

HIGH ALTITUDE CACTI

HOW HIGH CAN THEY GROW?

Paul Hoxey describes his endeavours to find the cactus growing at the highest altitude in the Andes.

Photographs by the author.

If you ask a member of the general public about cacti then their stereotype view is a spiny plant that grows in a hot desert environment where it thrives with minimal rainfall and exposure to a strong sun. There are many species that fit into that category but cacti are far more diverse and have adapted to successfully live in a range of different habitats.

Some species live in moist tropic environments as epiphytes (eg *Rhipsalis* species) and others in habitats far away from the tropics where they endure very cold and prolonged winters (e.g. *Opuntia fragilis* in Canada). Other species have managed to colonize another unlikely habitat for desert plants; that of extreme altitude, high in the Andes of South America. There they ensure a harsh set of alpine growing conditions where temperatures drop markedly at night, especially in the winter when sub-zero temperatures are common place. During the daytime the sun can be intense



Fig 1. An unidentified plant PH1219.01 with slightly succulent leaves growing at 5100m on the pass at Picavilque in northern Chile.



Fig 2. *Austrocylindropuntia floccosa* PH727.01, *Punotia lagopus* PH727.02 and *Lobivia maximiliana* PH727.03 all growing together at Macusani, Puno, Peru at 4610m.



Fig 3. *Austrocylindropuntia floccosa* PH727.01 Macusani, Puno, Peru at 4610m.



Fig 4. *Punotia lagopus* PH727.02 with a little overnight snow yet to melt. Macusani, Puno, Peru at 4610m.



Fig 5. *Lobivia maximiliana* PH727.03 a large clumping specimen. Macusani, Puno, Peru at 4610m.



Fig 6. *Cumulopuntia ignescens* PH933.01 above Palca, near the Chilean border, Tacna, Peru at 4580m



Fig 7. A road sign incorrectly stating an altitude of 5250m on the road passing by Volcan Taapacá near Putre in northern Chile. My own measurement at this locality is 4790m.

and the UV levels high due to the thin atmosphere but temperature generally remain low. Often strong winds are present. Some habitats may have low annual rainfall but other may have significant rainfall that can fall as snow when temperatures drop below freezing.

During my travels in Peru and Chile I have observed cacti high in the Andes on many occasions and I admired the plants that could survive in such alpine habitats. I also started to ask myself: What is the maximum elevation that cacti grow? Generally speaking the flora of the high Andes tends to thin out to a relatively small number of plant species above 4500m but a few plants can grow and thrive to about 5000m. Beyond 5000m, slopes become barren and only a few scattered plants, usually protected in rock

Table 1. Observational records from Chile and Peru

Number	Species	Locality	Altitude	Date
PH932.01	<i>Cumulopuntia ignescens</i>	Peru; Tacna; above Palca, approaching the Chilean border	4540m	21 Mar 2011
PH976.01	<i>Cumulopuntia ignescens</i>	Peru; Tacna; above Palca, near the Chilean border	4540m	9 Mar 2012
PH933.01	<i>Cumulopuntia ignescens</i>	Peru; Tacna; above Palca, near the Chilean border	4580m	21 Mar 2011
PH727.01	<i>Austrocylindropuntia floccosa</i>	Peru; Puno; Macusani	4610m	24 Feb 2008
PH727.02	<i>Punotia lagopus</i>	Peru; Puno; Macusani	4610m	24 Feb 2008
PH727.03	<i>Lobivia maximiliana</i>	Peru; Puno; Macusani	4610m	24 Feb 2008



Fig 8. *Cumulopuntia ignescens* PH1207A.01 Volcán Taapacá, Arica and Parinacota, Chile at 4770m.

cracks, can be found. My elevation record is at 5100m for a plant, presently unidentified, found growing in rock cracks on the high pass at Picavilque in the north of Chile (Fig.1).

So what about the cacti? What is their altitude limit? Using an altitude of 4500m as a starting point I have the observational records in Table 1 from Chile and Peru based on field trips up to the end of 2015.

Remarkably, three of the four species grow together in the Peruvian department of Puno near the town of Macusani, one of the highest towns in the world at 4350m. Climate data for Macusani indicates day time temperatures reach the mid teens centigrade throughout the year but drop below freezing most of the year at night and fall to at least -10°C during the winter months of June to August. Rainfall averages about 700mm a year with a noticeable drier period between May and August which corresponds to the colder time of year. During my visit to Macusani in February 2008, overnight snow had fallen yet this is the warmest time of year and equivalent to snow falling during mid summer in the northern hemisphere! All three species are found growing on gentle grass covered hills with rocky patches above the town (Fig.2).

Punotia lagopus (perhaps better known as *Austrocylindropuntia lagopus*) has obvious

adaptations to an alpine habitat (Fig.4) and forms large clumps of densely-packed heads, a shape typical of high elevation plants which helps the plant to retain heat most effectively within the body. It is also densely covered in white wool and bristles. *Punotia lagopus* has a restricted distribution in Puno, Peru extending just into western Bolivia and is only found in a narrow altitude band from 4300m to 4600m

Austrocylindropuntia floccosa (Fig.3) is a wide ranging species from northern Peru and into Bolivia found in high mountain areas with an altitude range of 3500–4600m based on my personal observations. Near to Macusani the plants from loose clumps of rather large heads densely covered in white hairs but in other habitats it can have much smaller heads and less hair.

Lobivia maximiliana (Fig.5) is a globular species, sometimes clustering, and perhaps the most surprising species to find at such high altitudes with its small size and lack of obvious adaptation to alpine conditions. Unique in the genus *Lobivia*, it has a hummingbird adapted flower. I have found it growing from 3200–4600m.

My observations of *Cumulopuntia ignescens* above 4500m are all in the same general area in southern Peru near to the Chilean border overlooking Volcán Tacora. The climate here is



Fig 9. High altitudes slope (4850–5000m) on Volcán Taapacá dominated by *Azorella compacta* PH1267.05.

rather different to Macusani; the rainfall is lower and so the habitat is much drier. Sparse clumps of ichu grass dominate the flora with the specimens of *Cumulopuntia ignescens* (Fig.6) interspersed between them. The hemispherical clumps are densely covered in spination but lack hair. *Cumulopuntia ignescens* is found at altitudes from 3300m and above.

In January 2016, I undertook a field trip to northern Chile, accompanied by Andrew Gdaniec, curator of Gibraltar Botanic Gardens. One of our goals for the trip was to investigate high Andean cacti and to try and improve on my altitude record

of 4610m. I had heard of rumors and seen unsubstantiated records of cacti growing as high as 5000m so the ultimate aim was to find plants at or close to that altitude.

From my previous observations in southern Peru, *Cumulopuntia ignescens* was the likely target for our search as it is frequently found in northern Chile. In an earlier trip to Chile in 2006 I had seen large clumps near to the geysers at El Tatio at 4300m. The guide there stated temperatures drop to -25°C at night during winter so clearly this species has the capability to survive a harsh frost. Rainfall is low and at nearby San Pedro de Atacama it is less than 50mm a year, although likely to be a little higher at El Tatio.

On just the third day of the 2016 Chile trip, we left the village of Putre in the far north of the country to explore towards the Peruvian border. Overlooking Putre, a dormant volcano, Volcán Taapacá, rises high above the surrounding land with a snow covered summit reaching an altitude of 5860m. We took a very conveniently constructed road that climbs the lower slopes and passes to the west of the mountain before heading off further north. A road sign indicating the highest point of the road reaches 5200m (Fig.7) is clearly a little optimistic based on my own GPS reading of 4790m which is in line with Google Earth. The vegetation



Figs 10 & 11. *Nototriche* sp. PH1267.



Fig 12. Asteraceae species PH1267.03.



Fig 13. Asteraceae species PH1267.03.



Fig 14. *Pycnophyllum bryoides* PH1267.06 tiny heads, flat cushion forming.



Fig 15. *Pycnophyllum bryoides* PH1267.06 tiny heads, flat cushion forming.



Figs 16 & 17. PH1267.07 a small plant with a woody stem and small slightly succulent leaves.



Fig. 18 & 19. PH1267.08 tiny white flowers on inflorescence.



Figs. 20 & 21. PH1267.09 small branching plant with reduced succulent leaves, flowers terminal on branches.

here is dominated by clumps of *Azorella compacta* (Family Apiaceae) commonly called llareta and a widespread Andean plant found growing at altitudes from 4000–5000m.

The key to finding cacti at the extreme end of the elevation range is to find favourable habitats that are exposed to the sun for as much of the day as possible but are sheltered from the worst of the strong winds. In northern Chile these tend to be north or northwest facing slopes and it is noticeable how much more vegetation is found on these sheltered slopes compared to others facing in different directions. We succeeded in finding *Cumulopuntia ignescens* at 4770m on Volcán Taapacá (Fig.8). The plants found at this elevation were healthy and not stunted or struggling as one would expect of plants at the extreme end of distributions so that gave us encouragement to continue looking for even higher altitude plants during the remainder of the trip.

We failed to increase our new altitude record of 4770m until on our final day in Chile when we returned to Putre. Once again we took the road to Volcán Taapacá and on this occasion we found a faint track into another gully close to our previous location. The track gently climbed from the road and reached about 4850m where we parked the car. From there we explored a northwest facing slope covered with llareta (Fig.9) and various smaller alpine plants. A selection of plants found between 4850m and 5000m are illustrated here (Figs.10–21) and I would welcome help with their identification. A pretty alpine *Notoriche* sp. in flower was very common in the area with the densest population growing in loose gravel in the gully below the slope. The largest plants, to 10cm tall and forming clusters of heads, were found on the edge of vicuña dug sites, where they must benefit from some natural fertilizer! As luck would have it, a group of vicuña passed by indicating that these hardy animals are quite happy to live at 5000m.

After climbing to 5000m on the northwest facing slope we had failed to find any cacti, although *Azorella compacta* continued a little higher, so we decided to walk down the ridge looking for the 'first' and hence highest elevation cactus which we encountered at 4830m (Fig.22). Again the plant was very healthy and growing well so it was not clear why we failed to find any examples a little higher. A second specimen a few metres lower was in flower and with immature fruits (Fig.23). *Cumulopuntia ignescens* usually has a bright red flower so this example is rather lighter-coloured than usual.

Table 2 contains details of all my observations of cacti above 4500m during the January 2016 trip in Chile/Peru.

Table 2. Observational records of cacti above 4500m during the January 2016 trip in Chile/Peru.

Number	Species	Locality	Altitude	Date
PH1220.01	<i>Cumulopuntia ignescens</i>	Chile; Tarapacá; between Lirima and Paso Picavilque	4640m	8 Jan 2016
PH1207A.01	<i>Cumulopuntia ignescens</i>	Chile; Arica and Parinacota; north west slopes of Volcán Taapacá	4770m	4 Jan 2016
PH1268.01	<i>Cumulopuntia ignescens</i>	Peru; Tacna; near Chilean border overlooking Volcán Tacora	4700m	24 Jan 2016
PH1218.01	<i>Cumulopuntia ignescens</i>	Chile; Tarapacá; about 8km north of Paso Picavilque	4740m	8 Jan 2016
PH1267.01	<i>Cumulopuntia ignescens</i>	Chile; Arica and Parinacota; north west slopes of Volcan Taapacá	4830m	23 Jan 2016

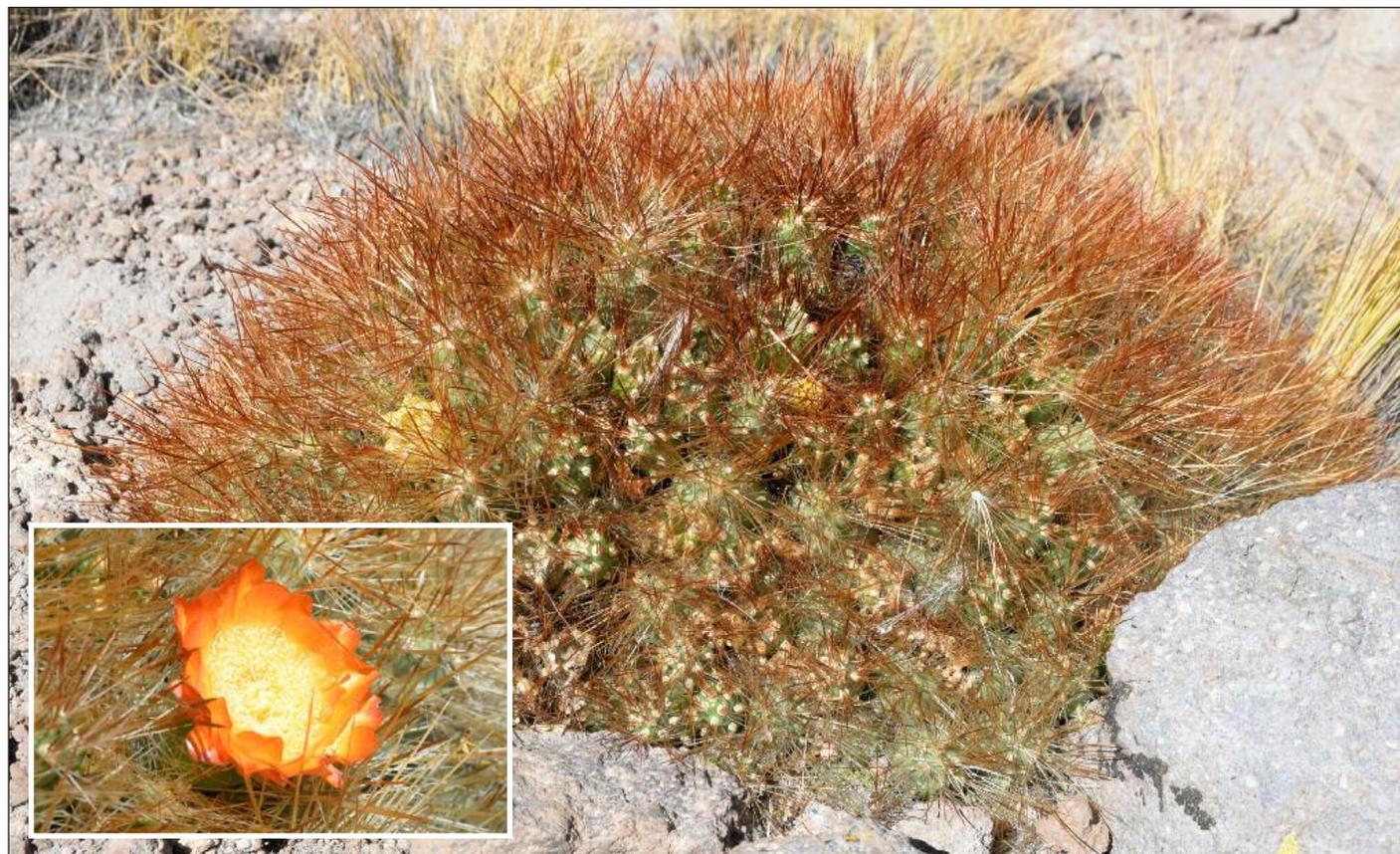


Fig. 22 *Cumulopuntia ignescens* PH1267.01 at 4830m, the highest altitude I have found a cactus to date.

Fig. 23 (inset) *Cumulopuntia ignescens* PH1267.01 a flowering example at 4790m.

My new altitude record is just 170m shy of the magic 5000m level so can cacti reach that elevation? I know of two reports of cacti at 5000m.

Firstly Frič reports that *Neowerdermannia vorwerkii* grows at 5000m. This has generally been dismissed as improbable. Based on more recent field observations an altitude range of 3500-4300m is more typical for this species and Frič is likely to be mistaken. Perhaps his altimeter was poorly calibrated or a transcription error occurred with 4000m switched to 5000m.

Secondly, there is a specimen in the Kew herbarium of *Cumulopuntia ignescens* that has a reported elevation of 5200m. Full details from the online database are:

Name: *Opuntia ignescens* Vaupel
 Collector No.: Wickens 1589
 Collection Date: 10/12/1989
 Location: Chile; El Loa Cosca

Lat. and Long.: S21°7', W68°22'
 Altitude: 5200m

(<http://specimens.kew.org/herbarium/K000100910>)

The altitude from Google Earth at the given coordinates is 4070m, so the recorded altitude of 5200m altitude is likely to be a transcription error with a 4 switched for a 5, giving a reading 1000m higher than the reality.

So a well documented case of a cactus growing at 5000m is still elusive yet I believe it may exist so that is why I am asking all cactus explorers to see if they can add to the four species found growing about 4500m or improve of my altitude record of 4830m. Good luck with the search and I hope you will share with us your successes in this quest within the pages of the **Cactus Explorer**.

[Paul Hoxey](#)