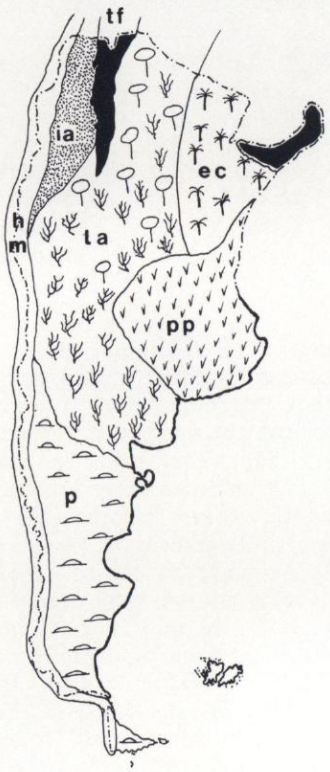
Fig. 1. *Oreocereus trollii* in the north of the Humahuaca Valley towards Bolivia (intermediate altitudes).

COLD RESISTANT CACTI OF ARGENTINA

ROBERTO KIESLING[1]
Instituto de Botanica Darwinion

During recent years many people from the U.S.A. and Europe ask me about cold resistant cacti of Argentina. The answer is simple: most of them are. But there are other considerations: 1. the great intensity of light they receive during much of the year in habitat but which can rarely be duplicated in cultivation; 2. in habitat there are great thermic differences between day and night and between winter and summer.

For these reasons I think the problem is not so simple as it may have seemed at first glance and, indeed, we must study other climatic conditions as well, not just temperature. In the following notes I am giving some examples of climates in various localities of Argentina and mentioning some cacti which grow under these conditions. The areas into which I am dividing the country for the purposes of these notes are not climatic or phytogeographic divisions, but are made only in consideration of cacti with more or less similar cold resistance. Some cacti grow in more than one of these areas. On the other hand, some species may occur very near, but the conditions may be quite different because of altitude differences.



MAP OF ARGENTINA: *hm*, high mountains; *ia*, internmediate altitudes; *la*, low areas; *p*, Patagonia; *ec*, eastern Chaco; *TF/tf*, tropical forest.

[1] Member of the Carrera del Investigador of the Consejo Nacional de Investigaciones Cientificas y technicas.

Fig. 2. *Parodia penicillata* near Cafayate (Salta), just at the border between "intermediate altitudes" and "low areas", growing on rocky walls.

HIGH MOUNTAINS:

The climate of the high mountains (*hm* on the map, in western Argentina), the Andes and other smaller ones, is similar from north to south. In the north (Jujuy) the cacti and the accompanying vegetation occurs to altitudes of 3,500-4,000m above sea level, more to the south, in the center of Argentina (Mendoza, San Juan) to 2,500-3,000m above sea level, and in the far south only to 500-800m. The increments of altitude have the same effect as increments of latitude.

Fig. 3. *Lobivia famatimensis*, near Famatina (not Famatima), in La Rioja Province (intermediate areas).

The cacti which are living under these conditions are *Pterocactus reticulatus, P. gonjianii, Maihueniopsis boliviana, M. glomerata, M. pentlandii, M. minuta, Lobivia brucchii, L. formosa* and the other *Lobivia* of the "*Soehrensia*" group, and some opuntias: the subgenus "*Airampoe*": *O. soehrensii, O. corrugata, O. longispina, Puna clavarioides, P. subterranea, Austrocylindropuntia shaferi, Rebutia einsteinii, R. pseudominuscula, R. pygmaea, Pyrrhocactus atrospinosus, Oreocereus trollii* and *O. celsianus.*

PATAGONIA

This example of climate is a locality (*p* on the map; Climatogram of Comodoro Rivadavia, ca. 46° S, 67° W) and the conditions are the extreme in Argentina. Most Argentine cacti grow under less severe conditions.

Fig. 4. *Austrocylindropuntia shaferi* (the correct name for *A. weingartiana*) growing in the Humahuaca valley (intermediate altitudes).

Fig. 5. Landscape near La Quiaca (Jujuy, border with Bolivia) with the ground covered by hail in the middle of the summer (intermediate altitudes).

In the graph it is possible to see that rain is irregular and scarce. As a consequence, during nearly the entire year the sky is clear and the sunlight intense. The humidity is low all year long. The wind is nearly constant and quite strong, punishing the plants and producing, with the help of the intense sunlight, the typical cushion-shaped growth forms. The soil is poor, composed of sediments of stone or sand. Obviously, these soils have good drainage and the plants must quickly absorb the water.

The cacti of this zone include: all species of *Maihuenia, Pterocactus australis, P. hickenii, P. fischeri, P. kuntzei* (=*P. tuberosus*), *Maihueniopsis darwinii* and its variety *hickenii, Opuntia peniciligera*, all *Austrocactus* spp., *Wigginsia tephracantha, Gymnocalycium gibbosum* and *G. chubutense.*

INTERMEDIATE ALTITUDES

This area includes several different types of vegetation. According to the botanical scheme of Cabrera (1976), this area includes two provinces: Puna and Prepuna. In spite of the fact that they have no great floristic affinity, we can consider them together for the purposes of this paper.

Here (Climatogram of Humahuaca, ca. 22° S, 66° W) it is notable that the rains are concentrated in the summer, from November to March in the southern Hemisphere. In winter (from May to Septem-ber) there is virtually no rain, and this is just when the temperatures are very low. This annual rain distribution is characteristic of all of northwestern Argentina and Bolivia. It is a consequence of the high and low atmospheric centers in summer and winter. In summer the sun heats the high plateaus and mountains of Bolivia, northwestern Argentina and northern Chile, producing a low atmospheric pressure area. The winds converge in these low pressure areas, coming mainly from the east, laden with

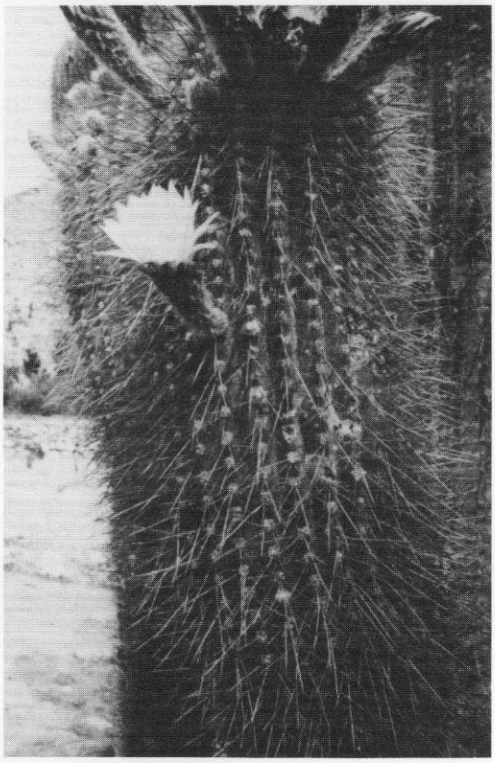


Fig. 6. *Trichocereus pasacana*, a very common species in Humahuaca and other dry valleys between 2,000-3,000 meters above sea level in northwestern Argentina.

Fig. 7. *Opuntia* cf. *soehrensii*, "airampo": a small opuntia very common in all the mountains of northwestern Argentina.

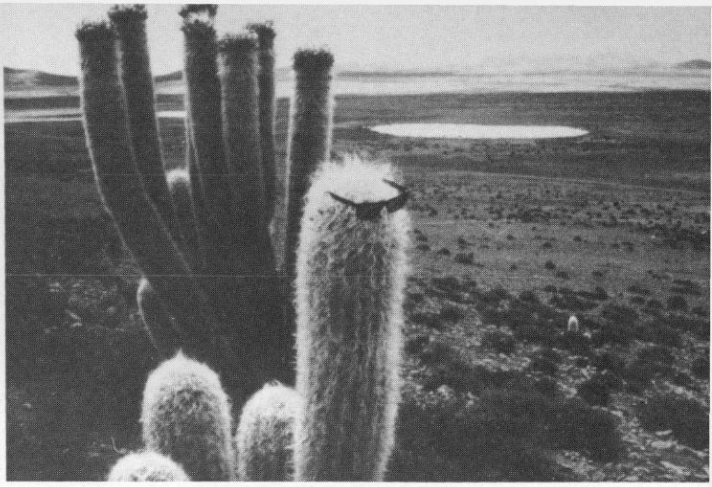


Fig. 8. *Oreocereus celsianus*, near the border with Bolivia, in the "hills" of the *altiplano* (flat highlands).

moisture from the Atlantic Ocean though it crosses half a continent. The moisture is dropped on the mountains. From the west the Andes stop the winds, or when they do cross they lose their moisture and become very dry. In summer the temperature is not as high as one would expect for the latitude because of the altitude and because of clouds which reduce radiation. In the winter the opposite is the case. The mountains become cold, producing a high atmospheric center. The winds are dry and there is virtually no humidity in the air. During the day the sun light is intense. During the night the temperature drops very low.

The species which occur here are several species of *Maihueniopsis*, *Austrocylindropuntia verschafeltii*, *A. vestita*, *A. shaferi* (=*A. weingartiana*), *Opuntia* spp. ("Airampoe"), *O. sulphurea*, *Trichocereus pasacana*, *T. tarijensis* (=*T. poco*) and many spp. of *Lobivia*, the *Mediolobivia* group of *Rebutia*, *Acanthocalycium thionanthum* (including *A. chionanthum*, *A. variflorum*, etc.), *Pyrrhocactus umadeave*, *Parodia maassii*, *P. chrysacanthion*, *P. stuemeri*, *Gymnocalycium spegazzinii*, *Neowerdermannia vorwerkii*, *Weingartia neumanniana*, *Cleistocactus hyalacanthus*, (=*C. jujuyensis*), *Oreocereus celsianus* and *O. trollii*.

Fig. 9. *Austrocactus bertinii*, common in rocky places in the north of Patagonia.

LOW AREAS:

The arbitrary name, "low areas" (*la* on the map, 300 to 2,500m above sea level), refers to the botanical provinces of Monte, Espinal and western part of Chaco. [Climatogram of Andalgala (Catamarca, ca. 28°S, 67°W).] As can be seen on the climatogram, the distribution of rains is similar to the previous area. The medium temperatures are higher, but the absolute minimum is low: -6°C in Andalgala, but to -10°C in other localities. Also, freezing occurs more or less during all of the year. Cloud conditions are the same as in the "intermediate altitude" areas.

The cacti which grow in this area are *Pterocactus kuntzei* (=*P. tuberosus*), several *Opuntia* spp., *Rhipsalis aculeata*, *Harrisia tortuosa*, *H. pomanensis*, *Cereus aethiops*, *Cereus validus*, many species of *Trichocereus* (*T. terscheckii*, *T. candicans*, *T. huascha*, *T. andalgalensis*, etc.), *Setiechinopsis mirabilis*, *Echinopsis leucantha*, *E. tubiflora*, *E. multiplex*, *E. aurea*, *Notocactus mammulosus*, *Lobivia famatimensis*, *Pyrrhocactus*

Fig. 10. *Maihuenia philippii*, a cushion-forming species in northern Neuquen (Patagonia).

bulbocalyx, P. megliolii, P. sanjuanensis, Acanthocalycium violaceum, A. glaucum, A. petcherianum, Parodia microsperma with its many variations, many species of *Gymnocalycium, Cleistocactus baumannii, C. smaragdiflorus* and *Denmoza rhodacantha* (=*D. erythrocephala*).

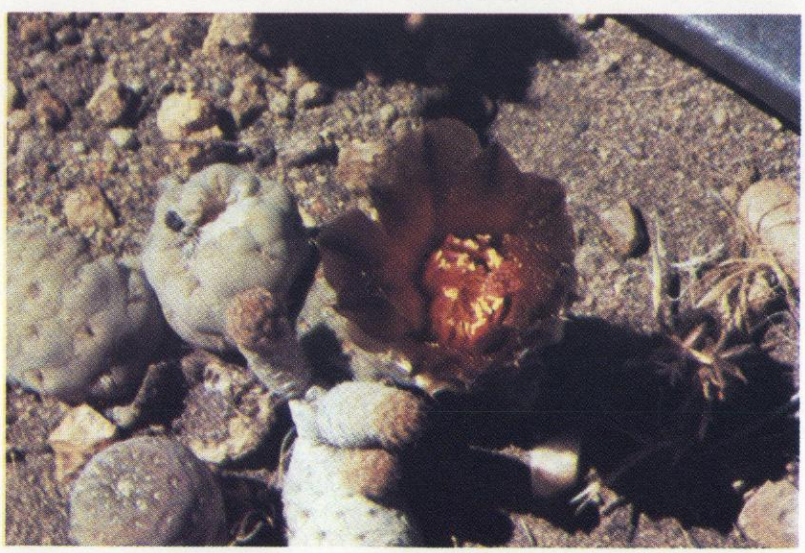
In the northeastern portion of this area, that is to say, the occidental part of Chaco (botanical Chaco), the summer maximum temperatures are the highest: 36-46°C. Under these conditions the effect of the rains is minimal as the water soon evaporates.

Fig. 11. *Pterocactus araucanus* with small segments but big tuberous roots, also in Neuquen (Patagonia).

Some of the cacti of this sub-zone are: *Pereskia sacharosa, Quiabentia pflanzii, Opuntia brasiliensis* (which drops the young branches when frosts occur), *Opuntia salmiana, O. retrorsa, O. quimilo, Rhipsalis aculeata, R. lumbricoides, Harrisia tortuosa, H. martinii, Monvillea cavendischii, M. spegazzinii, Stetsonia coryne, Cereus forbesii* (=*C. validus*), *C. aethiops, C. huntingtonianus,* some gymnocalyciums: *G. schickendantzii, G. mihanovichii, Cleistocactus smaragdiflorus* and *C. baumannii.*

NON (OR LESS) COLD RESISTANT CACTI:

In the northwest there are two tropical forests (*TF, tf*). In the northeast part of the botanical province, Paranaense (which coincides with the political province of Misiones) the air is humid all the year and rains are frequent. Below



freezing temperatures are rare. Some rhipsalis grow here: *Rhipsalis cereuscula, R. linearis* (rare!), *R. cruciformis, Phyllocactus phyllanthus, Selenicereus setaceus* (=*Mediocactus coccineus*), *Notocactus schumannianus, Gymnocalycium denudatum, Frailea* spp., etc. Obviously, all these plants need humid air and cold protection (*TF*).

The other tropical forest in the northwest (*tf*) is named Yungas and occurs on the eastern slopes of the mountains. This tropical vegetation is caused by the summer rains brought in by the Atlantic winds. Winter, as in all of the northwest, is the dry season. In this forest grow some rhipsalis, also, such as *Rhipsalis tucumanensis, R. lorentziana, R. monacantha, R. lumbricoides,* and *Pfeiffera ianthothele*, all epiphytically, of course. In the highest part of this area a vegetation of bushes and herbaceous plants begins. Here there are several species of *Rebutia* s.s.: *R. minuscula, R. senilis, R. wessneriana* and others of the *Aylostera* subgenus: *R. fiebrigii, R. margarethae, R. fabrisii*, etc. As this high part borders with the area we designated "high mountain" (hm), these species are intermediate with respect to cold resistance. They are especially resistant if they are kept dry in winter.

In the Pampeana botanical province (*pp* on the map) only a few cacti grow: *Cereus aethiops, Wigginsia* spp., *Gymnocalycium schroederianum, Opuntia paraguayensis* (=*O. bonaerensis*), *O. aurantiaca, Echinopsis multiplex, Frailea* spp. and *Notocactus mammulosus.*

The eastern part of Chaco (*ec*) has similar conditions to the Pampeana province, but is hotter throughout the year. There is not a dry season and rain occurs more or less uniformly all year long (total rainfall ca. 1,000mm per year). Here grow *Gymnocalycium denudatum, G. mesopotamicum*, several spp. of *Frailea, Cereus argentinensis, C. dayamii* and others, *Echinopsis rhodotricha, Opuntia paraguayensis, O. brasiliensis, Cleistocactus baumannii, Monvillea cavendischii, M. spegazzinii, Harrisia martinii, Rhipsalis lumbricoides* and *R. aculeata.*

Knowing the approximate climatic conditions of Argentine cacti in habitat, one should be able to deduce the sort of care they would need to survive and grow normally in countries to the north, such as the United States, in North America in general, and in Europe.

Additional suggestions would be:

1). Try to arrange for as much light as possible throughout the year, for instance by planning your greenhouse or conservatory to face south (in the northern hemisphere) and by adding, in winter, some hours of special or supplemental lighting for the plants. Such light is cheaper than heaters and the plants will be better for it and will flower more readily and profusely.

2). Provide a soil or planting medium with good drainage. Small pebbles mixed in with the medium are a convenient way of achieving this.

3). Reduce the heating! Electric heaters are more convenient than paraphin or gas ones because they do not produce humidity. When the air is very wet, electric heaters reduce the relative humidity.

Fig. 12. *Rebutia pseudominuscula* grows in the upper part of the tropical forest named Yungas, in the border with the area we refer to as "high mountains".

Plants from Patagonia, from "high mountains", and from many of the "intermediate altitudes" can be grown outdoors in climates such as London, for instance, provided they are situated, say, next to a white wall facing south, perhaps with a small roof covering as protection from rain, and grown in well drained soil in a raised bed. Such seemingly minor considerations can create different micro-climates which can make the difference in survival! Also, probably

Fig. 13. *Gymnocalycium bruchii* from Cordoba in the "lower altitudes". It grows in a cold and relatively wet habitat. Fig. 14 (right). *Tephrocactus aoracanthus* from the lower altitudes can resist -15°C if it is very dry. It needs water only in the spring.

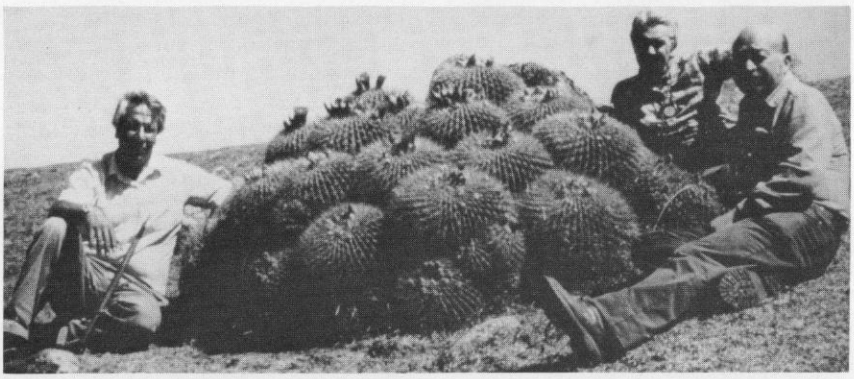


Fig. 15. *Lobivia* (*Soehrensia*) *bruchii* from lower portion of the "high mountains" area.

Fig. 16. *Cleistocactus baumannii* from the lower altitudes can tolerate temperatures below the freezing point during night only if is kept in a very dry place (dry soil **and** dry air!). Fig. 17. *Stetsonia coryne* is from low, salty deserts. During summer in habitat the soil is wet but salty. For osmotic reasons the plant absorbs only the water it needs.

Fig. 18 & 19. *Maihueniopsis boliviana* is the species which grows at the highest altitudes in the mountains of Argentina (near 4,000m) in Salta and Jujuy. It has several different variants in segmentation, spination (number, color, size, consistency, etc.).

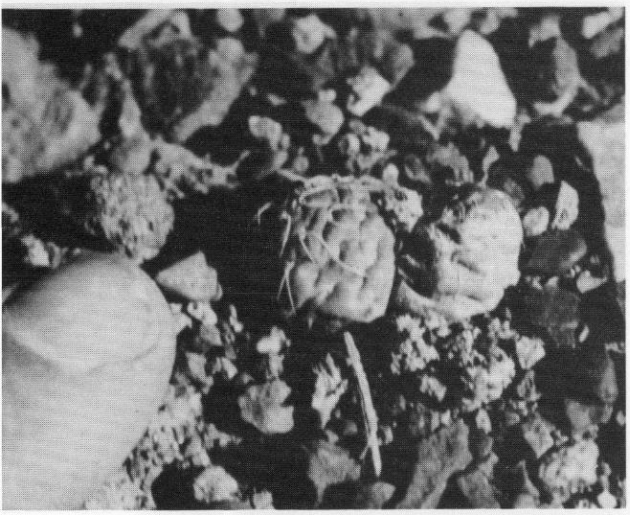


Fig. 20. *Maihueniopsis minuta* (= *Tephrocactus mandragora*), the smallest of this genus, grows near Tastil, in Salta (high mountains).

the best time to plant a plant out of doors is after winter is over, at the beginning of spring, so that it has nearly a year to acclimate itself and be better prepared for the lack of artificial heating the following winter!

Of course, it should be remembered that this is a theoretic and general guide. Each species has its own specific requirements. For instance, *Oreocereus trollii* is very sensitive to humidity of the air as well as of the soil! *Trichocereus andalgalensis* grows near Andalgala, under the climatic conditions as shown in the climatogram, but *Gymnocalycium baldianum*, which also grows near Andalgala but in the mountains (500m maximum) gets colder temperatures and more water in the form of dew and fog as well as of rain and so its requirements are different from the trichocereus.

What's more, the "personal history" of each specimen is different and important!

INTERPRETATION OF THE CLIMATO-GRAMS: (after Walter, 1964 & 1975)
left coordinate: temperature in ^{o}C.; right coordinate: rain in mm; numbers on the left, temperatures: from top to bottom, absolute maxima, daily media of the hottest month, daily media of the coldest month, absolute minima; horizontal coordinate: months of the year, with summer in the center; black lines: months with minimum daily media under freezing point; oblique lines: months with absolute minimum daily media under freezing point (= possibility of freezing); numbers in the upper part: altitude, medium annual temperatures and annual rainfall. When the temperature line is on the rain line it is considered a dry season (pointed surface); if the opposite (lined surface) a wet or rainy season.

BIBLIOGRAPHY:

Cabrera, A.L., 1976, La vegetation de Argentina. Enciclopedia Argentina de Agricultura y Jardineria, ACME, Buenos Aires.

Dalacour, 1953. Un jardin de cactees en plein air en Normandie. Cactus 8(35): 169-171.

Chiozza, E.M. & Z.G. de Domcelar, 1958. Clima, en Aparicio F. y Difrieri, H.A., Argentina, Suma de Geografia II: 1-183, Ed. Peuser, Buenos Aires.

Silvania Gro-Lux, Kakteen und andere Sukkulenten 32 (9): 213, 1981.

Walter, 1977. Zonas de vegetation y clima, 245pp, Barcelona, Ed. Omega.