

SOME LATE-MATURING AVOCADO SEEDLINGS OF VARIOUS PARENTAGE

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Previous publications have illustrated a few early-maturing selections (4—in the Literature Cited), and some Hass open-pollinated progenies (2). The present article will discuss seedlings maturing late in the season, from late winter to mid-summer.

Some of these were the result of self-pollinating individual varieties. This is the most severe form of inbreeding possible, and results in greater uniformity among the offspring. Genetic theory shows that about one-half of the hereditary variability is lost in each generation of selfing.

But the avocado has a peculiar flower mechanism (3), known technically as "synchronous protogynous dichogamy," that ensures cross-pollination under the natural conditions where the avocado developed. And crossing in any organism, even as in human beings, builds up a huge store of what is termed genetic heterogeneity; this is why, for example, there is so much variation among brothers and sisters. Similarly, if a given avocado tree could be selfed and yield millions of seedling offspring, probably no two of them would be actually alike.

Hence, even when avocados are now self-fertilized great seedling variability is to be expected.

The only way to combine in one plant characters that are complementary in two different varieties is by hybridization. This is now being practiced very little in the University of California avocado breeding program because the necessary hand labor, in conjunction with a fruit-set of less than 1%, results in a very high cost per seedling (1), especially in view of the wide range of genetic variability already present in our varieties. But many of the seedlings to be illustrated herein are the result of hand hybridizations in earlier years.

Figures 1 to 5 show seedlings growing in U.C.R.'s Field 16H, harvested in August, 1967; the remaining photographs are from the South Coast Field Station, Fields 6 and 23, taken in June, 1967.

All illustrations are at the same magnification.

FIGURE 1

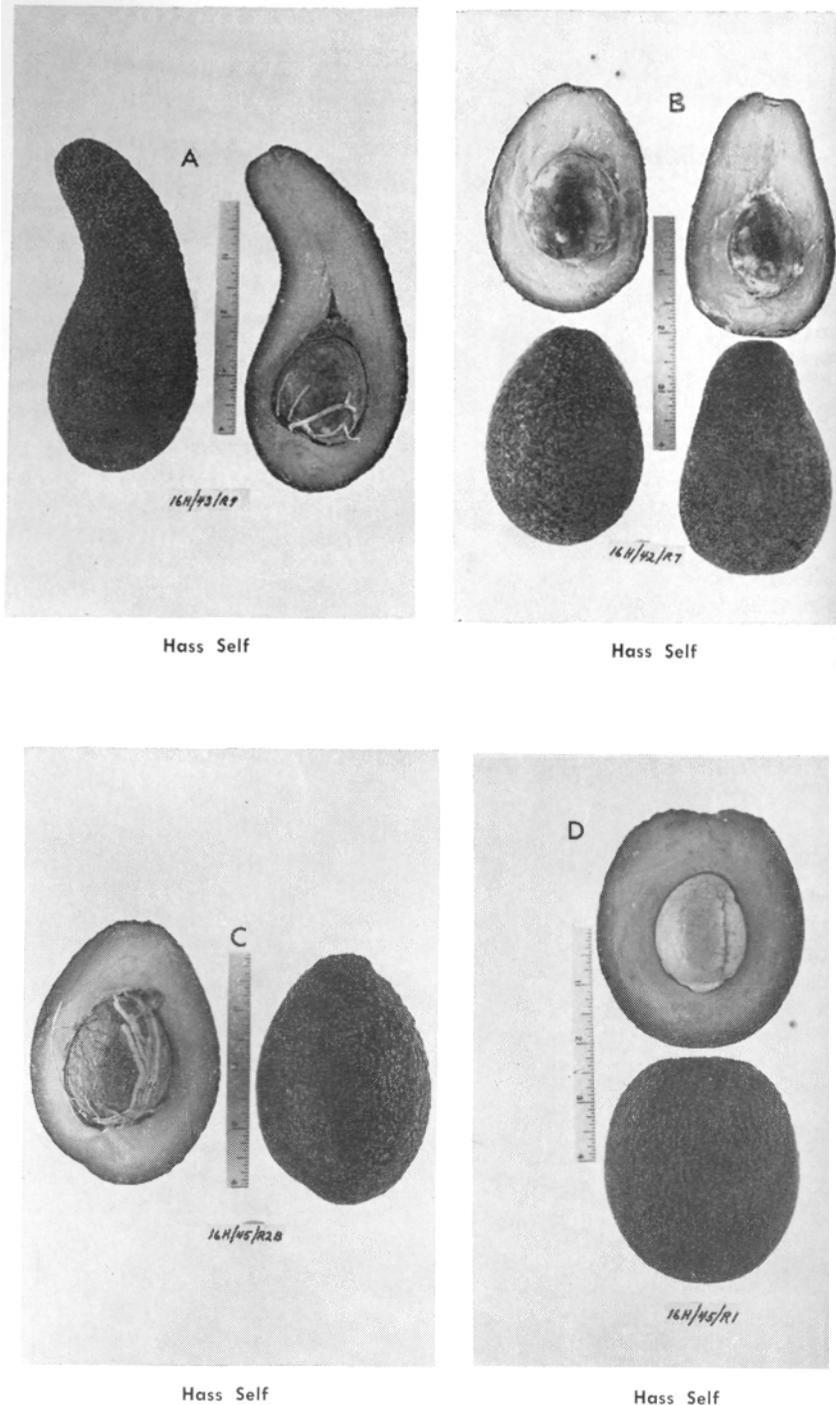


Figure 1. *Selfed Hass seedlings*. These illustrations illustrate some of the variability due to genetic segregation, even following self-fertilization.

It is rather difficult to imagine the elongate **A** shape hidden in the squat-oval Hass fruit. Its shape rules it out for commercial consideration, the extended seed cavity doesn't help any, and neither does the exterior russet and end corking.

B is more the Hass shape, but was discarded because of its severe corking, in spite of good fruit set. Even in a heavily-russeting region like Riverside, such corking in a Hass offspring would hardly be predicted.

C is more of a credit to its parentage. It is an attractive fruit, with no major drawbacks. Flesh color is paler than Hass, and so less appetizing. The fruits were past maturity at this time.

D also looks promising. The surface is exceptionally nice, interior color is richer, seed size averages smaller. The skin is thicker and so more like Hass, but less rough. The skin is green at maturity, darkening as it ripens — as in all four of these seedlings. However, it does not peel well. The flavor in our single sample was disappointing. Set for the 1967-68 season is good.

FIGURE 2

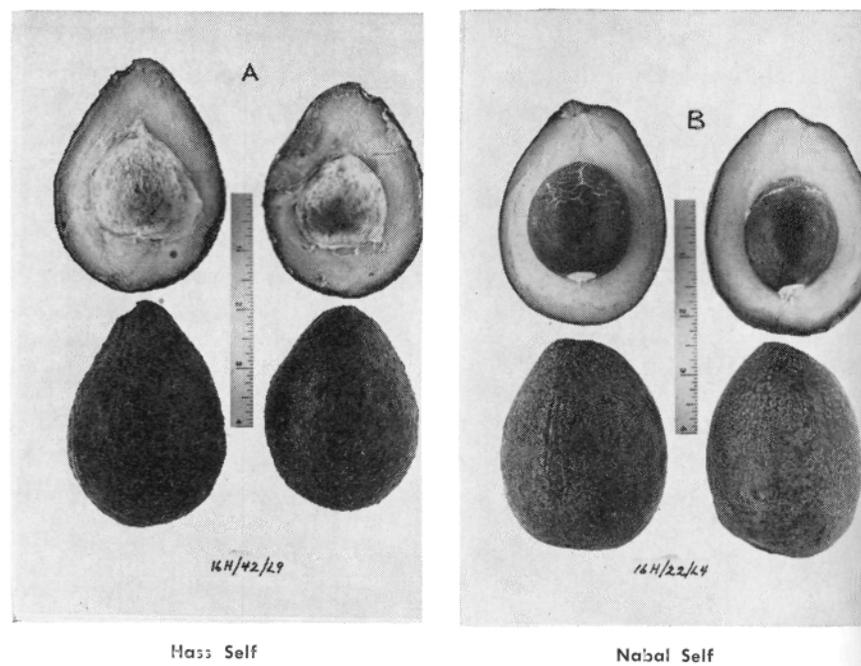


Figure 2. *Hass A* and *Nabal B* selfs. These two are quite a bit alike and both show promise.

A averages a smaller seed than in the two fruits photographed, and had a very good crop. Its skin is green at maturity but purples as it ripens. There is some russet toward the blossom end. Flavor is rich-nutty, although past maturity. The poorly-softened fruits photographed show an objectionable tendency for pulp to adhere to the skin.

As one might expect from the different parentage, **B** averages a larger seed and a smoother skin. Also, it is a pure green when dead ripe. The set was very good. The pulp is less rich in color than is desirable.

FIGURE 3

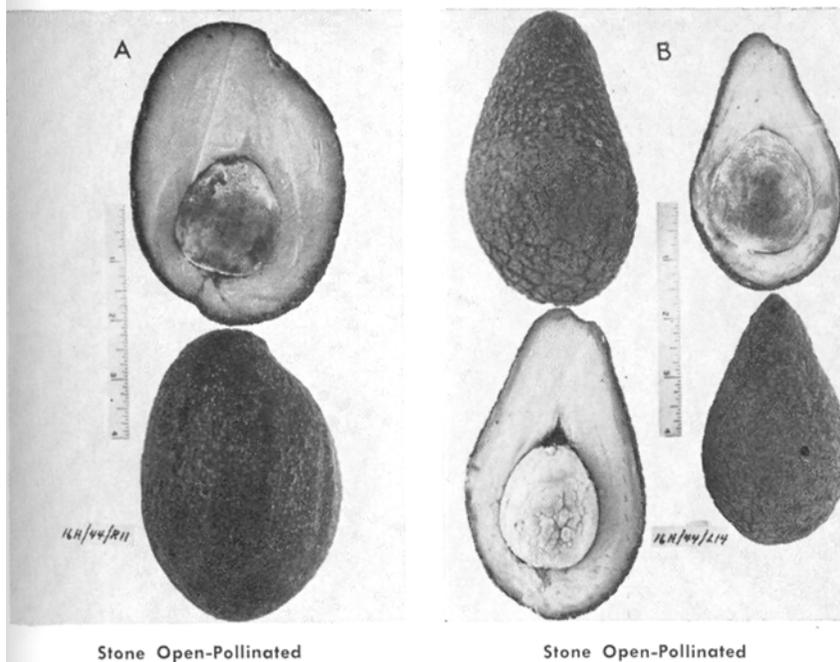


Figure 3. *Stone open-pollinated*. These are from a backyard seedling in Santa Ana. The parent matures in the late-Fuerte season. There were no other avocados growing close at hand, so there seems little danger of out-crossing.

A is a large fruit with a rather small seed. It is green when ripe. In the Riverside area there is some blossom-end russeting, becoming rapidly worse as it softens. Peeling is poor. Fruits are seldom as off-shaped as the one photographed.

B is one of the worst-corked avocados that I have ever seen -- it is worthless.

FIGURE 4

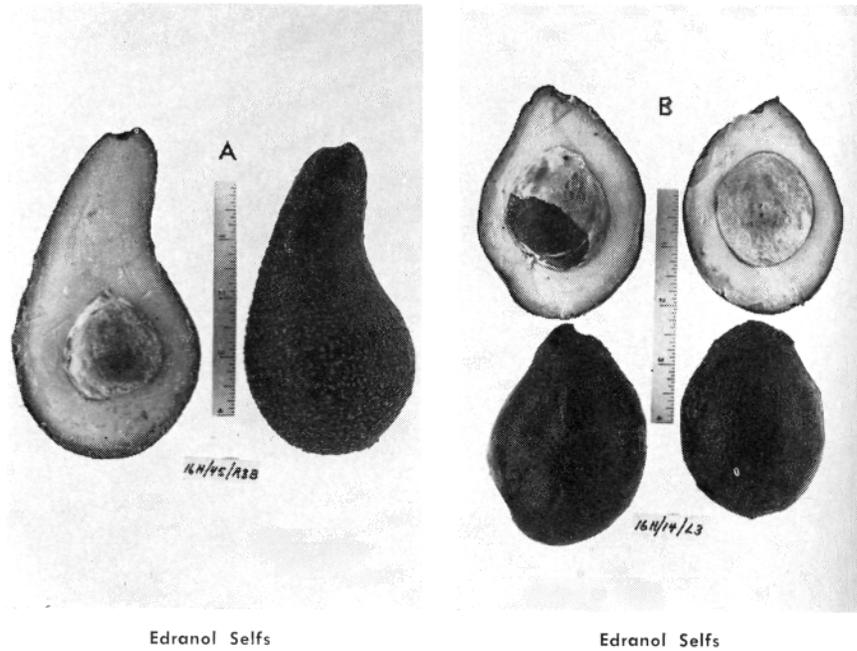


Figure 4. *Edranol selfs*. These illustrate the two opposed tendencies among seedlings derived from self-fertilization: they average rather like their parent, but totally unpredictable types do segregate out.

A definitely reminds one of *Edranol* -- pear shape, green color, russeted skin, skin a little rough but not thick, small seed, nice flesh. Our sampled fruit had a somewhat "sour" taste. I do not care for this fruit shape.

B is entirely different — ovate, purple, very little russet, large seed, greenish flesh. It, also had a flavor much inferior to that of its parent.

FIGURE 5

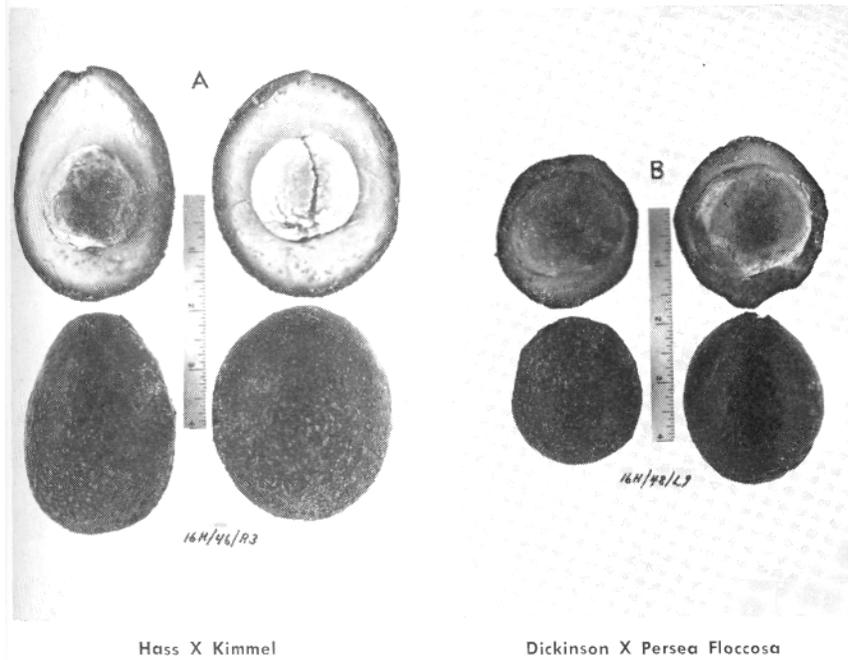
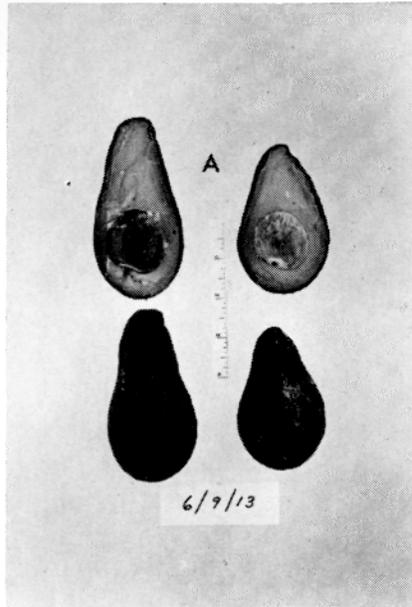


Figure 5. *Two hybrids*. These are the result of pollen applied by hand on flowering branches sleeved to exclude bees (which bring about self-pollination or uncontrolled cross-pollination).

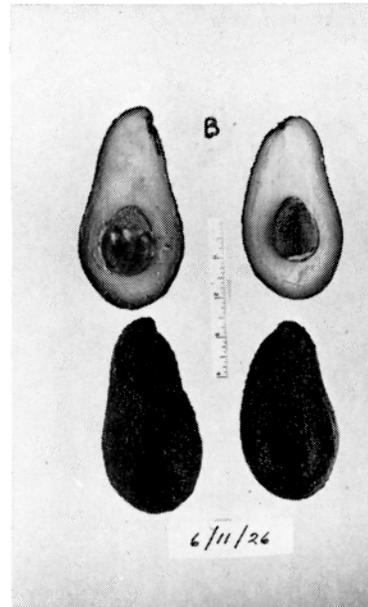
A is a cross of Hass by un-registered variety "Kimmel." A turns purple as it matures. It has some russet. It has a thick skin that peels well. Pulp color is rich and flavor good.

B is a hybrid of Dickinson and the heavy-setting species *Persea floccosa*. It has inherited the monstrous seed of the latter, also its greenish flesh and russeting tendencies; but its set is not outstanding. Fruit size and skin thickness are both considerably greater than *P. floccosa*. And it has the Dickinson purple skin.

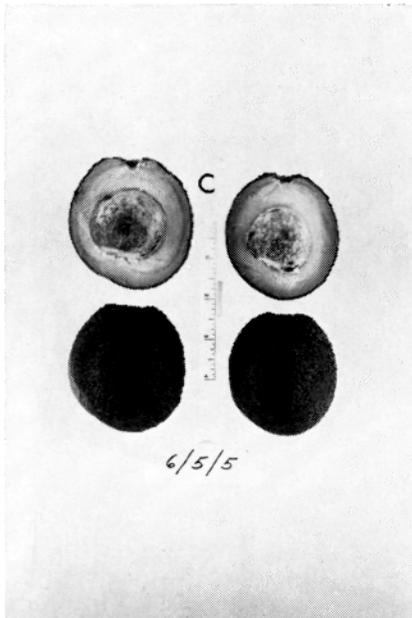
FIGURE 6



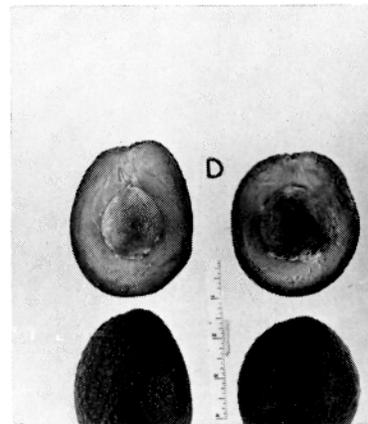
Hass Self



Hass Self



Hass Self



Hass Self

Figure 6. (This begins the seedling selections in Field 6 at S.C.F.S.) *Hass selfs*. These were obtained from a Hass tree on the property formerly owned by Harlan Griswold near Fallbrook. This tree was covered with a cage that excluded bees and other large flying insects, and a hive of bees (supplied with the necessary water) was placed inside after flowering.

A and **B** are two pear-shaped segregants — the shape is too elongated to be ideal. Both turn dark as they ripen. Both have the thicker skin desirable to provide protection during fruit movement to market. Both, and especially **A**, average small proportional seed size. Both have an average fruit size (about 8 ounces) that I consider a bit smaller than the optimum. **B** has some skin russet.

C and **D** are oval to round, a shape that makes packing easier. Both are attractive, with very little russet. Both have the Hass thick skin. They also have its rich-yellow interior, and (which does not necessarily follow) its rich flavor. **C** is a little small and has too large a seed— it sets huge crops. **D** differs from the preceding three in remaining green at maturity; it also has oddly chlorotic foliage.

FIGURE 7

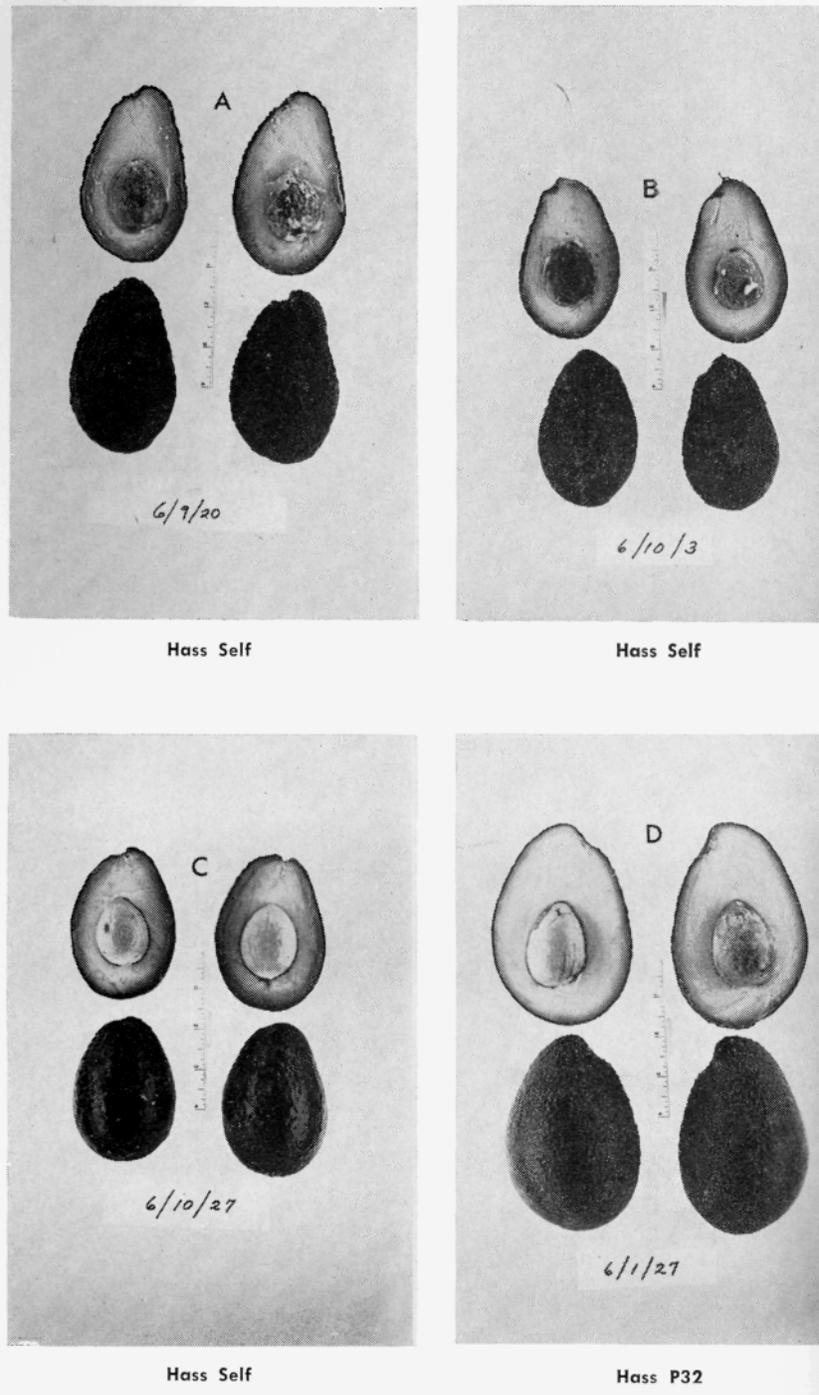


Figure 7. *Hass selfs*, cont. From the same source as Figure 6 are the following selections.

A and **B** are Hass-like in size (which means that they usually don't quite reach the most favorable weight); in purple color; in attractive, blemish-free surface; in thick, rough skin; in small seed size (both are slightly superior to Hass in this respect); in rich-colored interior. Unfortunately neither has set as well as the Hass so far (a selection must be distinctly superior to a named variety in overall commercial promise if it is to be

considered for grower introduction).

C is also slightly small, deep purple, attractive both outside and inside, with a fairly thick skin and a seed that is a bit larger but still averages at least as small as the Hass proportion. It sets well.

The identification-tag was lost in the case of **D**, but it bears the marks of selfed-Hass origin. It has a thick, slightly rough skin of very good appearance, which peels fairly well. The seed is small. The pulp is rich in color; it has no objectionable fibres, and the flavor is good. Fruit shape and size are both favorable. It remains green when fully ripe. The fruit matures about June and is still in good condition at S.C.F.S. by the end of the year. Unfortunately, the preliminary indications of yield have not been propitious. This may be related to the fact that the foliage is oddly distorted, with wavy edges and puckered form. The effect is quite ornamental — but we are primarily concerned with the commercial rather than the backyard grower.

FIGURE 8

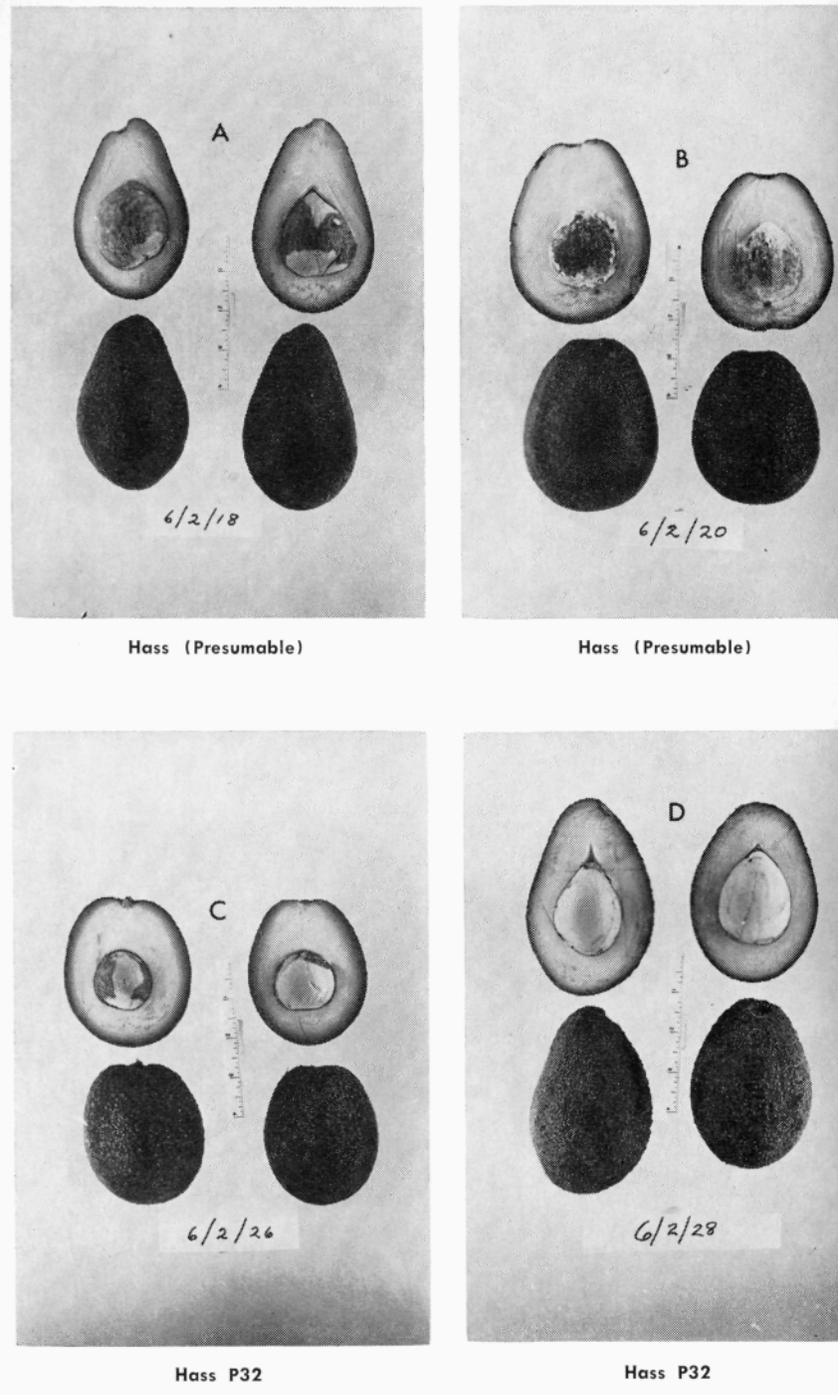


Figure 8. *Presumable Hass selfs*. An attempt was made to induce mutations in Hass scions by means of radioactive P32; there were no apparent vegetative alternations in the ensuing trees, so they were allowed to fruit in the hope that recessive mutations might segregate out. No obvious mutants appeared in either foliage or fruit of the resulting seedlings. But a few look commercially promising enough for further testing. All four were actually the result of open-pollination; however, the evident products of cross-pollination (outcrosses) were all inferior and so have been discarded.

A is somewhat Hass-like, but earlier maturing and with less thick a skin (these two characters are commonly associated by genetic linkage). In two respects it is inferior to the Hass: the fruits have larger seeds, and sometimes have a more curved neck. It is purple at maturity.

The foliage of **B** was remarkably Hass-like. It has good fruit size and shape. There is a little russet toward the blossom end, but the fruits are fairly attractive. They turn part purple as they ripen. Seed size is variable, but averages medium. Interior pulp color is a rich yellow. The skin peels unusually well. The fruits were barely mature in mid-June, but had the pleasant anise flavor typical of Mexican-race types—remarkable for a fruit this late.

C has an unusual oblong-oval shape. It is a green fruit, with much scattered russet of a type that detracts less than usual from its appearance. While the seed coats were brown, the pulp cut with some of the crackling of immature fruits. The seed averages small (the fruit shown to the right has an atypically large seed).

D has such an unusual degree of seed-size variability that we are going to check for sport-differences within the one tree; the two fruits illustrated have objectionably large seeds, plus cavity extension. It is a green fruit of very good surface appearance. Like **C**, in June it gave differing evidence concerning the maturity level. The fruit to the left has a more typical shape, which unfortunately in this seedling is usually slightly crook-necked.

FIGURE 9

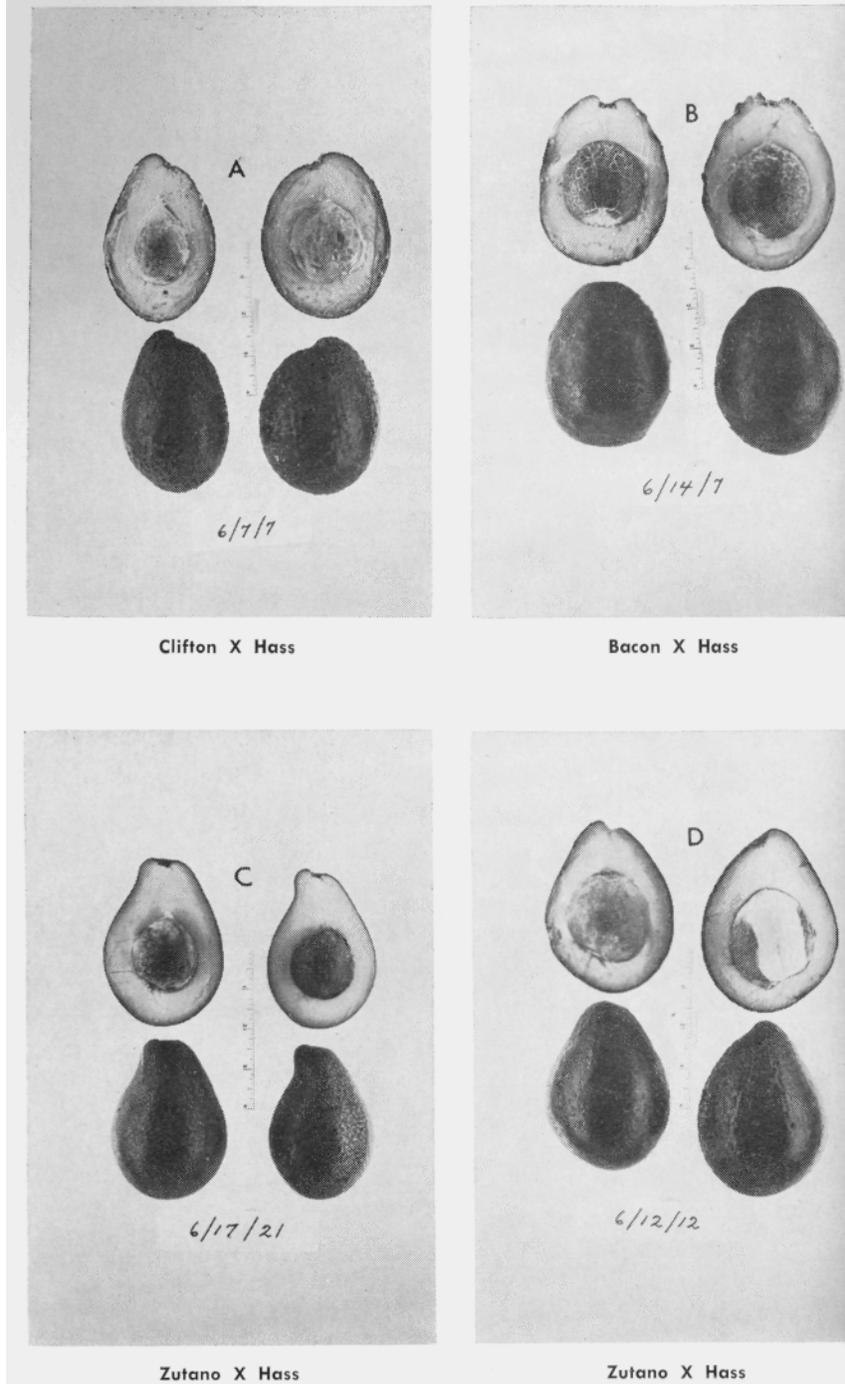


Figure 9. *Hass hybrids*. These hybridizations were made in the hope of adding to the well-known Hass virtues such additional qualities as cold tolerance, general tree toughness, and more regular bearing. Also a Hass type maturing in the Fuerte season might be useful in regions where the latter is not well-adapted. Of the resulting progeny, the great majority were inferior — as is always the case. A few early-maturing ones look good. So do the following late hybrids, chiefly for use in further breeding.

A (Clifton x Hass) is a purple fruit, fairly attractive, with fibre that is more seen than tasted. It peels poorly. The flavor is good.

B (Bacon x Hass) stays green through ripening, and is an attractive fruit with very little russet. The seeds in the photograph are rather large, but they average only medium; their coats have an unusual, checked appearance. Yields are consistently very good. The skin is remarkable because it is as thin as its Bacon parent (unusual for a fruit in this season) and yet it has hints of Hass roughness.

C and **D** (both Zutano x Hass) are slightly necked, thick pears, with **C** especially attractive in appearance. **D** is purple and **C** green, at full maturity. **D** has the advantages of a thicker skin, a richer pulp color, and less neck-crooking. It is one of the heaviest-setting avocados that I have seen. Unfortunately, the seed is just too large (averaging even larger than those illustrated).

FIGURE 10

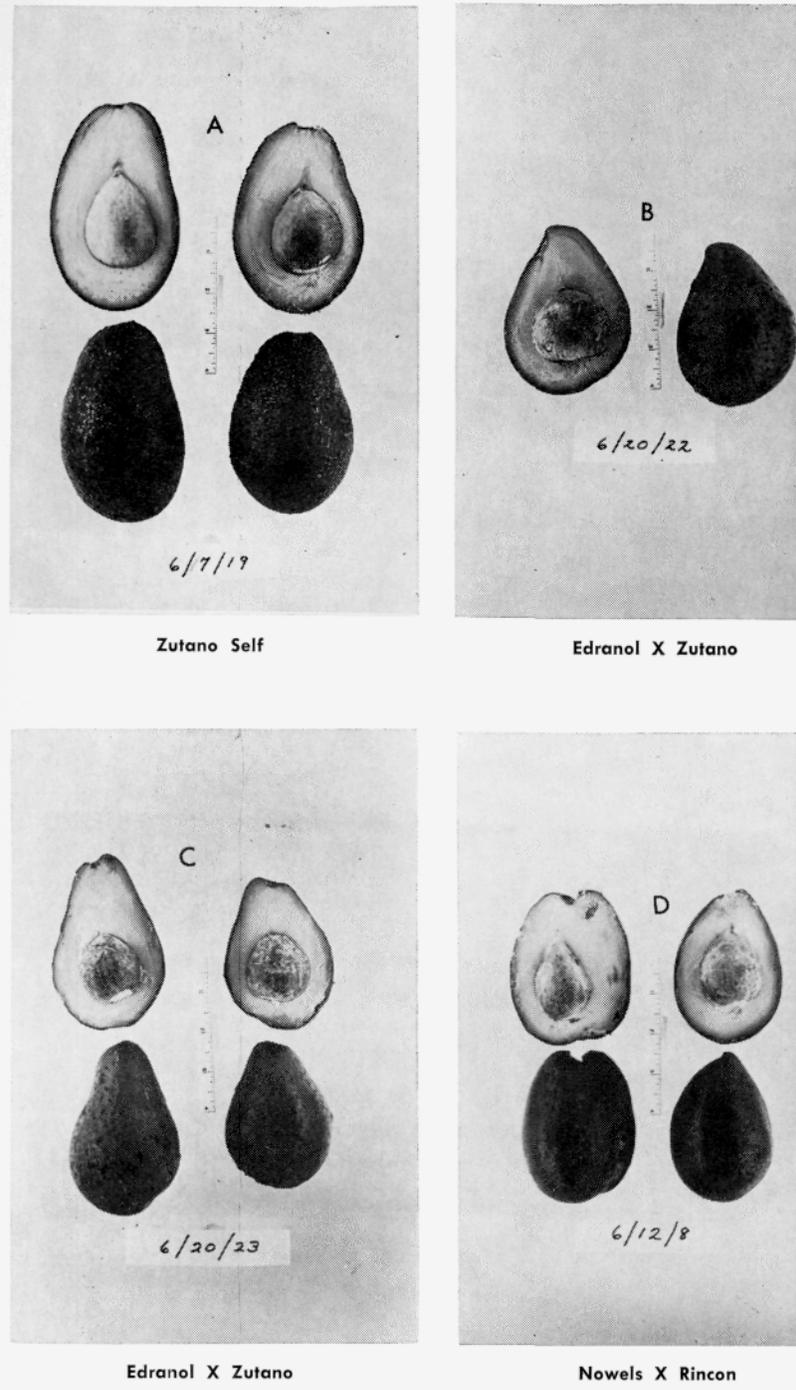


Figure 10. Mostly Zutano.

A is the best of a large number of selfed-Zutano seedlings obtained at the Griswold ranch by the method described for Hass. It has good shape and size, with a smaller seed and much thicker skin than its parent. It is green when full-ripe, but russets much and develops the parental corky end-spot. Peeling is poor. The flesh is a little pale, hut

with good flavor.

B and **C** are hybrids, Edranol x Zutano. Such squatty pears may not be an ideal shape, but are acceptable. Both are green, with considerable russet and neither is attractive. The pulp is the beautiful rich color of the Edranol parent. Both set good crops. **C** averages a smaller seed. It will be interesting to see what combinations segregate out in the F^2 from this cross.

D is a "maverick" hybrid (Nowels x Rincon), included here for convenience. It is a deep green fruit like Rincon, very attractive as it matures on the tree, but with much russet-browning as it ripens. The skin is surprisingly thick. Flesh color is rather pale. Peeling is only fair. A small minority of the fruits has the fleshy ridge of the fruit to the left; this is a consequence of a flower with two ovules instead of one—the second ovule aborting instead of producing a second seed. It sets very good crops.

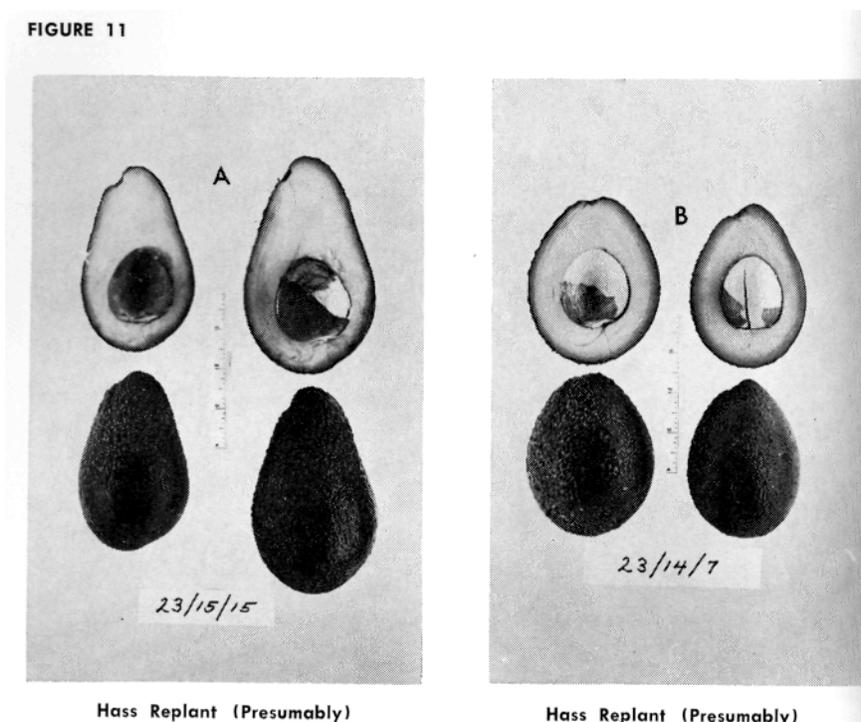
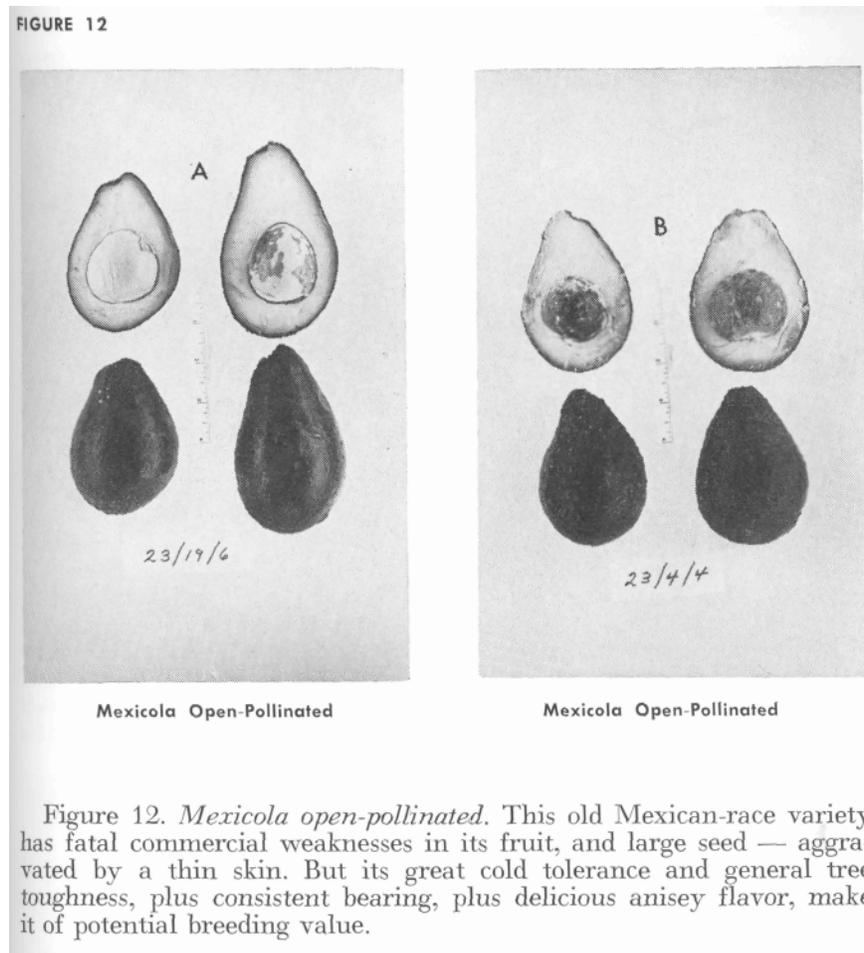


Figure 11. (This begins the selections from Field 23 at S.C.F.S.)
Hass selfs. Each of these was a re-plant, after the original tree died.

A resembles its parent. Its skin is somewhat thinner, and much smoother. It is somewhat more elongate. Its seed proportion is a bit larger — and a bit larger on the average than the two illustrated. Like Hass, it turns dark as it matures.

B is another fruit of slightly below optimum size. Its shape has advantages. Its skin is

thinner if anything, but definitely rougher. It peels fairly well. Its surface is beautiful. Its seed is larger than we prefer. It holds on the tree well past maturity, but does drop many fruits by June. Interior color is rich. The flavor is mild but good.



A and **B** are two obvious outcrosses. The pollen parent, while unknown, was evidently of the Guatemalan race in both cases. Both are still a little sub-standard in terms of both fruit and seed size; but since each is an F^1 (first generation) racial hybrid, selfing it to obtain an F^2 (second generation) population will produce a wide range of interesting and hopefully superior segregant seedlings.

A turns an attractive purple color at maturity, drops most of its fruits by mid-June, has somewhat pale flesh. Its skin is of medium thickness, and smooth. Its foliage has the ornamental appearance of its maternal parent.

B is a glossy green, darkening as it ripens. The skin is both thicker and rougher, peeling fairly well. Fibres show in the pulp but are not tough enough to be serious. The anise flavor is present to a reduced degree. Set is good and hangs well on the tree.

FIGURE 13

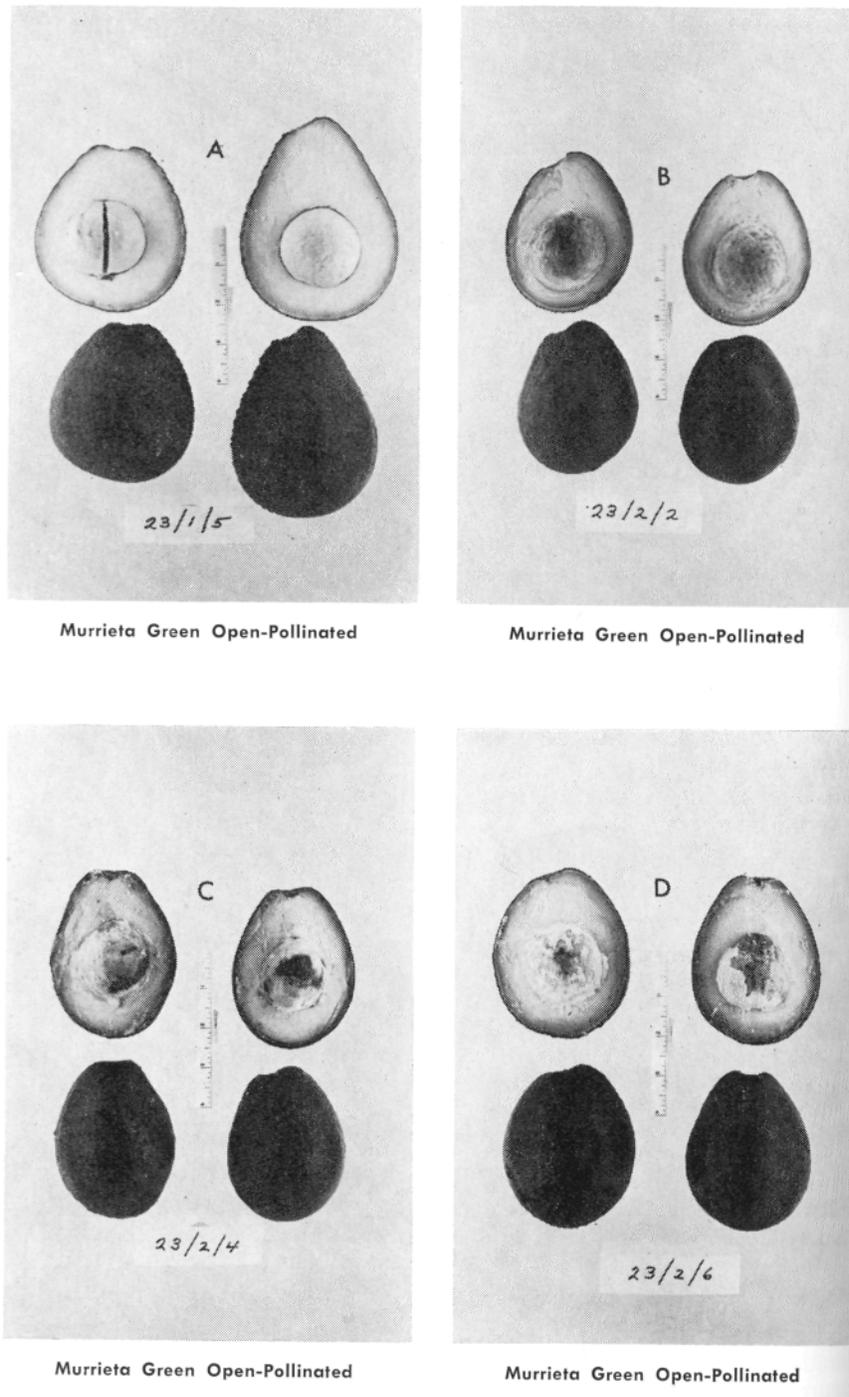


Figure 13. *Murrieta Green open-pollinated*. Like the Mexicola, M.G. originated in California about 55 years ago. It is a Guatemalan, requiring about 15 months to mature from fruit-set—so it matures roughly in the Mexicola period but a year later. The M.G. is of equally high quality (of course without anise). The fruit errs in the opposite direction by being too large for ready marketability in most American markets. An even more serious shortcoming is the weak growth of most trees propagated in the usual way.

We hope to find a seedling without the latter problem. If its fruit size were somewhat smaller, it might be of direct commercial value; otherwise, it might be a useful parent for hybridizing with undersized Mexicans such as Mexicola or Yama. The M.G. seedlings proved generally vigorous. As with all progeny sets, many failed to set fruit. Those that did were all of the general M.G. type, indicating that there was very little outcrossing and so the seedlings are largely M.G. selfs.

Seed size consistently averaged just above medium (the two fruits sampled for **A** have seed proportions a bit below average for the tree, while the fruits in **B** are atypical in the opposite direction). **B**, **C**, and **D** are barely of good commercial size, while **A** is closer to M.G. Each has a thick skin, with that of **B** remarkably so. **A** is moderately rough; **C** and especially **D** have objectionable scattered "warts." **A** and **D** have especially attractive surfaces, with the latter of a very deep green color. **B** has a corky end spot. All remain green when ripe. All had brown seed coats, but cut barely ripe, indicating that these M.G. offspring are late-summer fruits. In fact, **D** cut immature in mid-June, and had a very mild flavor, while **C** was flat-tasting and watery. Set was generally moderate, except for a huge crop on **D**.

FIGURE 14

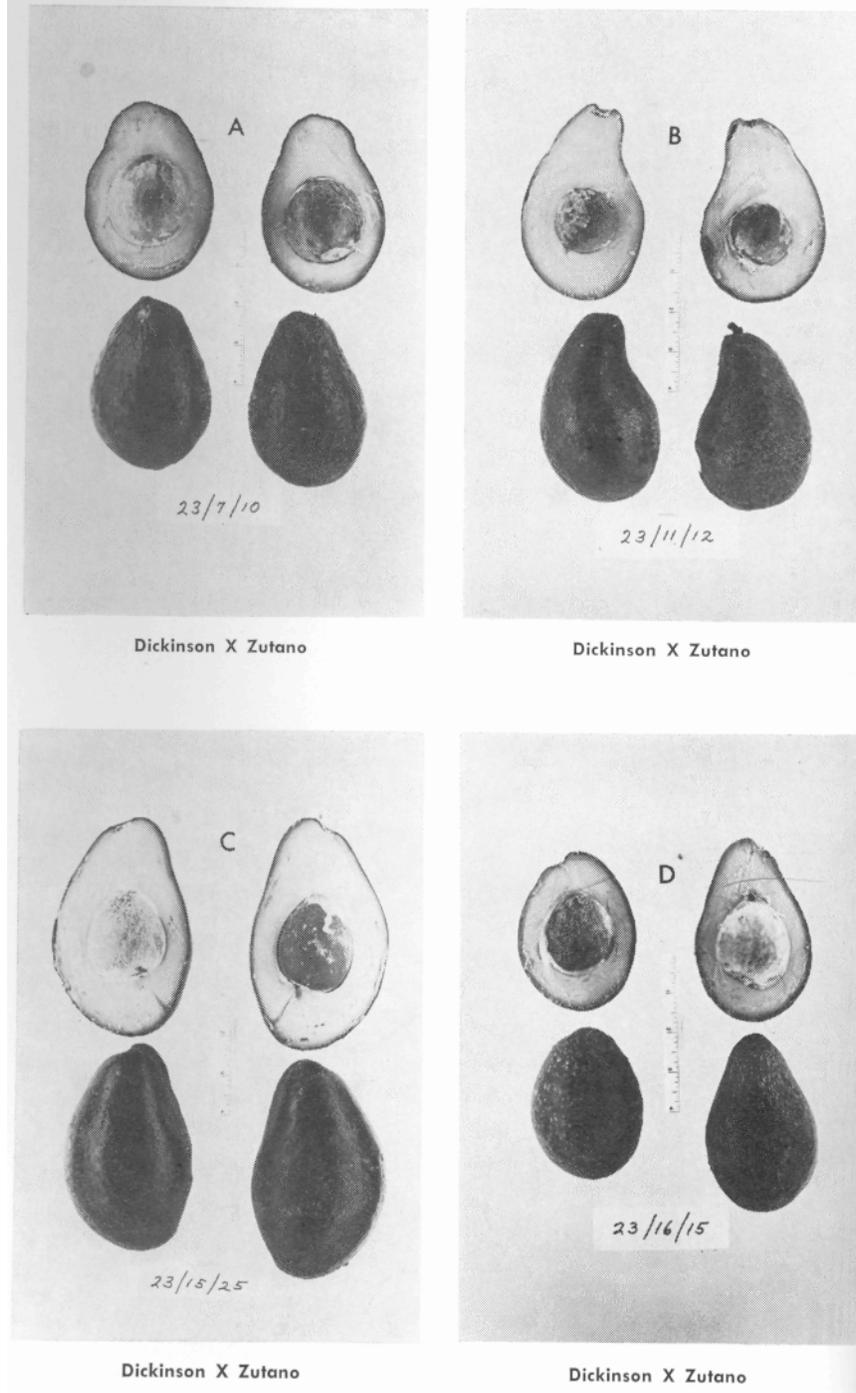


Figure 14. *Dickinson x Zutano hybrids*. The aim here was to combine the hardiness and perhaps the green color of the latter with the small seed, better flavor, nicer surface, richer pulp color, and longer season of the former, while retaining the good-setting features of both; a superior fruit should combine their genes to achieve a medium-thick skin better than either extreme, plus a fruit size that is intermediate or nearer the smaller (Zutano) parent, plus a fruit shape intermediate or nearer the rounder (Dickinson) parent.

A and **C** are purple, the other two green-skinned.

The seed ratios of **A** and **D** are at least as great as that of Zutano, **C** has a medium seed, and only **B** has the small Dickinson seed.

All have a fairly good, rather mild, flavor; **C** seemed to have a hint of anise.

A, **B** and **D** are all russeted, though only **B** had the typical Zutano end spot. The yellow surface spotting of **D** is also suggestive of Zutano—but in the seedling this trait is not as favorable as it is in the (male) parent.

B has pale but attractive flesh, **C** is intermediate, and the other two are rich yellow in color—**D** has the richest-colored pulp that I can recall seeing in an avocado.

All were fully mature, although only **A** and **B** had as yet dropped many of their fruits.

All four were good fruit-setters.

The skin was rather thin in the case of **B** and **C**, while the other two had thick skins. **D** is of interest in that it combines a thick skin (from the Dickinson parent) with a smooth surface (like Zutano); the result is a skin rather like that of Nabal, for example.

In terms of fruit size, **D** is smaller than is ideal; the other three are large—but I think not unacceptably so.

All four have shapes intermediate between the two parents; the curved necks of **B** and **C** are less desirable.

In this small sample of four, the various parental traits are thus seen to be juggled almost at random. This indicates that there is no close chromosomal linkage between the genes responsible for the various traits of economic importance. Such a situation is propitious for the combining in one fruit of characters present in two different varieties.

FIGURE 15

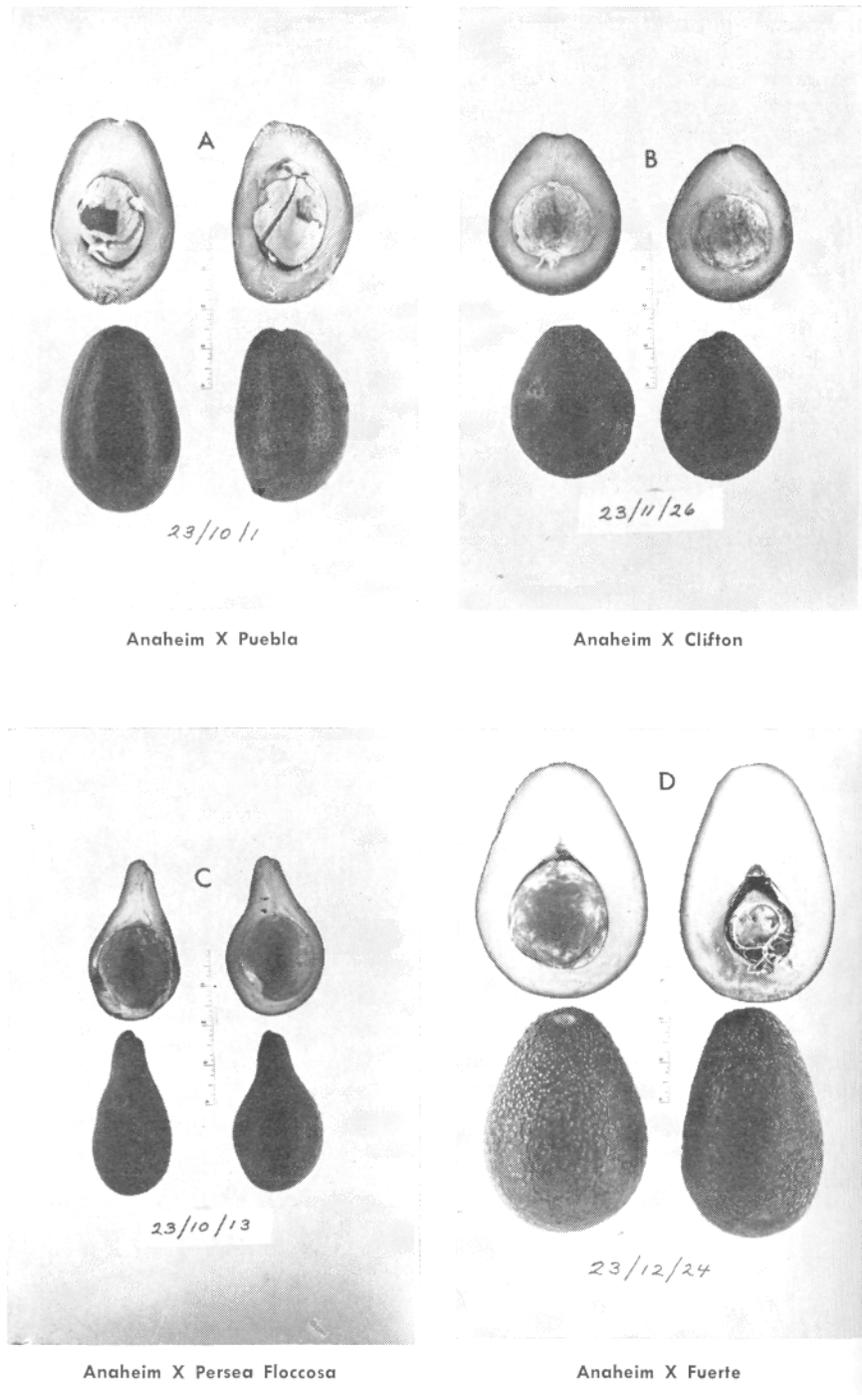


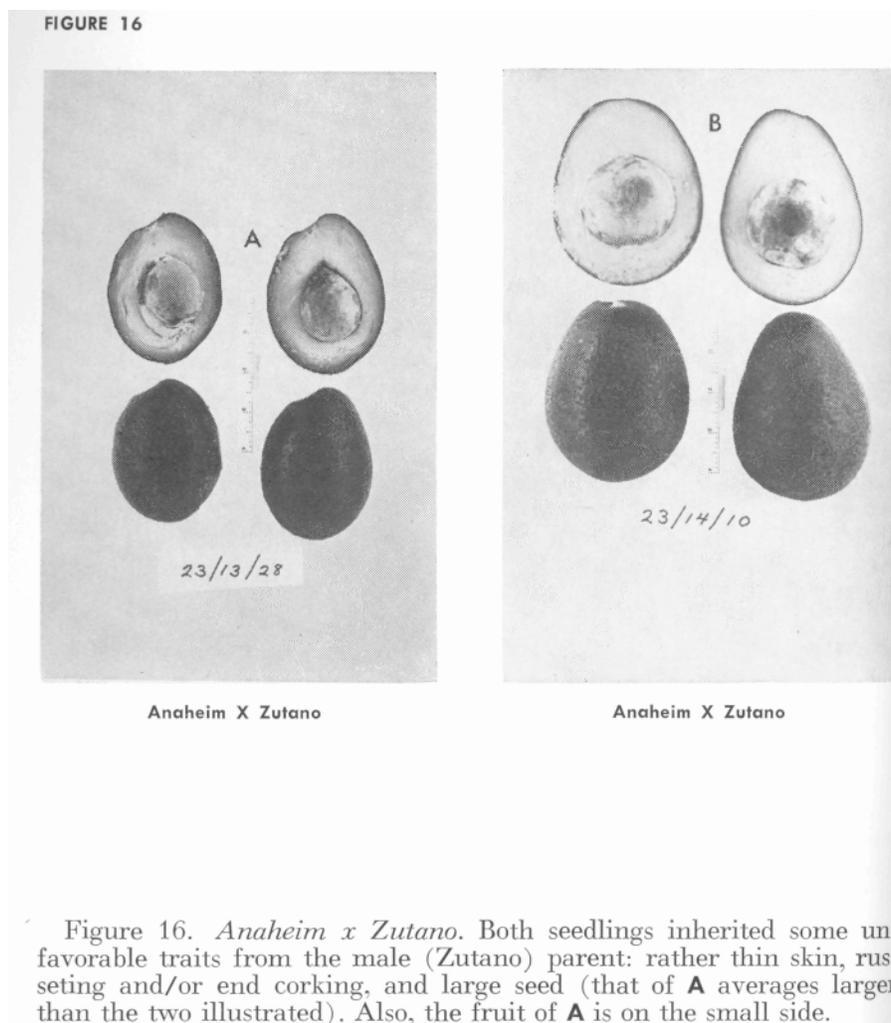
Figure 15. *Anaheim* hybrids.

A and **B** represent crosses to Puebla and Clifton respectively. In both cases the aim was to retain the Anaheim prolificity, thick skin, and small seed ratio, while reducing fruit size, increasing flavor, and putting the fruit in a hardier tree. Unfortunately, both seedlings have too large a seed. Tree hardiness can be rated only after we experience

a freeze. In other respects the aim was achieved reasonably well. **B** is the better of the two in that it has a more attractive appearance, retains its green color when ripening, has yellower pulp, peels better, has a superior flavor, and sets very heavily.

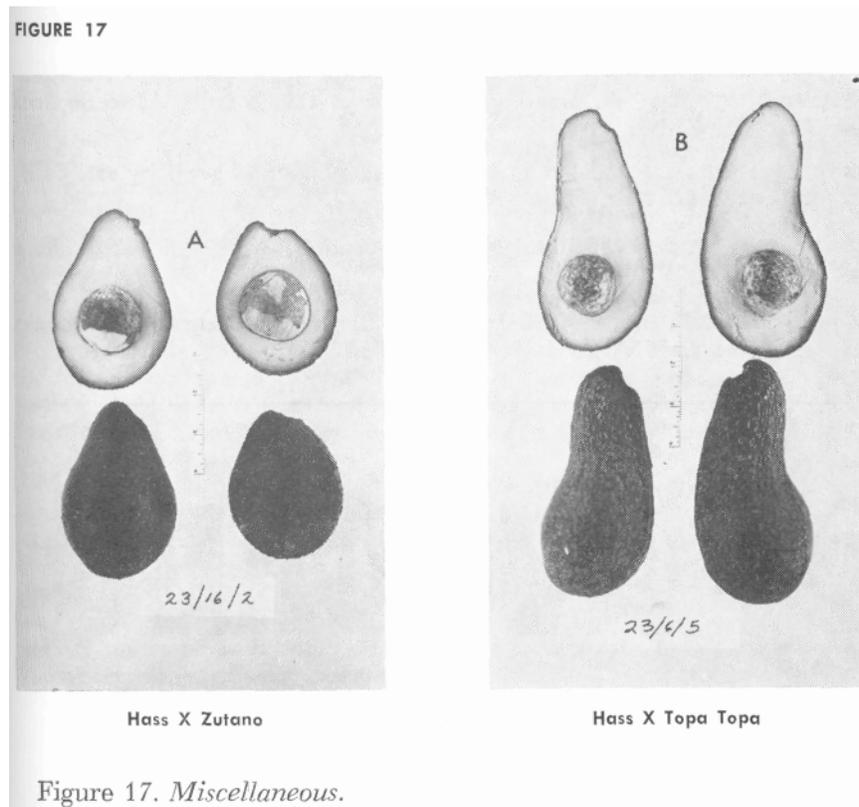
C is another cross to the prolific *Persea floccosa*. It indeed sets tremendous crops, but has an ugly russeted surface as well as a huge seed (reflected in the slim-necked "bell" shape,). A fruit this un-commercial is probably not even worth selfing.

In the case of **D** the male parent was Fuerte. The skin is thicker than that of Fuerte; but set has been disappointing, the seed averages larger than either parent (the one sectioned on the right is atypical), the cavity usually extends, the flavor is somewhat bitter (at least late in its season), and it russets. One may feel a sentimental attachment for a hybrid of the mighty Fuerte—but a commercial avocado enterprise is not helped by sentiment.



B has a good shape and a very good set; its flesh is pale. Selfing the F^1 hybrid of two such dissimilar varieties may well give us a good commercial fruit among the variable F^2

types that would be expected to segregate out.



A is yet another Zutano cross, this time with California's "best all around avocado," the Hass. If one could get a Hass type with a green skin for some markets, plus a tree more resistant to cold and other environmental adversities, one would really have something. Another reasonable contribution by the Zutano genes, earlier maturity, would be a fine addition for a second seedling. **A** is the most promising of this progeny set. It is in the Hass season, so must compete with the "best." It is about the Hass size, and also purple in color. It is very attractive—but so is Hass, in a different way. It sets heavily—but so does Hass. It is markedly inferior in terms of average seed size. Its thinner skin is probably also a drawback; there is less culinary wastage, but the skin is barely thicker than that of the Fuerte, and may well give inadequate shipping protection.

B is an open-pollinated Topa Topa seedling. That the offspring of such a variety could have the smallest seed ratio of all seedlings in these three fields is a jolting reminder of the tremendous genetic variability inherent in the avocado. It also has a fairly thick skin, a fairly rich pulp color, fairly good flavor (much superior to its maternal parent), and good peeling qualities—as well as this a remarkably late season. Its "banana" shape rules it out commercially; in addition, its irregular purpling plus considerable russet give it a poor appearance. But the breeder immediately wonders about genetic segregants . . .

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