The Chilean Strawberry (Fragaria chiloensis): Over 1000 Years of Domestication

Chad E. Finn
U.S. Department of Agriculture, Agricultural Research Service, Horticultural Crops Research Unit, 3420 NW Orchard Avenue, Corvallis, OR 97330

Jorge B. Retamales and Gustavo A. Lobos
Centro de Mejoramiento y Fenomica Vegetal, Facultad de Ciencias Agrarias, Universidad de Talca, Casilla 747, Talca, Chile

James F. Hancock
Department of Horticulture, College of Agriculture and Natural Resources, Michigan State University, A288 Plant & Soil Science Building, East Lansing, MI 48824

Abstract. The cultivated strawberry of South America, the octoploid Fragaria chiloensis, has a long and interesting history. Although the origin of the species in Chile has not been completely determined, it may have been introduced from North America by birds. After making landfall in Chile, the species spread from the coast into the mountains eventually developing four biotypes. At least two native peoples, the Mapuche, between Rio Bio-Bio and south-central Chile, and the Picunche, between Rio Itata and Rio Bio-Bio, began the domestication process. Although white- and red-fruit types were domesticated, the white form (likely because of its fruit size) may have been preferred because the red-fruit types are not mentioned as frequently in the literature. At the time of the Spanish invasion of Chile, F. chiloensis was widely grown in small garden plots. Under the Spanish rule, larger plantings, first of 1 to 2 ha and later of many hectares, were grown. As the Spanish continued their exploration and conquest of South America, they carried F. chiloensis with them up the western coast to Peru and Ecuador. For many years these scattered plantings were the source of fresh fruit for the burgeoning human populations. The cultivated F. ×ananassa was introduced in Chile in 1830 but F. chiloensis was still preferentially grown. In the early 1900s, a large canning industry emerged serving hundreds of acres of F. chiloensis. By the 1950s, F. ×ananassa began to predominate and the rise in importance of the University of California and European-developed cultivars displaced much of the traditional F. chiloensis production. An increased awareness of this vast native Chilean genetic resource arose in the 1980s and 1990s. Scientists at the Universidad de Talca, associated with USDA-ARS Plant Exploration Office-sponsored trips to Chile, and with El Instituto de Investigaciones Agropecuarias–Cauquenes in Chile have collected and characterized germplasm that represents not only tremendous diversity, but captures many of the land races that have been developed. This germplasm has been used in small commercial plantings (0.1 to 0.3 ha) and in breeding programs to further develop F. chiloensis commercial cultivars. A small but vibrant community of small growers, particularly in Chile and Ecuador, produce the land races for commercial sale in local markets. Approximately 30 to 40 ha of open-field plantings are cultivated in Chile with yields averaging ~3 to 4 tons/ha. The selected F. chiloensis genotypes and collected clones from the wild have served as a valuable source of germplasm in modern breeding programs and the development of new cultivars with the white color and aromatic flavor typical of some of the traditional selections well underway.

HISTORY

The cultivated strawberry (Fragaria ×ananassa Duch. ex Rozier) originated from an accidental cross of the white-fruiting Chilean strawberry [F. chiloensis (L.) Mill. subsp. chiloensis f. chiloensis] and the meadow strawberry (F. virginiana Mill. subsp. virginiana) that occurred in a Royal Botanical Garden in France (Darrow, 1966; Staudt, 1999). Fragaria virginiana is an octoploid (2n = 8x = 56) species native throughout much of North America where there is sufficient moisture. Fragaria virginiana’s movement to Europe cannot be pinpointed to a single event or person; rather, it seems to have occurred many times from the settlers from present-day Virginia up to those along the St. Lawrence River and may have occurred as early as when Jacques Cartier explored this region in 1523 (Darrow, 1966; Wilhelm and Sagen, 1974). On the other hand, the colorful history of the journey of F. chiloensis, also an octoploid, to Europe is well described (Fig. 1; Darrow, 1966; Wilhelm and Sagen, 1974). Fragaria chiloensis is native to the fog belt along the Pacific Ocean from Alaska through British Columbia to the central California coast and as a disjunct distribution in Chile along the Pacific Ocean and into the Andes Mountains from lat. 35°30’S to long. 47°33’S and between sea level and 1850 m elevation (del Pozo and Lavin, 2005; Lavin et al., 2000). Migrating birds are presumed to have carried seeds from the North American to South American coast. Once established on the Chilean coast, the species moved inland and differentiated into different forms, often taking on the phenotype of F. virginiana growing inland in North America. In Chile, the mouth of the Biobio River is near current-day Concepcion. The native people in this region, the Picunche, to the north of the Biobio River, and the Mapuche, to the south of the Biobio, cultivated strawberries more than 1000 years ago (Hancock et al., 1999). The Picunche, who were largely an agrarian society, were believed to have taught the Mapuche, who were primarily hunter–gatherers, about agriculture, including strawberry cultivation. Further to the north, the invading Incas either received or took superior plants from the Picunche to grow in their gardens. The fruit in each of these cultures were consumed fresh, dried, or prepared as medicines (De Moebsbach, 1992). Like other cultures with access to native sweet fruits, the people fermented juice of the strawberry. Labarca (1994) reported that the Mapuche’s favorite fermented drink (lahuenë mushca) was made from the small, red-fruit native strawberry called “lahuene” or “lahuenë.” Although there were many uses for the small red form, over time two distinct cultivated types began to stand out: a large white and an improved, but not necessarily large, red form.
Although relatively uncommon, native white forms have been found in multiple sites in southern Chile (Hancock et al., 1999). Larger and larger selections of the white form ended up dominating the cultivated types and when comparisons of the modern *F. ×ananassa* cultivated types and the land race types are made, the modern types genotypically align with the white forms (Hancock et al., 1999; Hokanson et al., 2006; Lavin, 1997) more closely than with North American *F. chiloensis*. Apparently, whereas strawberries were well known as a native crop and they were commonly grown in garden plots by the native peoples, there was not a concerted effort to cultivate them in large quantities.

When the Spaniards invaded western South America, they came into conflict with the Mapuche in 1536, who kept them largely north of the Bío-Bío River until the 1880s. The large elite strawberries were considered a bounty of conquest and moved with the Spaniards north to Cuzco, Perú in 1557, and to Ecuador before 1789 (Popenoe, 1921). During the colonial period, strawberry production on a somewhat larger scale (1 to 2 ha) began to take place near Renca, just north of Santiago (Hancock et al., 1999). Surprisingly, although the Chilean strawberries were introduced to Perú in 1557, and although they were noted by explorers, it took until 1712 for these superior clones to be introduced to Europe from Chile (Darrow, 1966; Popenoe, 1921). Amédée François Frézier, an engineer in the French Army Intelligence Corps, was commissioned by King Louis XIV of France to conduct a reconnaissance mission to Chile and Perú. The King was apparently determined to keep his grandson on the Spanish throne and therefore wanted to know as much as possible about all parts of the Spanish empire (Darrow, 1966). Although not a botanist, Frézier, “had the botanist’s impulse for collecting” and collected unusually large-fruited strawberry plants that he transported back to France (Fig. 2; Darrow, 1966). As the story goes, he nursed the plants carefully with limited water on the six-month voyage and returned with five plants to Marseille (Popenoe, 1921). Frézier gave two plants to the ship’s owner, one plant to the Royal Garden, one to the minister of fortifications, and he kept one for himself (Popenoe, 1921).

Most evidence points to strawberries having been primarily a garden crop for the native Chileans, but during the Spanish colonial period, there were larger 1- to 2-ha plots of cultivated types raised in coastal valleys from west of Chillán (lat. 36°34′0″ S) to the Isle of Chiloé (lat. 41°40′ S to 43°40′ S) (Hancock et al., 1999). Most production was geared toward local markets until the early 1900s and fruit was usually transported to the markets by mule. Popenoe (1921) famously commented on the quality of the 1920 cultivars grown in the United States to the native types that had been taken from Chile and planted in Huachi, Ecuador (lat. 0°18′ S): “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 the market for two to three days at a temperature of 70 to 85 degrees? Even with such treatments as this, the Guachi strawberry (ed. Huachi/Guachi is a small community near Ambato, Ecuador) holds up well. Retaining its shape and texture to an extent altogether unknown among northern strawberries.”

As canning technology developed around the world, a large canning industry using *F. chiloensis* developed near Nueva Imperial, Chile (lat. 38°43′59″ S) and a somewhat smaller one near Corral, Chile (lat. 39°52′02″ S) between 1900 and 1950. In the mid-1990s, cultivars from Europe and from the United States began to displace the native strawberry (Hancock et al., 1999). Larger and larger selections of the white form ended up dominating the cultivated types and when comparisons of the modern *F. ×ananassa* cultivated types and the land race types are made, the modern types genotypically align with the white forms (Hancock et al., 1999; Hokanson et al., 2006; Lavin, 1997) more closely than with North American *F. chiloensis*.
expanding production of or currently used systems. Currently, the yield and fruit quality over the traditionally son and provide significant improvement in droponics, might expand the production sea-
drop high tunnels or greenhouse, maybe with hy-
or perhaps environmental modification using 
Researchers are exploring whether improve-
tion is hampered by selections/land races that 
(Table 1; Retamales et al., 2005). This expan-
advantage of a resurgent interest in new crops 
to find a niche in the market as well as to take 
Field production. The crop is sold mostly 
whiter than they would be if grown in open-
with ultraviolet-filtering plastic, the fruit are 
slightly red. When these are grown in tunnels 
around much of the world and Chile was no 
exception. Most of Chile as well as Perú and Ecuador, where the native F. chiloensis was 
for such an important part of production, 
are now planted in genotypes that trace their 
pedigree to California germplasm and are 
grown using the same annual, plasticulture 
system developed in California. Nonetheless, 
small pockets of production of pink- and 
white-fruited genotypes of F. chiloensis pro-
have held on in places like Curepto 
(lat. 35°08’ S), Putú (lat. 35°13’ S), Curanipe 
(lat. 35°50’ S), Chovellén (lat. 35°53’ S), 
Contulmo (lat. 38°00’ S), Purén (lat. 38°01’ S), 
Puerto Saavedra (lat. 38°46’ S), and the Island 
of Chiloé (lat. 41°40’ S to 43°40’ S), Chile; 
Cuzco (lat. 13°45’ S), Peru; and Huachi Grande 
(lat. 1°18’ S), Ecuador (Finn et al., 1998; Lavin et al., 2000).

CURRENT PRODUCTION

There has been increasing interest in 
expanding production of F. chiloensis in Chile 
to find a niche in the market as well as to take 
advantage of a resurgent interest in new crops 
(Table 1; Retamales et al., 2005). This expansion is hampered by selections/land races that 
are low-yielding and, when compared with our 
modern cultivars, very soft, small, and tender-
skinned with a very short shelf life. Traditional 
production systems have ranged from fields 
where plants are relatively evenly spaced in 
all directions, as might be found in Ecuador 
today, to systems very comparable to tradi-
tional matted row systems (Finn et al., 1998). 
Researchers are exploring whether improve-
ments in irrigation, fertilization, pest control, 
or perhaps environmental modification using 
high tunnels or greenhouse, maybe with hy-
donics, might expand the production sea-
son and provide significant improvement in 
yield and fruit quality over the traditionally 
or currently used systems. Currently, the 
F. chiloensis genotypes grown in Chile have 
a range of skin color from almost white to 
slightly red. When these are grown in tunnels 
with ultraviolet-filtering plastic, the fruit are 
whiter than they would be if grown in open-
field production. The crop is sold mostly 

Table 1. Comparison of Chilean native strawberry and commercial strawberry (FAOSTAT, 2013; Hancock, 1999).

<table>
<thead>
<tr>
<th>Item</th>
<th>Fragaria xananassa</th>
<th>F. chiloensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>World area planted (ha)</td>
<td>280,000</td>
<td>75–80</td>
</tr>
<tr>
<td>Yield (tons/ha)</td>
<td>50–70</td>
<td>3–5</td>
</tr>
<tr>
<td>Length of harvest season (month)</td>
<td>3–6</td>
<td>1–2</td>
</tr>
<tr>
<td>Planting duration (years)</td>
<td>1–2</td>
<td>6–8</td>
</tr>
</tbody>
</table>

where 900 to 1200 mm of rainfall is more 
common, are usually not irrigated. The nu-
trient program primarily consists of manure 
applications, although calcium carbonate is 
acted to soils where the pH is too low for 
good production. The leading disease prob-
lems are strawberry leaf spot (Ramularia 
tuxacei Sacc.), powdery mildew (Oidium 
sp.), and several viruses. Other than diseases, 
aphids (primarily Chaetosiphon fragaefolii 
Cockerell) and snails (primarily Helix aspersa 
O.F. Muller) are the predominant pests. Expan-
sion of production of F. chiloensis is desirable
but faces problems with low plant availabil-
ity, poor nursery plant quality (including an 
accumulation of viruses), low yields, and the
lack of a structured market to distribute this
unique crop. The marketing model being used
for the white-fruited strawberry called pine-
berry in Europe offers a marketing model that
may be applicable in Chile (<http://www.
vitalberry.eu/pineberries/>).

CURRENT USES IN BREEDING

The Universidad de Talca (Chile) has an
ongoing breeding effort toward developing
white- and pink-fruited, pure Fragaria chilo-
ensis types for the export market. This work
is based primarily on germplasm collected
by scientists sponsored by the USDA-ARS Plant
Exploration Office to collect in Chile (Cameron
et al., 1991, 1993; Lavin, 1997; Lavin et al.,
1993) and who were accompanied by research-
ers from El Instituto de Investigaciones
Agropecuarias–Cauquenes (Lavin et al., 1993).

At the beginning of this century, this work was
expanded by collections done by the Univer-
sidad de Talca (Retamales et al., 2005), who
in collaboration with C.E. Finn (USDA-
ARS, Corvallis, OR) gathered germplasm
from southern Chile (lat. 39 to 43° S). From
those germplasm collections, several pure
F. chiloensis crosses using white- and red-
fruited parents were made to develop improve-
ved selections from this species. The Universidad
de Talca plans to release three F. chiloensis
cultivars in 2013 with white-, pink-, or salmon-
colored fruit. The tragic earthquake in 2010
destroyed much of the university’s laboratories
and germplasm collections (in vitro and potted
material) and progress on different research
areas has been slowed. The USDA-ARS
(Corvallis, OR) continues to work on devel-
oping white-fruited, pure F. chiloensis types
as well as working with Michigan State Uni-
versity in recreating F. ×ananassa with a
much broader germplasm base than the origi-
nal source.

In 1996, the ‘Huachi Grande’ clone of
F. chiloensis was collected on a commercial
farm near Huachi Grande (Finn et al., 1998). This
type has been used extensively in the
USDA-ARS Corvallis and Michigan State
University breeding programs and was pre-
sumed to be similar to, or the same, genotype
as Darrow’s ‘Ambato’ (Darrow, 1952). Darrow
had used ‘Ambato’ in crosses in the USDA-
ARS Beltsville program but very little seems to
have come of that effort (Darrow, 1966).

This genotype was growing on volcanic,
extremely well-drained soils. It cyclically
ripened fruit that were large by “wild” stan-
dards but were in the 7- to 10-g size range in
the off-season. The fruit of ‘Huachi Grande’
was pinkish white, soft, and had a tender skin
but the fruit are extremely aromatic with a very
nice flavor. ‘Huachi’ does not survive out-
doors in Michigan as a result of cold tem-
peratures and struggles but lives through
Oregon’s very wet winters. When used in
crosses with adapted germplasm, selections
that are very large (20 to 30 g) with adapta-
tion, fair yield, and fruit that are flavorful
but soft can readily be selected in the first
generation hybrids between F. chiloensis and
F. ×ananassa.

Hancock et al. (2001a, 2001b) identified
other outstanding F. chiloensis clones for the
strawberry “supercore” group of 38 elite ge-
tonypes that represents the diversity present
in F. chiloensis and F. virginiana. This
“supercore” has since been extensively eval-
uated and used for germplasm enhancement,
especially as part of the cultivated strawberry
reconstruction project (Hancock et al., 2001a,
2001b, 2005, 2008, 2010; Stegmeir et al.,
2010). PI 236579, PI 551746, and PI 602567,
in addition to ‘Huachi Grande’ (PI 612318),
that trace to Chilean heritage have been par-
ticularly valuable parents and their genes are
in advanced selections for commercial trial
(USDA-ARS, National Clonal Germplasm
Repository, 2013).

One of the amazing genetic resources
contributed to the world from South America
has been F. chiloensis. A critical component
of the cultivated strawberry, it is still im-
portant as a cultivated species and as a source
or terrific germplasm for breeding modern
strawberries.

Literature Cited

Cameron, J.S., C.H. Shanks, Jr., T.M. Sjulin,
chiloensis in central and southern Chile, p. 108–
110. In: Dale, A. and J.J. Luby (eds.). The
strawberry into the 21st century. Timber Press,
Portland, OR.

Cameron, J.S., T.M. Sjulin, J.R. Ballington,
C. Shanks, C. Muñoz, and A. Lavin. 1993. Explo-
ration, collection, and evaluation of Chilean
Fragaria: Summary of 1990 and 1992 expedi-

Darrow, G.M. 1952. The Ambato strawberry of

Darrow, G.M. 1966. The strawberry. Holt, Rine-
hart, and Winston, New York, NY.

Chile y Fondo de Cultura Econo´mica. Santiago,
Chile.

Darrow, G.M. 1952. The strawberry of

Darrow, G.M. 1966. The strawberry. Holt, Rine-
hart, and Winston, New York, NY.

ed.). Temperate fruit crop breeding: Ger-
mplasm to genomics. Springer, New York, NY.

Notes on the strawberry of Ecuador. Ancient land
races, the community of farmers and modern

Hancock, J.F. 1999. Strawberries. CAB Publ.,
New York, NY.

Hancock, J.F., P.W. Callow, A. Dale, J.J. Luby,
C.E. Finn, S.C. Hokanson, and K.E. Hummer.
2001a. From the Andes to the Rockies: Native
strawberry collection and utilization. Hort-

Hancock, J.F., C.E. Finn, S.C. Hokanson, J.J. Luby,
B.L. Gaulart, K. Demchak, P.W. Callow, S.
together strawberries from North and South
586.

Genetic improvement of beach strawberry.

Hancock, J.F., C.E. Finn, J.J. Luby, A. Dale, P.W.
Callow, and S. Serce. 2010. Reconstruction of the
strawberry, Fragaria ×ananassa, using native
genotypes of F. virginiana and F. chiloensis.
HortScience 45:1006–1013.

Hancock et al. (2001a, 2001b) identified
other outstanding F. chiloensis clones for the
strawberry “supercore” group of 38 elite ge-
tonypes that represents the diversity present
in F. chiloensis and F. virginiana. This
“supercore” has since been extensively eval-
uated and used for germplasm enhancement,
especially as part of the cultivated strawberry
reconstruction project (Hancock et al., 2001a,
2001b, 2005, 2008, 2010; Stegmeir et al.,
2010). PI 236579, PI 551746, and PI 602567,
in addition to ‘Huachi Grande’ (PI 612318),
that trace to Chilean heritage have been par-
ticularly valuable parents and their genes are
in advanced selections for commercial trial
(USDA-ARS, National Clonal Germplasm
Repository, 2013).

One of the amazing genetic resources
contributed to the world from South America
has been F. chiloensis. A critical component
of the cultivated strawberry, it is still im-
portant as a cultivated species and as a source
or terrific germplasm for breeding modern
strawberries.