THE HIGH ALTITUDE TROPICS - A SOURCE OF PLANTS FOR NEW ZEALAND

S. N. Dawes,
Plant Diseases Division,
DSIR,
Auckland.

ABSTRACT

Few plants have been introduced to New Zealand from high altitude areas within the tropics where there is a zone of temperate climate which is very like that of New Zealand, with no great extremes of heat and cold. The warmer part of this zone is of great interest as a source of plants for our sub-tropical fruit growing areas. Undoubtedly these high altitude temperature zones should also be considered as a possible source of ornamental plants, grasses, field crops, and timber trees.

There are many high mountains within the tropics that have zones of temperate climate. Some of the areas are small, but there are also mountain ranges with a continous zone of temperate climate. Altogether these constitute a large area and include many places with a high percentage of indigenous species.

They have given us important crops such as kiwifruit,tamarillos and feijoas, but there is great scope for further introductions.

A very large number of exotic plants have been successfully established in New Zealand. These have mostly come from areas of similar latitude to that of New Zealand, whether from the northern or southern hemisphere. We generally expect that plants from regions of lower latitude will be unsuitable for our conditions. This is true if we think of places at or near sea level, especially within the tropics. If, however, we consider areas of higher altitude then this is not necessarily so.

Even at the equator, climate changes rapidly with increase in altitude, from tropical at sea level, to in some cases permanent snow, where there are very high mountains. Between these extremes, there is a zone of temperate climate very like that of New Zealand. If one looks at a relief map of the world, one sees that there are many areas of mountains within the tropics. This includes large areas of South East Asia, the Phillipines, Indonesia, southern India, New Guinea, Latin America and parts of Africa. Even a world scale climate map (The Times Atlas of the World, 1968) shows up some high altitude regions of cooler climate.

Maritime West Coast Climate

New Zealand falls wholly within the Maritime West Coast, Cbf, climate zone of the Koppen system, as modified by Trewartha (Finch and Trewartha, 1949). Areas of Maritime West Coast climate in the high altitude tropics, that are large enough to be shown on a large scale climate map, include parts of the mountains. of New Guinea, Borneo, Ethiopia, Kenya, eastern South Africa, south eastern Brazil and in the Andes mountains from Venezuela to Bolivia. These are areas where there is a large enough mountain mass or chain of mountains for such a climatic difference to be seen on a large scale map. In addition to this, there are many individual peaks or smaller mountainous areas of temperate climate that do not appear on a map of this scale. Altogether high altitude areas of Marine West Coast Climate add up to a large land mass. Add to this the fact, that in all the individual areas there are many endemic plants and one can see that the highland tropics is a very interesting source of plants for New Zealand. This includes fruit bearing plants, ornamentals and probably, timber trees, field crops and grasses. There has of course been some plant introduction from these areas, but there is great scope for further introductions.

Definition of Marine West Coast Climate

The classification of Marine West Coast Climate is broad, as is seen by the fact that the whole of New Zealand comes within this zone. New Zealand's designation Cbf is defined by C, rainy climates with mild winters, coolest month above 0°C but below 18°C and warmest month above 10°C, while b means the warmest month is below 22°C and f constantly moist, rainfall of the driest month at least 60 mm. This is a general classfication and we know that in the case of New Zealand, it can be divided into areas of distinct climate. If therefore, we wish to look for plant material for specific parts of New Zealand, we need to consider in closer detail what particular high altitude tropical zone is of interest to us.

Subtropical Fruiting Plants

Subtropical fruitgrowing in New Zealand is largely confined to coastal areas of the North Island and mainly to the sheltered east coast from Gisborne in the south to the Far North. For this climate we are therefore interested in plants from the warmest part of the Marine West Coast climate, that is the lowest altitude of this zone in the highland tropics.

We should also consider the cooler side of the Humid Subtropical Ca and Mediterranean Cs climate zones, where they occur within the tropics. For instance, even a relatively slight increase in altitude near the tropics of Cancer or Capricorn, with an area predominantly Humid Subtropical, will mean a

change to the warmer phase of Marine West Coast climate. The definition of Humid Subtropical Ca differs from that of Marine West Coast Cb Cc in that a designates that the warmest month is above 22°C. The warmest zone in New Zealand, in terms of the mean temperature of the warmest month, has a minimum temperature of 19°C and covers much of eastern Northland and part of the Bay of Plenty (Hurnard, pers. comm.). No part of New Zealand achieves the Cb designation, but we need to bear in mind that our subtropical fruit crops can only be successfully grown commercially in closely sheltered small, blocks of land. Shelterbelts of trees are planted to improve the microclimate and the resultant warmer conditions that are essential for these crops may come close to a Humid Subtropical climate. We do not yet have a comparison of climatic data from sheltered and unsheltered situations, in our subtropical fruitgrowing areas, to know to what extent this is true. We do know however, that we cannot grow the crops without good shelter.

Subtropical Fruit Crops of New Zealand

The subtropical fruit crops grown commercially in New Zealand are citrus, kiwifruit, tamarillos, feijoas, avocados and passionfruit. It is relevant to consider the origin of some of these plants.

The kiwifruit *Actinidia chinensis* has been developed from a wild plant native in South China near the Tropic of Cancer at altitudes from 500 to 2,000 metres above sea level (Li, 1952). This is an area designated as Humid Subtropical with well distributed rainfall Caf. This confirms the above statement that a moderate increase in altitude will affect this climate. In the case of south China there are many hills and mountains.

The avocado cultivars that are grown in New Zealand are hybrids of the Mexican *(Persea americana* var. drymifolia) and Guatemalan *(P.nubigina)* races of avocados that are indigenous in the highlands of Mexico and Central America. These avocados occur over a range of altitude from approximately 1,000 to 2,000 m.a.s.l. (Popenoe, 1919) the cooler side of a Humid Subtropical climate zone.

The tamarillo *(Cyphomandra betacea)* is native in the Andes mountains of northern South America at altitudes of 1,800 to 3,000 m.a.s.l. (Popenoe, 1974), which is roughly the lower part of the Marine West Coast climate zone in that area. Similarly, the feijoa *(Feijoa sellowiana)* and purple passionfruit *(Passiflora edulis)* are from the mountains of southern Brazil, in another Marine West Coast climate zone near the Tropic of Capricorn.

It can be seen, therefore, that most of our subtropical fruit crops have come from high altitude areas in the tropics. As there has been very little plant introduction from these areas there must be further important plant material to be obtained.

Latin American Highlands

As an example of a high altitude tropical area, I will consider the highlands of Latin America in more detail. This will include some aspects of climate and a little about the plant material of this area. Other regions of similar climate may offer just as many useful plants, but they are generally less well known.

There is a more or less continuous range of mountains down the whole west coast of the Americas from Alaska to southern Chile. Within the tropics, Mexico and Central America have large areas between 1,500 and 3,000 m.a.s.l., whilst the Andes mountains of South America are often 4,000 to 5,000 metres high with peaks over 7,000 m.a.s.l. This mountain mass greatly affects the climate. Naturally there are many variations depending on aspect latitude, rainfall etc. and in many areas not a great deal of climatic data is available. The following few facts in relation to two areas will serve to illustrate the effect of altitude on temperature. This information has been supplied by S.M. Hurnard, N.Z. Meteorological Service and is largely derived from Landsberg (1979)

Change of Climate with Altitude in Ecuador

Ecuador, as the name suggests, straddles the equator. Locally, climate is considered in terms of zones of different altitude. From sea level to 1,000 m.a.s.l. is the "tierra caliente" (hot zone), from here to 2,000 m.a.s.l. the "tierra templada" (temperate zone) and from 2,000 to 3,000 m.a.s.l. the "Tierra fria" (cold zone). The latter is not a good description, as the average annual temperature of this layer varies from 13°C to 18°C, which is warmer than many so called temperate regions of the world. Above 3,000 m.a.s.l. the term "paramos" (bleak uplands) is used up to the snow line.

These vertical divisions generally apply in neighbouring countries, but there are local complications. In Colombia the climate is often wetter with two wet seasons; in Peru the western slopes of the Andes are cooler than those of the east, and the west is drier; whilst in Bolovia the eastern slopes are more extensive. The same "caliente","templada" and "fria" altitudinal zones are also used in Guatemala, Central America.

This relationship between altitude and temperature is shown in Table 1 compiled from regression analysis of some 50 stations in Peru and Ecuador.

TABLE 1: Approximate mean annual temperature in relation to altitude[1] (Hurnard, pers. comm.)

Altitude (m) above sea level:	0	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500
Temperature °C:	27	24	21	20	17	16	13	9	6	3

1 Applicable to Ecuador and east and central Peru, excluding the coastal regions.

As a comparison with New Zealand, the mean annual temperature of Kaitaia, which is in the zone of highest mean annual temperature, is 15°C, whilst that of Tauranga is 14°C. Near the equator, the altitude range 2,000 to 3,000 m.a.s.l. is of greatest interest as a source of subtropical fruiting plants suitable for New Zealand.

With increase in latitude the altitude at which a similar climate zone occurs becomes lower. Near the tropics of Capricorn and Cancer, areas above 1,000 m.a.s.l. have a similar climate to 2,000 m.a.s.l. near the equator.

High Altitude Climate in Southern Brazil

The high altitude region of south-eastern Brazil, from Minas Gerais and inland of Rio de Janeiro, to Rio Grande do Sul, is an example of a highland region near the tropic of Capricorn, where there are considerable areas from 1,000 to ,2,000 m.a.s.l.. Curitiba in the province of Parana, with an altitude of 949m.a.s.l. and 25°S latitude, has a climate very close to Kaitaia (Hurnard pers.comm.). Some areas in this region have an average January temperature below 20°C.

Fruiting Plants of the Highlands of Latin America.

Having briefly considered the climate of some high altitude areas of Latin America and its similarity to the subtropical fruit-growing ares of New Zealand, I will describe a few of the plants of this region that are worthy of trial here. This is easiest accomplished by listing them in their plant families. The principal sources of information are: Hoehne (1946), Popenoe (1919,1924,1974), Romero Castaneda (1961-69) and Sykes (pers. comm.).

Caricaceae

This is the family to which the tropical papaya belongs

Mountain Papaya

The mountain papaya, or mountain pawpaw *(Carica pubescens),* is a common garden plant in northern New Zealand. It comes from elevations of 2,400 to 2,700 m.a.s.l. in the mountains of Colombia and Ecuador. The fruits of the mountain papaya are small and not much used in New Zealand, though canning is possible.

Babaco

Of much greater interest for our subtropical fruitgrowing areas is the babaco, a natural hybrid between the mountain papaya *Carica pubescens* and another high altitude species *C. stipulata.* The plant is very similar in appearance to the mountain papaya, but the fruit are much larger and of better quality. They are commonly 25cm in length and 10cm in diameter and up to 1.3kg in weight, with crisp, pleasantly-flavoured flesh.

The babaco is a rare plant outside of valleys of the inter-Andean region of Ecuador where its culture has only slowly spread. This undoubtedly is largely due to the fact that the fruit are set parthenocarpically and as there is no seed it can only be propagated by cuttings. I was fortunate in collecting a few cuttings in 1973 and now having proved that the babaco will grow and crop well under our conditions, only the slow job of multiplication is delaying commercial development.

Annonaceae

Some of the fruits from plants of this family are called custard apples.

Cherimoya

One of the species that seems well suited to New Zealand conditions is the cherimoya *Annona cherimola.* The small spreading semi-deciduous tree is native to the Andes mountains of Peru and Ecuador at altitudes of approximately 1,500 to 2,000 m.a.s.l. The fruits are compound (syncarpium) frequently heart-shaped or conical and range in weight from 200 grams to several kilograms. The white juicy flesh has a flavour with similarities to the pineapple and banana and contains several bean-like seeds.

Cherimoya fruits could be particularly useful as a fresh fruit in New Zealand as they ripen in spring and early summer when there is little fresh fruit available.

Solanaceae

The tamarillo *(Cyphomandra betaceae)* is only one of a large number of small shrubby trees of the Solanaceae that are indigenous in northern South America. It occurs at elevations of 1,800 to 3,000 m.a.s.l. and there are many other *Cyphomandra* species with large edible fruit that are native in the northern Andes and in Southern Brazil. These include species such as *C. naranjilla, C. crassifolium and Solanum grandiflorum*

Casana

As an example of this, a *Cyphomandra* species recently introduced into New Zealand from southern Ecuador by a local orchardist, shows promise of becoming a new subtropical crop. This is the casana, which was collected from approximately 3,000 m.a.s.l. and is yet to be properly identified.

The fruit of the casana are more elongated than the tamarillo, yellow when fully ripe, with a sweet peach-like flavour. The casana is growing well in New Zealand under good conditions and the first locally grown fruit were available this season.

This recent introduction of the casana is proof of the fact there are other members of the Solanaceae awaiting development.

Naranjilla

The small bushy shrub *Solanum quitoense,* is an important fruiting plant in the northern Andes. The fruits are round, about 5 cm in diameter and bright orange coloured when ripe. Their chief use is for producing beverages.

Pepino

The pepino (Solanum quitoense) is a bushy perennial that looks rather like a potato plant, with very similar leaves and flowers. It also is a native of the northern Andes, but has been widely distributed in Central and South America.

The fruits are very variable and may be egg or top-shaped, globose, or elongated and vary from 100 g to a kilo in weight. They are light green to light yellow when ripe, frequently with purple stripes. The

skin is very thin, while the thick yellow flesh is crisp and juicy, with only a few very small seeds in the central cavity. Good forms of the pepino have a very pleasant sweet flavour rather like a rock melon and they are eaten in a similar way to the rock melon as a dessert dish.

I have been making selections and crossing various strains of pepino from several recent seed introductions from South America. All the characters needed for a commercial cultivar are present and we are close to having a form of the plant that will give high yields of good quality fruit. It would be grown as an annual much like a dwarf tomato with the fruit available over the late summer/autumn period.

Sapotaceae

The name of the Sapotaceae is derived from the Aztec term tzapotl used to designate soft sweet fruits and there are many members of the family in the American tropics and subtropics that produce large edible fruit.

The green sapote *(Achradelpha viridis)* is indigenous in the highlands of Central America and is particularly abundant in northern Guatemala where it grows at elevations of 1200 to 1800 m.a.s.l. The tree is a handsome evergreen which bears top-shaped fruit up to 12 cm long that have sweet, reddish-brown flesh, with a pleasant almond-like flavour. The fruit is very popular with the Indians of the Guatemalan highlands.

Two other members of the family from similar climate zones, which bear large edible fruit are the yellow sapote *(Lucumo salicifolia)* of Mexico and the lucumo *(L. obovata)* of Peru.

Myrtaceae

The myrtle family contains a large number of plants with edible fruit. Of these the tropical guava *(Psidium guajava)* and feijoa *(Feijoa sellowiana)*, from different altitudes in Brazil, are best known. There are a number of other shrubby species with large edible fruit that are indigenous at high altitude in southern Brazil including *Britoa acida*, *Eugenia uvalha* and *E.klotzschiana*. Fruit of the Costa Rican guava *(Psidium friedrichsthalianum)* is very popular in the mountains of Costa Rica.

There is a second group of myrtles with edible fruit that are generally larger, more upright, trees with fruits the size of a grape.

Jaboticaba

This popular tree of southern Brazil has the unusual habit of bearing its fruit directly upon the trunk and larger limbs. The fruits are round 2 to 4 cms in diameter, maroon-purple in colour, having a tough skin and whitish juicy pulp, with an agreeable wine-like flavour.

The jaboticaba is often listed under the species name of *Myrciaria cauliflora*, but in effect there are several closely related species that include *M. jaboticaba, M. trunciflora and M. cauliflora* and hybrids between them.

The fruit are popular in southern Brazil where they are stewed for desserts and made into wine and jelly.

Pitanga

The pitanga *(Eugenia uniflora)*, is often known as the Brazilian cherry tree. The fruit are round, conspicuously eight ribbed, 2 to 3 cms in diameter, deep crimson when fully ripe and held on long stems like a cherry. The flesh is soft with an aromatic sub-acid flavour

Other species of eugenia that are locally important in Brazil for their cherry-like fruit include *E. dombeyi* and *E. iuschnathiana.*

Rutaceae

This is the large family to which citrus belong.

White Sapote

In the highlands of Mexico and Central America the white sapote *(Casimiroa edulis)* is found from elevations of 1000 to 2000 m and occasionally 2700 m.a.s.l. It is one of the principal fruits-of this region. The medium-sized evergreen tree bears yellowish-green fruits the size of an apple. These have a thin membranous skin, with sweet, yellowish flesh of a soft melting texture. This plant seems well adapted to coastal North Island conditions and shows real promise for development as a crop.

Other Subtropicals

The above are some of the better known subtropical fruiting plants from the appropriate climatic zone in the highlands of Latin America. That these represent only a few of the potential plants is shown by the species listed in Floras of particular areas.

It is obvious that the number of potentially useful plants is very great indeed.

CONCLUSION

The subtropical fruit-growing industry of New Zealand is rather unique in that several of the crops have been developed here. All of the latter are from high altitude areas within or near the tropics. Even a superficial coverage of one such region shows the wealth of plant material available. We must endeavour to increase the rate of introduction of plants from these highland tropical areas, from which we can expect important new crops of the future.

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