Notes on the Strawberry of Ecuador: Ancient Land Races, the Community of Farmers, and Modern Production

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The cultivated strawberry, *Fragaria* × *ananassa* Duch., is the result of the hybridization of two species, *F. virginiana* Duch. and *F. chiloensis* (L.) Duch., which first occurred in Europe in the 1700s (Darrow, 1966). The *F. chiloensis* that served as the parent for this original hybridization appears to have come from cultivated plants that Amedee François Frezier brought back to Europe from near Concepción, Chile, in 1714.

EARLY RECORDS

There are no records of *F. chiloensis* domestication in North America. However, the Huilliche people of Chile were probably the first to domesticate this species, and by the time of the Spanish Conquest in the mid-1500s, its cultivation was widespread throughout central Chile. During Pizarro's invasion, *F. chiloensis* (frutilla) was "counted as one of the spoils of conquest" (Darrow, 1966). As the Spanish continued their conquest of South America, they moved *F. chiloensis* north into regions where it had not been grown previously. Garcilaso de la Vega spoke of introducing the species into Cuzco, Peru, in 1557 (Popenoe, 1921). The species was also carried to Ecuador, although the date of introduction is less certain. The production of *frutilla* in the area around Quito, Ecuador, was described in 1789 by Father Velasco (Popenoe, 1921), although its cultivation probably began before that date.

The parish records from Huachi Grande Catholic Church, near Ambato, Ecuador, in combination with local oral tradition, offer a colorful record of the introduction of *F. chiloensis* to the Ecuadorian Andes. According to these sources, Jose Antonio Blanco Antorvoz de Salinas set out across the Andes from Chile to Ecuador in the late 1500s planting runners of an *F. chiloensis* land-race as he traveled. When this "Johnny Appleseed" of the strawberry finally arrived in Huachi Grande,

the plants flourished, and he traveled no further, as he had found the perfect combination of soils and environment. Huachi Grande later developed a country-wide reputation for its strawberries, and was billed as "*La tierra de las Frutillas*." The song 'Viva Huachi!' spoke of the strawberries in the community (Anonymous, 1959).

U.S. DEPT. OF AGRICULTURE EXPLORATIONS

Popenoe (1921) and Darrow (1953, 1954, 1957) traveled to South America early in this century to evaluate and collect fruit from the Ecuadorian Andes for the U.S. Dept. of Agriculture (USDA). While their trips were not focused on *F. chiloensis*, both men appeared fascinated with its place in agriculture and with the history of the crop. Popenoe (1921) found *F. chiloensis* to be extensively cultivated in the area around Huachi Grande (Fig. 1a); however, the extent of the plantings at the time of his visit is unclear. Darrow (1953) later mentioned that the plantings covered "several hundred acres." Growers in Huachi Grande have told us that strawberry production peaked between 500 and 700 ha in the late 1960s.

In his article, "The Ambato Strawberry of Ecuador," Darrow (1957) incorrectly applied the name 'Ambato' to the strawberry grown in Huachi, Ecuador, even though Popenoe (1921) had previously described it as the 'Guachi' strawberry. After discussion with members of the community, we have chosen to use the Spanish 'Huachi' spelling as opposed to the Indian 'Guachi', since this is the way the community has always spelled their name.

The strawberry fields in Huachi Grande today are very similar to Popenoe's (1921) description:

"Guachi (Huachi) lies at an elevation of 9,500–10,000 feet, and is a series of rolling hills, almost devoid of trees, with a soil which can be characterized as a very loose, fine, sandy loam of volcanic origin... the fields are never irrigated, and the rainfall is probably not more than 15 inches per annum. The temperature is rarely higher than 65° or 70°; and seldom lower than 35° F, above zero. Severe frosts are unknown."

What Popenoe (1921) found most remarkable about 'Huachi' fruit was its postharvest durability.

"What sorts have we, may I ask, which

could be thrown into boxes holding 30 to 35 quarts, carried seven or eight miles on mule back, worked over by hand and packed in two to six-quart baskets, and then shipped down to a tropical seaport, there to be kept in a market for two or three dates [sic] at temperatures of 70 to 85 degrees? Even with such treatment as this, the 'Huachi' strawberry holds up well, retaining its shape and texture to an extent altogether unknown among northern strawberries."

Darrow (1953, 1954, 1957) was most interested in the adaptive traits that allowed 'Huachi' to thrive on dry volcanic soils, along with its fruit firmness, large fruit size, and delicate, appealing flavor.

Although there is no written record of Popenoe bringing plants to North America, he must have done so, because in the 1930s, Waldo (1953) was using a USDA selection (US 836) that had 'Huachi' as a parent ['Progressive' × 'Huachi' (*F. chiloensis*)]. US 836 was later determined to be a source of red stele resistance (Waldo, 1953), and was used in crosses by Waldo in Oregon resulting in 25 resistant selections in 1932 and 1933. Subsequently, most of the cultivars released by the USDA–Agricultural Research Service (ARS) in Oregon can be traced to 'Huachi' (Sjulin and Dale, 1987). However, despite the remarkable characteristics of the 'Huachi' strawberry and its successful incorporation into Pacific Northwest germplasm, it does not appear to have been incorporated to any great extent in the breeding germplasm in the eastern United States, California, or Europe. 'Huachi' itself performed poorly in Beltsville, Md., and does not appear to have been tested elsewhere (Darrow, 1954).

The past performance and breeding success of the 'Huachi' berry suggested to us that it needed to be recollected and evaluated. Germplasm expeditions in the last few years have successfully collected *F. chiloensis* from Chile (Cameron et al., 1993), but the rest of South America has remained unexplored. A recent small fruit collection trip to Ecuador concentrated on genera other than *Fragaria* (Ballington et al., 1990). Since Popenoe and Darrow's work, there has been no effort to collect the potentially valuable land races of strawberry that are rapidly disappearing in Peru, Columbia, and Ecuador. With this recognition and the descriptions of this material made by Popenoe and Darrow, we felt it was

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Fig. 1. (a) 'Huachi' strawberry fields in 1921 (Popenoe, 1921). (b) 'Huachi' strawberry plant. (c) 'Huachi' fruit. (d) Establishing research plots in a grower's field; white stones mark treatment boundaries.

essential to collect this germplasm before it was lost. In the process of collecting germplasm, we established mutually beneficial ties with some farmers who still grow such fruit

EXPEDITION IN 1996

We arrived in Quito, Ecuador, on 28 Mar. 1996. Our group consisted of two small fruit breeders (Hancock and Finn) and a translator (Heider) who had previously collected small fruit germplasm in Ecuador. A brief account of our trip has been published (Hancock et al., 1997).

The region chosen is ≈ 200 km long between Ibarra and Baños (Fig. 2), and ranges in elevation from 2000 to 3000 m. The climate is moderate. In Ambato, 10 km north of Huachi, the mean annual temperature is 13.8°C (Harden, 1988), with maxima of $18\text{--}25^{\circ}\text{C}$ and minima of 7°C . Mean annual rainfall is 482 mm with peak precipitation in April and November (Harden, 1988). While many of the temperate zone fruit (e.g., apples, pears, plums) grown in the region have a definite season, others, such as the 'Huachi' strawberry, produce fruit throughout the year, although production peaks in the three driest months of the year, February, August, and December.

Search for 'Huachi'

Our search for the 'Huachi' berry began at the local markets. The produce markets of

Quito and the other large Ecuadorian cities are crowded with vendors, some under roofs and others lining the adjacent streets. We found many strawberries, but had difficulty pinpointing their sources as the vendors are no longer growing the fruit themselves and did not know their origins.

All of the strawberries in the city markets were red with white shoulders and had a variety of shapes. While many of the vendors assured us that their fruit was from the Ambato area, none fit the characteristics of the 'Huachi' strawberry as described by Popenoe and Darrow. Most vendors were selling 'Oso', which we assumed was 'Oso Grande'. They made a distinction between 'Oso', which was called *frutilla*, and the berries from Ambato, which they referred to as *fresa*. What they were calling *fresa* had the long wedge shape of the strawberry described by Darrow and Popenoe but were bright red rather than white to pink as previously described.

The *fresa* vs. *frutilla* terminology proved to be a challenge to us in all of our travels across Ecuador, and apparently changes with time and location. Popenoe wrote, "*Frutilla* [sic] is the term universally employed for the species by Spanish-speaking people on the western coast of South America; the Spanish name of the European strawberry, *fresa*, is reserved for the fruit of *F. vesca*. A strawberry field, if the plants are of the *chiloensis* species, is termed a *frutillar*, and there is a town by this name in southern Chile." After 2 weeks of

speaking with vendors and growers, we determined that *frutilla* currently refers to the preferred strawberries of a given region, whereas *fresa* is small and less preferred. So in Quito, *frutilla* refers to a higher grade of fruit from California cultivars grown in Ecuador and *fresa* to the lower grade or *F. vesca*. In contrast, in Ambato, the 'Huachi' strawberry was referred to as *frutilla* and all of the fruit from California cultivars as *fresa*.

In Ambato, ≈ 150 km south of Quito, the produce market had strawberries that looked similar to the types we had seen the previous day in Quito. We were told that the 'Huachi' strawberries had "all dried up" and were unavailable. We were also told that they were 10 times as expensive as strawberries from the California cultivars at 4000 sucres (\$1.33 U.S.) per kg. Having had no luck in the markets, we took a taxi to the nearby city of Huachi Grande. Our taxi driver questioned a roadside fruit vendor about the location of the 'Huachi' strawberry fields and she pointed to a nearby hill. We drove over one hill, onto a dirt road, across a soccer field, over some more dirt roads, and through an orchard. As we came out of the orchard we saw a strawberry field in the distance that looked exactly like the pictures in Popenoe's articles (Fig. 1a).

The farmers who were managing the plots were at first bewildered by our unusual interest in their strawberry field. Once they decided that we were serious, they were very accommodating and allowed us to pick a few runners

Fig. 2. Map of Ecuador. The region from Ibarra to Ulba was explored.

and fruit. The seed and plants (FRA 1480, FRA 1481) collected are currently at the USDA-ARS National Clonal Germplasm Repository, Corvallis, Ore.

Description of 'Huachi'

The strawberry plants and fruit in these and subsequent fields were uniform in appearance (Fig. 1b). The plants are grown without irrigation on a volcanic, sandy-loam soil and are often intercropped successfully with *uvilla* (*Physalis peruviana* L.), a Solanaceous crop. The scattered plants are maintained at a density of ≈ 10 plants/m², and are vigorous but short in stature. A few plants were dug and their root systems extended ≈ 25 cm deep. While these may have been young plants, we observed no deep, elongated crowns as are found in *F. chiloensis* along the northwestern coast of North America. The leaves are very thick, with a glossy leaf surface, and the abaxial surfaces of the leaves and the petioles are thickly pubescent. The runners are red and thick, and appear to persist for several years. The flowers are hermaphroditic and very large (3.2–3.6 cm in diameter) (Fig. 1c). The fruit varies in size from 5 to 15 g, which is impressive since we were not there during the prime production season. The fruit are long and wedge shaped; the exterior is white with a pink blush and the interior is white. The fruit is as firm as many modern North American cultivars, and its flavor is delicate and pleasant with a strong strawberry aroma.

As we were preparing to leave this first field, we met the owner of an adjacent field of 'Huachi' strawberries, Victor H. Salinas. When

we told him that we were scientists, he commented that he was willing to do anything to help science (a refreshing and welcomed attitude). We collected fruit and plants from throughout Salinas's field, and he suggested we contact his brother Manuel who is a commercial fruit grower in the area.

Other sources of 'Huachi'

We returned to our hotel feeling pleased that we had accomplished all our original objectives of the trip within 48 h of arriving in Ecuador, only to be greeted later that evening with a call from Manuel Salinas. He had tracked down the Parish record from the Huachi Grande Catholic Church (Anonymous, 1959) that we previously described and he wondered whether we would like to see it and visit some other fields. We excitedly agreed to come for lunch 2 days later.

We were curious whether the 'Huachi' strawberry had survived in any other communities, as well as the extent and nature of the commercial strawberry industry in Ecuador. We hiked along the road into the Rio Pastaza valley from Ambato southeast to Ulba the next day. Contrary to what we had been told in Ambato, we found no current or past evidence of strawberry production in Pelileo. Further down the valley, a taxi (back of a pickup) fortunately "forgot" to drop us in the town of Ulba where we wanted to go and instead delivered us ≈ 2 km farther to the east where we encountered several strawberry growers. At the first site, a woman was growing 0.1 ha of what appeared to be a North American straw-

berry cultivar in her front yard on ridges 15–20 cm high. The plants were vigorous but had a large amount of leafspot [probably *Mycosphaerella fragariae* (Tul.) Lindau]. Her plants had come from "a man up the road" and she had no idea what the cultivar might be. The next farm was much more substantial, for the family had 3–4 ha of fruit trees, mostly mandarin oranges (*Citrus nobilis* André non Lour.), but avocado (*Persea americana* Mill.), babaco (*Carica pentagona* Heilborn), and other citrus were grown as well. On the floor of a 1.5-ha orchard, vigorous and healthy strawberries were being cultivated on low ridges. As with the previous grower, the cultivar appeared to be North American and came from "a man up the road." Leafspot was also a problem at this farm, but was controlled by manually picking off the diseased leaves when an area began to get seriously infested.

For these small-scale growers, strawberries are not a large source of income, but provide a steady, year-round supplement to other income. The family mentioned above ran their strawberries as a pick-your-own operation. She also sold fruit pre-picked, but the price had dropped so substantially that she tried to sell most as pick-your-own. The price for a container that appeared to hold about 6 "quarts" (≈ 6 L) had been 20,000 sucres (\$6.50 U.S.) but was then 7,000 sucres (\$2.40 U.S.).

We continued our journey and finally found the source of the community's strawberry plants, Carlos Vargas. Vargas owns a store and has a small, poorly maintained, 0.2-ha strawberry planting. While his plants were very healthy, they had runnered so densely that the plants had become overcrowded and fruit production was limited. He also did not have any idea what cultivar he was growing. Based on later information, we guessed they were offspring of a California cultivar, since only California types had previously entered the country, even though Vargas's plants had fruit that were acidic and more similar in flavor and appearance to our eastern types.

The following day, we were able to view and later make copies of the Huachi Grande Parish record (Anonymous, 1959). Parish records are a valuable source of documentation that we had not previously considered, and, in countries where religious organizations with a tradition of written historical documentation exist, they can provide interesting background information.

We were then driven to nearby strawberry fields owned by Alberto Villacis, which were considered to be the best in the region. The fields appeared similar to those photographed by Popenoe, although Villacis's fields were managed more intensely than the smaller fields we had previously seen. Villacis reported that the area of cultivation had declined from 500 to 700 ha to what we estimated as 4–6 ha, with the largest field being ≈ 0.4 ha. Whereas the whole hillside had once been devoted to the 'Huachi' strawberry, there were now only three production areas separated by 2–4 km: Huachi Grande, upper Huachi Grande, and Santa Rosa (Fig. 3). There were now about 20 growers.

Fig. 3. Reproduction of map from Huachi Parish Records (Anonymous, 1959) indicating production areas of 'Huachi'.

Villacis provided several possible explanations for the decrease in production. He felt that "tired soils," after at least 200 years of continuous cultivation on the same sites with no real inputs, were a major problem. The ease of production and productivity of the imported California cultivars were also considered important as well as severe droughts in the 1970s that destroyed many fields, and local "thievery." People have been walking through and "grazing" on the Huachi Grande strawberry fields for centuries. While this wasn't a problem when there were hundreds of hectares, with only a few hectares remaining, it represented a critical loss in revenue.

Establishing research plots

We asked if growers had ever applied fertilizers or organic mulches. They knew, and the literature documented (Darrow, 1956; Popenoe, 1921), that when the 'Huachi' strawberry was planted on fertile soils in Ambato or Quito the plants remained highly vegetative and produced little fruit. We suggested that some trials could be done to try to increase productivity. Villacis asked if we would help them and we agreed to assist them later in the week.

On the day we planned to set up research plots, we were first asked to demonstrate how to make controlled crosses in strawberry and *Rubus glaucus* Benth (Andean blackberry). By the time we arrived for the crossing demonstration, we had a crowd of 35 interested people from the community. We were videotaped and questioned as we proceeded with the demonstration. These growers knew their crops and understood the basics of genetics. We were impressed by their depth of knowledge as evidenced by the questions they asked.

Later in the day, we rode to the upper Huachi Grande production fields. The treatment plots were set up in an established 0.4-ha field of 'Huachi' (Fig. 1d). Our goal was to keep the design simple—something that could be easily evaluated and repeated if further treatments were attempted. We settled on 1 × 10-m plots. The growers cooperatively determined what the treatments and rates should be. We alternated untreated control plots (termed a "witness" plot by the growers) with treated plots. The treatments included fertilizer application (10N-10P-10K; $\approx 115 \text{ g m}^{-2}$), incorporation of organic matter, a combination of fertilizer and organic matter, and a straw mulch treatment. The growers decided that fruit size and yield were the most important traits to evaluate. Since that time, they have collected data and, based on early results, have determined that the combination treatment of fertilizer with incorporation of organic matter gives the greatest production.

We had given Manuel Salinas copies of publications by Darrow (1953, 1954) and Popenoe (1921), which he brought to the field. Some growers tried to pick out family members from the grainy photocopies, others assured us that we were standing in the exact field pictured in Popenoe's article (1921). They were all enthralled with the idea that someone had taken the time and effort to publish articles about something they took for granted. As with any field day, the day ended with all of us chatting while leaning against pickup trucks. To top it all off, a rainbow appeared, with one end seemingly in our research plot.

Large-scale commercial production

The remainder of our visit to Ecuador was spent trying to gain a better understanding of

where and how most of the Ecuadorian strawberries were currently being produced. We heard that there was a large production area northeast of Quito near Guayllabamba and one near Quinche. As it turned out, there is a major production center on the small, dusty road that connects these two villages. As we walked west out of Quinche, we passed numerous cut flower operations before we came to a gated facility with an armed guard. The facility was owned by AGROMOD of El Salvador. The guard checked with the facility manager, Rodrigo Nuñez, and we were allowed in. Perched at the top of the stairs was a familiar pile of boxes from a California strawberry nursery.

AGROMOD packs fruit for the fresh and processed markets, and they are the largest producers of strawberries, with 70 ha of the estimated 350 ha in Ecuador. While we had heard mention of 'Oso Grande', 'Tufts', and 'Aliso' as we traveled across the country, we were now told that most of the large-scale production is in 'Chandler', 'Selva', and 'Oso Grande'. On these large-scale operations, the fruit is produced in a modified California system, where the field is kept in production for 2 years. The fruit are produced year-round, although there are peaks in production every 3 months. This type of system has been in place in Ecuador for about 12 years. Nearly all of the fruit is marketed in the United States as a fresh and frozen product. Production can be as high as $45,500 \text{ kg ha}^{-1}$. The biggest problems they described were Botrytis fruit rot (*Botrytis cinerea* Pers.:Fr.), Lygus bug (*Lygus* sp.) injury, and Anthracnose fruit rot (*Colletotrichum* sp.). AGROMOD was experimenting with vertical production in polyethylene tubes, but they were having trouble maintaining uniformity in fruit quality. Poor pollination and difficulty in effectively applying fungicides were two causes of poor uniformity. However, they felt land was expensive enough to justify the vertical system.

CONCLUSIONS AND FUTURE RESEARCH

After seeing these larger scale operations we felt our inquiry was complete. The 'Huachi' strawberry we had come in search of was still in production, but might have disappeared within a few years if we had not generated some renewed interest in this regional wonder. Every cultivar has a life expectancy, and there is no reason to keep a cultivar in production when it is no longer economically viable. However, we felt it would be unfortunate if this unique land-race were to disappear without the opportunity to save its genes in a broader collection of germplasm. As we listened to growers describing the decline in production of 'Huachi' we were unable to determine whether 'Huachi' was in decline due to environmental and soil problems, or to competition from higher yielding California cultivars that could be grown on traditional agricultural sites. Ideally, the growers in the Ambato area would like a genotype with the productivity and ease of production of the

California cultivars in combination with the fruit characteristics of the 'Huachi' strawberry.

We are currently establishing a germplasm exchange that would make that possible. Manuel Salinas will come to the United States during Summer 1998 and spend some time with the USDA-ARS program in Oregon and with the Michigan State Univ. program to learn about research and breeding in small fruit crops. Between now and then, we will make crosses between the 'Huachi' strawberry and an array of North American cultivars. Manuel and his colleagues will then grow the seedlings in Huachi Grande, Ecuador, and these will be evaluated by him and the community.

Ecuador is a poor country, but the energy and intelligence of the local growers are high. The government of Ecuador apparently does not have the funding or interest to carry on a small breeding or research program in a crop that is planted on <400 ha, and they have not provided funds for an extension program on

these commodities. However, we hope that with a small effort on our part, the growers of Ecuador can do it themselves.

Our original objective was to collect the *F. chiloensis* growing near Huachi Grande that Darrow had called the 'Ambato' strawberry. This objective was easily and quickly met. The interactions we had with growers turned into a true exchange of ideas and information and the potential for germplasm exchange unexpectedly became the major outcome of this trip.

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