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# An Ethnoecological Approach for the Study of *Persea:* A Case Study in the Maya Area

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***Abstract.*** **Avocado is one of the fruit trees mentioned since Prehispanic times in the Maya home-gardens by diverse chroniclers and explorers. A hypothesis to explain the process of domestication or semi-domestication of this plant in the home-gardens is presented. This hypothesis is tested using ethnobotanical and ethnoecological data as well as information regarding the iconography and plant remains. During the analysis, we review the ethnoecology and uses of the different varieties of *Persea* in the lowlands and highlands of the Maya area. A discussion of the implications of this information for the evolution and systematics of *Persea* is made from an ethnobotanical perspective.**

The development of the human race, cannot be fully appreciated without understanding the domestication of plants and animals. Domestication is the result of careful observation and experimentation by many ancient societies throughout millennia. All our current major food crops are a legacy from our ancestors. Compared with theirs, our improvements are meager. One striking example is the domestication of corn. The original wild corn, teosinte, was only a couple of centimeters long. Amerindian groups developed it into a great diversity of land races.

The process of domestication does not always result in such dramatic changes in size. The avocado is such a case. The fruit size, does not help to differentiate between wild and cultivated forms, since in both forms, different trees produce different sized fruit, especially in tropical areas. Through time, humans have selected and domesticated useful species. The domestication procedure, "the conscious decision of one person, included the selection of the most attractive, desirable, vigorous, and successful individuals". If the wild populations showed great variation, the selection was logical; if not, the initial selection perhaps reflected a matter of convenience, e.g., the plant nearby or small enough to transport or collect.

All over the earth humans have selected useful species from which to obtain food, fiber and medicine. Many of these species have been subjected to domestication or semi-domestication attempts. It is amazing that, in spite of our great advances in so many areas of science, our understanding of the domestication process by ancient peoples is still in it's infancy. Although we have identified the original parents of some of our useful species, we know little about how they were domesticated. One approach is to study the current practices of present day traditional ethnic groups.

## Avocado Domestication

We started a research project on the ethnoecology of edible avocados. We believe that the study of the domestication or semi-domestication of tropical trees, such as the avocado, is an important field that can provide valuable information.

Tropical trees were, and are, a predictable and stable source of food. People established dwellings close to these food sources and returned to the same food sources time after time. Fruit trees were used for a long time before any attempt was made to cultivate them. Information has been collected recently, on the management of natural stands to facilitate the growth of useful species (Barrera *et al*., 1977). The avocado was one of those "managed" trees.

Mesoamerica is considered the region of origin of cultivation of the avocado and the area where all the wild avocados still occur (Koop, 1966; Storey *et al.,* 1986). The ancient Maya that lived in this area or their predecessors in this region probably were the domesticators of the avocado.

The avocados belong to the large tropical family Lauraceae and to the genus *Persea.* Most authors recognize two subgenera: *Persea* and *Eriodaphne.* The subgenus *Persea,* which includes the avocado *Persea americana* Mill., contains species found between central Mexico and the northern part of South America. The most recently discovered species in this subgenus, *P. zentmyerii,* was described by Bergh and Ellstrand (1987). Also a possible new species known as "aguacate de mico" from Central America has been reported (Schieber and Zentmyer, 1981). We summarized earlier attempts to classify the species and varieties related to the avocado *Persea americana* Mill. (Table 1). Koop (1966) recognizes three varieties of *Persea americana.* Williams (1977) recognizes *Persea americana* with two varieties, and adds a new species *Persea nubigena* L, with two varieties var. nubigena and var. guatemalensis L. Wms. This last variety corresponds to the *Persea americana* var. nubigena of Koop (1966). Bergh and Ellstrand (1987), supported by biochemical and isozyme electrophoretic data, recognize for *Persea americana* the three varieties of Koop and renames the var. nubigena as *P. americana* var. guatemalensis, leaving *Persea nubigena* var. nubigena as a different species.

Recent studies on the evolution of avocado done in the University of California Riverside (Furnier, 1989) using modern techniques in DNA restriction site variation show that:

(i) *Persea americana* var. *americana* appears to be more closely related to *Persea nubigena;*
(ii) *Persea flocossa* Mez. and *Persea americana* var. drymifolia (Schlecht. & Cham.) Blake are very similar and are more closely related to *Persea steyermarkii* Allen; and

(iii) *Persea americana* var. guatemalensis appears to be a combination of *Persea nubigena* and *Persea steyermarkii.*

We believe that the complexity of the systematics of these taxa is related to the following two causes: (i) human intervention through selection, cultivation and introduction; and (ii) the outbreeding behavior of these taxa.

Table 1. Classifications of *Persea americana* Mill.

| Authority | | |
|---|---|---|
| Koop (1966) | Williams (1977) | Bergh and Ellstrand (1987) |
| *Persea americana* | *Persea americana* | *Persea americana* |
| var. americana | var. americana | var. americana |
| var. drymifolia | var. drymifolia | var. drymifolia |
| var. nubigena | *Persea nubigena* | var. guatemalensis |
| | var. nubigena | *Persea nubigena* |
| | var. guatemalensis | var. nubigena |

It is important to mention that there is very little information on the isolation mechanisms of the wild species of *Persea.* There have been reports of hybrids between the species and varieties in the field (Schieber and Zentmyer, 1977; Ellstrand *et al.,* 1986). This proves that: (i) there are no strong reproductive isolation mechanisms between the recognized species, and (ii) humans are influencing gene-flow between species by moving plants to all kinds of new environments.

Avocados are long-lived out-breeders with great genetic variability. This characteristic favors the successful invasion or introduction to newer, natural and human-made environments. This variability has great value for the development of new cultivars.

One proof of this variation is found in another species of a cultivated *Persea: Persea schiedeana* Nees known as "chineni" or "chinini" in Mexico and coyo in Guatemala. *Persea schiedeana* showed a broad range in variability not only in the size, form and color of the fruit but in the characters of the leaves.

Domestication occurred long before our time. Ancient peoples moved plants from the wild to close to their home-sites and back to the wild again. Seeds were transported all over between homes and settlements in different regions. Trade was common in the Maya region.

Selection of different genotypes was performed by different people through time. This produced a great diversity of cultivars based on the diversity of the wild populations. For trees this is very important because the number of individuals from which the selection is made is very small when compared with annual plants. An important useful mutant is less likely to occur in a tree population in the lifetime of any keen human observer than in an herbaceous population.

One outstanding discovery was that the three varieties know today were described early after the conquest by several chroniclers like Landa (1560) and Cobo (Popenoe, 1963). In Landa's report we can read: "There is a big tree that the native people call "on"; it has a fruit like a large squash that is very tender with the taste of butter and very oily, it has a lot of substance; it has a big seed and a delicate peel."

**Ethnoecology**

We have started a study of the diversity of avocados in the Maya region to learn more about human practices in the introduction, selection, protection and cultivation of avocado. Our initial studies in the Maya region have confirmed that *Persea americana* var. americana grows mainly in the lowland areas of both coasts ascending to about 750 m (Table 2). This is the only variety cultivated in the northern part of the Yucatan peninsula as quoted by Landa (1560). The Guatemalan variety grows in home-gardens in very humid areas where coffee is planted in the cloud forests of Guatemala and Chiapas between 1100 and 2300 m. The variety drymifolia was collected in the highlands of Chiapas at an elevation of 2600 m in a pine-oak forest. *Persea schiedeana* in the Maya region was found in the lowlands of Tabasco, Chiapas and Guatemala up to 1800 m.

Table 2. Varieties of avocado found at the study sites.

| | Study Sites | | | |
|---|---|---|---|---|
| | Yucatan | Chiapas | Tabasco | Guatemala |
| No. of gardens visited | 15 | 6 | 5 | 16 |
| No. of trees found | 31 | 8 | 9 | 90 |
| *P. americana* | | | | |
| var. americana | 31 | 1 | 4 | 6 |
| var. guatemalensis | 0 | 5 | 5 | 84 |
| var. drymifolia | 0 | 2 | 0 | 0 |

We assume that the selection of avocado for cultivation in the past might have included other uses besides the fruit for food source; for example, leaf odor. These uses in the past may have played a role in the selection of the trees. For that reason we made a survey to find the different uses of avocado in the region (Table 3). Although the main use for the avocado trees is for its fruit, in Guatemala a major use is to provide shade for coffee. Some other uses include medicine, fodder, and as a condiment. Avocado wood has several uses including the construction of small boats.

Table 3. Results of the survey about uses of avocado in the area of study.

| | Study Sites | | | |
|---|---|---|---|---|
| | Yucatan | Chiapas | Tabasco | Guatemala |
| Medicine | 1 | 1 | — | 1 |
| Food | 19 | 6 | 5 | 16 |
| Fodder | -- | 1 | — | 3 |
| Shade | | 3 | 2 | 9 |
| Condiment | 2 | 1 | — | — |
| Other | — | — | — | 3[z] |

[z] Wood use to make tools or boats.

**Iconography and Linguistic Evidence**

According to Fox and Justeson (1980), the avocado name appears in the proto-Maya languages as far back as 2000 BC. with the name of "on". This name is applied also to the glyph of Kankin which is the fourteenth month in the Civil Maya calendar in the Cholan dialect. This glyph represents a leafless tree bearing a round striped fruit (stripes in Maya iconography represent the color black). The glyph probably represents an avocado tree of the variety guatemalensis.

If a quick analysis of the word "avocado" in the different Mayan languages is made, it can be seen that the term varies little (Table 4) and forms two groups (o, on, un, um) in Chiapas and Yucatan and (oj, uj) in Guatemala (Berlin, 1973; Stoll, 1884).

According to linguistic studies (Macquown 1956; Fox and Justeson, 1980), this separation occurred very early in time. A proof is that the Maya group living in the northern part of Veracruz the Huastecs, uses the word "uj" to name avocado (Alcorn, 1984), showing a strong relationship with the oldest group, namely the one using "oj" of Guatemala. Such little variation indicates the importance of the object named as avocado in this case, and also indicates that the term has been used for a long time.

Table 4. Maya names corresponding to *Persea americana* var. americana or var. guatemalensis. From Alcorn, 1984; Berlin, 1973; Stoll, 1884; and field research.

| Word for avocado | Languages |
|---|---|
| uj | Huastec |
| on | Maya Maya (Peten)<br>Tzental<br>Tzontzil<br>Chanabal |
| un | Chontal<br>Tzontzil |
| um | Choi |
| o | Quekchi |
| oj | Pokomchi<br>Pokoman<br>Cakchiquel<br>Quiche<br>Uspanteca<br>Aguacateca |

Schele (1978) reported another iconography of avocado was made by Schele (1978) in Palenque, in the Temple of Inscriptions on the Sarcophagus of Pacal. It depicts a leafy tree with dark pear shape fruits.

Avocado remains have been found in several archaeological excavations, dating back to 2,000 BC (Turner and Miksicek, 1984) (Table 5). Unfortunately, no information is available on the taxonomy of the remains.

## Conclusions

In summary, from our initial observations we believe that the domestication, or better semi-domestication process of this tree, occurred many times through history and is still happening today. Wild trees were brought into the home-gardens and orchards, and seeds from home-gardens and orchards went back into the wild. That is why there is no clear botanical, ethnobotanical, or ecological distinction between the cultivated avocados and those from natural forests, i.e., the wild avocados, making the differentiation between the wild and the cultivated forms a very difficult and perhaps an impossible task. This same model has been found in other tropical fruit trees.

An analysis of the factors, besides man, that are influencing population differentiation is urgently needed in order to establish a natural classification. The information obtained about cultivation and management from the people living in the Maya area was and is of great value in understanding the variations in the population differentiation process and in understanding the process of domestication.

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Table 5. Avocado remains found at archaeological sites of documented age (From Turner and Miksicek, 1984.).

| | Country | | | |
|---|---|---|---|---|
| | Northern | Belize | Guatemala | Honduras |
| Site | Cuello | Pullstrous Swamps | Tikal (Peten) | Copan |
| Date | 8000 B.C. to 250 A.D. | 850 A.D. | 850 A.D. | 850 A.D. |
| Type of Remain | Wood | Wood | Seeds | Seeds |

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case-control primary study question? Do cases (those with disease) and controls (w/o disease) have the same exposure histories? When to use a case-control study ? the disease is relatively uncommon, but a source of cases is available. key statistical measure for case-control studies? Odds ratio.Â  the proportion of individuals in the control group who experience an unfavorable outcome who could have been expected to have a favorable outcomes had they been in the active group instead high efficacy = intervention is successful. NNT. # needed to treat = # ppl who would have to receive TX to prevent an unfavorable outcome in one person.