DESCRIPTIONS OF NEAR-ISOGENIC LINES OF INBRED Hi27

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(NILS/HFSWEB/nilsdescription.doc) (docs/HFSWEB/nilsdecription.doc)

The following near-isogenic lines (NILs) of Hi27 have been developed in Hawaii through 6 or more backcrosses (BC). A few NILs like Ch (chocolate) have been BC'd >15 times. Hi27 is a hard yellow flint of tropical origin from inbred CM104 (India) that was Colombian (Amarillo Theobromina) in origin and that we converted to *Mv* gene (3L-78) for resistance to maize mosaic virus. It is of medium height (2m) and mid-maturity (60 days to silk) (*Image*). Hi27 has bronze anthers on reddish glumes, pink silks, red blush on lower stems, and colorless seedlings and coleoptiles. Our genetic testcrosses generally confirm that it is of the following genotype:

A1 A2 b1 Bz1 C1-I C2 Mv1 P1-ww Pl1Pr1 R-r Y1

Hi27 carries "wild-type" alleles of all other loci being introduced into NILs. It boasts a set of tolerances to diseases and pests virtually unknown in temperate germplasm, e.g., fusarium seedling and kernel rots, common and southern rusts, MDMVA and B viruses, maydis blight, ear and armyworms and stalk borers (Brewbaker, Crop Sci. 17:631-2, 1997). References for gene loci are from the classic "Mutants of Maize" (Neuffer, Coe and Wessler, 1997) and gene locations are from Ed Coe's excellent summary (Maize Genetics Cooperation Newsletter 82:87-102, 2007).

I'm eternally indebted to the Maize Genetics Coop (www.uiuc.edu/ph/www/maize) at U. Illinois, and especially to Earl Patterson with whom I worked at Cal Tech in summer '48 along with people like Earl and also Ed and Mary Olga Coe, Charlie Burnham, Don Robertson, Edgar Anderson and E. G. Anderson. Earl provided many of the stocks used to initiate this program in 1967, while Marty Sachs and Phil Stinnard have continued to offer great support. NILs that have been provided to the Coop are annotated here with their MGC stock numbers, and it is my intention to have all NILs preserved also at the Coop. I've accepted the convention of not adding "number 1's" to alleles often designated that way.

Photographs of these NILs, where available, are accessible by holding down CTRL and right-clicking on the italicized "*Image*" provided.

a^Hi27 -- Anthocyaninless. Location; 3L-174.75 (identical to sh2). MGC 322F. Origin: MGC 63-2665 sib (a1 Dt1 segregating sh2). Hawaii stock represents 7 BCs to Hi27 over 35 cycles of breeding. Plants are distinguished from Hi27 and other NILs by the green plant, silks, tassels and anthers, while inbred Hi27 has some basal stalk color, red silks, bronze tassels and anthers. All of our C stocks also have green silks. Our sh2, sh2 sl, and sh2 y NILs are also homozygous for a1; Image is of silks. *Image*

a2 (cf. NIL **(bt1 a2)^Hi27**)

ad^Hi27 (1:0, 1:1) – Adherent tassel. Location; 1L-192.0. MGC 110EA. Origin: MGC ad1 stock (1969). The two Hawaii stocks (ad/ad and 1:1) represent 8 BCs to Hi27 over 29 cycles of breeding. In the Hi27 background adherent affects the tassels but, unlike the early report of Kempton, the leaves are not adherent. The homozygous stock often includes highly

compressed tassels having little or no pollen. Plant height is about 10% below normal and ears are a bit high. *Image*

ae^Hi27 – Amylose extender. Location; ae = 5L-87.8. Origin: This monogenic NIL was derived from the ae wx double mutant (below) crossed with the bm ae double mutant in cycle 41 of breeding for the ae wx stock. Hawaii stock represents another backcross to Hi27 and selfing to homozygosity. Plants are tall, a few days late, and tassels are normal (not flta). Kernels are heavy and dark yellow in color, resembling those of the bm ae stock. Unlike aewx they do not attract fusarium rots.

ae wx flta^Hi27 – Amylose extender, Waxy endosperm, Floppy tassel. Two stocks; ae wx^Hi27 and ae wx^Hi27 3:1 (derived from cross of ae wx^Hi27 x wx^Hi27). Locations; ae = 5L-87.8, wx = 9S-47.9, flta = 9?. MGC M541P. Origin: Penn State breeding stock 64-702-3 self (ae su wx). Hawaii stock represents 6 BCs to Hi27 over 40 cycles of breeding. The double mutant is reduced ~20% in height compared with Hi27 or with wx^Hi27 but has similar floppy tassels (linked to wx). It produces typically compressed or collapsed kernels that are highly susceptible to kernel rot by fusarium (*Image3*), leading to entire ear rots. The homozygote has thus been difficult to maintain. In the 60's we did a little breeding of ae wx and ae su wx as potential sweet corns. See also ae (above) and bm1 ae, a mutant that is dwarfed and annoying to breed. *Image1* *Image2*

B^Hi27 – Booster colored plant. Locations; 2S-49.3. MGC M341BA. Origin: Carribean Composite (Thailand, 1967). Hawaii stock represents 8 BCs to Hi27 over 31 cycles of breeding. There is no reason to suspect that our B is different from that reported in 1921by the father of many corn genes, Cornell's R. A. Emerson. Our B stocks all have dark purple stalks, sheaths and husks (Hi27 is A Pl) with red anthers (vs. bronze for Hi27) and green silks (vs. red for Hi27). The cobs are strongly pigmented through indurate tissues, unlike the P locus cob colorations that occur only in soft floral tissues. Our B NILs tend to be taller (long internodes) and higher eared, somewhat fragile in appearance and with smaller ears. They succumb to premature senescence, especially when infected with southern rust, unlike Hi27 itself. *Image1* *Image2* *Image3* *Image4*

B C^Hi27 – Booster colored plant, Colored kernels. Locations; B = 2S-49.3, C = 9S-16.18, MGC M341BB. Origin: Identical to B^Hi27, separated after 28 cycles of breeding. Kernels have purple aleurone (Hi27 is C-I R Pr Pl) on the dark red cob, outcross kernels (from C-I pollen) are yellow. Plants are otherwise similar to B^Hi27 with purple stalks and husks, red anthers and green silks, and the plants tend to be attenuated and with smaller ears. Also more susceptible to rust.

B (C bz)^Hi27 – Booster colored plant, Colored kernels, Bronze aleurone and stalk. Locations; B = 2S-49.3, C = 9S-16.18, bz = 9S-22.53. Origin: Hybrid of NILs B^Hi27 and (bz C flta)^Hi27. These plants have bronze-reddish stalks and husks, easily distinguished from B^Hi27 (above). Tassels are largely of floppy-tassel (flta) type (cf. (bz C)^Hi27) Ears have bronze aleurone and cob and both anthers and silks are bronze-red. Very pretty. *Image*

ba^Hi27 3:1 – Barrenstalk. Location; 3L-109.0. MGC 318B. Origin: MGC 62F-1116 self. Hawaii stock represents 6 BCs to Hi27 over 27 cycles of breeding. Expression is typical with

missing ears and a single-spiked tassel with such poor pollen that maintenance of a 1:1 stock is difficult; ba is to the right in our photo. *Image*

bd^Hi27 3:1 – Branched silkless. Location; 7L-137.05. MGC 705DA. Origin: MGC ij bd stock (1962), exact record lost. Hawaii stock represens 6 BCs to Hi27 over 30 cycles of breeding. Expression is typical with multi-branched ears that often have a tassel-tip. The tassel itself appears very thick due to a great abundance of florets especially on central spike. However, tassel branch number is normal. *Image*

Bf^Hi27 – Blue fluorescent. Location; 9L-151.03. MGC 918F. Origin: MGC 63-3331 self. Hawaii stock represents 6 BCs to Hi27 over 21 cycles of breeding. Expression is typical of that described by Howard Teas and E. G. Anderson (1951). Anthers of heterozygotes show light blue fluorescence using black light while seedlings only fluoresce if homozygous.

Bif^Hi27 1:1 – Barren inflorescence. Location; 8L-54.0. MGC 827C. Origin: MGC 90-69-4 x 27-3. Hawaii stock represents 8 BCs to Hi27 over 12 cycles of breeding. Expression is typical of that described by Jerry Neuffer and Wm. Sheridan (1977) with tassels showing partial sterility and reduced branching. *Image*

(bk2 wx flta)^Hi27 – Brittle stalk, Waxy endosperm, Floppy tassel. Locations; bk2 = 9L-78.5, wx = 9S-47.9, flta = 9?. MGC916CA. Origin: MGC 59-1897 self (bk2 wx stock). Hawaii's NIL represents 6 BCs to Hi27 over 26 cycles of breeding and continues to be a double mutant with waxy (segregating). Breakage is typical for leaves, stalks, husks, tassels, cobs, etc. Maintaining a homozygous bk2 line has not been too difficult in Hawaii's gentle tradewinds, and it makes excellent ears. Like our other wx NILs this has floppy tassels. *Image Image2 Image3*

blo^Hi27 – Blotched leaf. Location; Unknown. Origin: Hawaii sweet corn AA8-163 (79-1143 sib) derived from 'Hawaiian Sugar' (Golden Bantam x Caribbean sugary). Hawaii stock represents 7 BCs to Hi27 over 21 cycles of breeding. This NIL shows chlorotic blotches as long stripes between veins, with somewhat weaker expression in hot summer days. It does not directly mimic any of the several lesion mutants of Jerry Neuffer. *Image*

blo p-wr^Hi27 – Blotched leaf, Red cob. Locations: blo = unknown; p-wr = 1L . Origin: This segregated in our p-wr stock as a single plant. Testcrosses to the blo stock confirmed allelism, and homozygous blo p-wr stock was selfed out.

(bm ae)^Hi27 – Brown midrib, Amylose extender. Locations; bm = 5S-79.25, ae = 5L-87.8. MGC 515D. Origin: MGC 69-543 self. Hawaii stock represents 7 BCs to Hi27 over 26 cycles of breeding. Kernels are typically denty in appearance (*Image3)* and testcrosses to ae wx^Hi27 confirmed homozygosity for ae. Unlike our ae RIL, this mutant is quite susceptible to fusarium that can lead to poor germination and to dwarfing, often with a delay of from 5 to 7 days to anthesis. I suspect a gene linked to bm1 for fusarium susceptibility. Midbrid colors are evident within 3 weeks of planting and become more intense before fading in older plants. They segregate both bronze and red anthers. See also ae and ae wx. *Image Image2*

bm2^Hi27 – Brown midrib 2. Location; 1L-259. MGC 119F. Origin: MGC 61-1956 sib (a stock with br, f, y and p-ww). Hawaii stock represents 7 BCs to Hi27 over 27 cycles of breeding. This NIL is normal in height, maturity and apparent yield, as reported by its discoverers R. A. Brink and Charlie Burnham. Midrib colors are evident within 3 weeks of planting and become intense, fading in older plants. *Image*

bm2^Hi27 ("bm3")– Brown midrib 2. Location; 1L-259. MGC 408EA. Origin: Pete Baumann's Purdue hybrid H55bm3 x H49bm3 (1972), later shown to be bm2, not bm3, in many types of testcrosses. Hawaii stock represents 7 BCs to Hi27 over 24 cycles of breeding. It is classical in appearance with early expression of color in midribs and sheaths, and of normal height. Similar misclassifications of bm2 and bm3 have been noted by J. Coors and others.

bm2 gt^Hi27 – Brown midrib 2, Grassy tiller. Location; bm2 = 1L-259, gt = 1S-?. MGC 408EB. Origin: Selfed out of hybrids in 2004 of our gt^Hi27 and a stock later shown to be bm2 (rather than bm3). NIL shows early expression of brown color in midribs and sheaths, with typical grassy tillers and long flag leaves that express the color also. *Image*

bm4^Hi27 – Brown midrib 4. Location; 9L-162. MGC 919A. Origin: MGC 86-1575 selfed. Hawaii stock represents 6 BCs to Hi27 over 20 cycles of breeding. NIL is classical in appearance with early expression of color in midribs and sheaths, as also described in 1947 by Dr. Burnham, with whom I had the pleasure of working at Cal Tech in the summer of 1948. However my stock is incredibly susceptible to fusarium as expressed through seedling mortality and is later seen in plants that are quite dwarfed (30%) and late (4-6 days to silk) compared to Hi27. *Image*

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br^Hi27 – Brachytic plant. Location; 1L-170.0. MGC 112H. Origin: MGC 65-193-1 x 186-7. Hawaii stock represents 7 BCs to Hi27 over 30 cycles of breeding. Extremely dwarfed (50%) with unusually erect and sharply-pointed leaves. Dwarfing mimics that of d1 dwarfs (also see br2 image). *Image2* . The mutant has very poor root development and essentially lacks brace roots (note; rootless (rt1) is on 3S). *Image3*

(br f)^Hi27 – Brachytic plant, Fine-stripe. Location; br =1L-170.0, f = 174.0. MGC 113C. Origin: MGC 65-193-1 x 186-7 (cf. br^Hi27 above). Hawaii stock represents 7 BCs to Hi27 over 27 cycles of breeding. This NIL is dwarfed somewhat less than br^Hi27 (above) and has better brace roots. It has the same type of erect and pointed leaves, and fine-stripe is expressed exactly as in the single mutant NIL f^Hi27. *Image*

br2^Hi27 – Brachytic 2 plant. Location; 1L-151.26. MGC 117A. Origin: Indian inbred CM104 br2 (1967). Hawaii stock represents 6 BCs to Hi27 (an inbred that was derived from CM104) over 32 cycles of breeding. Dwarfing is moderate (25%), vs. >40% in other inbreds I've studied. Comparable dwarfs include ct (compact). *Image*

br3^Hi27 – Brachytic 3 plant. Location; 5-?. MGC 520C. Origin: MGC 89-1674 sib. Hawaii stock represents 7 BCs to Hi27 over 22 cycles of breeding. In Hawaii this is moderately dwarfed (50% of normal), less than as noted by discoverer Ralph Singleton (1959). Heterozygotes appear also somewhat dwarfed. Our stocks seem to segregate for defective endosperm alleles.

Brta^Hi27 – Branched tassel. Location; Chrom. 2, linked to fl1 and v4. Origin: (fl Brta v4)^Hi27 breeding stocks, first observed in 2007 (BC6). See also (Brta v4)^Hi27 and fl Brta v4^Hi27. Tassels have extra primary and secondary branches that approximate twice the normal number (13) of Hi27. Branches tend to be more erect, but easily distinguished from mutants like ra2 (40+ branches). Ears are not affected. A similar phenotype occurs in Og B^Hi27 and su-jlb3^Hi27. Gene inherits as a co-dominant, with heterozygotes intermediate to parental homozygotes. Branch number of all NILs is reduced about half by Hawaii's short-day, low-light winters. *Image*,*Image2*

(Brta v4)^Hi27 – Branched tassel, Virescent 4. Locations; Brta = 2-?, linked to fl1 and v4 = 2L-87.0. Origin: (v4 fl)^Hi27 breeding stocks, segregating since 2007 (BC6). See also Brta^Hi27 and (fl Brta v4)^Hi27. Branched tassel is clearly linked to the v4 and fl loci in this region of Chromosome 2, and essentially all combinations of the three have been created as NILs. This stock appears to segregate for a linked semi-dwarf locus. Anthers are bronze.

(Brta v4) C^Hi27 – Branched tassel, Virescent 4, Colorless anthers. Locations; Brta = 2-?, linked to fl1 and v4 = 2L-87.0. Origin: Segregated in the (brta v4) stock. Assumed to be due to allele C (Hi27 has C-I).

bst^Hi27 -- Brown stripe. Location; Not known. Origin: Illinois sweet corn inbred 442 (in 1972). Hawaii stock represents 7 BCs to Hi27 over 24 cycles of breeding. It is distinguished from mutants like f, gs, ij, j1, j2 and li by linear stripes on leaves that turn rusty brown. It mimics j2 in the irregularity of stripes. Expression is quite variable and often difficult to identify. Severe symptoms involve some stunting and irregular seed set. *Image*

(bt a2)^Hi27 -- Brittle Anthocyaninless-2 endosperm. Locations: bt = 5S-80.01, a2 = 5S-72.01. MGC 511H. Origin: MGC 63-3023-8 x 3033-10 (segregating a2, bt1, bm1 and pr1 in an ACR background). Hawaii stock represents 7 BCs to Hi27 over 33 cycles of breeding. This is also the source of the brittle-1 gene used in all Hawaii breeding of "Hawaiian Supersweets" (Brewbaker, 1977), where segregants lacking a2 were used also in breeding but later discarded. The present double-mutant stock is dwarfed about 20% vs. Hi27 and vs. btA^Hi27 (*Image4*), and dwarfing is dominant in hybrids. All bt a2 stocks lack color in stalk, silks, anthers and tassels. They thus mimic the classic sh2 stocks that are all double-mutants with the a1 allele. Care was taken during breeding to select for high germination rates, thus favoring fusarium-tolerant lines with only occasional evidence of fusarium kernel rots *Image5* otherwise so common in sh2, o2, and other mutants. *Image1* *Image2* *Image3*

(bt a2)(sh2 a1)^Hi27 – Brittle Anthocyaninless-2 Shrunken-2 Anthocyaninless-1 endosperm. Locations: bt = 5S-80.01, a2 = 5S-72.01, sh2 and a1 = 3L-174.75. This double mutant of the two "high-sucrose" loci and their closely linked partners was created by crossing the respective NILs (bt a2)^Hi27 x (sh2 a1)^Hi27. The subline chosen is normal in height and has the expected green anthers and silks. The mature kernels have an unusual bronze color, presumed to be in aleurone, although the stock must carry inhibitor C-I. At sweet corn stage however the kernels are yellow. *Image*

(bt a2)(sh2 a1)vir^Hi27 – Brittle Anthocyaninless-2 Shrunken-2 Anthocyaninless-1 endosperm, Virescent. Locations: bt = 5S-80.01, a2 = 5S-72.01, sh2 and a1 = 3L-174.75, 'vir" = unknown. This virescent mutant segregated in the (bt a2)(sh2 a1) stock above and is suspected to be v4. Plants resemble the originating stock, as do the kernels that are an unusual bronze color when mature.

(bt a2) y^Hi27 – Brittle Anthocyaninless-2, White endosperm. Locations: bt = 5S-80.01, a2 = 5S-72.01, y1 = 6L-30.13. This double mutant was created by crossing the respective NILs (bt a2)^Hi27 x y^Hi27. The NIL mimics Hi27 in appearance and has the expected green anthers and silks. Kernels are not white, however, but an unusual bronze color identical in appearance to that of the double mutants with (bt a2)(sh2 a1) above.

bt1-A^Hi27 -- Brittle-A endosperm. Location; bt = 5S-80.01. Origin: Stock TS93-130 selfed from Tom Sullivan, U. Wis., originally from Curt Hannah. Seeds introduced in 1995 and backcrossed 6 times to Hi27. Carries allele A2 and shows color in silks and tassels. Allelism to bt in stock (bt a2)^Hi27 was verified. The two NILs differ about a foot in height, as do their hybrids, presumably related to a semi-dominant, linked dwarfing gene in the (bt a2) double mutant. Hybrids of the two NILs with supersweet breeding stocks were distinguished only by height, but were similar in yield (excellent), tenderness (average) and sweetness (not bad). Some potentially commercial hybrids were placed into Hawaii yield trials.

(bv pr) C^Hi27 – Brevis plant, Red aleurone. Locations; bv = 5L-84, pr = 5L-98, C = 9S-16.18. Origin: MGC ??? (a2 bv pr). Hawaii stock is in early stages of development, and retains the closely linked bv and pr alleles. Plants are dwarfed about 50%, as described by Cornell's H. W. Li in 1931.

(bz C flta)^Hi27 -- Bronze aleurone Colored aleurone Floppy tassel (bz C flta). Locations; bz = 9S-22.53, C = 9S-16.18, flta = 9S-?. MGC 905C. Origin: MGC 68-1238-5 x 1238-4 (C bz Wx). Hawaii stock represents 7 BCs to Hi27 over 30 cycles of breeding. Stock is marked by green silks (vs. red in Hi27) and the bronze aleurones. It is homozygous for or segregates the "floppy tassel" gene we've discovered to be linked closely to wx locus (Brewbaker and Huang, 2009). *Image*

C^Hi27 -- Colored (blue) aleurone. Location; C = 9S-16.18. MGC X17E. Origin: MGC 63-3065-5 self (a stock with A1A2CRPr). Hi27 lacks aleurone anthocyanins due to presence of the inhibitory allele C-I at the C locus. Many of our NILs have this inhibitor removed. This basic C^Hi27 NIL represents 5 BCs to Hi27 over 28 cycles of breeding, and aleurone color is blue due to presence in Hi27 of alleles R and Pr. The C^Hi27 stock is a classic and attractive flinty "blue corn" (aleurone), with no mottling evident. It is further distinguished by green silks, vs. red in Hi27. It does not carry flta (cf. bz C flta above). Other C containing NILs include B C p-wr, (bz C), (C sh bz wx), in B C R, and r-nj C. Also we've two stocks, R C and RBC, that evidently have a unique R allele from that in Hi27. All NILs with C (not C-I) have green silks, somewhat unusual for tropical flints. *Image1* *Image2*

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(C sh bz wx)^Hi27 -- Colored Shrunken Bronze Waxy Aleurone (C sh bz wx). Locations; C = 9S-16.18, sh = 9S-20.08, bz = 9S-22.53, wx = 9S-47.93. MGC 903B. Origin: Barbara McClintock's stock 358-2 self, received in 1970. Hawaii stock represents 9 BCs to Hi27 over

30 cycles of breeding. Like all C stocks this is distinguished by green silks, vs. red in Hi27. It is normally dwarfed ~20% vs. Hi27, mimicking our br2^Hi27. It does not carry flta, the "floppy tassel" gene common among our waxy stocks and also seen in (bz C flta)^Hi27. *Image*

c2 (cf. stock (o1 c2)^Hi27)

Cg^Hi27 1:1 -- Corngrass. Stock is maintained by backcrossing to Hi27 and segregates 50% Corngrass. Location; Cg = 3S-24.4. MGC 301D. Origin: MGC 65F-383 x 421Cg. Hawaii stock represents >10 BCs to Hi27 over 33 cycles of breeding. Plants are grassy and have tillers and flag leaves. They produce many 2- to 4-rowed ears and variable tassels. Selfs of corn-like segregants produced 3:1 ratio differing widely in expression, with homozygotes assumed to be the most severe and sterile, confirming Ralph Singleton's view (a951) that gene is partially (or co-) dominant. *Image1* (plant) *Image2* (ears) *Image3*

Ch^Hi27 – Chocolate pericarp. Location; Ch = 2L-162.6. MGC 219C. Origin: MGC 60-47 sib (a stock with lg gl2 fl1 and v4). Hawaii stock represents 19 BCs to Hi27 over 28 cycles of breeding. Stock has attractive brown pericarp and cob, as first reported by E. G. Anderson and R. A. Emerson (1931). I had the pleasure of working a summer with "Andy" at Cal Tech in 1948. His daughter enjoyed stealing shootbags from my rear pocket. In the Hi27 background this highly backcrossed NIL is notably vigorous, larger and more erect than Hi27, suggesting linked QTLs. *Image*, *Image2*, *Image3*

cr^Hi27 – Crinkled leaf. Location; cr = 3S-20.0. MGC 301A. Origin: MGC 63-2495-9 self. Hawaii stock represents 6 BCs to Hi27 over 29 cycles of breeding. Stock has leaf-rolling or "crinkling" typical of that described by R. A. Emerson (1921) that is identifiable within two weeks of planting. Leaves are shortened and plants dwarfed ~20% in the Hi27 background. I regret greatly that Emerson passed away shortly before I joined the team at Cornell, for he laid the entire solid foundation for maize genetics. *Image1 Image2 Image3*

ct^Hi27 – Compact plant. Location; ct = 8L-?. Origin: MGC 91-1102-1. Hawaii stock represents 6 BCs to Hi27 over 27 cycles of breeding. It has colorless anthers, possibly due to linkage with *a4* locus (8L-97). In the Hi27 background, the plants are dwarfed ~15% but without obvious shortening of leaves, tassels, or ears. The gene was described by Oliver Nelson and Ohlrogge in 1957 as "dwarfing all parts of the plant proportionately". They found it to be near "proline-responsive" *pro1* (8L-74). Ollie Nelson contributed immensely to our knowledge of maize genetics, notably of genes like *fl2, o2* and *wx* in the endosperm. *Image*

d^Hi27 – Dwarf. Location; 3S-30. MGC302E. Origin: MGC 65-245-7 x 244-5. Hawaii stock represents 7 BCs to Hi27 over 32 cycles of breeding. This NIL resembles the original of R. A. Emerson (1912) in height (dwarfed to about 35% of normal). Plants tend to be highly tillered unlike other Hi27 NILs (exceptions include gt and tlr). Leaves are shortened about 25% and are unusually broad (25% > Hi27) with 11-12 veins on each side of the midrib (vs. 8 in Hi27) at one month in age. Tassels are compact and ears are short and often tassel-tipped. Described in the literature as "andromonoecious" and with anthers buried in the glumes, in the Hi27 background the anthers emerge well and it sets seed well (*Image4*). The stock is notably the most susceptible of all of our NILs to southern rust (*Puccinia polysora*), and has been grown many years as an indicator of severity of the disease (see *Image2* below). All other NILs have

very high tolerance (2.5 on 1 to 9 scale, vs. 7.6 to 8.5 for d^Hi27). Our evidence is that a linked gene for susceptibility that is dominant or co-dominant came in from the MGC stock. The susceptibility may be related in part to the broad leaves and tillering of this mutant. *Image1* *Image2* *Image3*

dbcb^Hi27 – Double cob. Location; 1S-?. Origin: Double-cob segregated from our p-vv^Hi27 NIL derived from MGC 1969 p-vv stock after 10 BCs to Hi27. The trait segregated as a simple recessive, and has additional BCs to Hi27. The ears tend to split near the top of the cob, rarely producing more than two paired cobs with normal seeds. The plants are slightly more erect than Hi27, but otherwise normal in appearance and vigor. The eartips open up, leading to much damage from insects and diseases, described by Brewbaker and Huang (2009). This is unlike fascinated ear genes (fae1, fae2) that produce a multiply-branched ear (Hake and Viet, MGC, 1988). Gene fae1 occurred in a Mu-containing family, and Mu may also account from this mutant. *Image1* *Image2*

(dbcb p-rw)^Hi27 – Double cob, Red pericarp. Locations; dbcb =1S-?, p = 1S-69.58. Origin: cf. dbcb^Hi27. This is a clearly mutable line (Ac from p-vv stock?), with variations in leaf width, tassel color, sterility and anthesis-silk interval. Like most p-rw stocks it has both red pericarp, colorless cob and green anthers (vs. bronze in Hi27). Otherwise the plants are normal in appearance and vigor, with ears similar to the dbcb^Hi27 stock.

(dbcb p-vv)^Hi27 – Double cob, Variegated pericarp. Locations; dbcb =1S-?, p = 1S-69.58. Origin: cf. dbcb^Hi27. This is a clearly mutable line (Ac from p-vv stock?), with variations in leaf width, striping similar to japonica, tasselseed and sterility. Also having red anthers, it mimics the dbcb p-rw stock. *Image*

Dt a^Hi27 – Dotted aleurone, Anthocyaninless. Locations; a = 3L-174.75, Dt = 9S-0. MGC 323A. Origin: MGC 63-2665 sib (a1 Dt1 segregating sh2). Hawaii stock represents 6 BCs to Hi27 over 37 cycles of breeding. Plants are similar to a^Hi27 with green plant, silks, tassels and anthers. Aleurones are irregularly dotted and kernel abortion is common. Plants showed high susceptibility to an infection of Bacterial leaf blight.

du^Hi27 – Dull endosperm. Location; du = 10L-46.7925. MGC X10A. Origin: MGC 63-2127 x 2129. Hawaii stock represents 6 BCs to Hi27 over 24 cycles of breeding. Plants closely resemble Hi27. Kernels resemble description of discoverer Paul Mangelsdorf (1947) as "tarnished" but do not show any denting, as we do observe for ae. See also (li du)^Hi27.

el^Hi27 3:1 – Elongate (collapsed seed). Location; el = 8L-?, p = 1S-69.58. MGC 805E. Origin: MGC 63-787 x 786. Hawaii stock represents 6 BCs to Hi27 over 25 cycles of breeding with selection for red cob, assumed to be *p-wr*. Plants closely resemble Hi27 but have red cob, red anthers and green silks. Ears segregate collapsed el kernels that resemble sh2 seeds and generally fail to germinate. The el kernels evidently result from unreduced gametes identified by brilliant cytogeneticist Marcus Rhoades. *Image*

et^Hi27 3:1 – Etched endosperm. Location; 3L-190.01. MGC 320E. Origin: MGC 63-2656 x 2655, open-polinated in Thai nursery 67-141. Hawaii stock represents 6 BCs to Hi27 over 35 cycles of breeding, not an easy target. Kernels resemble those described by discoverer L. J.

Stadler, expert on mutation and mutability. The kernels are covered with networks of collapsed pericarp above collapsed endosperm cells. Etched kernels in this inbred usually abort and the few that germinate produce lethal white seedlings. Virescent seedlings were seen in early generations of backcrossing when stock was much more vigorous and kernels large. Heterozygous plants closely resemble Hi27 but have green silks. *Image*

et C^Hi27 3:1 – Etched and Colored endosperm. Locations; et = 3L-190.01, C = 9S-16.18. Origin: cf. et^Hi27. During the 6 BCs to Hi27 we retained purple kernels on which the etched trait was more easily identified. Surprisingly the plants with purple kernels (C locus, replacing C-I of Hi27) have always been dwarfed ~35% from normal. Dwarfing is recessive, and a linked gene to C is thus inferred. Like other C stocks, they have green silks. The etched kernels are colorful but resemble those of the et^Hi27 NIL. *Image*

f^Hi27 – Fine stripe. Location; 1L-174. MGC 127E. Origin: MGC 61-1956 self (br f bm2 p-vv and y). Hawaii stock represents 6 BCs to Hi27 over 21 cycles of breeding, with strong selection to separate f from br (cf. NIL (br f)^Hi27, from a different origin). Plants resemble closely those described by discoverer E. W. Lindstrom (1918), emerging as virescents that develop linear chlorotic stripes along leaf margins. Expression is seasonally variable, much more striking when we have cooler winters, as with most chlorotic mutants. *Image* *Image2*

(fl Brta v4)^Hi27 – Floury endosperm, Branched tassel, Virsecent 4 plant. Locations; fll = 2S-57, Brta 2L-?, v4 = 2L-87). MGC 215G. Origin: 63-2370 x 2369 (Chrom. 2 stock with linked lg gl2 b fl and v4). Stock involved 6 BCs to Hi27 over 25 cycles of breeding. Floury kernels resemble those described by Herbert Kendall Hayes (my father's professor) and his professor, E. M. East, in 1915, with classic dosage effect in the triploid endosperm. The v4 mutants resemble those described by discoverer Milislav Demerec (1924) as noted in description of the NIL (v4 fl)^Hi27, with best expression in Hawaii's cool winters. The branched tassel (brta) was first observed segregating in Hawaii NILs carrying fl (Brewbaker and Yu, 2009); see discussion under Brta^Hi27, a gene that co-segregates with genes fl (2S-75.7) and v4 (2L-87). See also pedigrees of (gl2 lg) and (v4 fl) mutants. *Image1* *Image2*

(fl v4) y8^Hi27 – Floury kernel, Virescent seedling, Pale yellow kernel. Location; fl = 2S-75.7, v4 = 2L-87.0, y8 = 7S-34. Origin: 63-2370 x 2369 (Chrom. 2 stock with linked lg gl2 b fl and v4), similar to (fl brta v4)^Hi27 pedigree (= MGC 215G). This originates from BC6 by the selection of whitish kernels. Otherwise similar to (fl v4)^Hi27 but with very pale yellow kernels (allelism verified to y8 locus). Tassels are normal, lacking the branched tassel gene Brta in related stocks.

fl2^Hi27 – Floury 2 endosperm. Location; fl2 = 4S-57.5. MGC 406C. Origin: Choe's thesis (1967). Hawaii stock represents 7 BCs to Hi27 over 29 cycles of breeding. Kernel type and inheritance similar to that described by Ollie Nelson and colleagues (1965). Otherwise similar to Hi27. *Image*

flta -- Floppy tassel (see wx flta^Hi27)

g^Hi27 – Golden plant. Location; g = 10L-78.0. MGC X11F. Origin: MGC 60-161-14 x 162-3. Hawaii stock represents 7 BCs to Hi27 over 28 cycles of breeding. NIL is typical in

appearance with yellowish sheaths. The yellowing progresses up to about sweetcorn stage, when one may see strikingly golden spots if infected by rusts or blights. Moderately dwarfed (20% below Hi27), unlike the double mutant g li (*Image2*). *Image*

(g li)^Hi27 -- Golden Lineate. Locations; g = 10L-78.0, li = 10L-62.0. MGC X09G. Origin: From our hybrid of the g and li stocks prior to BC3, with 7 BCs over 24 cycles of breeding. Both genes are typical in expression, but unlike the moderately dwarfed g stock (20% below Hi27) and the tall, attenuated li stock (20% above Hi27), the double mutant g li is more or less normal in height. Kernels are normal, not *du*, as in (li du)^Hi27. *Image*

Note: The following mutant has evidently been lost; will ask MGC if their seeds OK.
gl^Hi27 – Glossy seedling. Location; gl = 7L-66. MGC 709A. Origin: MGC 64-306 x 305. Hawaii stock represents 6 BCs to Hi27 over 22 cycles of breeding. Seedling leaves typical in appearance, glossy rather than whitish-dull, but quickly lost during maturity in our tropical fields. Otherwise similar to Hi27.

(gl2 lg)^Hi27 – Glossy seedling, Liguleless plant. Locations; gl2 = 2S-30.52, lg = 2S-11.75. MGC 205C. Origin: MGC 63-2370 x 2369 (Chromosome 2 linkage stock lg gl2 b fl v4). Hawaii stock represents 6 BCs to Hi27 over 24 cycles of breeding. Plants are similar to lg^Hi27. Seedling leaves are typically glossy in appearance, as first described by my father (Hayes and Brewbaker, 1928).

gs^Hi27 – Green striped leaves. Location; gs = 1L-224. MGC 119C. Origin: MGC 81-30 (71-6?). Hawaii stock represents 6 BCs to Hi27 over 21 cycles of breeding. Chlorotic stripes on leaves are similar to those described by discoverer R. A. Emerson (1912), but do not show rolling or wilting (as described by Emerson). In cooler weather the mutant is obvious in a month of growth, but in warm summer days it's only observed later in development. On one occasion we observed significant wilting under summer heat. The plants are significantly dwarfed (~20%) with pointed erect leaves. Unexpectedly both anthers and silks are green. Recent evidence (April, 2010) confirms that our stocks of gs1 and gs2 are identical, with both F1 hybrids and F2 plants entirely green-striped. Crosses with (bt a2)^Hi27 also had green anthers and silks.

gs2^Hi27 – Green striped leaves. Location; gs2 = 2S-50. MGC 221A. Origin: MGC 88-3339 sib, a stock with gs2 B pl. Hawaii stock represents 6 BCs to Hi27 over 19 cycles of breeding. Leaf chlorotic stripes are somewhat similar to those described by discoverer George Sprague (1933) but do not show characteristic yellowing (Maize GDB). The plants are significantly dwarfed (~15%) with pointed erect leaves, late to silk and with high "staygreen". Ears segregate dek (defective kernels). Unexpectedly both anthers and silks are green (cf. gs^Hi27). This has now been shown to be isoallelic to our gs1 mutant, and testcrosses are underway to clarify which mutant we have. *Image*

gt^Hi27 – Grassy tiller. Location; gt = 1L-?. MGC 127I. Origin: MGC 66Cal-2327 x 2328 (Don Shaver's gt id stock). Hawaii stock represents 7 BCs to Hi27 over 30 cycles of breeding. Shaver's id gene was never recovered. Plants are tillered and husks are tipped with flag leaves, each trait expressed in relation to growth vigor. In Hawaii's winters gt^Hi27 will have 4 to 8 tillers growing 3 to 5 feet tall and husk leaves will be from 4 to 8 inches in length. Mid-winter

plants may not even show tillers, and identification rests on appearance of husk leaves (Hi27 having none). The gene obviously affects totipotency of significant embryonic tissues in stalk and husk. We also discovered that all tested temperate American sweet and supersweet corn have the *gt* gene (Brewbaker and Josue, 2008). *Image1* (ears) *Image2* (seedling) *Image3* (plants and ears)

h^Hi27 – Horny Soft Starch endosperm. Location; h = 3S-?. MGC 330A. Origin: MGC 61-2372 x W23/L317. Hawaii stock represents 6 BCs to Hi27 over 34 cycles of breeding. Kernels are floury with soft starch, resembling o2 and fl2 in the Hi27 background. We've noticed high mortality of seedlings in fusarium-rich soils but no increased incidence of kernel rots. Plants are extremely late to flower (+ 7-10 days); since this is not so in Mainland inbreds (MGC) it appears due to the high susceptibility to fusarium. Plants are not unusually tall or high in leaf number; compared with *ij* in Image. *Image*

ij^Hi27 -- Iojap. Location; ij = 7L-82.78. MGC 711B. Origin: MGC 94-1615-1 * 1616-1 (ij 711B). Stock was derived from 6 BCs to Hi27 during 17 cycles of breeding. Stock is dwarfed 25%, pale green foliage, often a bit later to silk than Hi27. Expression is excellent and mimics expression in Mo17 background or japonica-1 in Hi27, but allelism tests confirmed their distinctness. Iojap does not transfer maternally in this background. *Image* *Image2*

in C^Hi27 – Intensifier (of kernel color). Location; in = 7S-39. MGC 707GA. Origin: MGC 70-1151 self (a red-leaf stock with dark blue kernels). Hawaii stock represents 7 BCs to Hi27 over 42 cycles of breeding. Hi27 is A1 A2 C-I R Pr, thus segregations involved C, R and Pr loci also. The leaf-color trait was not retained in conversions. Kernels are a shiny, deep blue-purple on white cob. Kernels on segregants with red cobs (p-wr) appeared even more intensely colored. Plants are vigorous and tall with normal silk color (red) and anther color (bronze).

j1^Hi27 -- Japonica 1. Location; j1 = 8L-122.0. MGC 810B. Origin: see ms8. Stock was derived from 7 BCs to Hi27 during 18 cycles of breeding. Leaf-striping is very bold and is evident 3 weeks after planting, and it is always chosen for demonstrations or class use. Plants otherwise resemble Hi27 in vigor. *Image1* *Image2*

j2^Hi27 -- Japonica 2. Location; j2 = 4L-123.0. MGC 415A. Origin: MGC 90-1948-1. Stock was derived from 6 BCs during 19 cycles of breeding. Expression is not as strong as ij^Hi27 or j^Hi27 and is suppressed during winter to marginal leaf stripes similar to f^Hi27 Plants otherwise resemble Hi27 in vigor. *Image*

Kn p-wr^Hi27 – Knotted leaves, red cob. Location; Kn = 1L-222.79, p-wr = 1L.69.58. MGC 117E. Origin: MGC Kn stock, 1967. Hawaii stock represents 7 BCs to Hi27 over 24 cycles of breeding. This stock was bred by simple backcrossing for the dominant gene, and it has reddish tassels, husks and cob but green silks. This suggests that it is a double mutant with the linked but distant P locus, where allele p-wr is associated with red cob, red anthers and green silks, while Hi27 has a white cob, bronze anthers and reddish silks. The leaves are seasonally variable in expression of the characteristic knots or roughness that mimics waves on a choppy sea (*Image2*). Plants are usually somewhat dwarfed and leaves are shortened and tassel banches very erect. *Image*

(la fl2)^Hi27 – Lazy plant, Floury 2 endosperm. Locations; la = 4S-52, fl2 = 4S-51.5. Origin: MGC 59-1320 x 1326 (a la su Tu gl3 stock evidently carrying fl2). Hawaii stock represents 6 BCs to Hi27 over 38 cycles of breeding, selected to remove *su* from this subline (selfs of heterozygous la fl2 su / la fl2 + segregated 15 sugary in 1243 seeds). Lazy is variably expressed in Hi27, with plants sub-erect in summer seasons and almost prostrate in others. Excellent seed production in this subline (in contrast to stock (la fl2 su)^Hi27). *Image1* *Image2*

(la fl2 su)^Hi27 – Lazy plant, Floury 2 and Sugary endosperm. Locations; la = 4S-52, fl2 = 4S-51.5, su = 4S-63.55. MGC 405DA. Origin: MGC 59-1320 x 1326 (a la su Tu gl3 stock evidently carrying fl2). Hawaii stock represents 6 BCs to Hi27 over 36 cycles of breeding. Plants are otherwise identical to (la fl2)^Hi27 stock. Sugary seeds from this subline are often rotted by fusarium. The sugary gene was isolated and is represented by our stock su

lc2^Hi27 – Leaf color. Location; Unknown. Origin: HIC9 (Hawaii Composite 9), previously known as "Kalakoa" (Brewbaker, JPR, 2009), a stock carrying many color genes including p-vv. Stock involved 8 BCs to Hi27 over 32 cycles of breeding. Mutants appear similar to those described by discoverer Bob Bray in Brink's lab (1964) of a dominant leaf-color gene called Lc1 that also came out of a tropical line (R-r Ecuador). Lc1 (now listed as 10L-97.0) is closely linked to R (10L-95.2537). The lc2 lines have always acted as fully recessive and segregations are Mendelian, and the trait is easily recognized within 3 weeks of planting. Possible involvement of R alleles (R1-ch) is implied. Plant heights are slightly reduced ~10% but maturity and fertility are normal. *Image*, *Image2*, *Image3*

lc2 p-rr^Hi27 – Leaf color, Pericarp and cob color. Location; lc2 = Unknown, p-rr = 10L-69.58. Origin: See lc2^Hi27 (a stock originally carrying p-vv). The pericarp/cob color variant was identified belatedly and is presumed to be p-rr. Pericarp, cob (glumes) and anthers are red in this stock, and the pith of the cob is strikingly colored. Cross-sectioned stems (including tassels) also show red veins, as noted by E. D. Styles for p-rr (1988). Plants are otherwise similar to lc2^Hi27, and a sub-line p-wr is being bred.

lfl^Hi27 – Leaf fleck. Location; unknown. Origin: Tuxpeño derived o2 germplasm in Thailand, 1968. Hawaii stock represents 6 BCs to Hi27 over 30 cycles of breeding. Mature leaves (>6 weeks) show small chlorotic (not necrotic) spots originally thought to be infection by *Curvularia maydis*. Flecks are similar to lesions described for the dominant Les8 mutant (9S-40) of Bird and Neuffer (1985), but lfl is completely recessive. See also (sky lfl)^Hi27. Flecking becomes very prominent under summer sun by sweetcorn stage. *Image1* *Image2*

lg^Hi27 – Liguleless. Location; lg = 2S-11.75. MGC 205B. Origin: MGC 63-2370 x 2369 (Chromosome 2 linkage stock lg gl2 b fl v4). Hawaii stock represents 7 BCs to Hi27 over 26 cycles of breeding. Liguleless expression is as observed by author R. A. Emerson (1912) giving plants a very erect and leggy appearance. Plant height exceeds Hi27 by 10 cm and tassels are poorly branched and occasionally single spiked. *Image*

lg2^Hi27 – Liguleless 2. Location; lg2 = 3L-103.25. MGC 320A. Origin: MGC 63-2564 sib (Chromosome 3 linkage stock ra2 pm lg2). Hawaii stock represents 6 BCs to Hi27 over 20 cycles of breeding. As noted by founder R. A. Brink, lg2 is not as completely liguless as is lg1 and often is a bit difficult to identify until approaching flowering. Plants are somewhat taller

than Hi27, tassels are normal (unlike lg1) and ears are occasionally "tassel-tipped". Early evidence that this stock carried recessive allele mv of the locus Mv (resistance to MMV, maize mosaic virus, homozygous in Hi27) led to identification by Ray Ming et al (1997) of the location of Mv on Chromosome 3 (~ 3L-78.0). This stock is now homozygous Mv/Mv. *Image1* *Image2*

Lg3^Hi27 – Liguleless 3. Location; Lg3 = 3S-57.64. MGC 312D. Origin: MGC Lg3 stock (1967). Hawaii stock represents 7 BCs to Hi27 over 22 cycles of breeding. Liguleless is fully dominant and plants appear very erect and compact. Plant height is seasonally variable, often dwarfed, and anthers are red (Hi27 is bronze). This mutant is homozygous Mv/Mv (cf. lg2^Hi27, pm^Hi27, ts4^Hi27) but highly susceptible to seedling mortality by fusarium. *Image*

(li du)^Hi27 – Lineate, Dull. Locations; li = 10L-62.0, du = 10L-46.79. MGC X08F. Origin: MGC 86H-686-1. Hawaii stock represents 7 BCs to Hi27 over 29 cycles of breeding. As noted by authors Collins and Kempton (1920) this gene creates fine chlorotic stripes above the veins. They are quite similar to striping by the Maize Mosaic Virus that is so common in Hawaii. Expression can be seasonally variable, severe enough in winter to reduce plant and ear size and lead to partial infertility. In summer trials the li stock is very tall (20% above Hi27 at 10 ft height), attenuated, with narrow leaves. Kernels are dull-colored flints (not quite floury or starchy) and assumed to be caused by linked locus du. See also double mutant g li^Hi27. *Image1* *Image2* *Image3*

lw^Hi27 3:1 -- Lemon white. Location; lw = 1L-224.0. MGC 118C. Origin: Maize Coop, received in 1967 but undocumented, although it must trace to Don Robertson. Hawaii stock represents 6 BCs to Hi27 over 18 cycles of breeding. Mutant is typical in appearance with lemon-yellow kernels with no vivipary that produce pure-white (lethal) seedlings. Hi27 kernels are flinty, dark yellow and noted for high beta-carotenoids. The lw mutant is excellent for displays of carotenoid protection of chlorophyll. Our NIL is somewhat variable in maturity and in tassel color (bronze and colorless). *Image*

ms6^Hi27 (cf. po^Hi27)

(ms8 1:1 j)^Hi27 -- Male-sterile 8, Japonica 1 stripe. Locations; **ms8** = 8L-113, j1 = 8L-122. MGC 805G. Origin: MGC 64-306/10 x 305/5, a Chrom. 8 stock noted to be v16 j ms8 (1:1) gl1 (1:1). Hawaii stock was derived from 6 BCs to Hi27 followed by sibbing to retain a stock homozygous for japonica-1 (*Image1*) but segregating ms8 over 32 cycles of breeding. Gene v16 (8L-?) segregated but was lost during conversions. Gene ms8 confers complete suppression of anthesis in this stock, although vigor is somewhat reduced due to j1. *Image*

ms10^Hi27 1:1 -- Male-sterile 10. Location; **ms10** = 10L-66.0. MGC X09F. Origin: MGC 71-1044 x 1059 in background of inbred N28. Stock was derived from 6 BCs to Hi27 over the course of 21 cycles of breeding. It shows considerable heterosis for ear length, and tassels have red anthers. Mutants are fully male sterile but with slightly reduced plant height. *Image*

ms-si (see si)

na^Hi27 3:1 – Nana dwarf. Location; 3L-120.0. MGC 318G. Origin: MGC 65-253 x 252. Hawaii stock represents 7 BCs to Hi27 over 25 cycles of breeding. Mutant plants are dwarfed <2 feet, erect with broad, short leaves. The mutant is delayed 1+ week to silk, but can produce tassels and tiny ears with abortive kernels. *Image1* *Image2*

na2^Hi27 3:1 – Nana dwarf 2. Location; 5S-57.0. MGC 518C. Origin: MGC 61-1988 x 1985. Hawaii stock represents 7 BCs to Hi27 over 25 cycles of breeding. Mutant plants are dwarfed <2 feet, erect with broad, short leaves. The mutant is delayed 1+ week to silk, but can produce tassels and tiny ears with abortive kernels. *Image1* *Image2*

nl3^Hi27 – Narrow leaf. Location; 1S-?. Origin: (nl3 p-rw)^Hi27 pedigree, BC8 selfed, 2003. Gene clearly linked to P locus; cf. stock (nl3 p-rw)^Hi27. Plants are normal in height and vigor Leaves are ~12% narrower than Hi27, measuring 48 mm at one month (vs. 55 for Hi27) and 77 mm at tasseling (vs. 88 for Hi27). Vein numbers are identical, 8 on each side of leaf at one month. Young plants and tassels appear more erect. Height, maturity and vigor are comparable to Hi27. Although cob is white the anthers are red, as in p-wr stocks. *Image*

(nl3 p-rw)^Hi27 – Narrow leaf, Pericarp color. Location; p = 1S-69.58, nl3 1S-?. Origin: MGC 63-2656 sib (A C R Dt p-rr). Hawaii stock represents 8 BCs to Hi27, using only red-pericarp female parents, over 28 cycles of breeding. Plants are normal in vigor, height, maturity and color, but the narrow leaf trait (cf. stock nl3^Hi27) became clear as homozygous lines were established for the (dominant) p-rw allele. Cobs are white, pericarps are red, and anthers are also red.

(o c2)^Hi27 – Opaque endosperm, Colorless. Locations; o = 4L-115, c2 = 4L-133.01. MGC 418FA. Origin: MGC 63-2154 sib. Hawaii stock represents 7 BCs to Hi27 over 26 cycles of breeding. From BC4 it was evident that the opaque selection was carrying linked locus c2, making mutant plants colorless (green plant, silk, anther). Plants tend to be heterotic in vigor and prolific but normal in height and maturity. Kernels are not unusually susceptible to fusarium kernel rot (cf. o2).

o2^Hi27 – Opaque 2 endosperm. Location; o2 = 7S-30.6. MGC 701D. Origin: MGC 64-258 x 267 (a stock with o2 v5 ra and gl). Hawaii stock represents 7 BCs to Hi27 over 34 cycles of breeding. The v5 was not eliminated until BC5 (cf. stock (v5 o2)^Hi27). Plants tend to be very vigorous but normal in height and maturity. Ears (cobs) are unusually large. Kernels are much more susceptible to fusarium rot, as they have been in all backgrounds we've studied. *Image1* *Image2*

o2^Hi27 (Tuxp) – Opaque 2 endosperm. Location; o2 = 7S-30.6. MGC 704B. Origin: An opaque-2 conversion of Mexican race Tuxpeño that I crossed in 1968 with a white opaque stock 650 of Rockefeller Foundation in Thailand. Hawaii stock represents 7 BCs to Hi27 over 31 cycles of breeding. Allelism with opaque-2 was verified. This is a very pale-colored denty type of kernel that was suspected to carry genes like y, y8 or y11, but testcrosses disproved each. Like other opaques it is quite susceptible to fusarium, and germination and emergence in Hawaii's fusarium-rich soils is often very poor. It is also notably more susceptible to BLB (bacterial leaf blight) and seems to have broader leaves.

(o5 gl)^Hi27 3:1 – Opaque 5 endosperm, Glossy seedling. Location; o5 = 7L-64, gl = 7L-66. Origin: MGC 91-2340 (Stock 710E o5gl1). Hawaii stock represents 6 BCs to Hi27 over 12 cycles of breeding (largely paired self and backcross). Seeds and seedlings generally resemble those described by discoverer Don Robertson (1967). Don recorded seeds to be opaque and pale yellow, often collapsed, and the seedlings to be virescent and often white, as characteristic of carotenoid involvement (cf. stock lw^Hi27). In this background of hard-flint Hi27, the o5/o5 kernels are best described as "white-capped", not always wholly opaque to transmitted light (cf. our stock of os^Hi27). The kernels are very pale in color. They are prone to fusarium rot, often fail to germinate in Hawaii, and generally produce yellow-green seedlings. Don's extensive work on this type of mutant started when he studied with E. G. Anderson at Cal Tech. I spent a wonderful summer of '48 with him and people like Ed Coe, Earl Patterson, Charlie Burnham and Edgar Anderson in E.G. Anderson's Bikini-bomb corn fields. .

Og^Hi27 – Old gold plant color. Location; Og = 10S-42. MGC X03B. Origin: MGC Og stock crossed with an ABPl stock (1967). This Hawaii stock represents 8 BCs to Hi27 over 29 cycles of breeding. Expression is similar to that recorded by discoverer E. W. Lindstrom (1935), with leaf blades having variously-broadened yellowish stripes that can be highly variable and often difficult to see. Plants are normal in vigor, height, maturity and color. *Image*

Og B^Hi27 – Old gold and Booster plant color. Locations; Og = 10S-42, B = 2S-49.3. Origin: MGC Og stock crossed with an ABPl stock (1967). This Hawaii stock represents 8 BCs to Hi27 over 32 cycles of breeding, obviously selected with a horticulturist's eye. Old gold expression is striking against the deep purple color of stems, sheaths, husks and cobs. Plants are often attenuated slightly in height as in all of our B stocks and tend to be a bit late in maturity and color. Tassels are compact and erect but with branch number similar to Hi27. As in all of our B lines the anthers and cobs are red but silks are colorless. *Image*

os^Hi27– Opaque crown. Location; os = 2S. MGC 220F. Origin: Xiao Wu Lu, doctoral student (1992-1996) obtained this stock evidently from discoverers C. Soave and F. Salamini (1981). The authors also called it "opaque endosperm small germ", thus "o" plus "s". The Hawaii stock represents 6 BCs to Hi27 over 18 cycles of breeding. Testcrosses excluded its identity with o1 or o2, but not o5. Plants are normal in vigor, height, maturity and color. The os kernels actually appear like dent segregants among normal Hi27 flints and have a soft-starch crown that can dent slightly. The germ does not seem small, and germination and seedling development is normal. Unlike our floury versions of Hi27 (especially o2, o5 and fl2) this stock doesn't seem prone to fusarium kernel rots. In this hard flint background it is tempting to call this gene "white cap" but unlike Wc1 (white cap) it is fully recessive. *Image* *Image2*

oy^Hi27 1:0, 3:1 – Oil yellow plant color. Location; oy = 10S-33.76. MGC X01A. Origin: MGC 69-372 self. Hawaii stock represents 7 BCs to Hi27 over 23 cycles of breeding. Expression is similar to that recorded by discoverer E. G. Anderson (1951), with seedlings that are very weak and yellowish. They become increasingly green later and can be sibbed in Hawaii's summer months. Flowering is delayed 7 to 10 days, leaves are variously narrowed, plants a bit dwarfed in height but obviously struggling for energy. Tassel branching is reduced about 50% (to 4-5 branches). Stinard (MNL83:52) provides evidence that this gene and *Og* may in fact be allelic. *Image* *(*from shaded plants in a 3:1 row).

p-rw^Hi27 – Pericarp color. Location; p = 1S-69.58. Origin: This line segregated from the dbcb p-rw stock, which traces to p-vv^Hi27 (and highly mutable). This represents at least a dozen BCs to Hi27 over >23 cycles of breeding. Plants are normal in vigor, height and maturity. Pericarps are red, cobs white and anthers also white (unlike our p-rr and p-wr stocks). White anthers (vs. bronze in Hi27) seem to occur in all our p-rw stocks; cf. (dbcb p-rw). *Image*

p-vv^Hi27 – Pericarp cob color. Location; p = 1S-69.58. MGC 107F. Origin: Derived from a 1969 MGC p-vv 1:1 stock (field data not recorded. Hawaii stock involved 10 BCs to Hi27 over 29 cycles of breeding. Homozygotes have presented immense variability that is evidently to be expected from this Ac-containing mutant. Variability has been seen in vigor, height, width of leaf width, striping of leaves and shape of cob. Ears are commonly weak, segregating defective endosperms and a wide range in variegation of pericarp. Cobs are white, silks are red and anthers bronze, as in Hi27. Mutants for double cob (dbcb^Hi27) and narrow leaf (nl3^Hi27) arose from this germplasm, and a japonica-like stripe also has appeared. *Image*

p-wr^Hi27 – Cob color. Location; p = 1S-69.58. MGC 107I. Origin: Segregated in Hi27 (which has bronze anthers) in 1991 as red anthers (91-1314 sib). Two additional BCs were made to Hi27 over 13 cycles of breeding. Plants are normal in vigor, height, leaf width and maturity, but uniquely red-anthered (vs. bronze in Hi27). Homozygotes revealed that the red anthers were always associated with the reddish soft floral parts of the cob typical of allele p-wr. This stock has red glumes and outer tissues of cob that are apparent at late sweet-corn stage (*Image3*). However, unlike lc2 p-rr^Hi27 (that has red pith), the pith of both cob and stalk in p-wr is white. The allele p-wr is also found in stocks blo, dbcb, el and Og B. *Image* *Image2*

pm^Hi27 – Pale midrib. Location; pm = 3L-77. MGC 307C. Origin: MGC 74-545 self (a stock with cr ts4 and pm). Stock involved 7 BCs to Hi27 over 35 cycles of breeding. As noted by discoverer Ralph Brink the pm plants are dwarfed (20%) and have broadened and chlorotic midbribs at base of leaves. They are late to flower and the ears are small ears and kernels are small and irregular. This mutant rarely germinates well and appears to be unusually susceptible to fusarium as a seedling rot. The gene is located in the region of Mv locus (~3L-78) and my stock may be segregating susceptibility. *Image1* *Image2*

Pn^Hi27 1:1, 3:1 – Papyrescent glumes. Location; Pn = 7L-?. MGC 714A. Origin: MGC 69-617Pn x M14/W23. Hawaii stock involved 10 BCs to Hi27 over 20 cycles of breeding. As recorded by discoverer Walt Galinat, his *Pn* heterozygotes had enlarged papery glumes covering the kernels and enlarged glumes in tassel. In Hi27 background the Pn tassels are indistinguishable from Hi27 and long glumes on ears are usually evident only at the base. Pn/+ plants tend to be delayed a few days in silking but otherwise similar to Hi27. In 3:1 progenies the homozygotes are silkless and the stock is best maintained as a 1:1. *Image* *Image2*

po-ms6^Hi27 1:1 – Polymitotic male-sterile. Location; po = 6S-17. MGC 612BA. Origin: MGC 89-1697 x 1696, received as ms6. Stock was derived from 6 BCs to Hi27 over 17 cycles of breeding. Another stock was developed from the same origin and labeled ms1 incorrectly; after 6 BCs during 16 cycles of breeding it was crossed with the ms6^Hi27 and they proved to be identical and were pooled and correctly labeled po-ms6^Hi27. Expression is similar to that of fellow Cornellian George Beadle's original description (1932) of polymitotic, with complete male sterility and partial female sterility. Plants are of normal height and vigor. I cherish

memories of teosinte-like corn seedstocks shared with me by George even after he became President of Chicago U. *Image*

py^Hi27 1:1, 1:0 – Pygmy plant. Location; py = 6L-77.75. MGC 612I (as "tan-py") Origin: MGC 61-2004 x 1998 (a stock with py p-rr and sm). Hawaii stock involved 7 BCs to Hi27 over 25 cycles of breeding. Plants are dwarfed to about 40% of normal and leaves are narrow and streaked. Anthers are red (unlike Hi27, bronze) but the p locus is represented by Hi27's p-ww. Plants are delayed about a week to flower and have high ASI. Both py/py and 1:1 stocks are maintained; homozygous seed is obtained from sibs of healthy plants under ideal growth conditions. Ears of py homozygotes are very small (2") but seed quality is normal. This is probably the py-tan ("tangled") allele that alters growth patterns throughout the plant, but I respect the original name given by A. D. Suttle in 1924 (a Cornellian of course). *Image1* *Image2*

R C^Hi27 – Blue kernels. Locations; R = 10L-95.25, C = 9S-16.18. MGC X17E. Origin: MGC stock a1 A2 C R Dt (field number not recorded), received in 1967. Stock was derived from 6 BCs to Hi27 over 40 cycles of breeding. This pure line is characterized by mottled blue kernels distinct from the "clean blue" kernels of our C^Hi27 stock. I assume the R allele here to be of different origin than that of Hi27 (which is C-I R). During breeding we recorded high kernel diversity (marbling, mottling) suggesting presence of mutators. Plant height is reduced ~20% (cf. R-nj C), anthers are red and silks green (as noted in most C stocks). *Image1* *Image2*

R B C^Hi27 – Blue kernels, Purple plant. Locations; R = 10L-95.25, B = 2S-49.3, C = 9S-16.18. MGC M341B. Origin: See R C^Hi27, which was segregating "sun-red" stalks early in the conversions to C and R. In cycle 35 of breeding it segregated A B Pl plants with purple stalks and husks and typically somewhat elongated thin stems. The pure line is also characterized by mottled blue kernels.

R-nj C^Hi27 – Navajo-red kernels. Locations; R = 10L-95.25, C = 9S-16.. MGC X17D. Origin: MGC stock Trisome 10. Stock was derived from7 BCs to Hi27 over 30 cycles of breeding. Kernels of the pure line are typical in appearance, capped with crowns of red-purple aleurone (purplish in this background). Our stock has always been dwarfed ~20% (*Image2*) compared with Hi27 or other stocks, as noted also for our R C stock (above), implying a linked QTL for plant height. *Image*

R-nj y C^Hi27 – Navajo-red kernels, White endosperm. Locations; R = 10L-95.25, y = 6S-30, C = 9S-16. Origin: Hybrids of Hi27 NILs R-nj C (above) and y. Stock was derived from 3 cycles of breeding. Kernels are attractively white with purple crowns.

ra2^Hi27 – Ramosa 2 tassel. Location; 3S-32.76. MGC 308E. Origin: MGC 63-2564 sib (a stock with lg2, pm and ra2). Two Hawaii stocks, ra2^Hi27 and ra2^Hi27 1:1, that represent 6 BCs over 24 cycles of breeding. Tassel expression is typical with many (30+) erect and tightly-clustered branches that are greatly shortened. Ears are often tipped with a miniature tassel, yields are poor with missing kernels and irregular kernel placement. Plants tend to be tall (8.5 ft., 15% above Hi27) and attenuated and ears are high (4 ft.) on stalk. Anthers are red (Hi27 has bronze anthers). *Image1* *Image2* *Image3*

rf4^Hi27 (cms C) – Fertility restorer for C cytoplasm. Location; 8S-4.0. MGC Z031G. Origin: Wf9 (C cytoplasm), BC8. Hawaii stock represents 6 BCs over 24 cycles of breeding. Fully male sterile and completely restored by allele Rf4, otherwise normal in appearance and yield. *Image*

Rf4^Hi27 (cms C) – Fertility restorer for C cytoplasm. Location; 8S-4.0. Origin; Fertility segregated in a hybrid of rf4^Hi27 and lg^Hi27 (on 4S) in a study of NIL heterosis (MGN 81:17, 2007). Homozgyous Rf4 line was derived by selfing or sibbing 5 cycles and eliminating *lg* gene, with appropriate testcrossing. Two stocks are maintained, both with small tassels and small ears on small plants; one tends to vivipary. i.e., both are strangely distinguishable from Hi27.

Rg^Hi27 1:1 – Ragged plant. Location; 3S-69.0. MGC315C. Origin: MGC Rg Tp stock (1967). Hawaii stock represents 15 BCs over 21 cycles of breeding. Expression typical of that described by discoverer Ralph Brink (1931), with plants dwarfed ~25%. Leaves are severely slashed, shortened and narrower, and tend to be parallel to the ground. Homozyous Rg/Rg plants even more gross and sterile. *Image1* *Image2* *Image3*

sh wx flta^Hi27 – Shrunken Waxy kernels, Floppy tassel. Locations; sh 9S-20.08, wx 9S-47.93, flta = 9S. MGC 909D. Origin: MGC 63-2696 sib (sh wx segregating C). Hawaii stock represents 6 BCs over 27 cycles of breeding. It is similar to other NILs of this region of chromosome 9 in having the floppy-tassel gene. It has occasionally segregated "Square-stalk", with opposite leaves and ears. Nice ears and kernels well-filled, basically looking like a dent in the Hi27 (flint) background.

(sh2 a1)^Hi27 – Shrunken 2. Location: sh2 and a1 = 3L-174.75. MGC 333D. Origin: MGC 63-2665-6/2666-2, a stock noted to be a1 sh2 with B, C, Dt, Pl and R (presumed to have reference allele sh2-R). Stock was derived from 6 BCs to Hi27 over the course of 27 cycles of breeding. No segregants were verified to have the two loci separated. This is an unusually tall NIL (linked gene?) that is highly susceptible to fusarium kernel and seedling rot (pleiotropic effect). In the Hi27 background it is a very green plant with colorless silks, anthers, and tassels. *Image*

(sh2 a1) sl1^Hi27 – Shrunken 2, Slashed leaves. Locations; sh2 and a1 = 3L-174.75, sl = 7L-84.0. MGC 705BB. Origin: MGC 69-612-2 selfed, a stock with o2, gl1, and sl1 (slashed, a gene my father Harvey discovered); the stock was recorded not to be segregating ra1 or v5 that are presumed to have been in its pedigree. In progenies from my first BC to Hi27, the slashed plants in 1973 segregated wrinkled kernels. These were recovered in BC3 in 1990 and 4 subsequent BCs were followed by selection for the uniquely green plants (a1) and associated sh2 seeds. Breeding involved a total of 28 cycles. Expression of the slashed leaves is environmentally sensitive with gross slashes in cool winters and minor slits in summer. Like all sh2 stocks, it has trouble with fusarium. See Image for sl^Hi27.

(sh2 a1) y^Hi27 – Shrunken 2, Anthocyaninless, White. Location: sh2 and a1 = 3L-174.75; y = 6S-30.13. Origin: Hybrid of (sh a1)^Hi27 x y^Hi27, followed by 3 cycles of selfing and sibbing. Unlike the sh2 parent, this is normal in height. Seeds germinate poorly due to fusarium

seedling rot. It is a green plant with colorless silks, anthers, and tassels. Kernels are a "dirty white", unlike (bt1 a2) y^Hi27, that is definitely bronze-kerneled.

si^Hi27 1:1 – Silky ear. Location; 6S-69.0. MGC 604F (as "ms-si"). Origin: MGC 64-13 x 10, referred to as ms-si ("male-sterile silky"). Hawaii stock represents 6 BCs over 29 cycles of breeding. Our stock is highly male sterile in summer, essentially impossible to self. Ear expression is inconsistent with ears variably silky. Double-cobs have been common, along with other abnormalities. *Image*

(sk fl)^Hi27 1:1 – Silkless ear Floury kernels. Locations; sk = 2S-57.0, fl = 2S-75.7. MGC 214JA. Origin: MGC 64-2472 x 2465 (lg gl2 b v4 segregating sk and fl). Hawaii stock represents 6 BCs over 25 cycles of breeding. Stock is similar to those described by D. F. Jones (1925) with no silks on ears. Tassels are spikes with a single branch. *Image* *Image2*

sky lfl^Hi27 – Skinny plant Leaf-flecked leaves. Locations; Not known. Origin: MGC 74-545-2 self (a stock segregating ts4, pm and lg). Hawaii stock represents 7 BCs over 25 cycles of breeding. The genes lg, pm and ts4 were eliminated early in backcrossing. The sky NIL is characterized by normal ligules but thin stalks of normal height (our lg1 NIL is quite tall, attenuated). The sky plants have a somewhat more erect leaf habit. It is a double mutant with lfl, heavily-flecked leaves but seasonal in expression. *Image*

sl^Hi27 – Slashed leaves. Location; 7L-84.0. MGC 705BA. Origin: MGC 69-612 self (a stock carrying o2 and gl). Hawaii stock represents 7 BCs over 22 cycles of breeding. It is similar to plants described by my father (Hayes and Brewbaker 1928) with slashes that grow with leaf expansion on leaves generally normal in length and width. Plants are of normal height but can be reduced in our low-light winter season. *Image*

sr^Hi27 – Striate leaves. Location; 1S-39.25. MGC 101C. Origin: MGC 65-201 sib. Hawaii stock represents 8 BCs over 26 cycles of breeding. The mutant is strikingly striped with both white and pale-green stripes, as reported by discoverer Art Brunson, with whom I later worked in Philippines 1954). Our NIL also shows early virescence and is delayed at least a week to flowering, but is normal in plant height. Sub-line with red cob (p-wr) is being bred. *Image1* *Image2*

su^Hi27 – Sugary endosperm. Location; 4S-63.55. MGC 407D. Origin: UH hybrid H68 (Brewbaker 1968), gene likely derived ultimately from either of its parents--Golden Bantam and Puerto Rico line. My stock represents 7 BCs over 27 cycles of breeding. Otherwise resembling Hi27 it tends to segregate poor tassels and bear kernels that are variously wrinkled and "pseudo-starchy". Also see (la su fl2)^Hi27, also with pseudo-starchy kernels (backed by fl2). *Image*

su lfl^Hi27 (TuJLB) – Sugary endosperm, Leaf fleck. Locations; su = 4S-63.55, lfl = ?. MGC 411AA. Origin: Segregated among selfs from 5th backcross of a Tunicate stock (Tu at 4S-118) from MGC 61F-607 x 801. Hawaii stock represents 3 additional BCs over 20 additional cycles of breeding. Validated to be su1, this stock has unusually pseudostarchy kernels and other unique traits. It has the leaf-freckle (cf. lfl^Hi27) that is different from reported *les* (lesion-mimic) mutants. It is weakly rooted and often leans in the field. This also

occurs in tropical varieties like “Hawaiian Sugar” that are suggested to segregate mutants resembling asr (absence of seminar roots). Plants often show fuzzy sheath similar to Tavcar’s “hairy sheath”. Tasssels have excessive number of branches (22). This host of traits confirms that many genes (and mutators) are often carried under the cloak of dominant mutants like Tunicate. While our Tu^Hi27 1:1 stock is quite normal, the homozygous *Tu/Tu* is grossly vegetative and basically a dominant lethal. This linkage drag eliminates selfs that might reveal linked recessive alleles like *su* or *la* that were in the original MGC stock. See also our la fl2 su stock in which the sugary kernels are often fusarium-damaged; see also our Tu stocks. *Image*

tan (see py^Hi27)

Tlr^Hi27 1:2:1 – Tillering. Location; Tlr = 1L-?. Origin: MGC 95-212 self. Hawaii’s NIL involved 6 BCs to Hi27 over 11 cycles of breeding. Mutants appear much as noted by (abundant-gene discoverer) Jerry Neuffer and colleagues (1987). The gene appears to be variably co-dominant with the heterozygotes producing no tillers but having long flag leaves and normal ears. However, the homozygous tlr plants are grossly vegetative (similar to tb1) with long flag leaves, tassel-tipped or tassel-replaced ears (often with no kernels), and spike-like tassels. Suspected to be allelic or close to tb and gt loci. *Image1* *Image2* *Image3*

Tp^Hi27 1:1, 3:1 -- Teopod. Tp^Hi27 1:1 and Tp^Hi27 3:1 are maintained as separate stocks. Location; 7L-76. MGC 711A. Origin: Both sublines have as origin MGC 61F-607x807-1. The 1:1 stock is in BC11 after 18 cycles of breeding and the 3:1 is in BC9. Heterozygotes are identical in the two stocks, with unbranched tassels, prolificacy, large ears and the characteristic long glumes especially around basal kernels similar to those described by discoverer E. W. Lindstrom in 1925. Homozogyous Tp/Tp plants have no tassels and are highly tillered, grassy, and very prolific with long husk covers. *Image1* *Image2* *Image3*

ts2^Hi27 1:1, 3:1 – Tassel seed 2. Location; ts2 = 1S-69.52. MGC 106BA. Origin: MGC 60-1019 sib (a stock carrying Chrom. 1 genes br1, f1 and bm2). Stock involved 6 BCs to Hi27 over 25 cycles of breeding, eliminating the linked loci. Mutants appear much as noted by discoverer R. A. Emerson (1920), with tassels elongate and seedy. When tassels are removed the ears can be pollinated but are shoepeg and poorly seedy, so no attempt was made to create a pure line. Plant height was reduced ~25%, and tassels attracted common smut (that is rare in Hawaii). *Image* *Image2*

ts4^Hi27 3:1 – Tassel seed 4. Location; ts4 = 3L-78. MGC 308A. Origin: MGC 59-1148 sib (a stock carrying Chrom. 3 genes cr and na). Stock involved 7 BCs to Hi27 over 23 cycles of breeding, eliminating the linked loci. Mutants appear much as noted by discoverer L. F. Phipps (1928), with very compact tassels having pistillate and staminate flowers. When tassels are removed the ears can be pollinated but are shoepeg with secondary florets and are poorly seedy, so a 1:1 line was challenging and no attempt was made to create a homozygous line. Plant heights were slightly reduced, and the stock is unusually tall and late to maturity. It is probable that this stock is a double mutant with recessive allele mv for susceptibility to Maize Mosaic Virus (locus also suspected to be 3L-78), since Hi27 and all other NILs were bred to be homozygous Mv. *Image*

Ts5^Hi27 1:1, 3:1 – Tassel seed 5. Location; Ts5 = 4S-48. MGC 402D. Origin: MGC 63-2781 x 2790 (a stock carrying Chrom. 4 gene su). Stock involved 10 BCs to Hi27 over 24 cycles of breeding, eliminating linked sugary locus. Mutants appear identical to those of discoverer R. A. Emerson (1932), with large tassels sparsely silky on heterozygotes. *Image2* . Ears also have irregular rows with secondary florets and are poorly seedy. It's possible a pure line could be created. Mutant plant height of homozygotes was reduced ~10% and silkiness of tassels is exaggerated greatly. *Image*

Ts6^Hi27 1:1 – Tassel seed 6. Location; Ts6 = 1L-260.04. MGC 119E. Origin: MGC 90-893 x 888. Stock involved 9 BCs to Hi27 over 12 cycles of breeding. Mutant heterozygotes appear identical to those of discoverer N. H. Nickerson (1955), with extremely compressed tassels that are sparsely silky or seedy. Ears also have irregular rows with secondary florets and are poorly seedy. Plant heights of heterozgyotes are greatly reduced ~30% (*Image3*). I've not studied homozygotes. *Image1* *Image2* *Image4* *Image5*

Tu^Hi27 1:1, 3:1 – Tunicate. Tu^Hi27 1:1 and Tu^Hi27 3:1 are maintained as separate stocks. Location; 4L-118. MGC 416A. Both have as origin MGC 59-1320-22 x 1326-3, a stock having Tu together with *la1* and *su1* (short arm of 4) and gl3 (4L-138). The 1:1 stock is in BC15 after 19 cycles of selection. Heterozygotes are classical in appearance, having ears with coarse glumes covering all kernels, a natural showpiece at our field days. Tassels have long glumes and condensed-appearing central spike, usually but not always easily distinguished. Homozygotes are dwarfed with no ears but a single complex branched tassel with long glumes and occasional kernels. See also su lfl^Hi27 (TuJLB), a sugary line with freckled leaves derived from this stock, and also our lazy stocks. *Image1* *Image2* *Image3*

v4 dbcb^Hi27 – Virescent 4 plant, Double-cob. Locations; v4 = 2L-87, dbcb = 1?. Origin: 63-2370 x 2369 (Chrom. 2 stock with linked lg gl2 b fl and v4). This normal-flint stock was extracted from the (v4 fl)^Hi27 in 2009. It is notable for strong brace roots, and segregates dwarfs. This stock does not have the highly branched tassels (Brta) observed in other NILs, e.g. (fl brta v4)^Hi27. Surprisingly it is homozygous for the mutant we called dbcb (double-cob) that appears to be on Chrom. 1. See images in (v4 fl) below.

(v4 fl)^Hi27 – Virescent 4 plant, Floury endosperm. Locations; v4 = 2L-87, fl = 2L 5.7. MGC 215G. Origin: 63-2370 x 2369 (Chrom. 2 stock with linked lg gl2 b fl and v4). Stock involved 6 BCs to Hi27 over 29 cycles of breeding. Mutants resemble those described by discoverer Milislav Demerec (1924) and are pale green almost immediately on emergence, and symptoms persist up until flowering. Unlike opaque-2 seeds (e.g., v5 o2) the floury kernels are less subject to rot by fusarium. This stock does not have the highly branched tassels (brta) observed in related NILs such as (fl brta v4)^Hi27, derived from the same source. *Image* *Image2*

(v5 o2)^Hi27 – Virescent 5 plant, Opaque 2 endosperm. Locations; v5 = 7S-37, 7S-30.6. MGC 703AA. Origin: 64-258 x 267 (stock with linked o2, v5, ra and gl). Stock involved 8 BCs to Hi27 over 34 cycles of breeding. Mutants resemble those described by discoverer Milislav Demerec (1924), whom I mistakenly asked at Cold Spring Harbor in 1950 about the progress of his corn research (he'd done none since grad school). As in other stocks the *opaque-2* seeds are always more subject to rot by fusarium, and dry kernels often have a brownish crown that

appears to be rot-induced. Young seedlings are pale yellow (*Image2*) that later develop into bold whitish stripes similar to j1 or ij. *Image*

Vg^Hi27 1:1, 3:1 – Vestigial glumes. Location; Vg = 1L-173. MGC 114D. Origin: MGC 74-550, from an innovative Walt Galinat, who tried to incorporate this into sweetcorn breeding. The stock is in BC13 after 19 cycles of selection. Heterozygotes are classical in appearance as described by discoverer George Sprague (1932). They have very short glumes in tassel and cob (*Image*) and are a showpiece at our field days. Heterozygotes produce some pollen in good seasons, but homozygotes appear entirely sterile (*Image2*). Heterozygotes are dwarfed ~15%, but otherwise similar to Hi27.

vp5^Hi27 3:1 – Viviparous kernels. Location; vp5 = 1S-40.25. MGC 103D. Origin: MGC 65-503 self. Hawaii stock is in BC15 after 19 cycles of selection. This stock is classical in appearance (Don Robertson, 1952) with 1/4 segregating carotenoid-deficient pale yellow kernels and albino seedlings. Heterozygous plants are normal in maturity and height, but have red anthers; ears segregate whitish kernels that may become viviparous late in maturity. *Image*

ws3^Hi27 1:0, 3:1 – White sheath 3 plant. Location; ws3 = 2S-2.0. MGC 201FA. Origin: MGC 66-274 self (a Chrom. 2 stock with linked ws3, lg, gl2 and b). Hawaii stock is in BC8 after 41 cycles of selection that eliminated linked loci from MGC. The ws3 stock was well described by discoverer Marcus Rhoades (1939) as having white leaf sheath and culms, whitish husks, and dwarfed plants that are slow to flower. Marcus asked me in 1950 about something I'd told him at Cornell but that I'd forgotten! He was a remarkable scholar with incredible intellect and memory. Our NIL emerges as a virescent seedling that is most striking in the field (*Image1*, *Image2*). Plants green up during growth but are dwarfed and very late to flower. It's actually easier to create the pure line than to provide a 1:1 population. *Image3*

(wx flta)^Hi27 – Waxy kernels, Floppy tassels. Locations; wx = 9S-47.93; flta = 9?. MGC 915A. Origin: MGC 70-1000-3 x 999-3, a stock with allele wx1-a (Argentina). Hawaii stock was derived from 6 BCs to Hi27 followed by selfing over 23 cycles of breeding. Homozygous *wx* lines are immediately identified as having unusual lax tassel branches, labeled "floppy tassel" (Brewbaker and Huang 2009). Trait is inherited as a tightly linked single gene interpreted as codominant, with intermediate expression in heterozygotes. During our breeding of "sticky" (waxy or glutinous) commercial vegetable corns for the Asian market, we found that the floppy tassel characterized all Asian waxies and could be used to identify many waxy genotypes (cf. ae wx, bk2 wx, sh wx). One NIL that has normal tassels is C sh bz wx^Hi27.

(wx flta) y^Hi27 – Waxy kernels, Floppy tassels, White endosperm. Locations; wx = 9S-47.93; flta = 9?; y = 6L-30.13. Origin: hybrid of (wx flta)^Hi27 x y^Hi27. Hawaii stock was simply bred from F2 of this hybrid. Plants and ears mimic the waxy parent, with its floppy tassels. The kernels are unusually chalky-white at base of ears but become more vitreous like the y^Hi27 seeds toward tips of the ears.

y^Hi27 – White kernel. Location; 6L-30.13. MGC 602C. Origin: MGC 87-65 sib. While rediscovering Mendel, Carl Correns (1901) identified y, a locus that usually provides pure white kernels but occasionally pale-yellow ones. The Hawaii stock is pure white and in BC6

after 18 cycles of selection and is classical in appearance. Plants appear identical to Hi27. *Image*

y^Hi27 (Guam)– White kernel, Guam. Location; 6L-30.13. MGC 604AA. Origin: "Guam corn", a large-kerneled white variety well known in Guam, obtained in 1967. Verified in crosses to be y/y. The Hawaii stock is white or very pale yellow (dry kernels) and is in BC7 after 33 cycles of selection. Plants appear identical to y^Hi27, but anthers are red and ears have tiny red glumes (Pl1 is at 6L-52.88). *Image*

y8^Hi27 – Pale yellow kernel. Location; 7S-34. MGC 707FA. Origin: MGC 96-532 self (707F y8 gl1). Merle Jenkins (1947) identified y8 as a pale yellow mutant, and our stock mimics his description. The Hawaii stock is in BC6 after 15 cycles of selection and resembles Hi27 in appearance. Freshly dried mature kernels are a very pale yellow, and testcrosses with y and y11 were distinguishing. *Image*

y11^Hi27 – Pale yellow kernel. Location; Not known. Origin: MGC 96-6422 self. Another of incredible breeder George Sprague's discoveries (1987) as a pale yellow mutant, and our stock mimics his description. The Hawaii stock is in BC6 (paired self and BC) after 11 cycles of selection and resembles Hi27 in appearance. The y11 allele has been verified in our sweet corns with Caribbean origin, and appears to be rather common. Freshly dried mature kernels are a dark pale yellow that is distinguishably darker than y8. *Image*

yg2^Hi27 3:1 – Yellow green plant. Location; 9S-minus 3. MGC 924C. Origin: MGC 63-327 sib (a Chrom. 9 stock with c sh wx and bz). Merle Jenkins (1927) identified yg2 as a pale yellow dwarf mutant, and our stock mimics his description. The Hawaii stock is in BC7 after 23 cycles of selection that eliminated other mutants. Plants remain pale yellow-green from emergence and are dwarfed (20%) and extremely late to flower. Homozygous lines could be created with difficulty. *Image1* *Image2*

zb 232^Hi27 – Zebra leaf 232. Location; Unknown. Origin: Inbred G232, a recombinant inbred in Hawaii's Set G (from B68 x Ki14). The Hawaii stock is in BC6 after 17 cycles of selection. This is a typical zebra pattern with whitish blotches as stripes on leaves, but it's seasonally variable, best seen in hot sunny days, and assumed to involve carotenoid damage. Bands are yellowish and resemble zb1 (Milislav Demerc, 1921). Allelism tests are continuing. *Image*

zbc^Hi27 – Zebra leaf Caribbean. Location; Unknown. Origin: Caribbean composite (1968, Thailand). The Hawaii stock is in BC6 after 29 cycles of selection A typical zebra pattern showing best in cool weather, unlike zb232, with whitish blotches as stripes on leaves after about 6 weeks. It cannot be seen during Hawaii's warm summers (as also noted for loci like zb4 and zb6), and is assumed to involve carotenoid damage. Allelism tests ruled out zb7. *Image*

zn^Hi27 – Zebra necrotic leaf. Location; 10L-44.0. MGC X10F. Origin: MGC zn stock, 1970. The Hawaii stock is in BC7 after 34 cycles of selection. Described by S. Horovitz in 1947, this zebra pattern involves necrosis that can weaken the plants. However our pure line is

late in maturity but otherwise is surprisingly healthy, with large zebra-necrotic blotches between leaf veins. It did once show some smut (rare in Hawaii), as have our gt lines. *Image* *Image2*

zn cm^Hi27 – Zebra necrotic CM207 leaf. Location; Unknown. Origin: Indian inbred CM207, derived out of Fla3H94. Discovered in 1995, the Hawaii stock is in BC6 after 19 cycles of selection. This resembles zn^Hi27 but is very late in development and much less severely necrotic. Neither gene is actually very zebra-like (striped) in this background. Plants resemble Hi27 but kernels are unusually denty. Allelism tests with zn1 and zn2 have not been completed. Image is with zn to left and zncm to right. *Image*

Translocation 4-6b. Location: 4S-80, 6L-16 (1970). Origin: MGC T4-6b. MGC2032F. Hawaii stock with 14 BCs in 17 cycles of breeding. Segregation ~1:1 of ears with defective kernels.

Translocation 4-10f. Location: 4L-90, 10L-14 (1970). Origin: MGC T4-10f. MGC3045A. Hawaii stock with 13 BCs in 17 cycles of breeding. Segregation ~1:1 of ears with defective kernels.

Translocation 9-10a. Location: Unknown. MGC2088B. Origin: MGC 71-B14A x 1805-5Tr. Hawaii stock with 13 BCs in 15 cycles of breeding. Segregation ~1:1 of ears with defective kernels.

TOTAL: 143 Stocks as of January 2011