VARIATION IN AVOCADOS AT THE RODILES PLANTATION

Edgar Anderson

When and how did our cultivated avocados originate? Presumably somewhere in Central America or Mexico but the question is not an easy one to answer. How, for instance, can we define a genuinely wild avocado? We may dig one up in what looks to us like a virgin forest but a thousand years ago there may have been a clearing with a few huts at that very spot or perhaps even a large community. One can find hundreds of potsherds in the soil of many a deserted hilltop in Central America. Who can say what the exact relation may be between any wild-growing avocado and the selected types which were being cultivated in that same area five hundred or a thousand years ago?

In such a quandary one turns to any kind of evidence. A comparatively new method of approaching such problems is based upon the correlation of characters. It has been shown that though the offspring of hybrids are usually remarkably variable, there is a strong tendency for the characteristics which went into a species cross together to stay together on the average. So generally is this true that one may even deduce the characteristics of the original species by studying the way in which characters are correlated in the hybrid offspring (see Anderson, *Introgressive Hybridization*, Wiley, 1949, for further discussion and technical details).

Applied to the avocado problem this means that by examining comprehensive collections of seedling avocados we may perhaps learn something about the combinations of characters which are tending to stick together in such collections. In this way we may hope to build up a picture of what some of the original species were like. For such purposes, probably the most significant collection of avocados in the world is the Rodiles grove near Atlixco, Mexico. For two generations the Rodiles family have planted seeds from the finest local avocados. The resulting orchard of several thousand trees, all of bearing

age, has become a Mecca for avocado authorities and several of the seedlings have been introduced into cultivation in the United States and elsewhere. I am indebted to Dr. Wilson Popenoe for the opportunity of studying this remarkable collection, to the Rodiles family for permission to measure the trees, to the Oficina de Estudios Especiales and to Ing. Efraim Hernández for transportation, and to Sr. Enrique Gilly and his wife for hospitality and encouragement.

The first hour or so at the Rodiles plantation was spent in looking around the entire grove, which occupies several old fields separated by irrigation ditches and accumulated hedges. The field in the northwest corner is at a higher level than the rest, and the trees there are larger and look older. Sr. Gilly said these trees were older; Rodiles' manager said they were the same age but the soil was better. The variation between trees has to be seen to be believed. The leaves vary from large to small, from bright silver underneath to yellow green. Some trees are small, some large, some spreading, while others are upright and for few the branches are almost pendent. Blooming and fruiting season vary like everything else. A few trees were dormant, some were just coming into flower, others bore young fruit along with the flowers and a considerable number were laden with ripening fruit. Since so small a proportion were in fruit, it was not practical to conduct the study on fruit size, shape, color, and quality, though records of size and proportionate fruit length and width were taken on all trees wherever possible. It was therefore expedient to concentrate upon a study of variation in leaf size, shape, and texture since these features vary markedly from tree to tree and are known to remain relatively constant when any particular tree is propagated vegetatively.

Considerable time and thought were spent in developing a method of choosing a representative leaf from each tree. On some trees there is great variation on different parts of the tree, on others there is little. The heavy attacks of borer have stimulated a number of trees in the grove into juvenile growth. Eventually all of the samples were taken from parts of the trees which were bearing and which seemed to be typical of the tree. On each flush of growth the earlier and the later leaves were

often smaller than the rest. Leaves were therefore chosen from the central parts of growth "flushes." Three leaves were chosen in this way from each tree. If they were quite similar, the most average one was taken for measuring. If they varied noticeably then two or more additional leaves were selected. From this series the most atypical ones were discarded and then the most average of the remaining leaves was selected for measurement. Trees were selected at random as related below, except that badly stunted and diseased trees with little but juvenile foliage were omitted after trial had shown that it was difficult to obtain a representative leaf from such trees.

A first selection was made of every second tree, going diagonally from the northwest corner of the entire grove to the southern boundary (excluding some very young trees on the southern margin). Since the percentage of diseased trees was highest on the southern part of the grove, the rest of the samples were selected from randomly chosen rows in the northern part of the grove. These various selections were all studied separately, and it can be shown that the grove is not planted completely at random. "Mexican" characters predominate slightly more in the large trees in the northwest corner, closest to the old hacienda buildings, than they do in the portions of the grove farther east and south. However, the general features of the variation are the same in all parts of the grove, and only the combination of all 132 trees is presented below. It was, however, originally worked up as three diagrams; and they all separately agree with the report on the grove as a whole.

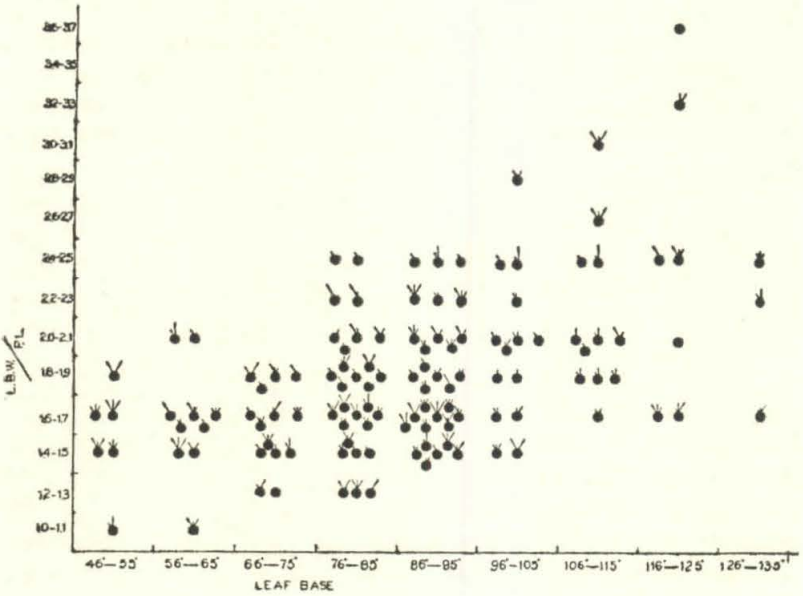
The following measurements were made on a selected leaf from each tree:

1. length of petiole to nearest half centimeter. Measured with sliding calipers.

2. width of blade to nearest half centimeter. Measured with sliding calipers.

3. length of blade to nearest half centimeter. Measured with sliding calipers.

4. cuneation of blade, the angle made by the two edges where they join the petiole. Measured with protractor.



EXPLANATION OF PLATE

Scatter diagram showing association of five characters in 125 seedling avocados from the Rodiles grove

Horizontal axis, acuteness of leaf base, measured in degrees. Vertical axis, porportional length of petiole (leaf-blade width divided by petiole length. Three other characters are scored on the arms which rise from each dot (each dot represents one tree). Upright arm scores leaf length. Long, leaf length 16 cm. or less; medium 17-18 cm.; no upright arm, 19 cm. or more. Arm sloping to left scores under surface of leaf. Long, underside glaucous; medium, underside medium; no left arm, underside green. Arm sloping to right scores anise odor of leaf. Long arm, strong anise smell; medium arm, perceptible anise smell; no right arm, faint anise smell of none.

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5. anise odor of leaf. Young leaf torn in two and the odor scored as slight or none, definite odor, strong scent of anise.

6. The under surface was scored as being green, glaucous, or intermediate. The scoring was done by selecting a glaucous leaf and a green leaf for reference and comparing each leaf with these standards.

As shown on the accompanying diagram there is a complex of characters which tends to go together in these avoca-

dos: small leaves, cuneate at the base and glaucous beneath, with a strong smell of anise. They tend to be narrow and with long petioles. These characters are all very slightly associated with each other, and none of the correlations are very strong.

The simplest hypothesis to explain the existence of this complex is that at least two entities were concerned in the development of these avocados. One would be the type described above, the other would be larger-leaved, broad at the base, green beneath, with no smell of anise, and with comparatively short petioles. The grove as a whole is much closer to the small-leaved, glaucous original than to the large-leaved green. The lightness of the association would suggest that the mixing of these two types has gone on for quite a number of generations. The general preponderance of the small-leaved glaucous would suggest that in the mixing, a little of the broad-leaved green was introduced into the small-leaved glaucous; in other words, that if there were some original hybrids between the different types, that these hybrids crossed back to the small-leaved glaucous and that it was from such back-crosses that the trees in the grove were raised.

Enough of the trees were in fruit to establish correlations between the leaf types and fruit types. Small fruits much longer than broad are associated with the small, glaucous type of leaf; spherical fruits, with the wide-leaved, green type.

The trees growing more or less spontaneously along the river were measured and were found to be uniformly of the small-leaved, glaucous type. The correlations reported above would therefore suggest that big-leaved-green-non-anise avocados (or crosses with them) were very anciently brought into this region and that they crossed back to the prevailing native type. From a series of such back-crosses, probably repeated numerous times, the avocados in the grove originated. The facts reported above strongly support such an hypothesis, though they are not absolute proof.

Unfortunately we not only do not know from what species these Mexican avocados were developed; we do not even know whether two or three or perhaps even more species may have gone into their composition. We therefore need to study figure 1 with particular care to note any exceptional trends. The gen-

eral location of the spots in figure 1 shows that the shape of the leaf base and the proportionate length of the petiole are correlated in the entire sample. While the other three characters *tend* to align themselves along with these two, there are many exceptions, though "exceptional" is scarcely the word to use in this connection since we expect some of them in the progeny of species crosses. Much more disturbing for our simple hypothesis is the fact that the bulk of these exceptions occur in the same part of the chart. There are a considerable number of trees whose leaves are broad at the base and with a medium short petiole, which tend to be small, glaucous and anise-scented. This concentration of exceptions may be due to the fact that a third species with small, glaucous leaves, wide at the base, went into the formation of these cultivated avocados. On the other hand, it may represent the fact that a hybrid with these characteristics was growing in the vicinity of Atlixco and that a considerable number of the trees in the Rodiles Grove trace back to this particular hybrid. By making measurements of the other seedling groves and measuring groups of wild-growing avocados it should eventually be possible to build up a history of the avocado which would incorporate all these seeming exceptions. — *Missouri Botanical Garden, Washington University, St. Louis, Missouri.*

TWO NEW PERSEAS FROM CENTRAL AMERICA

Louis O. Williams

THE two species of *Persea* described below, along with a number of others, were collected while making special trips from Mexico south to Costa Rica in search for species of *Persea* which might be useful as root stocks for the cultivated kinds.

Persea nubigena *L. Wms., sp. nov.*

Arbor usque ad 25 m. Folia elliptica vel elliptico-oblanceolata, acuta vel acuminata, basi cuneata, membranacea vel coriacea; petioli graciles, canaliculati. Inflorescentiae axillares, paniculatae. Flores flavescentes; petala elliptica vel oblongo-elliptica, acuta; sepala quam petalis breviora. Fructi globosi.