# British Columbia's Pacific Coast Beach Strawberry - Fragaria chiloensis

**Abstract**

The cultivated strawberry, *Fragaria* × *ananassa*, originated in the 18th century from a cross of a selection of *F. chiloensis*, from Chile, with a selection of *F. virginiana*, from Virginia. Since then other selections from each species have been used to breed improved cultivars. However, none of these contains genes of *F. chiloensis* native to British Columbia (BC). During the 1980s approximately two thousand selections of the species were collected from 123 sites in the Province. A selection from each site was evaluated for reactions to several important strawberry diseases or pests. A selection showing multiple resistances was crossed with 'Totem', the leading Pacific Northwest cultivar; subsequently a selection from this was crossed with 'Elsanta', the leading European cultivar. After two generations, there is at least one selection that approaches modern day cultivar standards and appears to have resistances approaching those of the *F. chiloensis* selection. This indicates the value of the collection which represents only a minuscule amount of the diversity of the native *F. chiloensis* of BC.

The Pacific Coast beach or sand strawberry, *Fragaria chiloensis*, is ubiquitous along the outer coasts of mainland BC and Vancouver Island, the Queen Charlotte Islands, and the many small offshore islands. The species is truly one of the botanical treasures of these spectacular locations. Typically plants have distinctive thick, leathery and glossy dark green leaves (Fig.1) and often grow in sand almost to the high tide level. They produce prolific runners with closely spaced plants that have extensive root systems and are important contributors to sand dune binding (Fig. 2). Plants also colonize rocky headlands and often are the main vegetation on small, jagged offshore pinnacles (Fig. 3). They are drought and salt tolerant and flourish under wind-swept conditions.

*Fragaria chiloensis* also occurs to the north, along the Alaska coast, onto the Aleutian Islands and to the south along the Washington, Oregon, and the northern and central California coasts as far south as the Monterey Peninsula. There is a gap in distribution through subtropical and tropical latitudes until the more temperate regions of South America where it occurs along the coast and into the foothills of the Andes south to Tierra del Fuego. There

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are also populations at higher elevations on two of the Hawaiian Islands, Maui and Hawaii. On southern Vancouver Island and in Washington, the species occurs on the more westerly beaches along the Strait of Juan de Fuca.

The extensive distribution of the species is associated with much variation (Hancock, 1999; Staudt, 1999). Currently four subspecies are recognized: (1) *Fragaria chiloensis* subsp. *lucida* - from the Queen Charlotte Islands to San Luis Obispo, California; (2) *F. chiloensis* subsp. *pacifica* - from the Aleutian Islands to San Francisco; (3) *F. chiloensis* subsp. *sandwiensis* - Hawaiian Islands; (4) *F. chiloensis* subsp. *chiloensis* - along the coast of temperate South America into the foot hills of the Andes (Staudt, 1999). Two forma of this last subspecies are recognized, the cultivated *F. chiloensis* and the native *F. patagonica* (Staudt, 1999). Recent DNA analyses of interspecific variation in *F. chiloensis* suggest that subspecies *lucida* and *pacifica* might intergrade too much to be considered separate subspecies (Porebski and Catling, 1998).

The specific epithet, *chiloensis*, is derived from Chiloe, an island off the southern coast of Chile, which supports an abundant native population of the species (Wilhelm and Sagen, 1994). *Fragaria chiloensis* is octoploid with 56 chromosomes; the base number for *Fragaria* species is 14. In North America most *F. chiloensis* plants are dioecious, with pistillate (female) and staminate (male) flowers on separate plants (Fig. 4). However, hermaphroditic (perfect-flowered) plants are found at several sites in California, Alaska and on some islands off the coast off northern British Columbia. Hermaphroditic plants are more common in Chile (Hancock, 1999). Compared with pistillate flowers, staminate flowers are usually larger and can make an especially spectacular show above the glossy leaves. External colour of ripe fruit (Fig. 5). varies considerably from shades of red through orange, pink, and white and can be dull or glossy. Internal colour is usually pale pink to white. Fruit shape varies from round to conic. The fruit is relatively firm and can weigh as much as four grams. Soluble solids, acidity, and aromatic content are highly variable. Flavour is usually mild and pleasant.

In South America, *F. chiloensis* selections have been propagated for at least seven hundred years (Staudt, 1999). A selection was taken to France in the early 1700s. Subsequently, plants from this were placed into botanic gardens throughout Europe. Selections of the Virginia scarlet or meadow strawberry, *F. virginiana*, a widely distributed North American octoploid *Fragaria* species,

had been taken to France from Virginia approximately one hundred years earlier. These selections became the basis of a flourishing strawberry industry in France and elsewhere in Europe.

It was observed that plants from the *F. chiloensis* selection set fruit only when grown near plants of *F. virginiana*. The *F. chiloensis* selection was obviously pistillate and fruit set required pollen from staminate flowers. In this case, the pollen came from one or more staminate selections of *F. virginiana*. The two *Fragaria* species appeared to be completely interfertile. *F. virginiana*, like *F. chiloensis*, is usually dioecious and it was widely recognized that fruit set within the species required both pistillate and staminate flowering selections. The initial cross between *F. chiloensis* and *F. virginiana* produced unusual seedlings with unique combinations of fruit and morphological characters. Plants combined the hardiness, vigour, and productivity of *F. virginiana* with the relatively large fruit size of *F. chiloensis*. The French botanist Antoine Duchesne determined that these were hybrids of the two species and designated them *Fragaria* × *ananassa* to denote that the fruit smelled like pineapple (*Ananas*). These hybrids were the basis of the present day cultivated strawberry now grown throughout the world.

Since the late 1700s, more plants taken from populations of the two *Fragaria* species have been intercrossed and selections from each have been crossed with plants derived from the hybrid *F.* × *ananassa*. The selections used from each of the two species represent only a minuscule amount of the original natural diversity, but it is difficult to ascertain just how much has been lost. The fragile beach habitats of *F. chiloensis* are especially vulnerable to damage from a myriad of human activities including the introduction of invasive species. This has been particularly evident in northern and central coastal California where urban and suburban developments have encroached onto the beaches where the species previously flourished. In some beach habitats, species such as the South African native *Carpobrotus edulis* (ice plant, Hottentot fig), have been introduced for erosion control. Plants of this species can be invasive and aggressive, subsequently endangering the slower growing *F. chiloensis*. Another, sometimes unrecognized, factor endangering natural populations of *F. chiloensis* is introgression (crossing) with the cultivated strawberry, *F.* × *ananassa*. This occurs more frequently in California than elsewhere because of the proximity of strawberry fields to the beach habitats of *F. chiloensis*.

The British Columbia coast is relatively pristine compared with other Pacific coasts and most *F. chiloensis* populations have not been unduly affected by any sort of development or by the introduction of invasive species. Possible exceptions are the Queen Charlotte Islands where the feeding of introduced deer has reduced plant populations in some areas (Pojar and MacKinnon, 1994). During the 1980s, the UBC Botanical Garden and Agriculture and Agri-Food Canada (AAFC) Vancouver Research Station (now integrated into the Pacific Agriculture Research Centre [PARC]), collaborated to collect approximately 2,000 selections of *F. chiloensis* from more than 123 sites (Luby et al., 1991).

In the early 1990s one selection from each site was evaluated for reactions to two diseases and one pest, each of which can be a limiting factor in strawberry plant growth and fruiting (Luby et al., 1991). Ten selections were identified with tolerance to the complex of virus diseases that occur in strawberry cultivars throughout the Pacific Northwest. In addition, eleven selections were identified with resistance to a composite of races of *Phytophthora fragariae* var. *fragaria*e (the red stele root rot causal organism). Red stele can be a serious strawberry disease, particularly on heavier soils that might be poorly drained during the winter and early spring months. Twenty selections showed some tolerance to two-spotted mite, *Tetranychus urticae*, a universal pest of strawberry. Plants from several selections had useful levels of resistance to both of the diseases as well as mite tolerance. All the selections had resistance to the common leaf diseases, powdery mildew (*Sphaerotheca macularis*) and leaf spot (*Mycosphaerella fragariae*).

Resistances or tolerances are not unexpected in wild *F. chiloensis* populations. In the early part of the 20th century, virus tolerance was recognized in California populations and several selections were used in a breeding programme conducted by Albert Etter, a pioneer strawberry grower (Wilhem and Sagen, 1974). One cultivar, 'Ettersburg 121' with a *F. chiloensis* parent from Cape Mendocino, became the basis of the virus tolerance of the many University of California cultivars which still dominate in Mediterranean-type production regions throughout the world (Wilhelm and Sagen, 1974; Hancock, 1999). 'Ettersburg 121' is also the likely source of virus tolerance in many other cultivars, including 'Totem' which has dominated strawberry production in the Pacific Northwest for more than 25 years. Clones from Washington and Oregon, as well as California, have been identified with resistance or

tolerance to red stele root rot, Verticillium wilt (*Verticillium albo-atrum*), leaf spot (*Mycosphaerella fragariae*), powdery mildew (*Sphaerotheca macularis*), black vine weevil (*Otiorhynchus sulcatus*), strawberry root weevil (*Otiorhynchus* spp.), the aphid vector (*Chaetosiphon fragaefolii*) of the strawberry virus complex, two-spotted spider mite, and root lesion nematode (*Pratylenchus penetrans*) (Wilhelm and Sagen, 1974; Hancock et. al., 1990; Hancock et. al, 2001).

A vigorous pistillate-flowered selection, collected from Providence Cove, south of Port San Juan on Vancouver Island, has been used in the BC strawberry breeding programme sponsored by AAFC at the PARC. Plants of the selection showed resistance to a composite of races of the red stele causal organism and tolerance to the virus complex. In 1989, the selection was used as the female parent in a cross with 'Totem'. Several particularly vigorous selections were made from the subsequent seedling population. One of these, which produced female flowers, was chosen as the parent in a cross with 'Elsanta', the leading cultivar in Britain and in much of Western Europe. In 1994, several perfect flowered selections with excellent fruit qualities were identified in the population derived from the 1991 cross. One in particular, designated BC 94-60-102, appears to have many of the qualities associated with named *Fragaria* × *ananassa* cultivars. The selection is now undergoing extensive tests in several Pacific Northwest locations and, at the same time, is being used in further breeding.

Evaluation of the BC *F. chiloensis* collection is far from complete. In fact, evaluations of plants for disease and pest reactions have just begun. Plant traits requiring evaluation include reactions to drought, water logging, salinity, variations in soil pH, cold, and heat. Fruit traits requiring evaluation include flavour, size, firmness, keeping quality, reactions to both pre- and post-harvest rots, season of ripening, and ease of harvest. Some of these traits have been evaluated in *F. chiloensis* populations along more southern parts of the Pacific coastline. For example, cold hardiness of plants was determined for 462 selections from California and Oregon (Luby et al., 1991). Latitude of origin was highly correlated with foliage hardiness and crown regrowth after a low temperature of -14°C, preceded by warm weather. Selections with particularly firm fruit have been found in Alaska, Oregon, California, and Chile and with larger than average size in Chile (Darrow, 1966; Staudt, 1999),

In California and Oregon local *F. chiloensis* selections have been used for ornamental ground cover. The deep root systems and extensive production

of runner plants give good erosion control on sloping terrain. Several selections from the BC collection were tested for this purpose but none produced sufficiently closely spaced runner plants to give a uniform stand. It is quite possible, though, that more extensive testing will reveal better suited selections.

The BC collection represents only a minuscule amount of the diversity of the Province's *F. chiloensis*. It is unlikely, at least in the foreseeable future, that further systematic collections will be made because funding for such endeavors is not readily available from the public sector. The private sector is more interested in funding "near market" research which means funding strawberry breeding programmes with the objective of developing cultivars that will bring immediate economic returns. This situation is similar to most fruit breeding programmes.

The current collection, represented by approximately seven hundred selections, is maintained at the Canadian Clonal Genebank at the AAFC Greenhouse and Processing Crops Research Centre at Harrow, Ontario. Unfortunately, the PARC no longer has resources to screen for reactions to the red stele root rot causal organism. However, the disease increases in economic impact. Control by chemicals is expensive, inefficient and, most important, environmentally unsound.

The germplasm base of the cultivated strawberry is considered dangerously narrow (Hancock et al., 2001). Thus, the value of the BC *Fragaria chiloensis* collection is potentially enormous. It is imperative that it be conserved, evaluated, and utilized in breeding programmes to produce strawberry cultivars that will grow successfully in an even wider range of climates and soil types without resorting to the use of chemicals for pest and disease control.

Plants of the *F. chiloensis* selection from Providence Cove, the cultivars 'Totem' and 'Elsanta', and the selections from the crosses involving each are now established at the UBC Botanical Garden. These plants illustrate the progress made towards producing a potential strawberry cultivar only two generations removed from a native selection. Also included in the planting are several other selections of *F. chiloensis* and *F. virginiana*. These illustrate some of the variation present in the species which are the progenitors of modern day strawberry cultivars.

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