimpinellifolium were normal, vigorous, and fully fertile. Meiosis examined in the esculentum-minutum hybrid was normal. Hybrids with L. hirsutum f. glabratum were subject to withering of the stems as also manifest in hybrids between this species and L. esculentum. Meiosis was normal but fertility reduced. Hybrids with S. pennellii were normal, vigorous, but with fertility reduced to the same extent as in the esculentum-pennellii combination.

Segregations were tested in F_2 for a_1, hl, c, d_1, l_1, and Wo received from the esculentum parent. In all cases recessive phenotypes were deficient, often significantly so. A recombination BC test was made with the a_1-hl markers of chromosome 11. The individual segregation of the two genes was normal, but recombination in the hybrid (6.33%) was considerably lower than that of the control (11.04%).

The acquisition of L. minutum is of interest in several respects. As a source of germplasm for genetic and breeding studies it should prove a useful addition, for it clearly belongs with members of the esculentum complex and gene transfers to L. esculentum should not prove difficult. Taxonomically it is anomalous. According to the monographs by Luckwill and Muller it should belong with species of Eriopersicon, yet its genetic affinities are clearly

with Eulycopersicon. The need for a revision of the subgenera is therefore evident. The status of L. minutum itself is problematic. Like L. pimpinellifolium, it behaves genetically like a variety of L. esculentum, yet all three are separated from each other by large morphological hiatuses.

Clayberg, C. D. Inheritance and linkage of fruit stripe, Fs. One characteristic of most or all species of Lycopersicon subgenus Eriopersicon is a dark green striping originating at the point of stylar attachment on the ripe fruit and extending a variable distance towards the stem end of the fruit. The number of stripes on a fruit equals the number of locules and they are opposite each other in arrangement. The pigment of the stripe is located in the epidermis. Upon backcrossing this trait from L. hirsutum f. glabratum (C. M. Rick, Baños strain) into L. esculentum, we found that its inheritance is determined by a single dominant gene. In a predominantly L. esculentum background, fruits, in addition to having the stripes at the mature green stage of development, are highly pigmented, similar to hp fruits. When the fruit ripens, the stripes disappear completely or leave short yellow lines at the stylar end. It has not been possible to distinguish phenotypically Fs/Fs from Fs/+ plants. A marked and irregular deficiency of Fs plants has occurred in some backcross and selfed progenies, and an attempt to determine the cause of this is underway. However, lines have been obtained which are segregating in a regular fashion, and linkage data for these are presented here.

Family No.	Type	Marker "m"	++	+m	Fs +	Fs m	Adjusted contingency Chi-square	CO
1	BC-C	u	0	28	31	0	54.97**	0
2	BC-C	u	2	33	23	0	46.65**	3 ± 2.2
3	BC-C	u	0	24	36	0	55.91**	0
4	F_2-C	u	0	20	36	0	51.17**	0
5	F_2-C	u	1	12	42	3	33.75**	7 ± 3.5
1	BC-C	t	5	23	20	11	11.40**	
2	BC-C	t	7	28	15	8	10.30**	
3	BC-C	t	8	16	30	6	13.42**	
4	F_2-C	t	12	8	31	5	3.68*	
5	F_2-C	t	7	6	31	14	0.439	

All five families confirm a tight linkage of u and Fs. The cross-over values were calculated by the maximum likelihood method, which also gives a combined best estimate of linkage value for u - Fs of 2 ± 1.2. The heterogeneity χ^2 for this estimate equals 39.27 and is significant ($\chi^2_{.05} = 9.49$, d.f. = 4), indicating that the five families are not segregating in the same ratio. Nevertheless, the estimate provides the best value for predicting future linkage results. Although u and t are both on chromosome 10, the progenies were too small to reveal gene sequence. The five families, which came from three sibling BC_4 plants in the previous generation, were also all segregating for a_1, e, mc, wf, and y. None of these five markers provided significant contingency χ^2 values with Fs except for family 5, where a_1 gave an adjusted $\chi^2 = 4.60$. To conserve space none of the other values are presented here, although they are available to interested parties.

The striped fruit phenotype in L. hirsutum f. typicum (PI 127826) appears to be determined also by Fs or an allele of it. The following BC_3 family has been grown.

Progeny	Fs++	+ut	Fs u t	+++	Fs + t	+u+	Fs u +	++t
BC_3-C	54	46	0	4	12	23	0	0

The adjusted contingency χ^2 for Fs-u is 120.40 and for Fs-t is 27.05. The linkage value for Fs-u is 3 ± 1.5 which compares favorably with the combined best estimate previously obtained. These data also indicate a gene sequence of Fs - u - t.

Dempsey, W. H., and J. E. Boynton

Effect of time of day on controlled pollinations.

A preliminary test to investigate effects of various environmental factors on pollination yielded such striking results that they are considered worthy of presentation here.

On August 2, 1961, isolated Pearson (ms_2) and San Marzano (ms_7) plants supplied by C. M. Rick were hand pollinated every three hours for 24 hours in the field at Davis. Sixteen flowers for each of three crosses (P x P, SM x SM, P x SM) were pollinated with pollen that was collected the morning of the test and stored under favorable conditions in gelatin capsules. Pollen germination and rate of pollen tube growth were measured in all treatments by collecting 2 styles from each of the crosses at 6, 9, and 12 hours after pollination and observing pollen tube fluorescence by Martin's technique (TGC 9:38). Ten pollinations thus remained in each treatment, and at fruit maturity determinations were made for fruit number, weight, seed weight, and ripeness. Temperatures in the field on the day of treatment varied from a high of 91° at 5 PM to a low of 50°F at 7 AM. This range of temperatures is a few degrees below that of an average day at that time of year.

Both pollen tube growth and pollen germination were greatly reduced during the midnight-to-6 AM period. While pollen tubes were able to grow to the base of the style in 6 hours during the day and evening, 12 hours were required during the early morning hours. In the P x SM cross, two to three times as many pollen grains germinated as compared with the P x P or SM x SM pollinations. Also, the rate of pollen tube growth, particularly during the critical early morning period, was much more rapid than in the case of the hybrid combination.

		P x P			P x SM		
Time	Temp. at 5 ft. level °F	Number of ft. per 10 poll'ns	Mean ft. wt. gms.	Mean wt. seeds per ft. gms.	Number of ft. per 10 poll'ns	Mean ft. wt. gms.	Mean wt. seeds per ft. gms.
12 N	73	9	123	0.15	8	239	0.62
3	86	10	127	0.13	7	257	0.58
6	91	6	148	0.19	9	206	0.52
9	74	5	64	0.07	10	138	0.27
12 M	60	2	95	0.10	5	200	0.39
3 PM	54	2	85	0.12	6	135	0.24
6	52	5	94	0.08	7	111	0.15
9	60	1	3	0	8	190	0.37

The pollen tube results were borne out by the fruit-set and seed-set information presented in the above table.

In the P x P data the strong effect of environmental conditions at night, causing the reduction in pollen germination and tube growth, is reflected in reduced fruit and seed set. To some extent, this reduction was overcome in the hybrid cross, but the decrease at night is still clearly discernible. The SM x SM data are similar to those for P x P.

An interesting side observation to the experiment was the striking difference in maturity noted among the fruits. The fruits of the hybrid combination were notably earlier in maturity as measured by color. This metaxenia was possibly due to the greater number of seeds which these fruits contained and consequently increased metabolic activity of the fruit tissues. Also noteworthy is the strong correlation between number of seeds per fruit and size of fruit, the latter evidently being a function of the former.

Frankel, Rafael Tomato inheritance punch card. A simple hand sorted selection punch card was developed (see inserted sample specimen). It was found, that the manual punch card system overcomes the inconvenience of searching for information recorded in tabulations and field books when the number of lines in a breeding program passes the 200 mark. It is suggested that TGC members adopt a standard punch card for tomato breeding material, which might accompany material exchanged between members. The purpose of this note is to arouse interest in this idea, and gather suggestions for an improved design of such a standard punch card.

In the card used by the author, recorded information can be selected for by manual separation of any combination of cross reference of the following:

1. Varieties, lines, or hybrids - by direct code.
2. Years grown - with years designation (13 years) - by direct code.
3. Fruit rating: Shipping quality - 4 grades.
   Processing quality - 4 grades with purpose designation.
   Organoleptic rating - 4 grades with type designation.
   - all by direct code.
4. Fruit shape - 6 shapes - by numerical code.
5. Days to maturity (in 10-day graduations) - by direct code.
6. Days to peak yield (in 20-day graduations) - by direct code.
7. Locule number (2,4,6,7 locules) - by direct code.
8. Plant height in cm. (5 graduations) - by direct code.
9. Disease resistance rating in 7 degrees for 10 diseases - by numerical code.
10. Average fruit weight (in 25 gr. graduations) (back of card) - by direct code.
11. First letter of variety name, line or hybrid designation (back of card) - by alphabetical code.
12. 8 reserve holes for mutually exclusive information in a numerical code from 1-99, or any other arrangement of a key.
13. Genotype of 18 seedling and growth characters, 16 flower and fruit characters, and 6 disease resistance genes - by double-row coding as follows:

Heterozygous = shallow punch = 

Homozygous recessive = intermediate punch = 

Homozygous dominant = deep punch = 

In most selection categories the direct code system was employed in the card in order to facilitate minimum step extraction of cards according to a certain cross reference, and to avoid mutually exclusive classifications.

The card provides space for written information on:
Fruit characters - 27 items
Plant characters - 12 items
Flower characters - 8 items
General characters - 5 items
and for yield data, remarks, and a serial card number.

Griffing, J. B., and J. B. Langridge
Modification of recombination frequency.

Much evidence has accumulated to show that recombination frequency is modifiable by both environmental and genetic factors. The objective of this study, then, was to examine the influence of as many different factors as possible, in the hope of finding some method of increasing recombination frequency. Such a method would aid the plant breeder in overcoming the linkage barrier to the selection of desirable genotypes. Although we found no reliable chemical method of increasing recombination frequency, the methods and substances tested are here summarized in the hope that someone may pursue the subject further.

Since a large scale attack was contemplated, a technique permitting the rapid accumulation of data was necessary. Our approach was as follows:

Two tomato seedling mutants approximately 20 recombination units apart in chromosome 11 were used. These mutants, $\underline{a}_1$ = anthocyanless and $\underline{hl}$ = hairless, can be scored on the hypocotyl a few days after germination. Seeds from plants doubly heterozygous in the coupling phase were placed in petri dishes for germination. The sprinkling of activated charcoal over the seed promoted rapid and almost complete germination. The germinating seeds were then placed in continuous light for the full development of anthocyanin. Scoring by aid of a low power binocular microscope was possible a few days after germination, or, in other words, in a week or so following fruit harvest. The above procedure was extremely efficient in providing a fast method of accumulating a vast amount of data.

1. Distribution of recombination frequency with regard to position of fruit in the plant structure.

The first objective was to examine the pattern of recombination frequencies as it occurs over the developing plant. In both pruned and unpruned plants, recombination frequencies were determined for individual fruits identified as to their origin in terms of clusters and branches. In the unpruned condition, 16,725 observations were taken. Significant differences were found among branches but the pattern of differences was complicated. In plants pruned to yield clusters only on the main stem, a significant negative correlation (based on approximately 10,000 observations) was found for recombination values and cluster number. This decline in recombination frequency, although significant, was not great. All plants in this study were maintained on a high plane of nutrition.

2. The effect of inorganic compounds on recombination.

Test plants were variously treated with EDTA, with foliar sprays of calcium and magnesium, and with nutrient solutions containing different levels of calcium and magnesium. Although over 35,000 seedlings were scored, none of these treatments could be shown to give unequivocal changes in recombination frequency.

In one experiment, the leaves adjacent to the cluster sampled were analyzed for calcium, magnesium, potassium, and sodium. A negative association between sodium and recombination frequency was the only significant result obtained.

The fact that poor nutrition may affect the frequency of recombination was indicated by periodic examinations of a test plant which was grown for over a year. In the absence of additional nutrients, the recombination frequency dropped from over 17 percent to 6 percent in six months. Mineral nutrients were then applied to the pot in which the plant was growing and the recombination frequency soon returned to 12 percent. However, in a further test involving 7,500 observations, foliar spraying with complete mineral solutions did not cause the treated plants to differ significantly from the untreated controls.

3. Effect of chemicals on recombination.

The effects on recombination of 21 chemicals when sprayed on test plants were assessed in a study involving over 27,000 observations. These chemicals (mutagens, hormones, anti-metabolites, metabolic inhibitors, etc.) were chosen for their known pronounced biological activities. A slight apparent increase was caused by IAA and benzthiazole oxyacetic acid. Barbituric acid, streptomycin and ribosenucleic acid lowered recombination frequency.

4. Effect of grafting on recombination.

In an attempt to determine the influence of the root system on recombination, a series of grafting experiments was made which yielded a total of 13,000 observations. The test plants were grafted onto another variety ('Sutton's Best of All'), onto Lycopersicon species (L. pimpinellifolium, L. peruvianum and L. hirsutum), and onto related genera (Capsicum annuum, Solanum tuberosum and Datura stramonium). Grafted and ungrafted controls were included. Grafting of Solanum tuberosum produced the only significant result, which was a pronounced decrease in recombination frequency.

5. Genetic modification of recombination frequency.

The influence of the genetic background on the frequency of recombination between the two test loci was investigated by a series of backcrosses to eight different stocks which included L. pimpinellifolium, several cherry size varieties and several commercial types. After three backcrosses, the frequencies were examined in a study involving 19,671 observations.

It was shown that the different genetic backgrounds produced highly significant modifications in recombination frequencies - from 9.7 percent in L. pimpinellifolium to 21.0 percent in the 'Ponderosa' variety.

6. Summary.

Although this survey involved only a superficial study of an array of potential recombination stimulants, several points emerge:

(1) The frequency of recombination is apparently modifiable by environmental factors (internal agencies producing ageing effects associated with poor nutrition) and also by genetic factors.
(2) The possibility of increasing recombination frequency by the manipulation of environmental stimuli still remains unsolved.
(3) Tomato breeders should maintain crossing material in good nutrition and if possible use flowers from the first cluster.
(4) It might be wise to screen tomato breeding stocks for recombination frequency, and, in the long run, it may be wise to select for increased frequency of recombination.

Hagemann, R. Instability at the yv locus.

By means of X-irradiation a green-yellow variegated plant originated from the tomato variety Condine Red. The mutant line, to which this plant gave rise, consists of seedlings with pure green cotyledons, seedlings with green-yellow variegated cotyledons, and pure yellow seedlings. The variegated seedlings show all gradations of variegation, so that the pure green and the pure yellow seedlings are really the extremes.

The yellow seedlings gradually develop into yellowish-green plants; in the greenhouse they even become light green. They form flowers, but they do not produce seeds after selfing, because they are completely male-sterile.

The green and the variegated seedlings develop into variegated plants with yellow spots or larger sectors on a green background. All gradations of variegation are also found in the foliage leaves. Variegated plants sometimes form pure yellow branches, which are male-sterile just as the yellow plants.

The progenies of variegated plants (both from green and from variegated seedlings) segregate into green, variegated, and yellow seedlings (the sum in 1961: 556 green, 4503 variegated, 1960 yellow seedlings). In the progenies of plants, which had variegated cotyledons, there are, in general, many more yellow (46%) and less green (6%) seedlings than in the progenies of variegated plants which had green cotyledons (24% yellow and 25% green).

The F_1 plants of the crosses
(1) yellow plant x Condine Red,
(2) yellow branch of a variegated plant x Condine Red,
(3) variegated plant x Condine Red and reciprocal,
are pure green.

All F_2 generations of (1), (2), and some of (3) segregate into green and yellow plants (no variegated!). The greater part of the F_2 generations of (3) segregate into green, variegated and yellow seedlings. The proportion between green and yellow resp. between green and (variegated + yellow) corresponds to a monohybrid ratio, but with a deficit of the mutant types, especially of the yellow ones.

Crosses between yellow plants of our mutant line (♀) and the marker stock yv, dl, al, wt (kindly supplied by Watkin Williams) revealed that the yellow plants are homozygous for an allele of yv (Robinson and Rick, 1954), which has been localized in chromosome 6 (IV) (TGC 10:5, 1960). The hybrid is yellow virescent in phenotype and self-fertile.

The following formal explanation is given for the results:

The yellow plants, as well as the yellow branches of variegated plants, are homozygous for the allele yellow virescent^{masculosterilis} (yv^{ms}). The cross yv^{ms} yv^{ms} x + + (= Condine Red) gives green F_1 plants (+ yv^{ms}), and in F_2 there is a segregation into green (+ + and + yv^{ms}) and yellow plants ($yv^{ms}yv^{ms}$) [Cross (1) and (2)].

The variegated plants contain the allele yellow virescent^{mutabilis} (yv^{mut}), which determines green plant color just as +, but mutates in vegetative tissues regularly to yv^{ms}.

Almost all seedlings with variegated cotyledons have developed from yv^{mut} yv^{ms} zygotes. In such cells the mutation of yv^{mut} produces a yv^{ms} yv^{ms}

(yellow) constitution. Whether this mutation causes a yellow spot on a leaf, a larger yellow sector or a pure yellow branch depends upon the developmental stage in which the mutation takes place. Almost all seedlings with pure green cotyledons have developed from $\underline{yv^{mut}yv^{mut}}$ zygotes. Thus two mutational events (in both homologous loci in a cell or its descendants are necessary to produce a yellow spot. This usually does not happen before the leaves are formed. These differences between the two types of variegated plants explain why the first type produces more yellow and less green seedlings in its progeny than the second (as mentioned above).

The cross (3) variegated plant $[(\underline{yv^{mut}yv^{mut}} +) \underline{yv^{mut}yv^{ms}} + \underline{yv^{ms}yv^{ms}}]$ x Condine Red [+ +] gives two types of green F_1 plants. The greater part of the F_2 generations (progenies of + $\underline{yv^{mut}}$ plants) segregates into green, varietaged and yellow seedlings. Some F_2 generations (progenies of + $\underline{yv^{ms}}$ plants) segregate only into green and yellow seedlings.

Within the multiple series at the yv locus there are the following relations of dominance:

$$+ > \underline{yv^{mut}} > \underline{yv} > \underline{yv^{ms}}.$$

The event which underlies the hereditary change, formally called mutation of $\underline{yv^{mut}}$ to $\underline{yv^{ms}}$, may be a

(a) gene mutation,
(b) loss of a part of chromosome 6 (induction of a deficiency),
(c) loss of a fragment, which together with a deficient chromosome 6 gives a normal phenotype (as described in the "flaked" mutant by Lesley and Lesley in Genetics 46:831, 1961). Cytological studies are under way to find out which of these possibilities is realized in the present case.

Hansen, D., C. M. Rick, and J. E. Boynton Linkage tests with mutants of Stubbe group III.

Mutants of this group are being systematically screened for linkages following procedures outlined in previous notes (TGC 10:38; TGC 11:22). Mutants with dependable seedling expression are selected for this study. To date linkages have been encountered for 6 of these mutants. Results of all completed tests between these 6 and a series of testers are summarized with similar results with two mutants of the Stubbe I series in the note by Rick and Martin (p. 43). Segregations for the linked combinations are presented in the following table. Crossover values are given only for the most dependable segregations.

The data permit positioning only for one (spa) of the six mutants. Limited as the data for spa are, its locus must be between dl and l_1. The indicated distances fit surprisingly well with the existing map, but a position for spa midway between the two markers can only be tentative. In the spa-l_1 segregation some doubt existed about the expression of l_1 in the two spa-l_1 segregants; it is possible that no recombinants appeared and that the map distance between the two genes might be considerably less than estimated. Obviously much more needs to be done here, and spa will be entered in multipoint tests. Stocks of these mutants and pertinent segregating progenies have been transmitted to cooperators in charge of the respective chromosomes.

Combination	+ +	+ t	m +	m t	Adjusted contingency Chi-square	co.	Mean co.
bip-d_1	293	114	119	27	4.63		
	178	62	62	5	9.31		
	211	98	78	1	29.11	11.5	
gri-e	299	119	130	20	12.87	37.0	
id-a_1	214	103	97	15	14.20	34.5	29.5
	242	104	71	3	20.36	21.0	
	194	104	97	15	17.25	33.0	
mu-c	274	108	78	0	25.47	0-8	
oli-H	179	81	80	8	15.67		
	229	84	66	1	18.98	14.0	
spa-l_1	182	102	58	2?	23.41	17.0	
spa-dl	157	72	40	1	13.39	16.0	

Joubert, T. G. la G. A new jointless gene, j_2^{in}.

This new jointless gene (j_2^{in}) was first reported in TGC 11:13. It differs from j_1 and j_2 in that it shows a normal pedicel joint, but the abscission layer is absent in the mature stage. This jointless condition is delayed until the fruits reach a fair stage of enlargement. It is associated with leafiness, but in most of the cases examined this leafiness is also delayed and only found on the third or fourth truss on the plant. When crossed with normal jointed varieties j_2^{in} behaves as a monogenic recessive. It behaves as a dominant when crossed with j_1 and j_2.

The results of a few crosses are given below:

No.	Cross	F_2 segregation +	j_2^{in}	j_1	j_2
1	j_1 x j_2^{in}	13	58	22	--
2	j_2^{in} x j_1	28	95	30	--
3	j_2 x j_2^{in}	2	59	--	22
4	j_2 x j_2^{in}	0	94	--	23
5	+ x j_2^{in}	77	25	--	--

These data show recovery of + phenotypes in the F_2 of j_1 x j_2^{in}; whereas, with few exceptions, none are recovered from the F_2 of j_2 x j_2^{in}. The new mutant thus appears to be a new and different allele of j_2 and is assigned the symbol j_2^{in} for jointless-2 with incomplete action.

If the pedicel joint of j_2^{in} plants are examined in F_2, a variation in the degree of woodiness of the abscission layer is quite obvious. Plants with slightly, moderately and very woody abscission layers are present. Selections of these different types in F_2 segregated in F_3 as follows:

Cross	Character selected in F_2	F_3 segregation		
		+	j_2^{in}	j_1
j_2^{in} x j_1	Slightly woody	21	35	4
j_2^{in} x j_1	Moderately woody	4	78	0
j_2^{in} x j_1	Very woody	1	73	1

Kerr, E. A. Another virescent gene. What shall we call it?

A virescent mutant arose in 1957 as a single plant in a breeding line derived from Fireball x (Oxheart-Pritchard-L3700II-Red Jacket). Under winter greenhouse conditions the new leaves are pale but frequently the mutants are indistinguishable from normal under summer conditions in the field. Growth and fertility are normal. F_2 populations give good 3:1 ratios. Preliminary tests indicate that there is no close linkage with a, ag, c, d, e, l_1, mc, r, sp, t, tf, u, wf, y, or yv. Further tests are being made with genes on chromosome 2 as there was a slight suggestion of linkage with d.

In preliminary tests to establish that this is a new mutant, it has been designated as vir I5, i.e., a virescent mutant from the breeding line I5. However, vir is not an acceptable symbol for this gene as it has previously been used for viridis--a dark green mutant with third-order leaf divisions. The symbol v was used for a virescent mutant in 1933. This mutant apparently was semi-lethal and has been lost. The present mutant is definitely not a mimic of v. In many respects it resembles op and t^v. It may resemble dis, luc, va, or ver but these have not been compared.

The system of gene symbolism is becoming too complex. Many genes that are mimics or have similar phenotypes have been given dissimilar designations. The following genes all give green-stemmed plants: a, ae, af, ag, ah, ai, al, ao, and aw. The following have third-order leaf divisions: vir, tp, ff and a new mutant which we are now testing. A host of mutants have "light-green", "yellow-green", "gray-green", and "pale-green" foliage.

The work of establishing the linkage relationships in specific chromosomes has been assigned to specific people. I propose that, as soon as possible, we do something similar in naming new mutants and in re-naming many of the old ones. To this end a committee--possibly the committee on nomenclature--could assign one or two people to compare all present and future mutants of, for example, one of the following: stem growth, leaf color, leaf shape, flower characters, fruitfulness, mature fruit characters. These people would then be in a position to clarify the designation of mutants and could either assign names and symbols for mutants or at least make recommendations for their naming.

The symbol v_2 has been tentatively assigned to this mutant (Ed.).

Kerr, E. A. Light green-5, a second marker for chromosome 5.

This mutant was first noticed in the spring greenhouse crop of 1959 in a line derived from PI#126954 (L. pimpinellifolium) x (Vetomold-L. hirsutum) outcrossed four times to Tuckqueen. It has normal fertility and almost normal growth. As it closely resembles lg_1 on chromosome 10, the gene symbol lg_5 is proposed. One

F_2 population with the marker c d gs h j_1 r gave 250+ : 63 lg_5, i.e., a slight deficiency of lg_5 plants. No linkage was indicated with c d h j_1 or r but a crossover value of 12 was obtained with gs (++166 : +gs 84 : lg_5 + 62 : lg_5 gs 1). This indicates that we now have a second gene on chromosome 5. As it can be easily classified shortly after the plants are set in the field, it should prove useful as a marker for this "neglected" chromosome.

The F_1 of lg_1 x lg_5 is normal and 4 small F_2 populations gave 81+ : 52 lg. No extremely pale plants were noted. This suggests that the homozygote lg_1 lg_5 is lethal or that there is reduced viability.

A small repulsion F_2 with marker LA159 (a e mc t u wf y) gave unexpected results. It produced 44+ : 11 lg_5 : 4 yellow-green. The yellow-green plants had normal growth and fertility and proved to be homozygous recessive. Preliminary F_2 tests indicate that this yellow-green phenotype is the homozygous double recessive of lg_5 and a hypostatic gene from LA159.

Lesley, J. W. Recombination data with blue-green (be). Blue-green described in Genetics 41:575 (1956) and in Am. Jour. Bot. 45:598 (1958) is associated with a short inversion in a chromosome not yet identified. Blue-green is not easily recognized in the greenhouse at temperatures ranging from 65° to 85°F but at Riverside, California, is easily identified by plant size and color after a few weeks growth in the field. It tends to wilt more than normal sibs but is quite fruitful. Blue-green is less easily identified in combination with genes affecting plant size and green color so that such data are less reliable. The following F_2 data suggest independent recombination but may help in future linkage studies. Seed of blue-green is available from TGC sources. Ratio +:be was $\frac{1}{3.3}$.

Combination		Phase	++	+t	m+	mt	χ^2_L	Ref.
m	t							
be	j	C	96	28	42	10	0.4	
		R	60	27	9	13	0.5	
be	sn	R	76	34	31	12	0.1	TGC 11:15, 1961
be	d	R	149	40	48	28	7.9	contrary to phase
be	c	C	36	9	11	7	2.7	
		R	102	33	26	9	0.02	
be	sp	R	18	4	6	4	2.0	
be	r	R	70	15	14	5	0.8	
be	l	R	65	21	19	6	0.0	
be	a	R	68	21	8	14	11.5	contrary to phase
be	y	R	70	25	20	3	0.1	
be	al	R	39	8	6	5	3.4	contrary to phase

Lesley, Margaret M. Change of fragment size in "flaked" variegation (submitted by J. W. Lesley).

It was reported (J. W. and M. Lesley, Genetics 46:831-844, 1961) that "Flaked" plants have either one or two minute extra chromosome fragments. A lightly flaked plant with one, and a moderately flaked plant with two, much larger extra fragments have been found in plants derived from selfing flaked. When these two extra fragments are present at diakinesis or M_1, they show a definite attraction for one another, but close pairing is rare. As a consequence their orientation on the spindle is erratic, and occasional loss of one or both fragments should occur. At pachytene two short extra rods are easily demonstrated but they are rarely closely associated. When only one such fragment is present it shows a strong tendency to associate with a pair of chromosomes, possibly number eleven. A dimorphic pair may result in which the centromere of one member is increased in length and has a large pycnotic body at its center. This pycnotic body is nearly the size of the free fragment. It may also be attached to a whole chromosome (No. 11?) by one slender strand. A drawing of this chromosome at pachytene measures 5 inches in length; the free fragment only measures three sixteenths of an inch. In one cell at pachytene a clear ring was found in addition to 12 pairs. This ring might have originated from two breaks near the centromere, one on either side of the central pycnotic body in the heteromorphic pair. Both rings and telocentric rods-fragments have been described as giving rise to larger or smaller fragments.

Lyall, L. H. Necrotic (ne) phenotypes in crosses with the Atom variety.

Atom tomato is a very early type with a small determinate plant and has the ability to flower and set its small fruit under cold temperatures.

At Ottawa in 1961 F_2 progenies from 3 crosses, each with the variety Atom as one parent, segregated for ne in the proportion of 13 normal : 3 necrotic plants as follows:

Cross	Normal	Necrotic	P. for 13:1 ratio
0.60M x Atom	120	30	0.7
0.60R x Atom	99	21	0.5 to 0.7
0.60D x Atom	126	23	0.3

The expression of ne requires the presence Cf_2 (C. fulvum resistance) and necrotic plants should be $Cf_2/-$ ne/ne. The gene ne is carried by most varieties of L. esculentum and it would appear that Cf_2 must be carried by the Atom variety.

Atom was originally obtained by us from Thomas Cullen & Sons, Witham, Essex, England.

Mathan, D. S., and R. F. Stettler Age of seed effect in homozygous lanceolate seedlings.

As previously reported (Science 131:36-37) La+ plants, upon selfing, segregate typically 1 normal: 2 lanceolate: 1 homozygous lanceolate, the latter class often being somewhat deficient. In the early stages after germination two distinct forms can be recognized among

the LaLa genotypes, i.e.,"modified" and "reduced." Later on, some of the "modified" seedlings often give rise to "narrow" plants while others never develop beyond a short first leaf. "Reduced" plants, on the other hand, always remain a short cylindrical stub without a trace of cotyledons or plumule. (For further description of these phenotypes see the Science paper.) Earlier data had suggested that the proportion of "reduced" plants among LaLa genotypes was a function of age of seed. To further investigate this question several large seedlots were extracted from the same culture and then aged under normal storage conditions. At various intervals, samples were taken and either dissected or germinated in sterile petri dishes.

Except for ++ and La+,which could not be distinguished from each other, all phenotypes could be recognized clearly in dissected seed. Moreover, there was a close agreement between data from dissection and data from germination of seed drawn from the same lot, which indicated that the germination process did not induce any significant shift in the relative frequency of the types distinguished. Careful scrutiny under the dissecting scope revealed an additional form among LaLa seedlings characterized by incomplete reduction of the single cotyledon. Since these "almost reduced" seedlings invariably behaved like truly "reduced" ones in their subsequent development they were included in the latter group for means of comparison. Preliminary data are summarized in the table below:

Segregation of phenotypes in progenies of selfed La+ stored for various lengths of time.*

		Period of seed storage			
		32 days	119 days	154 days	190 days
++ and La+		158	447	786	680
LaLa	non-reduced	36	86	106	75
	reduced	10	70	139	121
Total		204	603	1031	876
Reduced in % of all LaLa		22	45	57	62

*In each lot all seeds were analyzed; those which failed to germinate were dissected and classified.

The data clearly indicate an increase of the fraction of "reduced" seedlings with length of seed storage. Moreover, this conclusion is supported by similar observations in related but different cultures of the same line. Hence, during the process of aging some of the "modified" seedlings seem to be converted into "reduced" ones. This conversion is presumably the result of a process by which the single cotyledon of the "modified" is progressively absorbed. The various intermediate forms observed are assumed to represent different stages in the sequence of this process. More critical techniques are presently being devised to subject this phenomenon to a closer examination.

Mauli, Chandra, and N. K. Notani

A survey of naturally occurring seedling mutations in the tomato populations around Bombay.

Progenies from 45 tomatoes collected from the local market were screened for pollen sterility, chromosomal aberrations, aneuploidy and gene mutations. Although a great deal of variation for pollen sterility was observed, no chromosomal aberrations or extra chromosomes could be detected. However, one line clearly segregated for a chlorophyll deficiency which seemed simply inherited. Assuming complete self-pollination and a gametic mutation rate of μ ($\underline{A} \rightarrow \underline{a}$), the probability that a homozygous diploid individual will become a heterozygote through the mutation of one of the two alleles is 2μ in any generation. Since the proportion of heterozygotes in a selfing population is halved in each generation, the proportion of heterozygotes due to mutation pressure in such a pure line is (Haldane, J. B. S., 1936, J. Genetics 32:375-391):

$$2\mu \left(1 + \frac{1}{2} + \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^3 \ldots\ldots\ldots\ldots\right) = 4\mu \ldots\ldots(1)$$

If the mutant gene is lethal in homozygous condition, a heterozygote on selfing will produce $\frac{1}{3}$ AA + $\frac{2}{3}$ Aa. Therefore, the proportion of heterozygotes due to recurrent mutations in a selfing population is:

$$2\mu \left(1 + \frac{2}{3} + \left(\frac{2}{3}\right)^2 + \left(\frac{2}{3}\right)^3 \ldots\ldots\ldots\ldots\right) = 6\mu \ldots\ldots(2)$$

Assuming even the highest rate of natural mutation known in plants, that for R locus in maize of 5×10^{-4}, the number of heterozygotes expected would be $4 \times 5 \times 10^{-4}$ or 1 in 500 plants, which is still about one-eleventh of what is observed here. It appeared, therefore, that this might be fortuitous.

A second collection was, therefore, made from Panvel, a place about 40 miles from Bombay. 151 progenies from single fruits were screened and two mutations, one for much reduced anthocyanin (segregation 21 wild: 7 reduced anthocyanin) and another one for hairlessness (23 wild: 8 hairless), segregated out. This gives an average gametic mutation rate of about 1 in 38 for the two viable mutations and 1 in 8 for the lethal mutation--an extremely high mutation rate (two populations considered different). It is possible that the apparently high mutation rate is due to often cross-pollination in tomato under these conditions.

Notani, N. K. Probable genetic location of the centromere on the linkage map of chromosome 8 in tomato.

Genetic location of the centromere on the linkage map of chromosome 8 in tomato was attempted. The method relied on the chance generation of a secondary trisome from a primary one, resulting in the altered segregation of the gene markers borne on the two chromosomal arms. Stocks with three markers, dl (dialytic), bu (bushy) and l_1 (lutescent) were crossed to the primary trisome 8. The genetic map positions of the three markers are as follows: dl at 40, bu at 49 and l_1 at 76. From four F_2 progenies over 1600 seedlings were classified for the three markers. Results are relatively consistent from progeny to progeny and there is no evidence of any marked imbalance of the ratios which would indicate that a secondary trisome had been generated (Table 1). Frequency of dl seems to be very high as is somewhat true for other markers also, but it is extremely unlikely that this is indicative of any telocentric or an isochromosome in as much as all the four progenies seem consistent in this respect.

The classification, taken singly, of the markers is as follows: dl 23.73%, bu 15.22% and l_1 17.51%. This relative segregation seems to be obtained consistently from progeny to progeny. Consequently, it seemed tempting to assume that the segregation of these markers (from a trisome) is proportional to their distance from the centromere. Advantage was taken of the fact that the known genetic data impose a constraint and specify the gene order with bu as the middle gene. Thus the centromere can take only four positions: 1) Sfa dl bu l_1, 2) dl Sfa bu l_1, 3) dl bu Sfa l_1, 4) dl bu l_1 Sfa (Sfa abbreviation for Spindle Fibre Attachment).

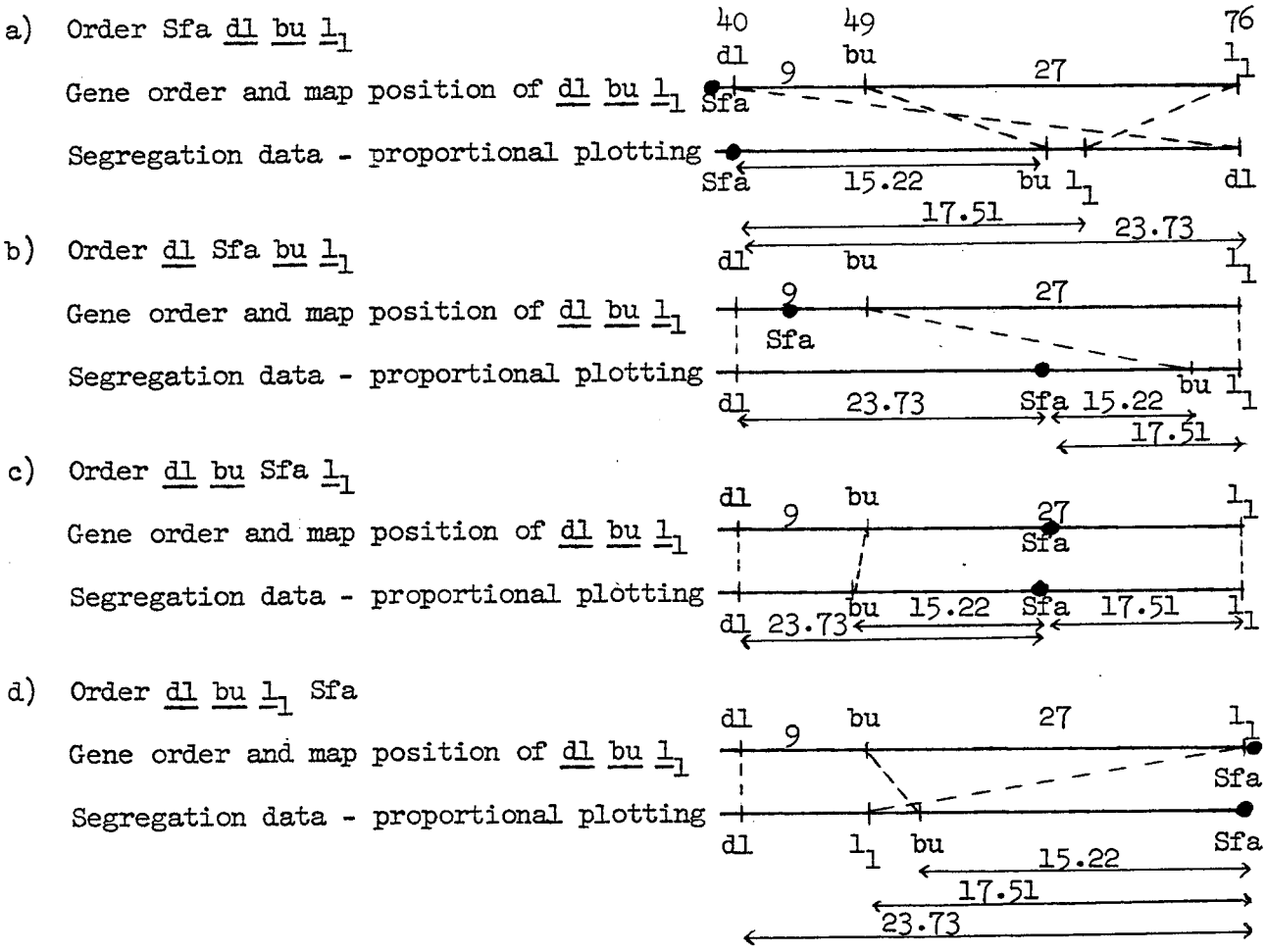
Thus it can be seen that the order Sfa dl bu l_1 is not possible because dl segregation should then be the lowest being nearest to the centromere. The second possible order dl Sfa bu l_1 is also not likely because the genetic distance between dl and bu is 9 map units, with segregations of 23.73% and 15.22% respectively, whereas l_1 with over 27 map units gives a segregation of only 17.51%. The third order dl bu Sfa l_1 seems to satisfy the genetic data and the segregation data. With 27 map units distributed over bu Sfa l_1 (segregation respectively 15.22% and 17.51%) and with dl 9 units distal to bu, it can be seen that both the segregation data and the proportionality data are satisfied. The fourth possible order - dl bu l_1 Sfa - is excluded by a similar argument that l_1 being nearer to the centromere should give a smaller proportion than bu which is contrary to what is observed here. Thus the position of the centromere seems to be between bu and l_1 with centromere slightly nearer bu than l_1 (See Fig. 1). It should, however, be emphasized that proportions of all three markers are far too numerous even when one considers maximum random chromatid segregation, the reason for which remains obscure. The data are, however, meaningful if the legitimate assumption is made that the double reduction is proportional to the distance of a gene from the centromere and that the total segregation is the sum of a proportionality component and a constant component. Also, these deductions do not consider any localized interference phenomena or changed dominance relationships.

Proof for this could come from an experiment in which a multiple linked recessive stock is crossed on to an 'asynaptic' plant (but having the wild type genotype for other markers). If the asynaptic generates an isochromosome or a telocentric, the F_1 plant should have the phenotype of some of the recessive markers, owing to the loss of the chromosomal arm that carried the dominant wild type markers. The F_1 screening can be done phenotypically and the presumable isochromosome or telocentric carrying plants can be confirmed cytologically.

Table 1. Segregations observed in the F_2 of the cross Triplo 8 x dl bu l_1

Plant No.	+ + +	dl + +	+ bu +	+ + l_1	dl bu +	+ bu l_1	dl + l_1	dl bu l_1	Total
3 - 1	337	71	27	36	14	39	13	9	546
3 - 2	87	26	9	14	5	7	2	3	153
3 - 3	253	73	17	38	5	14	7	1	408
3 - 4	239	119	49	41	7	31	19	10	515
Total	916	289	102	129	31	91	41	23	1622
% of Total		23.73	15.22	17.51					

Fig. 1.



(Grateful thanks are due Prof. C. M. Rick for his encouragement and for help given by way of materials and consultation in doing this problem.)

Prend, J. Effect of gibberellin upon male sterile plants of $\underline{ms}_{23}$ Early Pak.

Since gibberellins are known to induce flowering in a variety of plants including staminate flower formation in gynoecious cucumber, interest was focused here on the possible effect of this substance on genetically male sterile plants.

In preliminary tests conducted during the summers of 1960 and 1961, an application of potassium giberellate (Gibrel, a solution of potassium gibberellate, Merck) in concentration of 250 ppm made upon male sterile plants of $\underline{ms}_{23}$ Early Pak (kindly made available by Dr. C. M. Rick) caused considerable elongation of the style and also appeared to have stimulated parthenocarpic fruit formation.

The chemical was applied early in August and late in July respectively, in 1960 and 1961 upon 3 and 5 male sterile plants at a rate sufficient to wet the plants with no excess to drip off. An equivalent number of plants were left untreated. In about 7 to 10 days following the application, style elongation approaching nearly twice the length of those untreated was observed on flowers of all treated plants. This condition prevailed for about 5 to 6 days and flowers developing after that period appeared to be normal.

Summary of Fruit and Seed Production

Year	No. of Parthenocarpic Fruit per Plant		No. of Fruit per Plant With One or More Seeds	
	Treated	Untreated	Treated	Untreated
1960	9.0	1.9	0.0	1.7
1961	15.4	1.4	6.0	6.6

The fruit set examined later in the season revealed that the number of parthenocarpic fruit on the treated plants was considerably higher than the number on the untreated. The recorded number of seed-bearing fruit (apparently the result of natural cross pollination) on the treated plants showed no increase over the untreated. While gibberellin increased the length of the style, it evidently did not restore self fertility.

Rick, C. M. Inheritance and linkage relations of compact, cpt.

Discovered as an unfruitful plant (2- 377) in the variety XL Pearson, this mutant has consistently shown the same features in several seasons of field culture. Although few fruits were set on the source plant, they were moderately seedy, and all cultures planted from this source have bred true for the following phenotype. The plant differs strikingly from normal in its assuming a uniformly compact mound of growth. Unlike the typical straggly growth of a tomato plant, the periphery of cpt plants in midseason is smooth and well rounded. This compactness is vested in a slower rate of growth and marked increase in degree of branching. The main branches of the plant produce laterals from nearly every leaf axil; scores of shoots can be counted in the periphery of growth. In spite of its slower growth rate, cpt exceeds normal in total growth by virtue of its not being impeded by heavy fruit set.

Leaves of cpt are so different from normal in color and form that they alone are sufficiently diagnostic for accurate field identification. Leaf color deviates in a yellow-green direction. Leaves are smaller, have fewer small segments and, as a result of foreshortening of the main axis, the segments are brought into closer approximation, lending a unique appearance to the plant. Stems are more lax and leaves more limp, imparting a soft texture to the plant.

Flowers and fruits are modified little or none in cpt. Pollen is abundant and the cause of unfruitfulness is unknown. Plants set about 5% of a normal fruit load. Attempts to identify cpt in the seedling stage have been unsuccessful.

Outcrosses to normal have yielded only normal plants. Segregation in nine F_2 families from crosses to different lines shows normal monogenic recessive inheritance (Total of 9 families : 1212 + : 386 cpt; $\chi^2 = 0.57$, $p > 0.3$; Het. $\chi^2 = 13.54$, 8 df, $P > 0.05$). Linkage tests with 16 markers are summarized in the accompanying table. Chi-square tests were made only for data sets that show marked deviations in the direction of linkage.

Significant deviations are revealed for dl, l_1, H, and tf. Those for dl and l_1 are mutually confirmatory, while those for H and tf are on the borderline of significance. Moreover, the linkage with dl and l_1 was confirmed by trisomic segregation in triplo-8 (75 2N+:3 2Ncpt:24 tr-8+:1 tr-8 cpt), while

the trisomic segregations for chromosome 7 (47 2N+: 12 2Ncpt: 24 tr-7+: 7 tr-7cpt) and chromosome 10 (36 2N+: 13 2Ncpt: 6 tr-10+: 2 tr-10cpt) discounted the possibility of a linkage with either H or tf. A locus for cpt on chromosome 8 is therefore a certainty. The linkage data fit reasonably well with the existing map, yielding the following relationship: $\frac{dl}{40}$ - 11 - $\frac{cpt}{51}$ - 26 - $\frac{l_1}{77}$.

Tester		+ +	+ t	cpt +	cpt t	Adj. con. Chi-square	Co.
a_1	F_2-R	160	63	53	24		
ah		169	62	61	22		
au		213	49	45	13		
c		153	70	56	21		
d_1		95	42	14	8		
		161	62	63	14		
dl		153	77	83	1	32.648	11
e		182	61	55	20		
j_1		184	59	60	15		
l_1		157	66	72	5	15.655	26
H		168	75	62	13	4.588	
r		162	53	58	15		
rv		216	27	65	10		
tf		185	77	53	5	9.685	
wf		182	61	52	23		
y		170	45	54	19		
yv		184	46	73	11		

Rick, C. M. Inheritance and linkage relations of Hirtum, Hrt.

Hirtum is characterized by a striking increase in the density of large trichomes on stems and peduncles. The hairiness is so dense in field-grown plants that the stems have a fuzzy appearance. Unlike Wo and its alleles, Hrt has leaf hairs that do not seem to be modified. Other manifestations of Hrt have not been detected. Attempts to distinguish it in the seedling stage have not been successful. Two sources are known for Hrt: (1) LA501 a single spontaneous rogue encountered in experimental plantings at Shafter, California; (2) LA393 a primitive cultivated tomato purchased in the market at Chiclayo, Peru. All of the 4 F_1 plants from a cross between these two lines and all of the 58 F_2's showed the same hairy phenotype, thereby revealing an allelic relationship between the responsible genes of the two. Plants of F_1 Wo^m x Hrt from both sources showed intermediate phenotype for both genes and the F_2 showed independent segregation for both, 5/83 plants being of normal phenotype in respect to both characters.

Crosses between Hrt and + yield hybrids that are noticeably hairier than normal and F_2 segregation in 8 families provides a good fit to monogenic expectations when hairy is classified against normal (692 Hrt: 220 +; $\chi^2 = 0.33$, $p > 0.5$; $\chi^2_{het} = 9.54$, 7 df, $p > 0.2$). Distinguishing between Hrt and Hrt/+

in these families has thus far not been successful, although gradations in the degree of excess hairiness are evident. Extensive linkage tests have not been attempted, but a cross intended to combine Hrt with La revealed the following interesting relationship:

	+/+	Hrt/+	Hrt/Hrt
+	3	5	13
La	22	36	2

Although these are small figures and the separation between Hrt/+ and Hrt/Hrt is debatable, the test for independence in a 2 x 3 table gives a chi-square of 30.83, which is very highly significant. This indication of linkage with La is currently being tested by a cross between Hrt and La-deb.

Rick, C. M. New male-sterile mutants.

Following past practice, we have been investigating new male-sterile mutants only when they appear in new varieties or present some features of unusual interest. Of the four mutants reported here, ms_{30} in San Marzano and ms_{35} in A-1 are reported because they differ in interesting ways from mutants previously reported in those varieties, and ms_{33} and ms_{34} constitute the first male-sterile mutants of the variety VF-11 Pearson. The symbol ms_{30}, previously applied to a mutant of A-1, is reassigned to the new mutant of San Marzano for the following reasons. In the two seasons following its introduction, the original ms_{30} proved undependable because it produced variable amounts of fertile pollen and selfed seeds. Unquestionably a hereditary defect exists in this line, but it clearly is not a male-sterile mutant. Unless some interest should develop in this mutant (2-443) it will not be reassigned a symbol but will be kept in the inactive list.

As in the past, it is assumed that the new mutants reflect different genes than those reported previously for the following reasons. The phenotype of ms_{30} is completely different from any previously described mutant and therefore must represent a new mutation, most likely at a new locus. The same reasoning applies to ms_{35}. For the mutants in VF-11 there can be no dispute concerning their recent origin because they were discovered in this variety only four generations subsequent to the original single plant selection. Since they differ from each other in drastically different phenotypes, it is also likely that they represent mutants at new and different loci. Previous allele testing with the San Marzano series revealed all completely male-sterile mutants to be non-allelic.

It is interesting to note that two different mutants were found in the new variety VF-11 in 1959, when no more than four generations, and possibly only three, had intervened since the original single plant selection originating this variety. Since no sterile plants had appeared in the second generation it follows that the mutations giving rise to these new mutants must have occurred at some time during development of the second or third generations. A third sterile plant had been found at the same time with phenotype identical with that of ms_{34}, its F_2 segregating for the same phenotype. Although their identity has not been proved, it is very likely that both original plants had the same mutant gene and were segregants from the same original mutation. The chances for such repeated recovery would be much greater in such a recent variety, in which only a limited number of plants sired the examined population.

Descriptive information for these new mutants is presented in the following table. From the standpoint of ease of identification and exposure of stigma, all four mutants are satisfactory for hybridization. Within the limits of a single season's data, the seed yields indicate normal fertility for $\underline{ms}_{33}$ and $\underline{ms}_{35}$ and reduced fertility for the other two mutants, qualifying the former pair as better parents for large-scale crossing.

Mutant	Acc. no.	Variety	Flower size	Percent flowers with exposed stigmas	Stamens	
					Color	Size and Shape
ms_{30}	2-455	San Marzano	Much reduced	100	greenish to pale yellow	highly modified; very slender, seldom connate; anther tube spreads basally
ms_{33}	2-511	VF-11	Normal but distorted	100	green or slightly yellow	highly modified and irregular; basally expanded but distally filamentous; some anthers connate and aften adnate to style
ms_{34}	2-513	VF-11	Normal	100	paler; comparable to corolla color	short, shrivelled, and partially dialytic basally
ms_{35}	2-517	A-1	Smaller than normal	100	paler; comparable to corolla color	uniformly very much reduced; usually connate; slender symmetrical tube

Mutant	Time of breakdown	Meiosis	Contents of mature anther	Additional features
ms_{30}	early prophase of meiosis	early stages appear abnormal	empty	very low female fertility
ms_{33}	early prophase of meiosis	early stages appear abnormal	empty	distorted gynoecium
ms_{34}	tetrad and early microspore	normal but possibly delayed	empty PMC; disintegrating tetrads; rare stainable pollen grains	subnormal female fertility
ms_{35}	prophase to metaphase I; rarely telo. II	disintegration in first division	empty	

Data on inheritance are presented in the next table. The segregations for $\underline{ms}_{34}$ border on significance for a deficiency of recessives. Within the limits of the small populations, all other segregations fit monogenic expectations.

Mutant	Family number	Generation	+	ms	Total
ms_{30}	60L1069	F_2	22	8	30
	61L1172	BC	12	17	29
ms_{33}	61L1175	F_2	22	8	30
	61L1638	F_2	104	36	140
	Total		126	44	170
	Expected			42.5 ± 6.1	
ms_{34}	61L1176	F_2	25	4	29
	61L1177	F_2	23	6	29
	61L1639	F_2	90	21	111
	Total		138	31	169
	Expected			42.25 ± 6.0	
ms_{35}	61L1178	F_2	25	5	30
	61L1639	F_2	88	28	116
	Total		113	33	146
	Expected			36.5 ± 5.3	

Rick, C. M. New mutations at old loci. Since the last list was issued (TGC 8:31) five new instances have been discovered of independent appearances of previously known mutants. In each instance the new mutant was found in material so completely unrelated to the original source that it is either impossible or highly unlikely that the same two deviants had a common origin. The allele tests prove a common locus although they do not prove that the new allele is necessarily identical with the original one.

ag (LA422). The entire population of an accession native to Cristobal Island, Galápagos completely lacked anthocyanin. In contrast to typical ag, no anthocyanin was observed at any stage of development. Test crosses with a_1 and aw yielded normal progeny, but the cross with ag produced 26 greenstem seedlings.

e. A broad-leaved line was received from Dr. H. B. Cordner of Oklahoma State in 1959. He had received it in turn from his brother-in-law, who had discovered it as a variant of the var. Big Boy growing at Orem, Utah. In the seedling stage it resembles both c and e, but in later development it resembles the latter to a greater extent by its waviness of the midvein, tendency of lower segments to webb with the midvein, and other leaf distortions. Hybrids with c gave only normal seedlings, but the cross with an e stock gave 5 seedlings with undivided leaves of the e phenotype.

ff (2-505). In searching a field of V-San Marzano-A (a selected line not yet introduced) our attention was attracted to a partly fruitful plant with distinctive foliage. The leaf shape of this plant and of its progeny was remarkably similar to that of filicifolium. An allele cross between the

two lines yielded a progeny of 21 seedlings, all with ff phenotype. Numerous plants of the same phenotype, therefore likely allelic to ff, have been encountered subsequently in the same variety, suggesting that the new mutation occurred in an early generation of the seed increase of this new line.

l_1 (2-491). This variant was found as an off-type in the variety Roma by Mr. Melvin Zobel. According to his description and our experience with progeny of the original plant, foliage is yellow, more intense in older leaves, stigmas lack chlorophyll, and fruits have less pigment at all stages. Our suspicions that this might be an allele of l_1 were confirmed by the lutescent phenotype of all nine plants in the progeny of a test cross. The more extreme phenotype of the new mutant suggests that it might represent a different allele. This possibility will be tested with F_2 segregation.

ps (2-471). Discovered as a highly unfruitful plant in variety San Marzano, this mutant proved identical with the original ps in every aspect of floral structure. It bred true from the seeds that had been naturally set. With very few exceptions, it has been our experience that mutants that are identical in a specific phenotype turn out to be allelic. It is therefore very likely that in 2-471 we are dealing with another appearance of ps, adding San Marzano to the list of varieties--John Baer and Pearson--in which this mutation has spontaneously occurred.

Rick, C. M., and W. H. Dempsey

Trisomic segregations for cm.

Recent trisomic segregations are of interest in respect to the genes cpt and cm. Since data for the former are given in the note concerning segregation and linkage relations of that gene, they need not be repeated here. Figures allegedly locating cm on chromosome 11 were presented in TGC 9:42. Difficulties were encountered in the classification of cm, and it was difficult to account for the appearance of a high proportion of cm/cm/cm triplo-11 individuals. The data for cm-triplo-11 are presented again herewith because an error was made in reporting them; an additional family is also reported for this combination. In the meanwhile data, also included below, have been secured showing significant deviations in the direction of trisomic segregation for cm in triplo-10.

Family	Chromosome	Phenotype	2N	2N+1	Total
57L78-80	11?	cm+	209	73	282
		cm	32	4	36
58L285	11?	cm+			130
	Seedling	cm			29
59L466	11?	cm+	89	22	111
		cm	9	0	9
59L66	10	cm+	67	26	93
		cm	14	0	14
59L464	10	cm+	77	25	102
		cm	17	0	17

In the above figures only the family 59L466 gives a strong trisomic ratio, yet all families deviate significantly from normal inheritance and the absence of trisomic cm segregants is suggestive. It is interesting to note that simultaneous segregations in trisomics for other chromosomes tended to yield more than the expected proportion of cm (1958 data: 74+:50 cm/, 103+:51 cm/, 107+:69 cm/, 139+:80; 1959 data: 71+:29 cm). Heterozygous expression of cm

might account for such excessive frequencies of cm. Whatever the explanation, the control results contrast sharply with those for triplo-11? and triplo-10. Although the data are not unequivocal, they strongly suggest that cm was located on the extra chromosome in both trisomics.

The presence of cm on chromosome 10 and 11? fortifies the suspicions that the latter is not a primary trisomic. In many progenies of 11? we have also observed a **fair** frequency of triplo-10 and a few of triplo-7, suggesting that 11? might be a tertiary with parts of 7 and 10 constituting the extra chromosome. Until recently, however, we could not confirm this cytologically. In new smears made in 1961, however, this material reveals an occasional pentavalent. The rarity of such configurations might result from an unequal interchange between 7 and 10.

Evidence from radiation-induced deletions (Genetics 46:1231-1235, 1961) clearly established that chromosome 11 carries linkage group V. Since earlier trisomic tests between triplo-11? had not given trisomic ratios for genes of group V, triplo-11? cannot be triplo-11. All of this information is therefore compatible in establishing the linkage group for chromosome 11 and suggesting that triplo-11? is a tertiary trisomic with the extra being an interchange between 7 and 10. Bona fide triplo-11 is being sought in our material and a number of likely candidates in the progeny of triploids are being investigated.

Rick, C. M., and F. W. Martin

Continued linkage tests with mutants of Stubbe's group I.

Linkage tests have been continued, following the same procedures reported in TGC 10 and 11. Two new linkages have been encountered. Results of all completed tests between these and an assortment of markers are given in the following table. Linkages are indicated by L, suggested but non-significant indications of linkage by S, and no significant departures from random recombination by X. In order to conserve space, data for the last two categories are not presented but records are kept for anyone who might want them. Of special interest in this tabulation is the linkage of flavescens with both y and pr. Since these results have been confirmed in several independent tests, pr and fla must be on chromosome 1, providing better seedling markers for that chromosome. The following tabulation also summarizes tests with six mutants of the Stubbe III series (see note by Hansen, Rick, and Boynton).

Linkages with Dr. Stubbe's mutants detected in 1961

		Mutants							
		Stubbe I		Stubbe III					
Testers	Ch's'm	def	fla	bip	gri	id	mu	oli	spa
a_1	11	X	X	X	X	L	X	X	X
ah	9	X	X	X	X	X	X	X	X
au	1			X	S			X	
c	6	L	X	S	X	X	L	X	X
d_1	2	X	X	L	X	X	S	X	X
dl	8	X	X	X	X	X	X	X	L
e	4	X	X		L		S	X	X
H	10		X	X	X			L	
l_1	8	X	X		X		X	X	L

(cont. on next page)

Linkages with Dr. Stubbe's mutants detected in 1961 (cont.)

		Mutants							
		Stubbe I		Stubbe III					
Testers	Ch's'm	def	fla	bip	gri	id	mu	oli	spa
La	?	X	X	X		X	X	X	
pr	1?	X	L						
r	3		X						
rv	?		X						
sf	?		X						
tf	7		X	X	X			X	
w_4	?		X						
Wo^m	2				X				
y	1		L						
yv	6	L		X	X	X	X	X	

Segregation data for the linked combinations are presented below. Data for the fla-pr were given in TGC 11:23.

Combination	+ +	+ t	m +	m t	Adj. cont. chi-square	co.
def - c	132	33	31	3	1.68	37.0
def - yv	47	22	21	0	7.22	0-20.0
	117	45	50	2	11.79	21.5
fla - y	22	9	8	1	0.43	
	Selected for y		26	1	5.44	
	46	23	15	1	3.47	24.0

Stocks of these mutants and pertinent segregating progenies have been transmitted to cooperators in charge of the respective chromosomes.

Smith, P. G. Linkage with the Tm_2 gene.

Selfed populations of lines supposedly having the linkage between the Tm_2 and nv genes broken (Clayberg, C. D., TGC 11) yielded 0 to 2 per cent virescent plants. None of these lines were homozygous Tm_2/Tm_2, but segregated in approximately a 2:1 ratio for TMV resistance.

It would appear that the presumed broken linkage is instead an added lethal factor, the cause of which has not been determined. Because of this, however, breeding programs using the presumed broken linkage lines should be reassessed in the light of the above information.

Snoad, B. Pachytene chromosomes and the linkage maps.

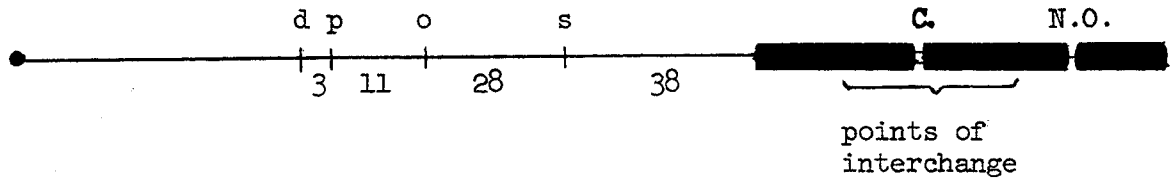
A comparison of the genetic activity of the euchromatin and heterochromatin of tomato chromosomes is being attempted by means of X-ray-induced interchanges. The chromosomes involved in each interchange are identified at pachytene, the point of interchange plotted and the linkage between this point and selected genes is then estimated.

Pollen treated with 4000r was used to produce 490 plants of which 24 were subsequently determined to have interchanges. In only two of these plants had an interchange taken place in the euchromatin.

Seven plants, each with an interchange in the heterochromatin of chromosome 2, have been used in test crosses. Linkage between d, p, o, s and the points of interchange was determined. The results show that there is no direct relationship between linkage values and the physical distance between a gene and a point of chromosome breakage in the heterochromatin. For example, the linkage value between T (the point of interchange) and s remained reasonably constant around 38 units although the physical distance varied considerably in these seven plants.

As crossing-over probably does not occur in the heterochromatin the linkage values must be assumed to measure the distance between the genes and the point on the chromosome at which euchromatin is replaced by heterochromatin.

Thus the map of chromosome 2, from my figures, appears to be:



An interchange between chromosomes 1 and 2 has brought about linkage between y (on chromosome 1) and s (on chromosome 2). It would seem that y is only 13 units from the heterochromatin in the long arm of chromosome 1 and it will be interesting to find out where br and Cf_1 are situated in relation to the centromere considering that each is some 30 units either side of y.

It is hoped that other interchanges in the euchromatin will be isolated so that a more accurate idea of the relationship between a chromosome, as seen at pachytene, and the linkage map may be obtained. Meanwhile chromosomes other than number 2 will soon be under test.

Stettler, R. F. Dosage effect of the lanceolate gene. In a study investigating morphogenetic effects of the La gene ++ and La+ sister plants of isogenic background were treated with colchicine. Suspected tetraploid shoots were subjected to pollen analysis and chromosome counts, and only verified inflorescences were selected for reciprocal crosses (LaLa++ x ++++). Excessive flower drop and a Fusarium outbreak reduced the number of successful crosses drastically. Two progenies with a total of 20 individuals were recovered and germinated. They were classified as 3 normal plants with compound leaves, 4 plants with simple leaves and 13 plants with clearly intermediate phenotype. The segregation ratio was fairly close to expectation on the basis of either chromosome or chromatid segregation. The third and later leaves of the 13 intermediate plants were compound with 2 lateral leaflets and a proportionally long terminal leaflet in contrast to the relatively short terminal and 4 laterals of the normal tetraploid (++++). The new segregants are, therefore, considered to be of La+++ genotype subject to verification by breeding tests. These findings do not agree with those reported by L. Monaco in TGC 11, 1961, according to which the La+++ genotype was supposed to have the characteristics of the normal tomato leaf.

Further evidence for the dosage effect of La was recently found when a triploid seedling, confirmed by chromosome counts, arose spontaneously in the progeny of a selfed La+ plant. Its leaves showed a range of variation between the phenotypes of LaLa++ and La+++, and it is, therefore, assumed to be La++. This hypothesis is now being tested.

Thompson, A. E. A new unstable chlorophyll mutant.

A new unstable chlorophyll mutant was found this year that resembles ghost (gh), but is not nearly as extreme in its expression. The seed came from an amateur "Luther Burbank" residing near Chicago, and the original parentage of the mutant is unknown. Inheritance studies and tests for allelism with gh are in progress. It is very likely a recessive since plants of the F_1 between two normal lines and the mutant are normal in all respects. The cotyledons appear normal, but small albino sectors of a superficial nature may usually be detected on the first true leaves. The terminal growing point does not progress continually toward a more extreme expression of albinism as is usually observed with ghost. Both white and yellow phase albino sectors on leaves and stems have been observed. The albino sectors are well expressed in the greenhouse during the winter months, but surprisingly good vegetative growth is maintained. Normal or near normal male and female fertility has been observed. Flowers and fruits occasionally show a few light green sectors, but apparently normal development of carotenoid pigments occurs. Plants transplanted and grown in the field during the past summer were nearly normal in all respects. Small albino sectors were found only on the first true leaves. Classification of segregating material under field conditions may prove to be difficult. Ghost plants also tend to fare better during late spring, summer, and early fall thus extending the similarity between ghost and the new mutant.

Fruits from plants of the mutant grown in the field were analyzed for total carotenoid pigments and carotene in comparison with three normal varieties and one high-pigment line. Fruits were harvested at the turning stage and ripened for 14 days in an air-conditioned chamber at 65° ± 1.5°F. Measurements of total carotenoids and carotene were made using the spectrophotometric method of McCollum.

Variety	Total	Carotene	T/C	Hunter a/b
Acc. 387	5.54	0.46	12.04	1.86
Garden State	6.02	0.24	25.08	1.94
Kc 109	6.26	0.27	23.19	1.99
Kc 146	6.52	0.46	14.17	2.05
1252-102 (hp/hp)	12.76	0.58	22.00	2.48

The data indicate that the new mutant (Acc. 387) contains slightly less total carotenoid pigments than the normal varieties. At this time it is not known if the apparent reduction in total carotenoids is caused by the mutant character. Work is currently in progress to determine if higher than normal levels of colorless carotenoids are metabolized as is the case with ghost.

PART II

DIRECTORY OF MEMBERS

Abdel-El, Zidan E., Dept. Vegetable Crops, N. Y. Agric. Expt. Station, Geneva, N.Y.
Alexander, L. J., Dept. Botany and Plant Pathology, Agric. Expt. Station, Wooster, Ohio
Alvarez, Eduardo, Rockefeller Foundacion, Londres 40, Mexico 6, D.F., Mexico
Andeweg, J. M., Institute of Horticultural Plant Breeding, 15 S. L. Mansholtlaan, P.O. Box 16, Wageningen, Holland
Andrus, C. F., U.S.S.E. Veg. Breeding Laboratory, Box 3348, St. Andrews Branch P. O., Charleston, South Carolina
Associated Seed Growers, Inc., P. O. Box 6, Milpitas, California
Barham, W. S., Sunspiced Vegetables, Inc., Vacaville, California
Barnes, G. S. C., Box 105, Aguirre, Puerto Rico
Beadle, G. W., University of Chicago, Chicago, Illinois
Beckett, Jack B., Dept. Agronomy, University of Illinois, Urbana, Illinois
Bergh, B. O., Citrus Expt. Station, University of California, Riverside, California
Berry, Stanley, 538 I Street, Davis, California
Bessey, Paul M., University of Arizona Research Laboratory, Box 631, Mesa, Arizona
Bishop, Charles J., Genetics and Plant Breeding Research Institute, Central Experimental Farm, Ottawa, Canada
Bohn, G. W., Torrey Pines Horticultural Field Station, Box 150, La Jolla, California
Boynton, John E., Dept. Vegetable Crops, University of California, Davis, California
Brauer, Oscar, Am.Pfingstanger Nr. 49, Göttingen, Germany
Brock, R. D., Div. Plant Industry, C.S.I.R.O., P. O. Box 109, Canberra, Australia
Broertjes, C., Tomato Mutation Breeding Group, Institute for Atomic Sciences, Postbus 48, Wageningen, Netherlands
Brown, Ralph T., Plaquemines Parish Expt. Station, Rt. 1, Port Sulphur, Louisiana
Brown, Walter N., Dept. Horticulture, Ohio State University, Columbus, Ohio
Burdick, Alan, Dept. Biological Sciences, Purdue University, Lafayette, Indiana
Burgess, David E., Burgess Seed & Plant Co., Galesburg, Michigan
Burnett, John H., Dept. Botany, University of St. Andrews, St. Andrews, Fife, Scotland
Butler, L., Dept. Zoology, University of Toronto, Toronto 5, Canada
University of California, Genetics Department, Berkeley 4, California
Cannon, O. S., Dept. Botany and Plant Pathology, Utah State University, Box 85, Logan, Utah
Casseres, E. H., c/o Rockefeller Foundation, Londres 40, Mexico 6, D.F., Mexico
Castronovo, Alfonso, Instituto de Fitotecnia, Castelar, Argentina
Chambers, Miss E. V., Ministry of Agriculture, Room 222, Stormont, Belfast, N. Ireland
Chiasson, Leo P., Dept. Biology, St. Francis Xavier University, Antigonish, Nova Scotia
Chiscon, J. Alfred, Dept. Biological Sciences, Purdue University, Lafayette, Indiana
Chmielewski, Tadeusz, Institute of Genetics, Polish Academy of Sciences, Skierniewice, Poland
Chroboczek, Emil, Zaklad Warzywnictwa, Instytutu Uprawy, Nawzenia i Gleboznawstwa, Skierniewice, sk. poczt. 69, Poland

Ciccarone, Antonio, Instituto di Patologia vegetale, Facolta di Agraria, Bari, Italy
Clayberg, Carl, Dept. Genetics, Agric. Expt. Station, P. O. Box 1106, New Haven, Connecticut
Condit, Alson, W. Atlee Burpee Co., R.F.D. 1, Box 191, Santa Paula, California
Cornell University, Albert R. Mann Library, Ithaca, New York
Costa, A. S., Instituto Agronomico, Campinas, Est. S. Paulo, Brazil, S. A.
Creech, Roy G., Dept. Horticulture, Pennsylvania State University, University Park, Pennsylvania
D'Cruz, Rui, Botany Section, College of Agriculture, Poona 5, India
C.S.I.R.O., P.O. Box 109 City, Canberra, A.C.T., Australia
C.S.I.R.O., Commonwealth Research Station, Merbein, Victoria, Australia
Cottrell-Dormer, W., Dept. Agriculture, Samarai, Papua, New Guinea
Curme, John H., P. O. Box 215, West Chicago, Illinois
Currence, T. M., Div. Horticulture, University of Minnesota, Saint Paul, Minnesota
Darby, L. A., Glasshouse Crops Research Institute, Littlehampton, Sussex, England
Daubeny, Hugh A., Department of Agriculture, Experimental Farm, Agassiz, B.C., Canada
Dean, Donald S., Biology Dept., Baldwin-Wallace College, Berea, Ohio
Dempsey, Wesley, Dept. Biology, Chico State College, Chico, California
Denby, Lyall, Experimental Station, Summerland, Dom. B. C., Canada
Dennett, R. K., Alpha Seeds, Box 1042, Lompoc, California
Dias, Marcilio, Instituto de Genetica, Escola Superior de Agricultura, Piracicaba, Est. de Sao Paulo, Brasil
Dolan, D. D., Regional Coordinator, NE-9, Seed Investigations, Agric. Expt. Station, Geneva, New York
Downes, J. D., Jr., Horticulture Dept., Michigan State University, East Lansing, Michigan
Elle, George O., Dept. Horticulture, Texas Technical College, Lubbock, Texas
Emery, George C., Dept. Biology, Brookhaven National Laboratory, Upton, Long Island, New York
Epps, W. M., Dept. Botany and Bacteriology, Clemson College, Clemson, South Carolina
Everett, H. L., Dept. Plant Breeding, Cornell University, Ithaca, New York
FAO Library, United Nations, Via della Terme di Caracalla, Rome (8-47), Italy
Flory, Walter S., Jr., Blandy Experimental Farm, Boyce, Virginia
Foskett, R. L., Dept. Horticulture, Colorado State University, Fort Collins, Colorado
Francis, F. J., Dept. Food Technology, University of Massachusetts, Amherst, Massachusetts
Frankel, Rafael, Agricultural Experiment Station, Rehovot, Israel
Frazier, W. A., Dept. Vegetable Crops, Oregon State College, Corvallis, Oregon
Gabelman, W. H., Dept. Horticulture, University of Wisconsin, Madison 6, Wisconsin
Gallegly, M. E., Dept. Plant Pathology and Bacteriology, West Virginia University, Morgantown, West Virginia
Garber, E. D., Dept. Botany, University of Chicago, Chicago 37, Illinois
Gentile, Adrian, Dept. Vegetable Crops, University of California, Davis, California
Gilbert, J. C., Dept. Vegetable Crops, Agric. Expt. Station, Honolulu, Hawaii
Gowen, Fred A., Hillside Farm, Stratham, New Hampshire
Graham, K. M., Dept. Agr. Research Station, P. O. Box 280, Fredericton, N. Br., Canada
Graham, T. O., Dept. Field Husbandry, Ontario Agricultural College, Guelph, Ontario, Canada

Grant, W. F., Dept. Genetics, McGill University, Macdonald College P.O., Quebec, Canada
Greenleaf, W. H., Dept. Horticulture, Alabama Agric. Expt. Station, Auburn, Alabama
Gries, Mary L., 11110 S. Wallace Street, Chicago 28, Illinois
Gyorffy, Barna, Institute of Genetics, Herman Otto ut 15, Budapest, Hungary
Hafen, Leslie, Dept. Horticulture, Purdue University, Lafayette, Indiana
Haigh, J. C., National Vegetable Research Station, Wellesbourne, Warwickshire, England
Hall, R. J., Libby, McNeill & Libby, Chatham, Ontario, Canada
Hanna, G. C., Dept. Vegetable Crops, University of California, Davis, California
Hansen, David E., Casa de los Amigos, Ignacio Marescal 132, Mexico 1, D.F., Mexico
Hardin, M., Geary, Oklahoma
Hardon, Jaap, Dept. Vegetable Crops, University of California, Davis, California
Hargrave, P. D., Provincial Horticultural Station, Brooks, Alberta, Canada
Harrison, A. L., Plant Disease Laboratory, Rt. 3, Yoakum, Texas
Haskell, Gordon, Genetics Dept., Scottish Horticultural Research Institute, Mylnefield, Invergowrie by Dundee, Scotland
Helsel, Paul E., Asgrow Seed Co., 202 Walcaid Building, Bradenton, Florida
Henderson, Warren R., Dept. Horticulture, North Carolina State College, Raleigh, North Carolina
Hoadley, Alfred D., Campbell Soup Co., Napoleon, Ohio
Hepler, Roger W., California Packing Corporation, 850 Thornton Street, San Leandro, California
Hepler, Paul R., Dept. Horticulture, University of Maine, Orono, Maine
Hepner, Leon W., 617 College Drive, Starkville, Mississippi
Hikida, H. R., Dept. Botany and Plant Pathology, Oregon State College, Corvallis, Oregon
Hildering, G. J., Laboratory of Genetics, Agricultural University, 53 Generaal Foulkesweg, Wageningen, Netherlands
Höjby, H., Bohemia, Flat 405, 631 Church Street, Arcadia, Pretoria, South Africa
Holl, Lawrence A., Libby, McNeill & Libby, Leipsic, Indiana
Honma, Shigemi, Dept. Horticulture, Michigan State University, East Lansing, Michigan
Hood, Kenneth J., Dept. Horticulture, Ohio Agric. Expt. Station, Wooster, Ohio
Hornby, C. A., Dept. Horticulture, University of British Columbia, Vancouver, Canada
Hu, C. C., Dept. Horticulture, National Taiwan University, Taipei, Taiwan, China
Huang, Han, Dept. Horticulture, National Taiwan University, Taipei, Taiwan, China
Hudson, L. W., Regional Plant Introduction Station, Box 148, C. S., Pullman, Washington
Huxley, Peter, Makerere College, P. O. Box 262, Kampala, Uganda, Africa
Instituto de Ecologia, Esperimentation Agricola, Caixa Postal 1620, Rio de Janeiro, Brazil
Jacoby, Daniel, 383 Andrews Road, East Williston, Long Island, New York
Jenkins, J. A., Dept. Genetics, University of California, Berkeley, California
Jensma, J. R., Bruinsma's Selectiebedrijf, Middelbroekweg 10, Naaldwyk, Holland
John, C. A., H. J. Heinz Co., Bowling Green, Ohio
John Innes Horticultural Institute, Bayfordbury, Hertford, Hertfordshire, England
Johnson, Kenneth W., Dept. Horticulture, Purdue University, Lafayette, Indiana
Johnston, R. E., States Experimental Farm, Howard Davis Farm, Trinity, Jersey, C.I., Great Britain
Joubert, T. G., Pretoria Horticultural Research Station, P. O. Box 994, Pretoria, Union of South Africa
Jucci, Carlo, Centro di Genetica, Istituto di Zoologia, Universitá Pavia, Pavia, Italy
Kadinopoulos, Costas D., 10 Kastoros Street, Thessaloniki, Greece

Kamimura, Shoji, Horticultural Division, Tohoku National Agricultural Expt. Sta., Shimokuriyagawa, Morioka, Iwate, Japan
Kedar, N., Faculty of Agriculture, P. O. Box 12, Rehovot, Israel
Kemp, G. A., Experimental Station, Department of Agriculture, Lethbridge, Alberta, Canada
Kerr, E. A., Horticulture Experimental Station, Vineland, Ontario, Canada
Khush, Gurdev S., Dept. Vegetable Crops, University of California, Davis, California
Kihara, H., Kihara Institute, Mutsukawa, Minami-ku, Yokahama, Japan
Kim, Dong Woo, Seoul Branch, National Institute of Horticulture, 43-1 Hikyong-Dong, Dongdaemoon-ku, Seoul, Korea
King, Ray, Agricultural Extension Service, 203 Post Office Building, San Jose 13, California
Kloz, Josef, Czecoslovac Academy of Sciences, Biological Institute, Na cvicisti 2, Prague 6, Czechoslovakia
Lambeth, Victor N., Dept. Horticulture, University of Missouri, Columbia, Missouri
Lamm, Robert, Lomma, Sweden
Larson, R. E., Dept. Horticulture, Pennsylvania State University, University Park, Pennsylvania
Laumont, Professeur, chef du Service de l'experimentacion Agricole, Maison Carreé, Alger, Algerie
Lawrence, C. W., c/o Miss A. P. King, Office of the Scientific Attache, British Embassy, 1907 K Street, N.W., Washington 6, D.C.
Lesley, J. W., Dept. Horticulture, Citrus Experiment Station, Riverside, California
Lindgreen, P., H. P. Lindgreen's Enke, Stollig nr. Aabenraa, Denmark
Locke, L. F., S. Great Plains Field Station, Woodward, Oklahoma
Lorenz, LeVern, Isabella, Oklahoma
Lyall, L. H., Genetics and Plant Breeding Research Institute, Research Branch, Canada Agriculture, Central Experimental Farm, Ottawa, Canada
MacFarland, C. S., Jr., American Tomato Yearbook, 8 Elm Street, Westfield, New Jersey
Madill, H. D., Smithfield Experimental Farm, Canada Dept. Agriculture, RR #4, Trenton, Ontario, Canada
Maliani, Cirillo, Federazione Italiana dei Consorzi Agrari, Via Curtatone 3, Casella Postale 2-463 AD, Rome, Italy
University of Manitoba, Library, Reference Department, Winnipeg, Canada
Marchesi, Giuseppe, Istituto di Genetica Vegetale, Fac. di Agraria, Universita Cattolica del S. Cuore, Piacenza, Italy
Mariota-Trias, F., College of Agriculture, Mayaguez, Puerto Rico
Martin, Frank W., Fed. Exp. Station, Mayaguez, Puerto Rico
Martin, Mark W., Botany Department, Utah State University, Logan, Utah
Marx, G. A., Dept. Vegetable Crops, Agricultural Experiment Station, Geneva, New York
Mathan, David, Dept. Genetics, University of California, Berkeley 4, California
Matsumura, Seiji, National Institute of Genetics, Nisima, Sizuoka-ken, Japan
Maurer, A. R., Ministry of Agriculture, Samaru, Zaria, Northern Region, Nigeria
McGuire, D. C., Dept. Vegetable Crops, Agricultural Experiment Station, Honolulu 14, Hawaii
Michigan State University, Library Department, East Lansing, Michigan
Mohamed, Mohamed Abdel Maksoud, Faculty of Agriculture, University of Ein Shemes, Kuba Palace, Cairo, Egypt
Meddens, J. J., Nunhem's Zaden, Haelen, Netherlands
Menzel, Margaret Y., U. S. Dept. of Agriculture, Florida State University, Tallahassee, Florida
Mertens, Thomas R., Dept. Science, Ball State Teachers College, Muncie, Indiana
Mikell, J. J., Dept. Horticulture, Agricultural Experiment Station, Baton Rouge 3, Louisiana
University of Minnesota, Agriculture Library, St. Paul 1, Minnesota

Mishanec, William, Division of Vegetable Crops, Agric. Expt. Station, Geneva, New York
Moore, John F., Campbell Soup Co., Ltd., Box 458, Cooksville, Ontario, Canada
Munger, H. M., Dept. Plant Breeding, Cornell University, Ithaca, New York
National Science Foundation, Program Director for Genetic Biology, Washington 25, D.C.
Nickeson, Richard L., Agric. Research Dept., Campbell's Soups Ltd., King's Lynn, Norfolk, England
Nishi, Sadao, Dept. Vegetable Crops, Horticulture Research Station, Hiratsuka, Kanagawa Pref., Japan
Nonnecke, I. L., Experimental Station, Lethbridge, Alberta, Canada
Noonan, John C., Sub-Tropical Experimental Station, Rt. 1, Box 560, Homestead, Florida
Notani, N. K., Biology Division, AEET, Richardson & Cruddas Building., V Floor, Byculla, Bombay 8, India
Odland, M. L., Dept. Horticulture, Pennsylvania State University, University Park, Pennsylvania
De Oliveira Nunes, Waldyr, Rua Baratta Ribeiro 668 apto. 301, Rio de Janeiro, Brazil
Orton, E. R., Dept. Horticulture, Rutgers University, New Brunswick, New Jersey
Ounsworth, L. F., Experimental Station, Box 247, Harrow, Ontario, Canada
Paddock, Elton F., Dept. Botany, Ohio State University, Columbus, Ohio
Palenzona, Domenico, Istituto di Genetica, Universita di Pavia, Via Sant' Epifanio 14, Pavia, Italy
Pearson, O. H., Seed Research Specialists, Waldo-Rohnert Co., Hollister, California
Pecaut, P., Station d'Amelioration des Plantes, Domaine St. Maurice, Montfavet (Vse) France
Persson, Arnulf R., Institute of Vegetable Crops, Agricultural College of Norway, Vollebekk, Norway
Peirce, Lincoln C., Dept. Horticulture, Iowa State College, Ames, Iowa
Perlasca, Gerardo, Campbell's Soups S.P.A., Felegara, Parma, Italy
Perry, B. A., Texas Agricultural Experiment Station Substation 19, Crystal City, Texas
Peto, Howard B., Peto Seed Co., P. O. Box 138, Saticoy, California
Piovano, Abelardo, CIRIO, San Giovanni A Teduccio, Naples, Italy
Pollack, B. L., Blake Hall, Rutgers University, New Brunswick, New Jersey
Poole, D. Donald, Hunts Foods and Industries, Inc., Rt. 1, Box 151, Holtville, California
Pratt, David, 5 Rue Carteret, Geneva, Switzerland
Prend, J., Crop Research Department, H. J. Heinz Co., Bowling Green, Ohio
Proefstation voor de Groeten en Fruitteelt onder Glas, Naaldwijk, Netherlands
Pryke, P. I., Dept. Agriculture, Plant Breeding Laboratory, Burnley Gardens, Swan Street, Burnley, E.I., Victoria, Australia
Puerto Rico Agricultural Experiment Station, Librarian, P. O. Box 516, Rio Piedras, Puerto Rico
Purdue University AES Library, AES Building, Lafayette, Indiana
Relyea, K. E., Farmer Seed & Nursery Co., Faribault, Minnesota
Reynard, G. B., Campbell Soup Co., Riverton, New Jersey
Richardson, R. W., Jr., Rockefeller Foundation, Londres 40, Mexico 6, D.F., Mexico
Rick, C. M., Dept. Vegetable Crops, University of California, Davis, California
Robinson, R. W., Dept. Vegetable Crops, Agricultural Experiment Station, Geneva, New York
Rockefeller Foundation, Agricultural Library, Londres 40, Mexico 6, D.F., Mexico
Roever, W. E., Dept. Horticulture, University of Tennessee, Knoxville, Tennessee

Sang, Yu Tian, C. A. Men's Dormitory, University of the Philippines College, Laguna, Philippines
Sarma, V. S., Bose Research Institute, 93/1 Upper Circular Road, Calcutta, India
Sathianswasti, Wattana, Dept. Horticulture, Kasetsart University, Bankok, Thailand
Sawant, Anand C., Dept. Zoology, Michigan State University, East Lansing, Michigan
Schaible, L. W., Campbell Soup Co., Agricultural Research Department, Riverton, New Jersey
Schroeder, W. T., Dept. Plant Pathology, New York State Agricultural Experiment Station, Geneva, New York
Scossiroli, R. E., Istituto di Genetica, Universita di Pavia, Via Sant' Epifanio 14, Pavia, Italy
Scott, Wilbur, Joseph Harris Co., Inc., Moreton Farm, Rochester 11, New York
Selman, Ireson, Wye College, Nr. Ashford, Kent, England
Shapiro, Nathan, Dept. Biological Sciences, Purdue University, Lafayette, Indiana
Shifriss, Oved, Dept. Horticulture, Rutgers University, New Brunswick, New Jersey
Smith, P. G., Dept. Vegetable Crops, University of California, Davis, California
Soost, R. K., Citrus Experiment Station, University of California, Riverside, California
South Dakota State College, Dept. Horticulture, Brookings, South Dakota
Stark, F. C., Jr., Dept. Horticulture, University of Maryland, College Park, Maryland
Stettler, R. F., Dept. Genetics, University of California, Berkeley 4, California
Strobel, James W., Box 554, Rt. 1, Homestead, Florida
Stubbe, Hans, Hölderlinstrasse 11, Berlin-Charlottenburg 9, Germany
Sweden-Royal Agricultural College, Kungl. Lantbrukshogskolan, Biblioteket, Uppsala 7, Sweden
Takii Seed Co., P. O. Box 7 Kyoto Central, Kyoto, Japan
Tézier, Claude, Tézier Frères, 27 Ave. Gambetta, Valence Sur-Rhone, France
Thompson, A. E., Dept. Horticulture, University of Illinois, Urbana, Illinois
Tindall, H. D., Horticulturist, Freetown, Sierra Leone, West Africa
Tomes, M. L., Dept. Plant Pathology, Indiana Agricultural Experiment Station, Lafayette, Indiana
Torrey, T. C., W. A. Burpee Co., Fordhook Farms, Doylestown, Pennsylvania
Toyama, Tom, Research Station, Harrow, Ontario, Canada
Trotter, Allen R., Associated Seed Growers, Inc., 272 George Street, New Haven 10, Connecticut
Tschusi, Eugenio Machado, Estacion Experimental de Horticultura y Jard., Santa Cruz de Tenerife, Canary Island, Spain
Tschuya, T., Kihara Institute for Biological Research, Mutsukawa, Minamiku, Yokohama, Japan
Uzo, J. O., Agriculture Division, Ministry of Agriculture, Enugu, Nigeria, West Africa
Venkataratnam, L., Horticulture Specialist, Ministry of Agriculture, New Delhi 2, India
Virgin, W. J., California Packing Corporation, 850 Thornton Street, San Leandro, California
Walkof, Charles, Experiment Farm, Morden, Manitoba, Canada
Wall, J. Robert, Southeastern Vegetable Breeding Laboratory, Box 3348, St. Andrews Branch P. O., Charleston, South Carolina
Walter, J. M., Box 2125, Vegetable Crops Laboratory, Bradenton, Florida
Warnock, S. J., Campbell Research Laboratory, P. O. Box 356, Davis, California
Washington State University, Library, Pullman, Washington
Webb, Raymon E., Vegetables & Ornamentals Branch, Agricultural Research Service, U. S. Dept. Agriculture, Beltsville, Maryland

Weizmann Institute of Science, c/o Gerard E. Haagens, 26 Pondfield Road West, Bronxville, New York
Whalen, Richard H., Dept. Horticulture, Purdue University, Lafayette, Indiana
Williams, Watkin, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts, England
Woolliams, G. E., Plant Pathology Laboratory, Research Station, Department of Agriculture, Summerland, British Columbia
Wright, I. J., c/o Welex, P. O. Box 1658, Houston 27, Texas
Wyatt, C. C., Crop Research Department, H. J. Heinz Co., Bowling Green, Ohio
Yarnell, S. H., U.S.S.C. Vegetable Breeding Laboratory, U.S.D.A., Box 3348, St. Andrews Branch, Charleston, South Carolina
Yen, Douglas E., Vegetable Station, Crop Research Division, Robinson Road, Otahuhu, Auckland, New Zealand
Young, Harold W., University of Florida, North Florida Experiment Station, Quincy, Florida
Young, P. A., Tomato Disease Laboratory, Rt. 1, Jacksonville, Texas
Young, Robert E., Field Station, University of Massachusetts, Waltham 54, Massachusetts
Younkin, S. G., Campbell Soup Co., 100 Market Street, Camden 1, New Jersey
de Zerpa, Ingo. Dora M., Catedra de Genetica, Facultad de Ing. Agronomica, Maracay, Venezuela
Zuta, Zeev, Kfar Shalem Farm, P. O. Box 1180, Tel Aviv, Israel

PART III

ADDITIONS TO STOCK LIST

(Last complete stock list issued in TGC 10; see also additions in TGC 11 and sources in gene lists in this issue)

STOCKS AVAILABLE

Source	Description
Denby, L. G.	Verticillium-resistant Ve Ve strains of the following established varieties. (Resistance from the variety Loran Blood, supplied by Dr. O. S. Cannon).

Ace
Bonny Best
Bounty
Break o' Day
Clark's Early (Dohler #7)
Earliest of All
Early Baltimore
Early Chatham
Early Harkness
Early Jersey
Early Lethbridge
Farthest North
Fireball
Firesteel
Geneva #6
Harris Gem
John Baer
Longred
Manasota
Marmande
Meteor
Morses 498
Non-acid
Pennheart
Pritchard
Puck
Red Chief
Red Cloud
Red Jacket
Rutgers
Signet
Sioux
Speed
Splendid
Stokesdale #4
Sugawara
Summerland Gem
Superior
Valiant
Valnorth
Victor
Wasatch
Windowbox
Wisconsin 55
Wisconsin (James)

PART IV

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PART V

FINANCIAL STATEMENT

(to December 31, 1961)

		Total
Balance from 1960		$161.38
Receipts		
Assessments	$261.75	
Sale of back numbers	91.00	
Interest on savings	5.42	358.17
Assets		519.55
Expenditures		
TGC Report No. 11, 1961		
Multilithing and covers	155.49	
Stencils, envelopes, and clasps	17.87	
Postage	25.81	
Miscellaneous		
Postage for meeting notice	10.68	
Postage for newsletter	11.00	
Invoice form	.54	221.39
Balance		298.16

MEMBERSHIP STATUS

Assessments paid for 1961	38
1962	36
1963	149
1964	12
1965	2
1966	2
1968	1
1970	1
Total members	241