California Avocado Society 1986 Yearbook 70: 135-146

Taxonomy of the Avocado

Bob Bergh and Norm Ellstrand
Department of Botany and Plant Sciences, University of California, Riverside

Anyone familiar with avocados knows that there are many different kinds. They differ in such significant ways as length of time from bloom to fruit maturity, thickness of skin, tolerance of cold, etc. What major classifications do these differences fall into? And, first of all, where does the avocado fit in the plant world? Taxonomic study tries to answer such questions.

The Laurel Family

The avocado is a member of the large plant family known as the Lauraceae, or laurels. The family is named for the Grecian laurel tree, or "sweet bay" *(Laurus nobilis),* whose foliage adorned the brows of the champions in the ancient Pythian contests at Delphi, Greece, every four years; unlike the rival Olympic games, the Pythian competitions included cultural events like music and literature.

Most of the laurels have foliage that is fragrant when crushed, for example the Mexican race of avocado — from whose leaves pleasant teas and wines have been made. The only California native is the California laurel *(Umbellularia californica),* also known as the California bay, Oregon myrtle, or pepperwood; its leaves are so powerfully aromatic that they can cause headaches. Both the Grecian and the California laurels grow well in our avocado areas. Both are grown as ornamentals, and the leaves of both are used as flavoring in soups and stews.

Most members of the laurel family are tropical or subtropical, including the avocado. But there are two hardy American natives: spicebush, sometimes used as a substitute for allspice; and sassafras, whose powdered bark is still used medicinally and whose bark and leaf flavoring make a pleasantly scented tea, are used in cooking and in carbonated beverages.

More typical of the family in terms of both origin (Southeast Asia) and climatic adaptation (tropical) is the *Cinnamomum* genus. Two species of it provide bark for commercial cinnamon spice, whose aroma made it valuable for perfume, incense, and sacred anointing oil in Old Testament times ("sweet-smelling cinnamon"), and worth more per pound than gold in later trade out of Ceylon (now Sri Lanka). A third species provides the pungent camphor of medicinal and also industrial uses; it makes a handsome large ornamental tree in southern California and elsewhere, and has been somewhat grown commercially in the Gulf States. This genus is the only one besides avocado of significant commercial importance. Like the avocado, these and most family members produce many small yellowish flowers.

The *Persea* genus

The great Swedish botanist and taxonomist, Carolus Linnaeus, placed the avocado in the *Laurus* genus with the Greek laurel. But, in his "Gardeners Dictionary," Miller (1754) published a description of the valid genus *Persea,* That name had been used by others earlier. It was apparently taken from Greek mythology and has no known factual connection with the country of Persia (Kopp, 1966).

The *Persea* genus contains some 50 species. One of these is the true avocado, *"americana."* So, adding the abbreviated name of its describer, the avocado is botanically designated *Persea americana* Mill.

As its name indicates, *P. americana* originated in the New World. So did most of the species, but *P. indica* came from the Canary-Madeira-Azores islands, and several presumed species are native to southeast Asia.

The species fall into two groups: *P. americana* and a few closely related species on the one hand, and a large and quite variable group of species on the other. Each of the two groups is a subgenus. The commercial avocado, P. *americana,* is in subg. *Persea* (the same as the genus name), and the larger group of species are placed in subg. *Eriodaphne,* The two subgenera are sharply distinct. This is unfortunate for us, because subg. *Eriodaphne* contains a few species that have total resistance to *Phytophthora cinnamomi* root rot; repeated attempts to graft *P. americana* on them, or to hybridize *P. americana* with them, have invariably failed. We hope that the new, developing fields of microbiology ("genetic engineering") will enable us to bridge the chasm — possibly by cell fusion.

Most species in the *Persea* genus have their trees used for firewood or construction. A native of the southeastern United States, *P. borbonia* (swamp-bay or red-bay) has been described as having beautiful cabinet wood. And one of the species in the avocado group, *P. schiedeana,* is cultivated on a small scale in Mexico for its (inferior to most people) fruit. Moreover, since *P. schiedeana* is thought to be one of the parents of the promising new G755 rootstock, the species may prove of value to the avocado industry. Also, as noted above, scientific advance may make resistant members of subg. *Eriodaphne* valuable. But, at this time, the only *Persea* species of much economic importance is the avocado itself, *P. americana.*

The avocado—*Persea americana*

Three distinguishable ecological races of avocado have long been recognized. They have ordinarily been termed the Mexican, Guatemalan, and West Indian types or races, named for their presumed respective centers of origin. (Their origins are discussed in a paper elsewhere in this Yearbook.) The races differ in many traits, some of commercial importance (Table 1, adapted from Bergh 1975).

Table 1. Comparison of the three avocado races.

Trait	Mexican	Guatemalan	West Indian
TREE			
Climatic adaptation:	"semitropical"	subtropical	tropical
Cold tolerance:	most	intermediate	least
Salt tolerance:	least	intermediate	most
Hairiness:	most	less	less
Leaf anise:	present	absent	absent
Leaf color:	medium	often redder	paler
FRUIT			
Months to mature:	6	12 or more	5
Size:	small	variable	variable
Pedicel (stem):	slender	thick	"nail-head"
Skin thickness:	very thin	thick	medium
Skin surface:	waxy bloom	rough	shiny
Seed size:	large	small	variable
Seed cavity:	loose	tight	variable
Seed surface:	smooth	smooth	rough
Oil content:	highest	high	low
Pulp flavor:	spicy	often nutty	mild

The botanical classification of these three races has varied. A number of observers have split off the Mexican type into a separate species, *P. drymifolia.* Kopp (1966) accepted that separation, but concluded that the Guatemalan and West Indian races differed from the Mexican to a lesser degree, so that they were not different species but only different subspecies. More recently, Williams (1977) instead separated the Guatemalan race into its own species, *P. nubigena,* distinct from the other two which he left in *P. americana.*

We will be publishing elsewhere a detailed technical evaluation of this taxonomic dispute, considering all the available evidence — morphological, geographical, physiological, and biochemical. The evaluation is much strengthened by the addition of enzyme electrophoresis data. Such isozyme data are a powerful new tool for studying different aspects of a crop like the avocado, particularly parentage and taxonomy problems. Isozyme work began at UC Riverside with a generous grant in 1978 from the California Avocado Advisory Board, forerunner of the present California Avocado Commission. As a result, we have published several papers on avocado isozymes, including two in the 1978 Yearbook of the California Avocado Society (by Torres and Bergh).

More recent isozyme data strongly support the taxonomic conclusion that the three avocado races are about equally related, each one to the other two. Thus, the taxonomic separation of either the Mexican (Kopp) or the Guatemalan (Williams) is not substantiated.

What is the best taxonomic status of the three races? The isozyme data support other evidence in indicating that the three are not different enough to be separate species and are too different to be merely separate forms. They can be designated three subspecies or three botanical "varieties". We have adopted the latter terminology. So the Mexican, Guatemalan, and West Indian ecological races become respectively, *Persea americana* var. *drymifolia, P. americana* var. *guatemalensis,* and *P. americana* var. *americana.*

This conclusion, that the three races are about equally distinct from each other, agrees with the judgment from extensive field observations over 45 years ago (Popenoe, 1941). Wilson Popenoe was indeed a remarkably discerning authority on the avocado.

Guatemalan race (Figure 1). As Table 1 suggests, this fruit averages the highest in horticultural quality of the three races. The skin is thicker, protecting the pulp inside. The seed is usually smaller, and it is tight in the cavity. These advantages are illustrated in Figure 1. (The seed of Dickinson in A looks slightly loose; this is a consequence of seed movement when a soft-ripe fruit was sectioned.) Both of these Guatemalan race photographs were taken about 75 years ago.

Actually, the two skins illustrated in Figure 1, especially A, are thicker and suffer than is horticulturally desirable. They do not yield to gentle pressure, and so make it difficult to tell when the pulp has softened for eating. In fact, the ripeness of Dickinson and other Guatemalan hard-shell types sometimes was tested by inserting a toothpick or similar probe into the open stem end. This stiff skin also tends to chip instead of peel; however, it does lend itself to eating the fruit in the "half-shell." Not all Guatemalan avocados have this thick or woody a skin.

Another invaluable advantage of Guatemalans is their much greater length of time to maturity (Table 1). This not only of itself provides a later harvesting season, but hybrids with the two earlier-maturing races bridge the race maturity gap; in a climate like California, fruit is therefore picked commercially year-round. The Nabal, which was as one time second only to the Fuerte in importance in California, may take 15 months from bloom to maturity in our climate; the Queen, even longer.

In Figures 1-3, the term "variety", abbreviated var., is used for the three "sub-species." This is the correct botanical terminology, which uses the word "cultivar", abbreviated cv., for particular clones like Dickinson, Queen, Hass. But the commercial avocado industry, like most fruit industries, instead usually uses the term variety for such clones. That is, "variety" has two quite different uses, a commercial versus a much broader botanical meaning. This confusion is unfortunate. In this rather technical paper, we will limit the use of variety to its botanical-taxonomic sense, and use cultivar if necessary when referring to clones such as Hass. We minimize use of variety by substituting the long-established comparable word, "race."

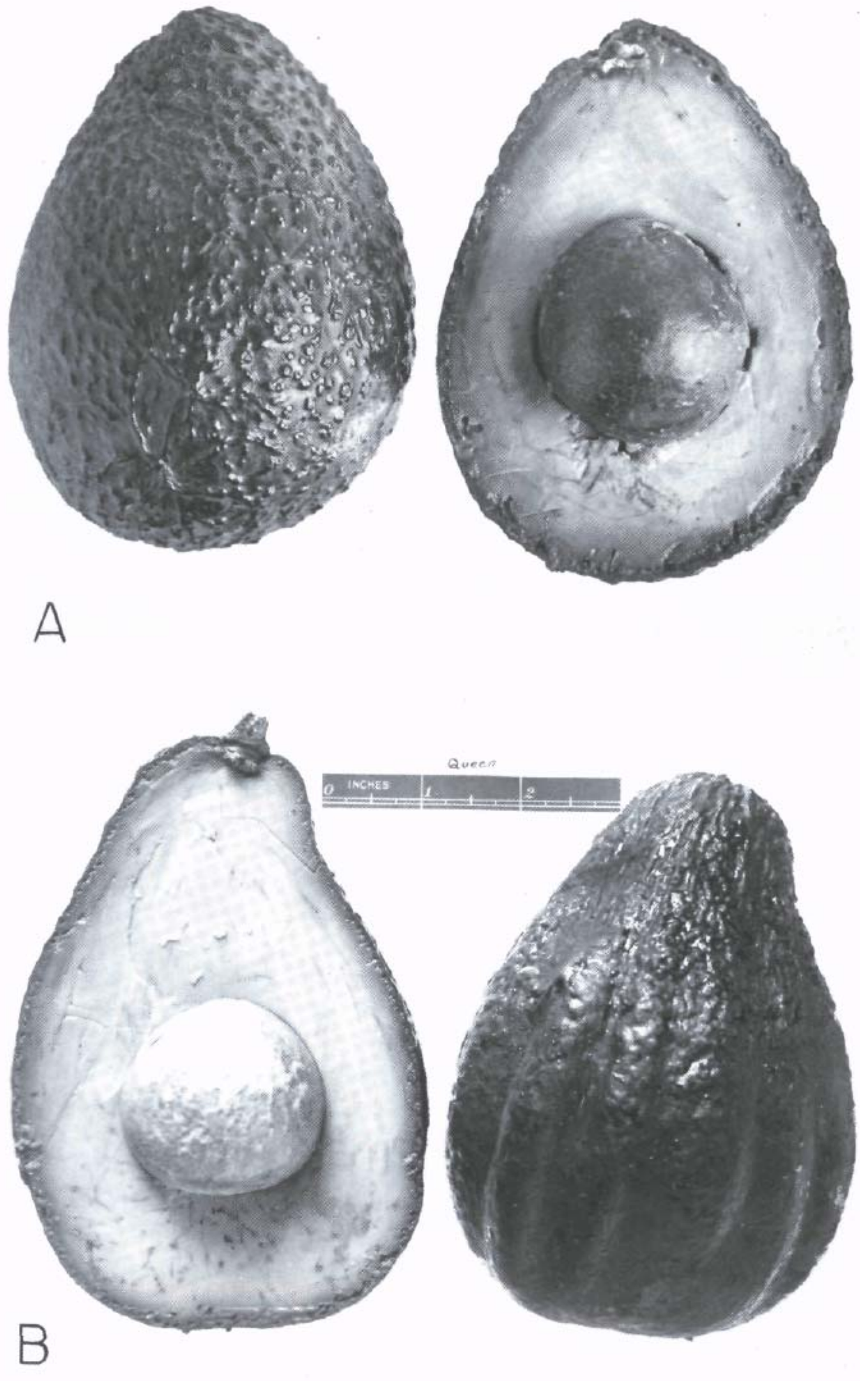

Figure 1. Guatemalan-race avocados. Variety Dickinson (A) and Queen (B). Persea americana *var.* guatemalensis.

Mexican race (Figure 2). As Table 1 states and Figure 2 illustrates, the Mexican type has a delicate skin that provides little protection for fruit shipping or handling; a fingernail can rupture it. Additionally, the seed is large and often objectionably loose in the cavity. That of A, Topa Topa, looks tight, but only the seed coat fills the cavity; the seed is loose inside the coat. And the fruits are generally smaller than is commercially desirable.

Nevertheless, this race has found two valuable services for California avocado growing: hybridization and rootstocks. Hybridization with Guatemalan types can amend the serious drawbacks noted above. Moreover, the Mexicans have two important positive contributions of their own to make: advancing the Guatemalan harvest season by half a year, with hybrids ranging from largely Mexican to largely Guatemalan, and adding much more cold hardiness.

Our dominant Hass cultivar illustrates both contributions. It is usually described as Guatemalan, but our observations of its selfed progeny indicate that it is about 10-15% Mexican; which explains why it matures months earlier than pure Guatemalans such as the Dickinson or Queen. Likewise, although much more cold tender than the Mexicans, it is hardier than pure Guatemalans like Anaheim, Dickinson, or Queen. Finally, the Hass skin is somewhat thinner and much more leathery than the woody Guatemalan skins shown in Figure 1 — a further positive contribution of a few Mexican genes.

For significant increases in cold hardiness, one needs significantly more Mexican genes. The once dominant Fuerte cultivar is about half each Mexican and Guatemalan; it achieved its dominance partly by exceptionally surviving the 1913 California killing freeze. Considerably hardier yet, and presumably with more Mexican heredity, is the Bacon.

Mexicans have been the dominant source of rootstocks in California. For that purpose, their small fruit size and large seeds are actually advantageous. And their much greater cold hardiness means that the seed supply is largely immune to occasional freezes.

The photographs in Figure 2 were also taken about 75 years ago.

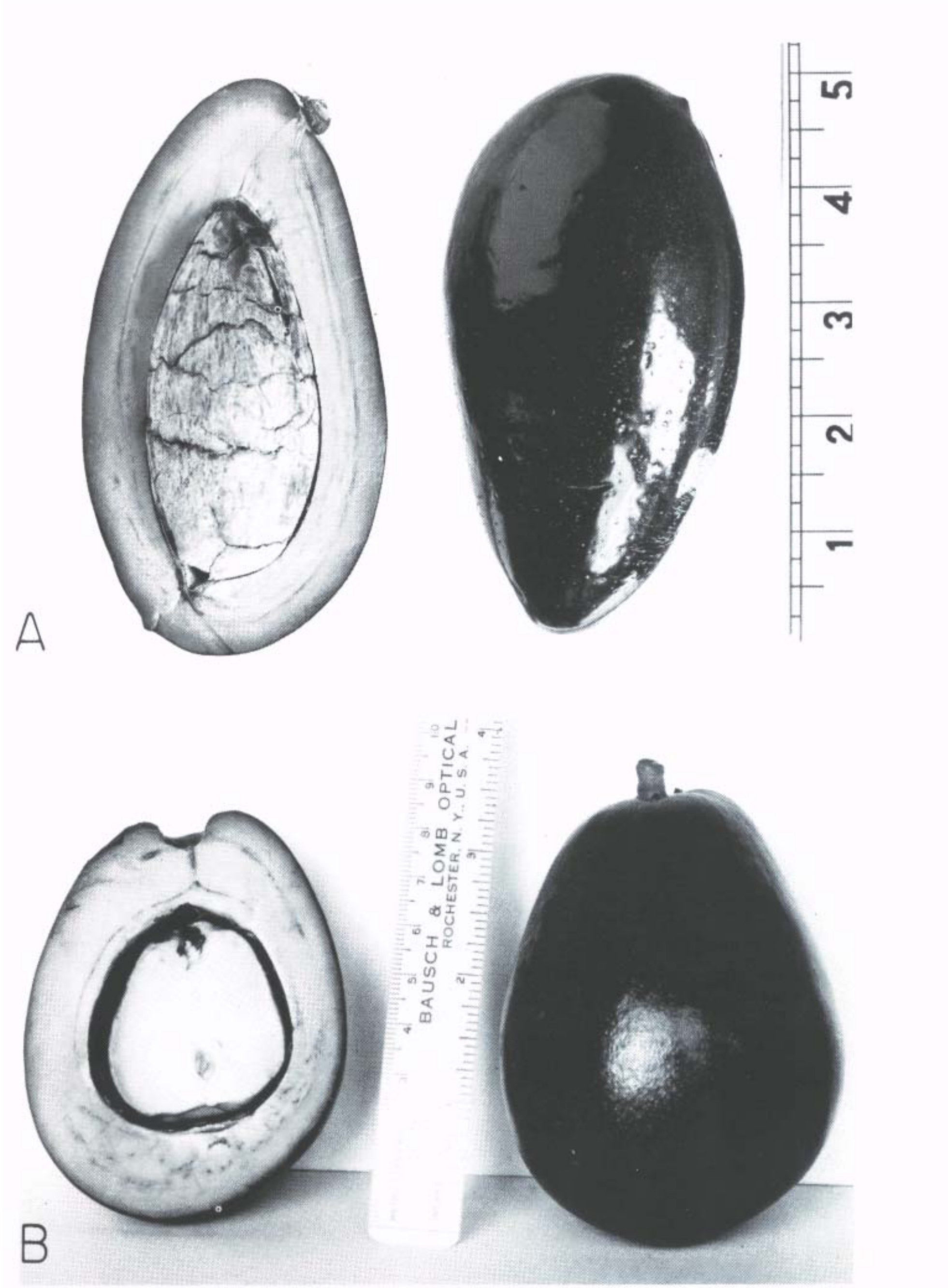

Figure 2. Mexican-race avocados. Variety Topa Topa (A) and Ganter (B). P. americana *var.* drymifolia.

West Indian race (Figure 3A). This tropical type is so ill-adapted to the comparative rigors of our California climate that in the pure form it will ordinarily not even flower here. Its greater salt (Table 1) and also chlorosis tolerance mean that it could be a valuable rootstock for us, but unfortunately it is ill-adapted to our cold winter soils.

However, for more tropical regions such as Florida, it serves a purpose somewhat comparable to the Mexican race for us: it itself is well adapted (it provides the early-season Florida cultivars), and its hybrids with Guatemalans bridge the two harvesting seasons, while combining good Guatemalan quality with good West Indian adaptation to tropical climates.

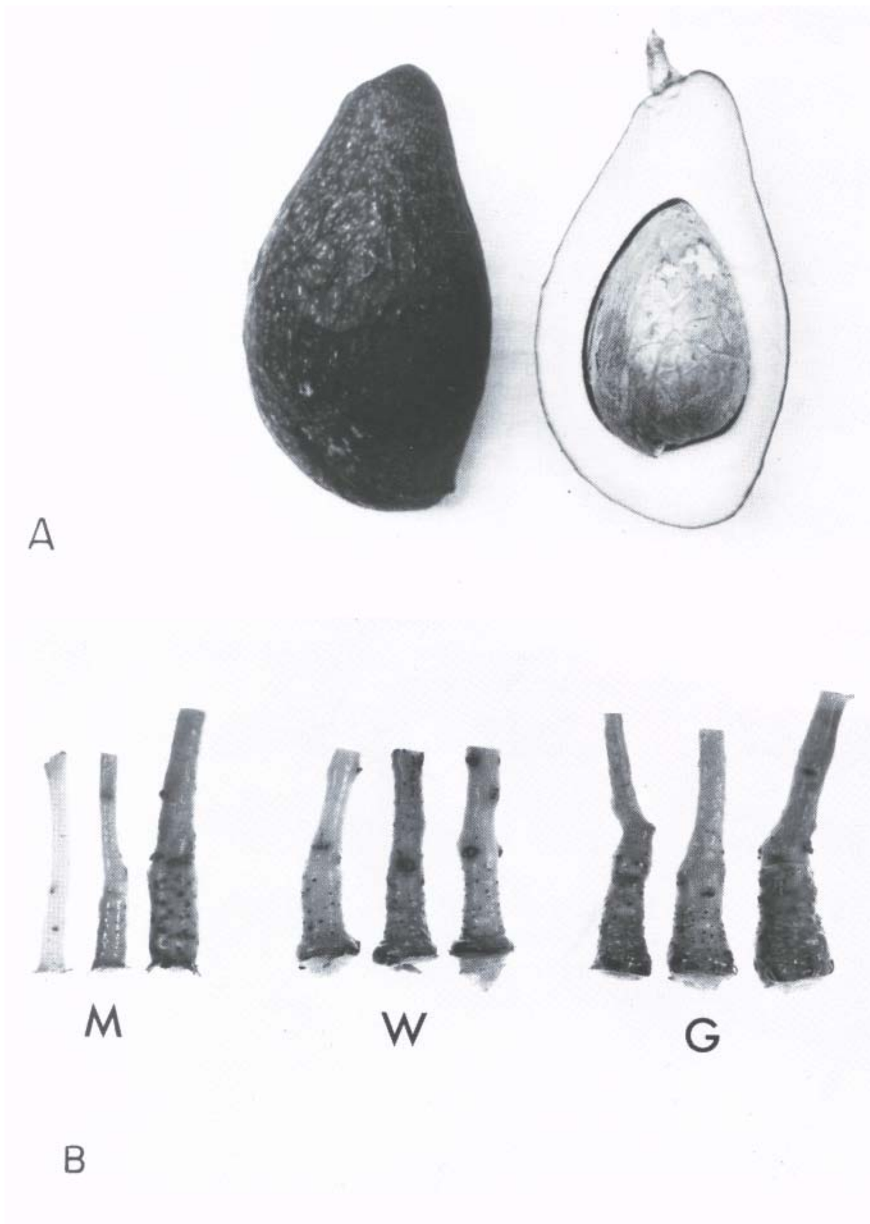

Figure 3. West Indian-race fruit (A). P. americana *var.* americana. *Contrasted pedic of the three races (B). M=Mexican, W=West Indian, G= Guatemalan.*

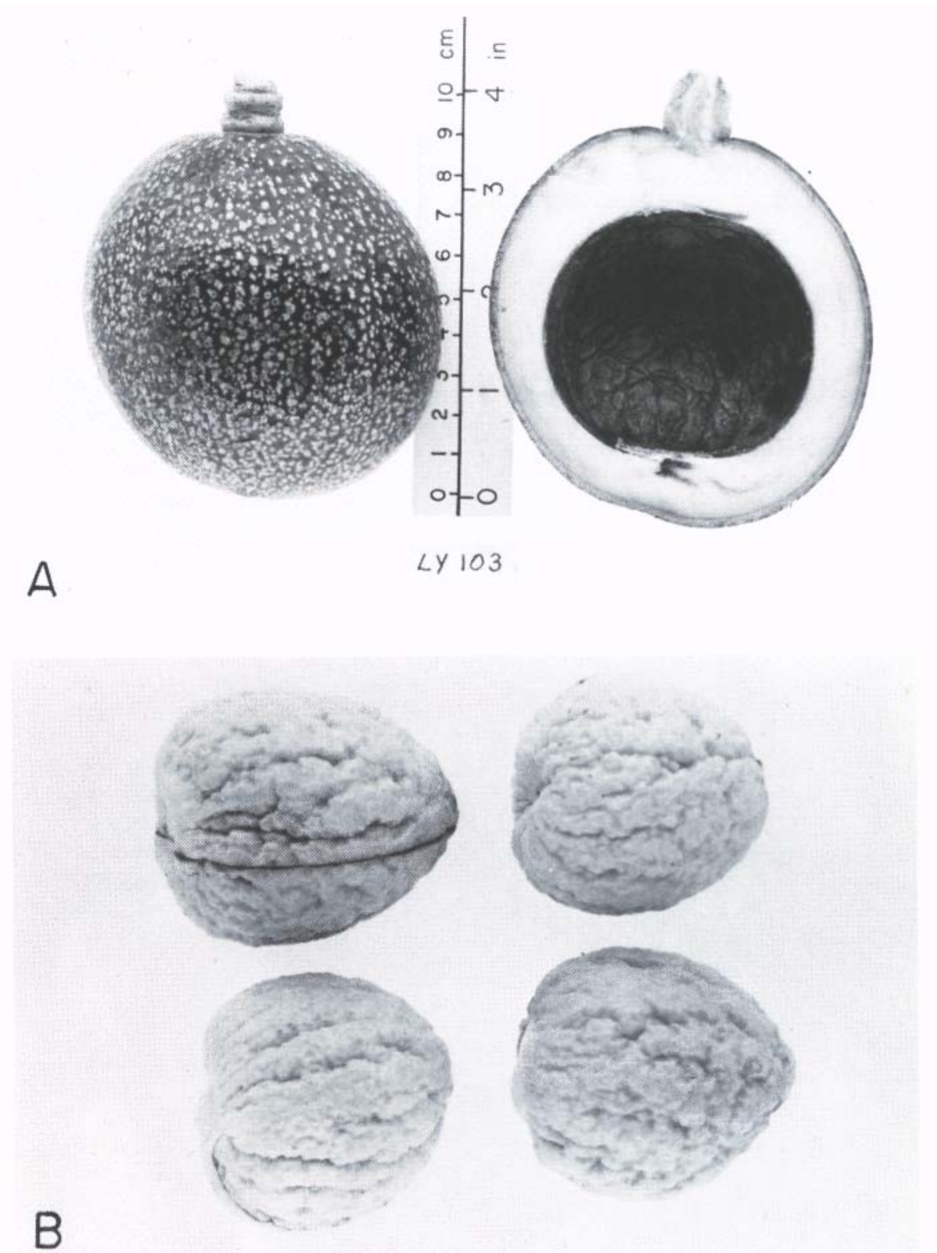

Figure 4. Examples of exceptions to the usual race phenotypes. A = chiefly Guatemalan (late maturity, and note the thick skin) but large-seeded. B = Guatemalan X Mexican, but rough seed surface like West Indians.

Figure 3B illustrates the unique "nail-head" or flange of the West Indian pedicel at its point of attachment to the fruit. The pedicels themselves tend to be slimmer in Mexicans, and tapering to much thicker in Guatemalans.

Figure 4 reminds us that the various race differences do have occasional exceptions. Also, with free racial hybridizing wherever two of the races coexist, there soon appear trends toward bi-racial combinations.

Figure 4A shows a seedling of the old Lyon cultivar. The Lyon was considered Guatemalan, and this seedling has a rather thick skin and late maturity. But, note the seed size.

Figure 4B shows seeds of one of our Mexican x Guatemalan mixtures. But, it has the rough seeds typical of the West Indian race. This is the only MxG seedling we have ever seen with this degree of seed roughness.

Figure 5 reminds us that there are several other wild types closely related to the avocado. At least *Persea schiedeana* appears to be a valid species. Other types may best be classified as *P. americana* (botanical) varieties, additional to the three of commercial importance that we have been discussing — as suggested here for *P. americana* var. *floccosa.* Certain other types may be of real interest because of their postulated ancestral relationships to one of the avocado races, especially the Guatemalan. That subject merits its own paper.

Acknowledgment

The photographs in Figures 1 and 2 were made available by courtesy of C. A. Schroeder, University of California at Los Angeles.

Literature Cited

Bergh, Bob. 1975. Avocados, *in* Janick and Moore, eds,: Advances in fruit breeding, pp 541-567. Purdue University Press, Lafayette.

Kopp, Lucille E. 1966. A taxonomic revision of the genus *Persea* in the western hemisphere. (Perseae-Lauraceae). Memoirs of The New York Botanical Garden 14(1), 117 pp.

Miller, P. 1754. Gardeners dictionary, ed 4.

Popenoe, W. 1941. The avocado—a horticultural problem. Trop. Agr. 18: 3-7. Torres, A.M. and Bob Bergh. 1978a. Isozymes as indicators of outcrossing among 'Pinkerton' seedlings. Calif. Avocado Soc. Yrbk. 62:103-110.

Torres, A.M. and Bob Bergh. 1978b. Isozymes of 'Duke' and its derivatives. Calif. Avocado Soc. Yrbk. 62:111-117.

Williams, L.O. 1977. The avocados, a synopsis of the genus *Persea* subg. *Persea.*Economic Botany 31:315-320.