PLANTS OF THE HIGHLAND TROPICAL REGIONS

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Exotic plants have been successfully established in New Zealand from the very earliest days of European settlement. Naturally these introductions come mainly from areas of similar latitude to New Zealand in either the northern or southern hemispheres. There is, of course, still considerable scope for further introductions from this source. However, I want to point out that there are other areas with a climate similar to that of New Zealand which offer even greater scope for plant introduction. One such region is the high altitude tropics.

High Altitude Tropics. We tend to consider that plants from areas near the equator are going to be unsuitable for New Zealand conditions. Sometimes we are aware of exceptions and wonder at the adaptibility of such plants. Mostly we do not realise the effect that altitude has on climate, or even that all areas within the tropics are not low lying and tropical in nature. If, however, we look at even a world scale relief map we see that there are large mountainous regions between the tropics of Cancer and Capricorn. Altitude has a major effect on climate, and even at the equator, climate changes rapidly with increase in altitude. Where the mountains are high enough there are regions of permanent snow right on the equator. In such places, between the extremes of tropical climate at sea level and permanent snow at very high altitude, there are gradations from subtropical to temperate climates. It is the zone of temperate climate that I wish to consider in further detail.

Temperate Climate Zone in the Tropics. As an example of the effect of altitude on climate we can consider the case of Ecuador in northwestern South America. As the name suggests Ecuador straddles the equator, but it is bisected by the massive Andes mountain chain with peaks up to 6,000 metres above sea level (m.a.s.l.), permanently capped with snow. Here the local definition of climate is in terms of altitudinal zones. From sea level to 1,000 m.a.s.l. is the "tierra caliente" (hot zone), from 1,000 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 term "paramos" (bleak uplands) is used to describe the region from 3,000 m.a.s.l. up to the snow line. That this is a sensible and convenient division into climate

zones is shown by the mean annual temperatures at various altitudes listed in Table 1. This table is compiled from data derived from some 50 meteorological stations in Peru.

Table 1. Approximate mean annual temperature in relation to altitude[1] (Hurnard, N.Z. Met. Service, 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.

Given the latitude of New Zealand it is the "terra fria" or cold zone and the "paramos" that is of the most interest to us. The term cold zone is, in fact, not a good description of the climate of the 2,000 to 3,000 m.a.s.l. zone as its average annual temperature varies from 13° to 17°C, which is warmer than many temperate regions of the world. Better names for the various zones would be tropical, subtropical, temperate, and cold.

Comparison with New Zealand. As a comparison with New Zealand conditions the mean annual temperature of Kaitaia N.Z. is 15.5°C, that of Tauranga N.Z. 14.2°C, and for Invercargill, N.Z. 9.5°C. Other similarities in climate between high altitude areas of the tropics and New Zealand are the relatively small seasonal differences in temperature but considerable diurnal temperature changes and a long growing season. Annual hours of bright sunshine in the Ecuadorian highland basins are around 1,800 hrs which is similar to New Zealand locations where Auckland and Kaitaia enjoy 2,000 to 2,200 hrs, Tauranga 2,000 to 2,400 hrs, and Invercargill 1,600 to 1,800 hrs.

Increase in Latitude. With increase in latitude, the altitude at which a similar climate occurs decreases. The change is gradual and not very marked until about 17° to 20° south or north of the equator when seasonal and diurnal changes in temperature become more marked. Near the tropics of Capricorn and Cancer (23.5° latitude) areas at 1,000 m.a.s.l. have a similar climate to those of 2,000 m.a.s.l. near the equator or those at sea level at higher latitudes. For example, the city of Curitiba in the Province of Parana, Brazil, with an altitude of 950 m.a.s.l. and 25°S latitude has a climate very close to that of Kaitaia N.Z., at 80 m.a.s.l. and 35°S latitude.

Other High Altitude Areas of the Tropics. I have used South America as an example of high altitude climate in the tropics but I would like to emphasize that areas of similar climate occur in other mountainous regions within the tropics. This includes large areas of Southeast Asia, the Phillippines, Indonesia, Southern Indian, New Guinea, Central America, and parts of Africa. If one looks at a world climate map, where

New Zealand is wholly within the Maritime West Coast Cbf climate zone of the Koppen system, (a broad classification for cool moist climates) some of these areas have a large enough mountain mass for this climatic zone to be depicted. For example, there are parts of the mountains of New Guinea, Borneo, Ethiopia, Kenya, eastern South Africa, southeastern Brazil, and in the Andes from Venezuela to Bolivia. In addition to these areas, there are many individual peaks or smaller mountain masses of temperate climate that do not appear on a map of this scale. Taken together these high altitude areas of temperate climate add up to a large land mass. If one then considers that much of these areas is or has been forested and that there are many endemic plants, one can see that the highland tropics is a very interesting potential source of plants suitable for New Zealand's climate.

Subtropical Fruiting Plants. It is because of my work on subtropical fruit that I have become interested in plant introduction in general from the highland tropics. Several of the subtropical fruiting plants that are grown in northern coastal areas of New Zealand came originally from high altitude in Latin America. 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., while the mountain papaya (*Carica pubescens*) is found at 2,400 to 2,700 m.a.s.l. in Colombia and Ecuador. The feijoa (*Feijoa sellowiana*) and purple passionfruit (*Passiflora edulis*) are from the mountains of Southern Brazil and two important races of avocado (*Persea americana*) are from the highlands of Mexico and Central America. Similarly, many important field crops came originally from these highland areas including the potato, tomato, and sweet potato, which are native in the Andes mountains of South America. These are examples of some of the successful plant introductions that we have from the highland tropics and they help to demonstrate that there is a real similarity in climate to parts of New Zealand. This has led me to become interested in what other plant material there is in the highland tropics of Latin America in particular.

Plant Collecting in Latin America. I am fortunate in having had two trips to this region, in 1973 to Central and South America, and in 1980 to South America. A number of fruiting plants were introduced from these visits, notable ones being the babaco (*Carica* × *heilbornii* Badillo nm. *pentagona* (Heilborn) Badillo), first introduced to New Zealand by me in 1973, the lucuma (*Lucumo obovata*), *Cyphomandra* species, as well as improved material of the pepino (*Solanum muricatum*), and the cherimoya (*Annona cherimola*). Each visit has confirmed that there still remains a considerably body of plant material,

in the wild and in peasant gardens, from which it would be possible to develop further commercial subtropical fruit crops. The Division of Horticulture and Processing of D.S.I.R. has an ongoing programme of plant collection in these areas in co-operation with equivalent organizations in the countries concerned.

Ornamentals from High Altitudes. We now have a reasonable programme of introduction of fruiting plants from high altitudes in South America but, as far as I know, there has been little introduction of ornamental plants to New Zealand from this area, whilst in America attention has focused mainly on the orchids and bromeliads. This is the field that I want to stress, as I am sure that there are very many interesting plants in the highlands of South America alone that could be valuable to New Zealand and of interest to plant lovers around the world.

Plant Associations at High Altitudes. My recent visit to South America in the winter of 1980 took me to highland areas of Colombia, Ecuador, and Peru. Many of these mountainous areas were once clothed in subtropical rainforest very like our own with many handsome trees, shrubs, creepers, and palms, some of which bear beautiful flowers. They are found in associations ranging from tall forest at the lower altitudes to low shrub forest of the paramos.

Very likely much can be learnt about what plants should be present from botanical literature, but there is often no thorough Flora of a particular area available. I can only speak about what I have seen at a particular time but it is enough to convince me that there are many plants that we should collect. Unfortunately this is an urgent matter as the forest in many of these mountainous areas is being destroyed at an ever-increasing rate. We saw vast areas of the mountains of the Central Cordillera of Colombia for instance that had been completely stripped of all vegetation. In fact the greatest difficulty we had in collecting plant material was to find out where forest still existed. This inevitably was in the most remote parts of countries and even here the forest destruction was going on apace. Often we were looking at tiny remnants of forest that would soon not exist. Land is cleared, farmed for a little while, then abandoned and people move on to destroy more. Practically the only trees planted are occasional eucalypts. There are very few forest reserves in these countries and the high altitude rainforest may become virtually extinct. It would be best if we could have some influence on conservation in these areas but at least we can help to save some species from extinction.

Some of the notable ornamentals of the area are the indig-

enous podocarps, *Podocarpus oleifolius* and *P. glomeratus*, *Cecropia* species, *Aralia* species, tree ferns, palms, a number of beautiful flowering melastomes, *Tibouchina lepidota*, *T. laxa*, *Meriania nobilis*, and *Blakea sanguinea*, as well as *Solanum lixiodes* and *Chionanthus pubescens*. We collected seed of a number of these plants and have a co-operative programme with the Nursery Research Centre at Massey to trial plants they have raised. Future DSIR plant collecting expeditions will collect further ornamentals but as a side line to other work, and I would like to see other people, such as members of the International Plant Propagators' Society collecting also.

Plant Collection. The simplest way of collecting plant material is as seed which also ensures a reasonably wide genetic base and minimises the danger of introduction of pests and diseases. Frequently clean seed only has to be declared for inspection on arrival in New Zealand. However, if you are planning to introduce any plant material it is wise to consult your nearest Horticultural Inspector of the Ministry of Agriculture and Fisheries in case a Plant Quarantine Permit is required.

REFERENCE

1. Dawes, S.N. 1979. The high altitude tropics — a source of plants for New Zealand. *Proc. Agron. Soc. N.Z.* 9:85-88.

MAINTAINING TURGOR IN MACADAMIA SCIONS DURING GRAFTING

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One of the problems that we have encountered in the growing of grafted macadamia trees for commercial planting has been the development of techniques which will enable us to spread production over the whole year. The proper use of both facilities and people is tied to such an ability.

The central event that is required, is the ability to graft in summer or winter as well as in the more traditional spring and autumn periods. And the key to successful grafting is the ability to keep the scion alive and well until callusing has taken place and the rootstock can take over the job of supporting the graftlet.

Many methods are employed in New Zealand, Hawaii, Australia, California, and South Africa.