

The Salar de Tunupa (Salar de Uyuni)

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Why the Salar de Tunupa?

For the simple reason that it was known as such long before the town of Uyuni existed. A name has a meaning in itself and should not depend upon the will (or mistake) of a cartographer, or on the political situation of the moment.

Tunupa is both a volcano and a female figure of Aymara mythology. It presides over the salar and has great importance in the local way of life. It is by request of the local inhabitants that we decided to rehabilitate its original name.

Plate captions show first the Aymara names in bold, followed by the scientific nomenclature (genus, species and family, sometimes also class and order) and finally the common names. All scientific names are in italics.

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A brief introduction for the newly arrived...

The salt lake of Tunupa is the largest in the world. Imagine a 100 km wide plate of salt! The altitude (3653 m), the special weather conditions, and the presence of salt as a limiting factor for biodiversity, combine to create a very particular ecosystem.

The average temperature is 6°C with highs of over 30°C in summer and freezes of up to -25°C during winter (June-September). Combined with the strong winds, these conditions can provoke thermal sensations of -40°C. Owing to the reduced atmospheric thickness, sun radiation of heat is accentuated, hence the acute thermal difference one feels when passing from sunshine to shade. For the same reason, temperatures decrease abruptly when the sun goes down, an effect that is aggravated by the salt reflecting all the radiation back to space like a mirror, and thus preventing the accumulation of heat which occurs with normal soil. What to do to warm oneself? A scalding hot cup of tea would be a good start, and remember that due to the low atmospheric pressure, water boils at only 80°C...

Rainfall in the region is low (325 mm/year in the town of Salinas de Garci Mendoza, but much less in the centre of the salar), and is limited to late December until early April, a period in which parts of the salt lake are covered with a 10 to 50 cm-deep layer of water. When the weather is cloudy, it is frequent to experience the "white out" phenomenon, well-known to those who live in snowy areas. Everything is so white that the horizon disappears and it becomes impossible to see where the land meets the sky. It is very easy to get lost under these circumstances.

Despite these adverse conditions, a very particular and fragile ecosystem has developed on the shores of the salar and its islands. Care must be taken. What we observe nowadays is the result of thousands of years of adaptation of what 10,000 years ago was probably a much richer ecosystem. Back then, the entire southern part of the Altiplano was covered by a huge lake, a true interior sea. The desiccation of this great lake gave birth to the salt flats, and in the process condemned numerous species to extinction, allowing only the most adaptable organisms to subsist.

The giant cactus of the islands is without doubt the symbol of this ecosystem. Look around carefully and you will also observe numerous plants and animals, amongst them beautiful flowers, other types of cactus, the cuddly viscacha and even hummingbirds.

Since a few years ago, the Salar de Tunupa has become one of the main destinations for tourism in Bolivia. With reason: few places offer such exceptional landscapes. Those lucky enough to have spent one night in the middle of this

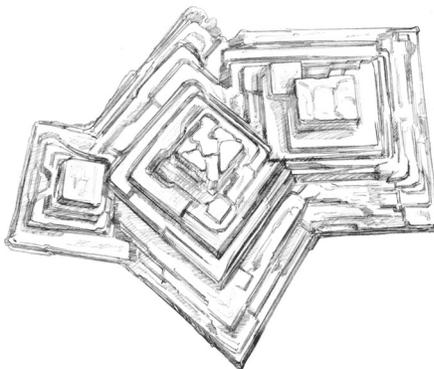
immaculate whiteness under a full moon know what we are talking about.

To travel to Tunupa and even further south towards the Sud LÍpez is still considered adventure tourism. The salar is still far from being invaded. Maybe not for much longer though... the number of visitors doubles each year and the trend has already passed from backpackers to organized tours. The next step tends to be luxury tourism. Let us imagine a nightmare scenario: a jet aeroplane at the doorstep of a ten-storey hotel in the middle of this great nothingness...

The degradation of the most frequented places, such as the Inkawasi Island (mistakenly called "Isla Pescado", Fish Island, by tourist guides and agencies), is notorious. Burnt or scarred cacti, up-rooted plants, fossilized algae reduced to dust by footprints, vehicle tracks and oil stains in the salt, "offerings" left behind the rocks... are sadly common place. In an ecosystem as slow to evolve as this one, the damage is practically irreversible. Furthermore, whatever is left behind certainly stays: the dryness of the air and the cold weather limit biodegradation. An "offering" will be remembered for years. With regard to plastic bottles or cigarette butts, they will only disappear if somebody takes them away...

To round off this little introduction, let us not forget that for thousands of years the people living in the area have adapted themselves to the ecosystem and are a part of it. They venerate and respect Pachamama, the Mother Earth. Let us, who are on their turf, do likewise.

Tunupa welcomes you...



Ruins of a pre-Columbian city? No, a salt crystal!

**A little Aymara girl
dedicates a poem to Tunupa**

Tunupa Mika Tayka
Tunupa k'acha mama
Chillima k'acha tata
Kirkipxi wayñunaka
Phusanti pinkullumpi
Tunupa irananakana utjaski
Qiñwanaka yaretanaka yawachulunaka
Tunupa thianakana
Utjaski jacha qura
Tunupa lichipa warsuñataki
Chillima katuski
Uywasiski tunuparu
Tawa marka
Taypin utjaski
Akham kirktasina sarxi
Mika tayka saraqañita
Kalil tullnaru kimsa pakjalli
Ukhamarak uywir malkulla kumpañt'ki
Jiwasakumpat'arakiñän klavelay rosasa

Norma Quispe, 11 years old, village of
Tawa

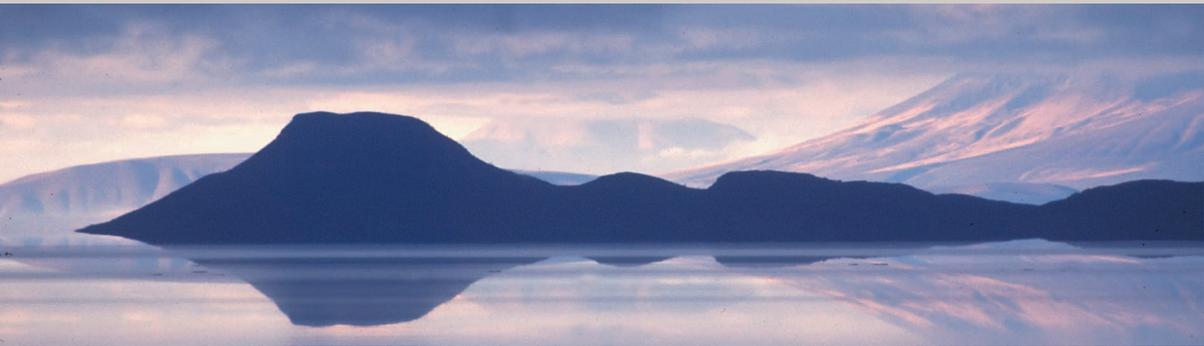
The ever changing landscape

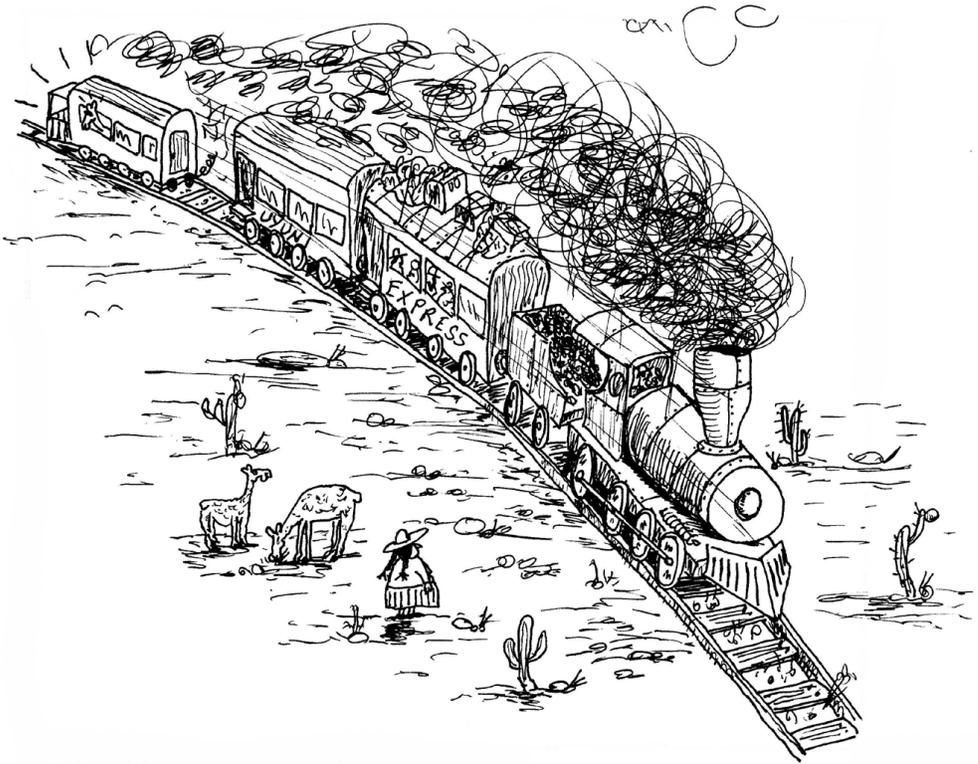
The mirage illusions

The moon sets at dawn

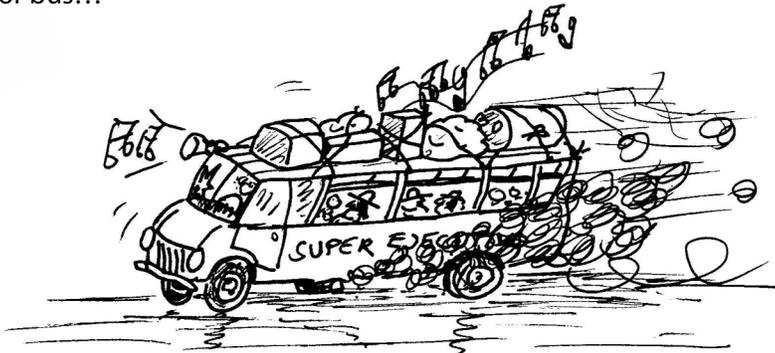
Tunupa pretty lady
Chillima handsome gentleman
They sing huayños
Accompanied by pinquillo flutes.
Living among the skirts of Tunupa
Are the queñuas, the yaretas and the yawachulus.
On the Tunupa shores
Algae has grown
And gushes forth the white water of Tunupa.
Chillima is holding
Is raising Tunupa with love.
He is living
At the centre of the town of Tawa.
Singing he was gone
Mika Tayka you will come down
Barely stuttering three flashes of lightning
The one who raises the condor is with her
And we will also be with you, my pink carnation.

Dawn in the rainy season





Uyuni is reached by train,
or bus...



The formation of the salar: science and legend



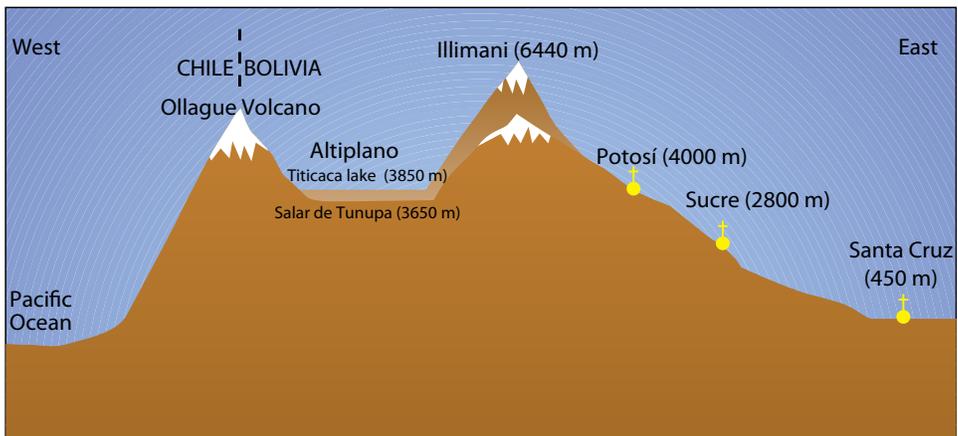
This picture was taken one night in February 1999 when this peculiar ray of lightning hit the waters close to the island of Asalchi. This photo is not a montage, it is pure luck.

Lightening... symbol of the primeval, of the genesis of the planet. Is not this the sensation provoked by the singular landscapes of the salar? From here arise questions of the why and how of things. Science provides an explanation for its formation, legend provides another. Let us consider them both...

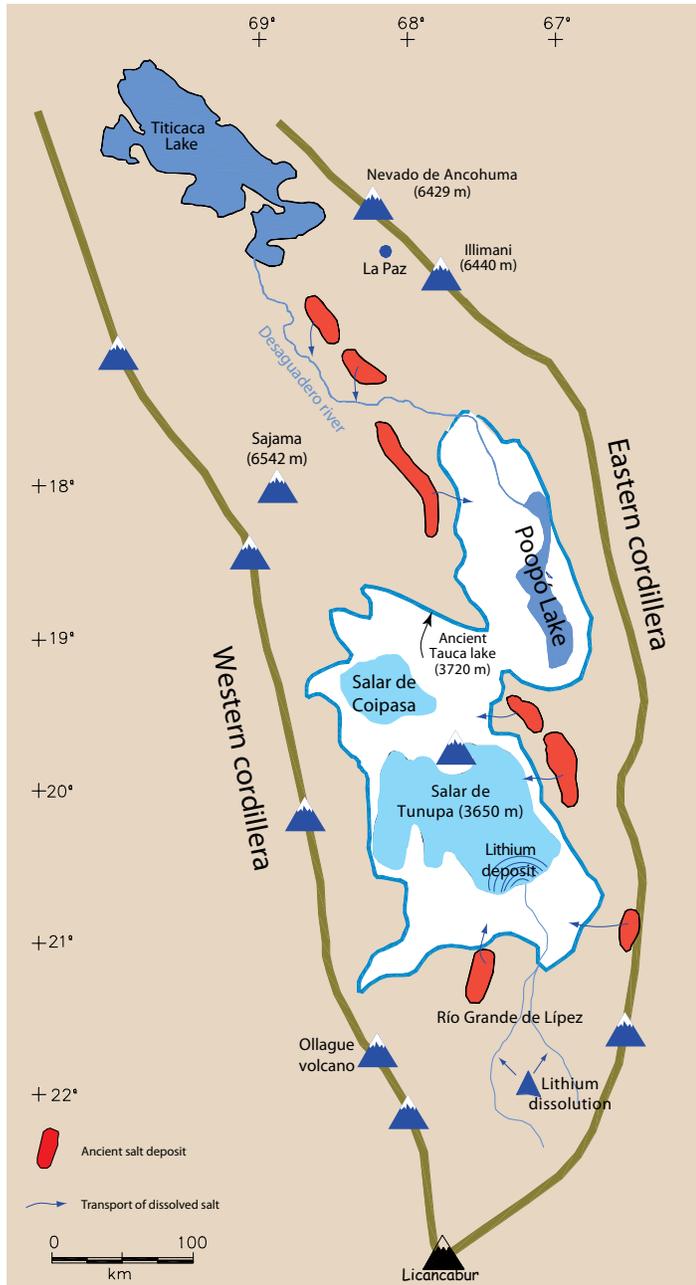
Where does the salt come from?

A hundred million years ago, the Andes did not exist. The region that today constitutes the Altiplano was at sea level and thick layers of marine salt deposited there as sediments. After the retreat of the seawater, these salt layers accumulated at great depth under more than 3000 meters of newer sediments.

Twenty-five million years ago, the compression of the western side of the South American plate by the Pacific plate caused the formation of the Andes. As a result of this compression, the salt climbed through the faults and, after a complicated process, arrived at the surface, assisted by its relatively low density. Thus, today we observe in the Altiplano numerous salt outcrops (in red on next page). Once on the surface, the salt was dissolved by draining waters and transported by watercourses. Since the Altiplano is a basin closed to the east and west by two mountain ranges, the waters could drain neither towards the Atlantic nor towards the Pacific, and accumulated in the lowest parts of the basin. Because the northern Altiplano is higher (3850 m), the increasingly salt-laden waters drained to the south in the direction of today's Salar de Tunupa, the lowest part of the Altiplano (3650 m).



The figures of pages 10 and 11 summarize the situation. The Altiplano is a depression located between two mountain ranges. There, large lakes formed from the accumulation of runoff water containing salt dissolved from old marine sediments. 12,000 years ago the last lake (white area page 11) was 70 m above the salar level. 10,000 years ago water progressively evaporated leaving solid salt as found in the present salars (light blue areas page 11).



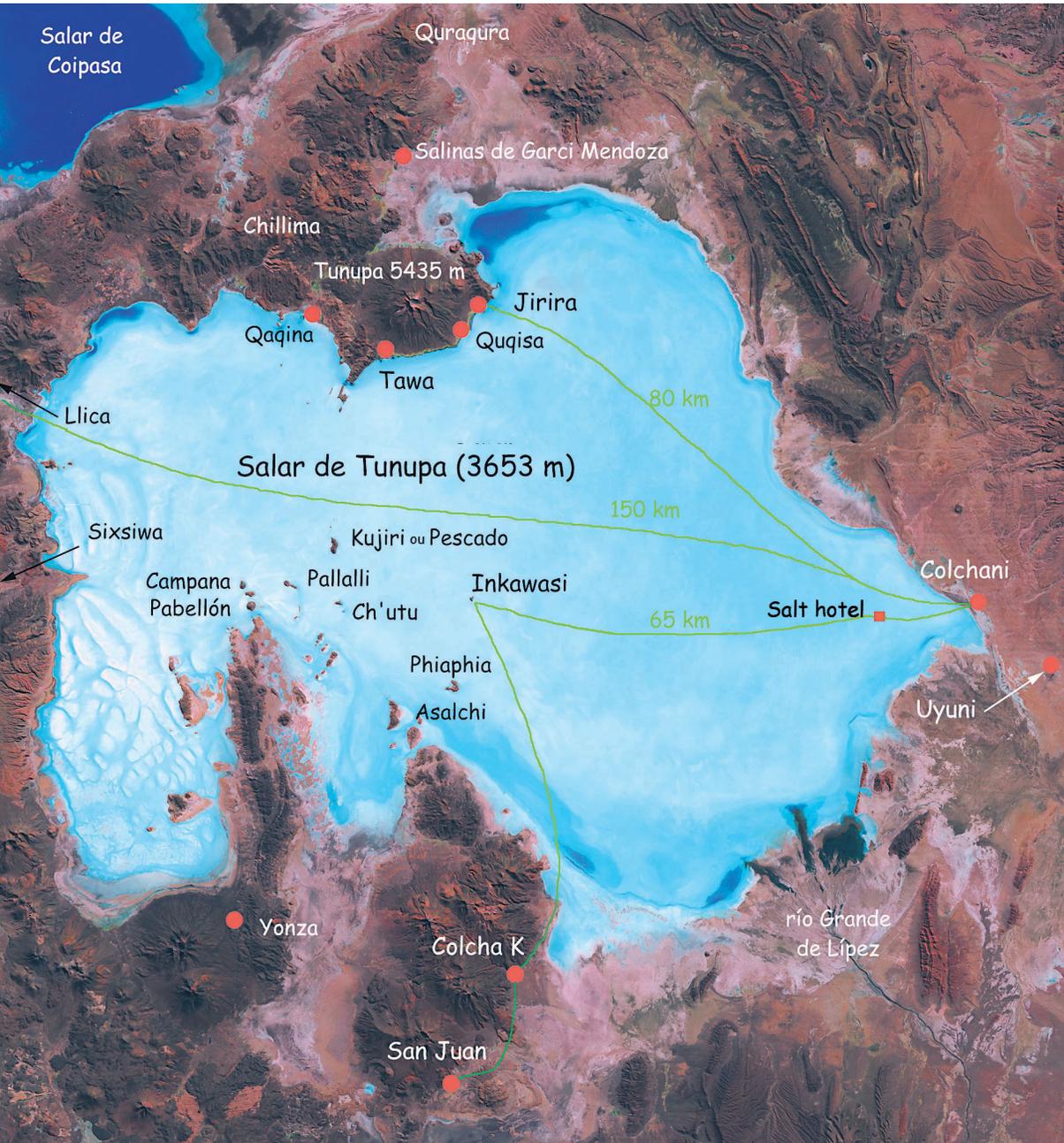
Today, these waters that flow towards lake Poopó do not reach it anymore since 2015 (climate change; crop irrigation), and the Tunupa salt lake floods only with rain water. However, this was not always so: 15,000 years ago all the southern Altiplano was flooded by the immense Lake Tauca, covering the actual Lake Poopó, and the salt lakes of Tunupa and Coipasa. The surface of Lake Tauca was at 3720 meters, which is 70 m above the present level of the salt flats. Due probably to the melting of mountain glaciers and to an increase in rainfall, Lake Tauca persisted for 3000 years before desiccating some 10,000 years ago to produce the Salar de Tunupa as we know it today.

Other flood-desiccation cycles existed before Lake Tauca: 40 to 25 thousand years ago, Lake Michin for instance, with a surface that was 100 m above the present salt lake, also flooded all the southern part of the Altiplano for 15,000 years before drying out. These are the cycles that caused the successive sedimentations of the salt layers that are now found on the surface of the salt lake. It is possible that new floods will occur in the future and that large lakes will again cover the Salar de Tunupa to add new deposits of salt.

What is the thickness of the salt under the surface?

Several drillings have been performed in the salt lake. The deepest one revealed that salt still persists at 120 m below the surface. Inspection of the samples obtained showed that it is not a 120 m-thick salt layer but rather a sequence of a few meters of salt alternating with clay sediments. This sequence of layers is the result of successive flood-desiccation cycles: during the flood period, rivers carry a lot of salty water and sediments into the lake, while during the dry period, rivers dry up and evaporation causes the crystallization of the salt above the deposited sediments. Down the 120 m shaft drilled, 11 cycles can be observed corresponding to 11 lakes that successively occupied the southern part of the Altiplano. The latest of these cycles, which corresponds to the desiccation of Lake Tauca, left a layer of salt averaging 6 m thick, which constitutes the present surface of the salt lake.

These 120 m represent the top portion of what is a much greater accumulation, which according to geophysical studies performed by oil companies, is estimated to be around 500 m deep.



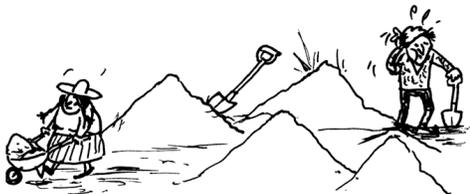
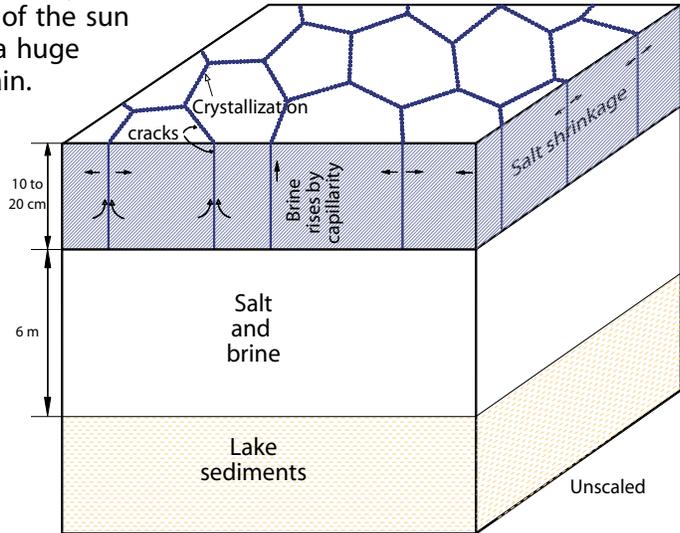
Why do we observe polygonal structures on the surface?

During the rainy season, from January to April, an extensive part of the salt lake is covered by rainwater that wets the salt. At the beginning of the dry season, water evaporates very fast (up to 6 millimeters per day) due to the combined effect of the sun and wind, unveiling a huge white and smooth plain.

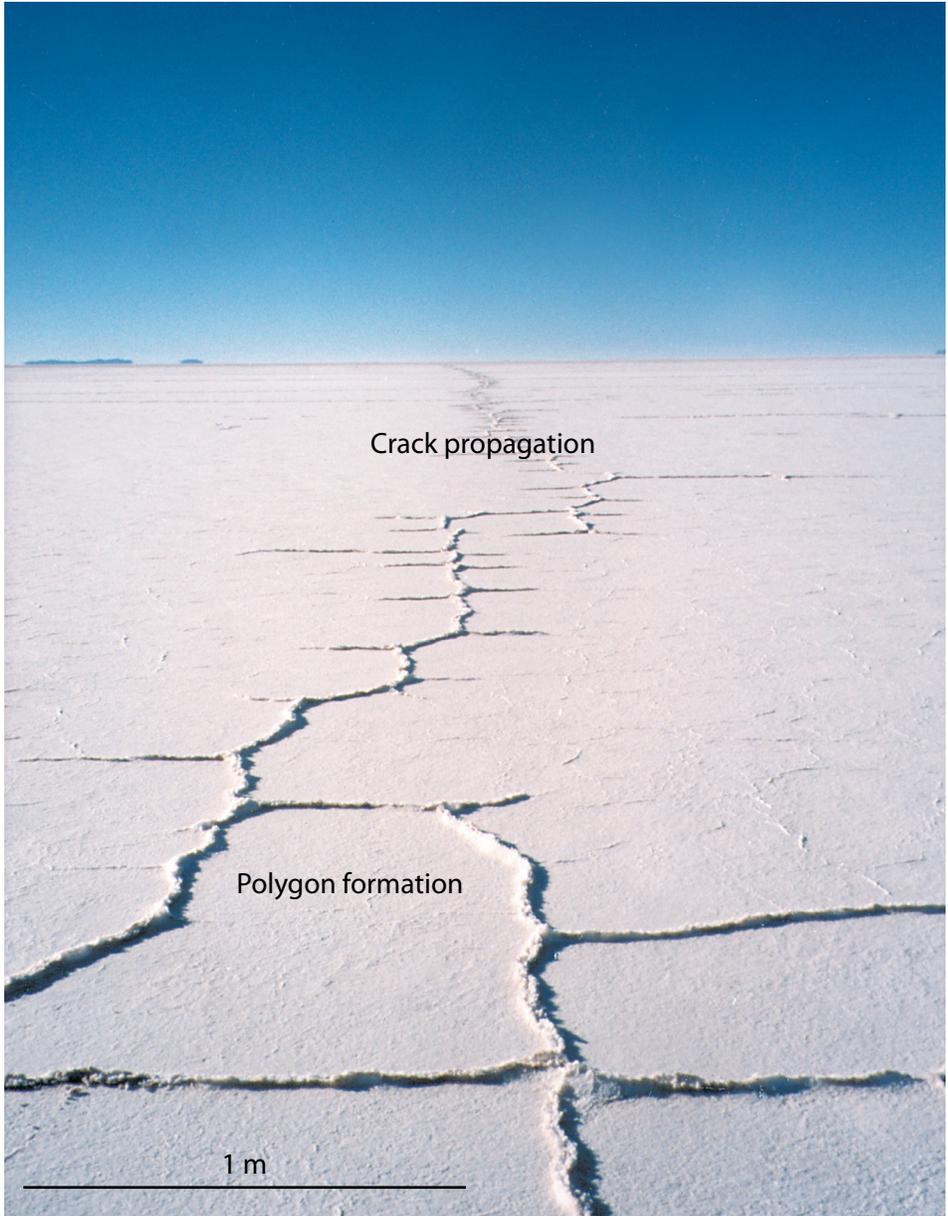
The top surface of the salar (10 to 20 centimeters thick) becomes extremely hard and dry. Under this superficial layer, the salt remains impregnated with brine (salt-saturated water): the result therefore is an immense salt lake covered by a hardened and dried salt crust.

Further desiccation causes this crust to contract and fracture: the first lineal crevices can extend for kilometers; afterwards, transverse fractures appear and the network of cracks becomes progressively denser and desiccation polygons are formed (similar to drying mud).

Brine climbs up by capillary action through these cracks and crystallizes when reaching the surface, forming small salt crystal rings a few centimeters high that delimits the polygons.



At the end of the dry season, the salar is covered with these polygons and small salt outlines. This peculiar pattern will disappear completely with the following rainy season.



Formation of polygons on the surface at the beginning of the dry season

Why do islands exist on the salar?

The islands in the middle of the salt lake, like Inkawasi, are ancient volcanoes of the Tunupa period (2.5 to 0.5 million years BC). During the phases of flooding, these volcanoes were completely or partially submerged: today, on the dark colored volcanic rocks of the islands we can observe a light colored calcareous crust which can be 10 cm thick or more. This crust is composed of fossil algae remains, called stromatolithes, which developed along the shallow water shores, thus marking the ancient water level.

Take a look at the geomorphology of these islands: from certain spots, for example looking westward from the top of the Inkawasi island, terrace-like forms can be observed (photograph opposite). These are in fact lake terraces which indicate the paleosurfaces of ancient shorelines.



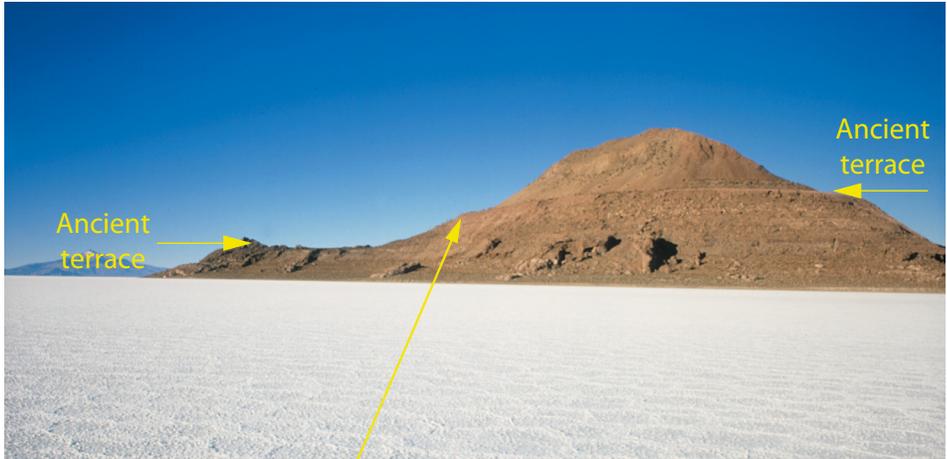
One of the multiple appearances of the salt crystals on the surface. Each one measures about 5 mm.

What are “water eyes” (“ojos de agua”)?

Water eyes are holes in the salt lake surface, inside which the brine located under the superficial crust can be observed. They allow a brief glimpse of the residual waters of Lake Tauca.

There are all sizes of water eyes. Most of them are only a few decimeters in diameter, but sometimes they can be wide and deep enough to swallow up an unwary car. It is at the bottom of these water eyes that the most beautiful salt crystals can be found.

The water eyes sometimes present a boiling effect due to the agitation of water movements under the superficial salt layer. This is caused by the subterranean intrusion of freshwater from the surrounding edges of the salar, and also by passing vehicles that deform the salt crust surface...



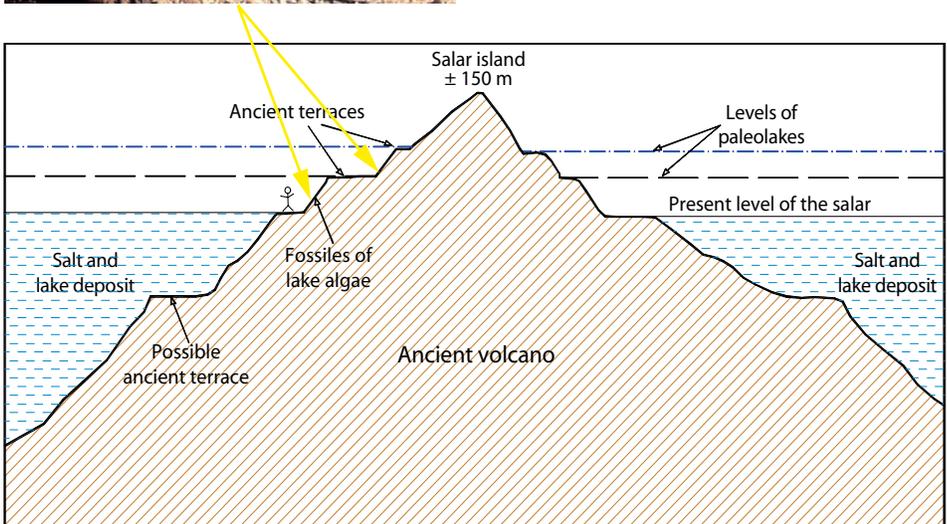
Ancient terrace

Ancient terrace



At the top of the volcano on the island of Campana, two lake terraces, marked by yellow lines, show the paleosurface level of the ancient lakes.

To the left, a blanket of fossil algae (stromatolites) covers the dark lava.



Community elders reminisce on the formation of the salt lake

There are many stories about Tunupa. Following is an extract of several short legends, translated from Spanish and worded as faithfully as possible to the particular manner of expression of the narrators:

“My grandparents used to tell me that long, long ago, the mountains were walking and falling in love just like us...

Mount Tunupa was like a mother, called Mika Tayka, who had arrived from Chile, they even say she had a sister quite alike in Chile. Tunupa arrived here and stayed to spend her life. In those days, she was a beautiful and formidable woman...

Her new-born son died, so like every mother having given birth, her breast obviously burst open, that is to say it became swollen because of the accumulated milk. Then Tunupa's milk spread on earth and got buried. That is the reason why they say the milk comes from the earth, because the milk had turned into salt. That is also why they say she stayed in this place. She had other children but gave them away to their father. If she had not spread her milk on these pampas, there would only be t'ula and shrubs. That is what they used to say in the old days.

Today, we can still see the tools that she used to harvest quinoa, close to Jirira. Even the quinoa she harvested is quite visible, they are like little piles visible around. They say she was a hard worker, she produced a lot of quinoa.

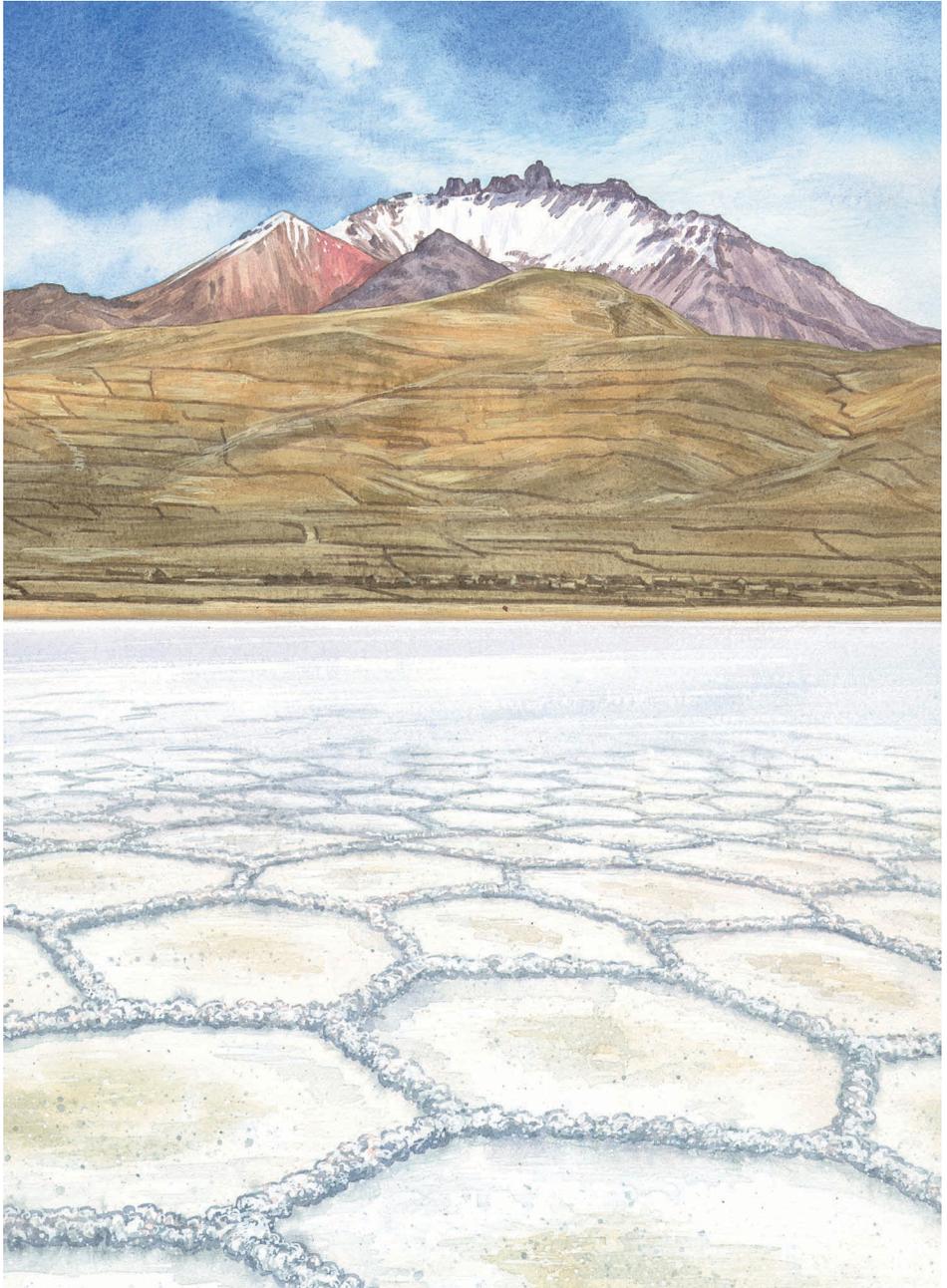
Then she fell in love with the mountain close to Salinas, Quraqura is his name, and she was looking toward him, but then she got upset and turned around, this is why she is now looking south...

Mount Chillima also fell in love with her and got into a fight with Quraqura, who knocked one of Chillima's teeth out with a slingshot, but Chillima burst Quraqura's bladder, which is why Quraqura has a lot of water. That is what my grandparents used to say.

This is, they say, the story of Tunupa, who was worshipped like a mother.”

“My grandparents told me that before, the salar was like a sea. Since the Chullpas times this lake has always existed. They say the end of the world arrived, so the God covered the lake with salt and the Chullpas ran away towards the top of the mountains. That sort of white stripe that can be seen today, they say it is the foam from the waters. This is what our grandparents told us in the old times...”

Next page: Tunupa looks southward...



Kids, do you like roots?

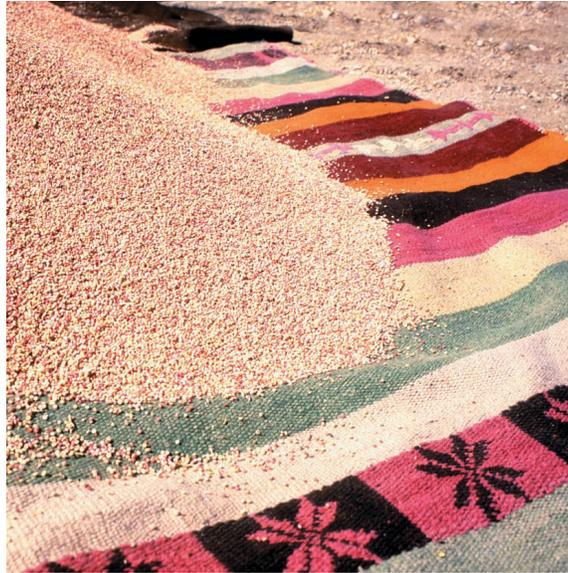
We love them. Unfortunately, we are not talking about food, but Greek or Latin roots that make up scientific words. Roots allow us to know what these words mean without any previous explanation. Isn't it wonderful? Here are some roots used in the text:

stroma-, carpet.
lith-, stone.
geo-, earth.
morph-, form, aspect.
log-, discourse, and by extension, study.
paleo-, ancient.
poly-, many.
penta-, five.
hexa-, six.
gon-, angle.

For example, pentagon is formed of penta- and gon-, which means "that has five angles". So... what is a geologist? Try to find other words in the text...



The desert people



Quinoa grains just harvested

Human beings have been dwelling in the semi-desert surrounding the salar for thousands of years. The volcanic region between the salt lakes of Tunupa and Coipasa, known as the intersalar region, has countless archaeological sites. Stone tools alongside seashells or corn remains from the valleys speak of the journeys and the lifestyle of the ancestors of the current residents. Maybe 10,000 years ago there were also people contemplating the reflection of the stars on Lake Tauca, bordered then by great *qiñwa* (*Polylepis* sp.) forests.

Harsh with the weather, parsimonious with water, the Mother Earth Pachamama is worshipped by everyone in the Altiplano. Despite her austerity she has shown kindness to her people. She has provided them with quinoa and potatoes for food, salt to trade for goods from the seashore or the valleys, and the llama to provide clothing, food, and to serve as a beast of burden.

Nowadays, people live the same frugal way of life of their ancestors.

Who are the people that live here?



Don Alberto is Aymara, just like all the people who live on the northern and western shores, arching from the town of Salinas to the town of Yonza in the south-west. They have been isolated from the Aymara region of Lake Titicaca for a very long time, and are the most influential people in the salt lake.

The Quechua people, settled throughout the region, live a few kilometers away from the muddy southern and eastern shores. The Quechua towns are San Juan, Colcha K and Colchani, the latter being the entrance "port" to Uyuni, a mushroom town built in 1889 during the construction of the railway.

At the age of 86, Don Alberto nostalgically remembers the times when he used to cross the salar on foot. Or could it be that he is saddened to see how the consecutive droughts and the attraction of the city are emptying the villages?

Times change... but, to what extent? People continue to cultivate quinua and potatoes, taking care of their llamas, praying for rain, and if this does not come, they go to Chile in search of a job, just as their grandparents did. Here, tradition is still the foundation of the community.



Of course there are changes: today there are trucks and buses to cross the salar, there are schools and hospitals, there is electricity, and quinoa is exported to Japan and Europe. But, the so-called modernity is viewed with caution. All know how vital it is to maintain their culture, where everyone has their place and is respected.

This is how this grandmother feels, seen here with her family harvesting quinoa. She has collected the fallen ears of grain, fed the workers, and now she takes care of her grandson.

Do people live on the islands?

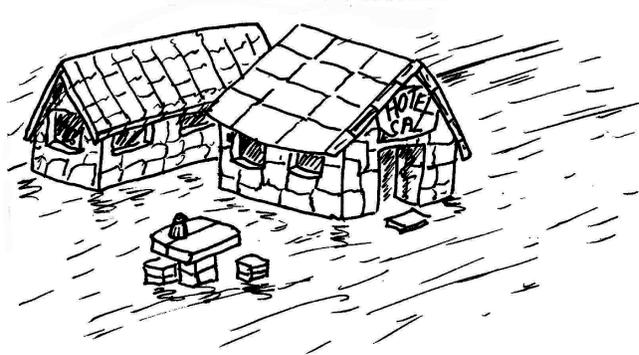
Nobody lives on the islands for the simple reason that there is no water, but people crossing the salar occasionally use the islands' natural caves for shelter. Some ruins found there may be remains of surveillance outposts from Inca times, or perhaps they were just walls to protect caravans from the wind and cold...

Despite what is said above, Don Alfredo and Doña Aurelia, an Aymara couple, have since 1994 made their home on the island of Inkawasi (a Quechua word meaning "the house of the Inca"). They take care of the island and always welcome the passing tourists. All the water they use is brought in.

For the sake of tourism, at the Colchani entrance to the salar are two hotels built entirely with salt bricks.

Why are they dressed the way they are?

The people's dress is perfectly adapted to the environment and local life-style. Don Alfredo wears a poncho. This garment has multiple uses: as clothing, as a blanket, as a bed, even as a means of carrying goods. Doña Aurelia wears the axsu, the beautiful Aymara outfit for women. It is a simple wool garment with tube-like shape, traditionally black or dark brown. Its finely woven fabric keeps out the wind and even protects from light rain. Both ends are decorated with lively symbolic designs. The top is held over the shoulders with a long spoon-like pin, the tupu, leaving the wide, comfortable sleeves to drop down as protection from the cold, or... to hide something!



The salt hotel, outpost of the new salt lake colonists...



How did people use to cross the salar?

Don Favio tells us: "The people from Tawa often used to go to Yonza to take care of the farms they had there. We all used to go: men, women and children. Small children rode on donkeys but those more than 10 years old had to go on foot. I went many times with my father, the last time was in 1956. We always slept in one of the islands close to Tawa, like Cuchilla Grande, in order to leave early the next day. It is better to walk at night to avoid the sun. During the day, people had to wear pieces of black wool over the eyes. We would leave at two in the morning and arrive at the island of Pallalli at about 10 in the morning. There, we rested and ate some pitu (roasted quinoa flour) and took off the shoes of the llamas before continuing towards the land. The salt is harmful to llama feet, which are soft, unlike those of sheep, you see? ... What is the shoe made of? Well, it is simple, it is a little leather square somewhat bigger than the foot with two holes for the hooves and four leather straps at the sides to tie, that's all. A llama carries 20 to 30 kilos, like a donkey, but can go for a week without water. Then, from the island of Pallalli we would cross over to that piece of land entering the salar, which is close, see? From there we would take small paths to arrive at Yonza always at about 6 in the afternoon."

The distance Don Favio and his father used to cross was about 80 to 100 km. Nobody wants to walk that much today. It is more comfortable to go by truck or by the rickety old bus half eaten away by the salt. Tourists now arrive in 4 wheel drive vehicles, on motorcycles, on bicycles, or even in aeroplanes. Some people get here with kite-driven tricycles or other wind-powered devices... These exotic means of transport render the salt lake crossings from Chile undertaken by car-smugglers an increasingly difficult task to accomplish unnoticed!





More memories from the ancestors...

In the common language use, the word Chullpa designates the tombs where mummies are found, usually at the top of the mountains. Here, Chullpas is also the name given to the first inhabitants of the region, and the tombs are said to be the remains of their homes. Hence the legends, expression of collective memory. Some chosen lines:

“They say the Chullpas lived under the moonlight in the old times because the sun did not exist. The sun came out and they all died, and the sun has existed ever since”.

“In the old times the Chullpas knew how to cultivate with stone tools... They lived at the top of the mountains, because in those days the salar was a lake filled with water... When the sun came out, the lake dried up, and this is how it became the salar”.

“Only two families survived near Lake Coipasa. Today, those living there are the Chipayas”.

“They say that we are the descendants of the Chullpas, our ancestors are the Chullpas, that’s what my grandparents say”.



Quinoa, the mother seed...

Such is the term of reverence for the most appreciated food in the Altiplano. Named *jupha* in Aymara (but the Quechua word *kiñwa* is used in the region), *Chenopodium quinoa* is a plant of the *Chenopodiaceae* family... to which belong spinach and beet. It is a grain but not a cereal (*Gramineae*).

This robust plant has been cultivated for 5000 years. It originated in the high central plateau of the Andes, where it grows at altitudes of up to 4000 m, being resistant to light frosts

and requiring little water. It is richer in high quality proteins than wheat, has all the amino acids required by humans, as well as vitamins C, E, B, calcium, phosphorous, magnesium, potassium, zinc and unsaturated fatty acids. All these qualities explain its growing popularity in the industrialized countries.

The long history of quinoa cultivation has resulted in its present multi-colored variety. Its grains can be yellow, green, red, violet, black, or white. All of them contain saponin, a water-soluble substance, bitter and toxic, found in the fine skin that wraps the grain. To remove it, one simply needs to soak and wash the grains several times. But, what to do in places where water is scarce? Doña Aurelia takes out her *takiraña*, a stone mortar, and in it places the seeds mixed with *poq'era*, a fine abrasive volcanic sand. She takes her shoes off, climbs into the mortar and starts a bizarre dance. Her feet shuffle to and fro laterally without lifting and the hips gracefully balance the operation. Just like the old 60's "twist"... Afterwards, she winnows the white grain to separate it from the *poq'era* and the bitter membrane. Now it's ready to be cooked!

Quinoa mixed with vegetables, makes tasty soups. The *graneado*, grain fried and cooked until the water evaporates, is served with a piece of dried llama meat. There is nothing better than *pitu*, toasted quinoa flour, to make beverages, or for sustenance on long treks. *Muqunas*, compact balls kneaded with llama grease, keep well. Quinoa mixed with a little wheat or corn flour yields excellent bread. Certain varieties are also good to prepare like popcorn. When will "popquinoa" be available at cinemas?

Between the months of March and May, striking spots of magenta contrast with the deep azure blue of the Altiplano sky and the ochre shades of the arid landscape. The quinoa fields are maturing. People are preparing for the harvest,



one of the most important moments in the life of the community. Food for the year depends on a good harvest. If it is bad, it will be necessary to emigrate temporarily in search of work to sustain the family that waits at home.

It is natural that this daily food be considered sacred. What respect and tenderness this grandmother pays to these spikes in her hands! If there is no water, there is no quinoa. If there is no quinoa, there is no livelihood. She has known this since she was a child. It is Pachamama who provides water and makes the plants grow. During the sowing period, her generosity is sought-after through offerings, and during the harvest she is never forgotten.



The grain is separated from the plant by pounding it with sticks, but is it not so much easier to do it with a truck? A couple of runs over are sufficient...

And if you do not have your own vehicle, you can always spread the quinoa along the road and wait for passing jeeps, a good method for learning to be patient...

This lady winnows, that is she uses the wind to separate the grain from the shuck. It now loses the lively colors it had in the plant. After careful drying, since it germinates easily, it will be ready to store.

Now let's eat!

Wash the grain several times, squeezing it between the palms of your hands until it is white. Apart from this special care, it is cooked just like rice with the advantage for beginners that quinoa does not take on a sticky consistence. Add two cups of water for each cup of grain in a pan and boil for





10 minutes until the little white rootlets appear. Add salt and condiments as desired. Easy, isn't it?

How about a quinoa cold dish mixed with raw vegetables? Or perhaps with milk and honey for breakfast? Or would you rather fry some onions and spices, add the quinoa, toast it for a few minutes and add hot water to finish cooking?

If at first you do not like the taste of quinoa, try mixing it with rice, wheat, lentils or whatever you like. Your imagination is the only limit... Bon appétit!

The salt...

Salt has always been used by the people of the region for their own consumption, but above all to trade for products from the valleys and the coast. Long llama caravans would leave loaded with salt blocks. These trips lasting several weeks were not purely commercial, they were also considered as initiations for young people, and as such included a good deal of ceremony. Today, salt is transported by truck, although once in a while a caravan does still make the trip, thus perpetuating the ancestral tradition.

The most important site of salt extraction is located in Colchani, due to the closeness of the road and railway. It is a cooperative system where each member has his concession. The workers cut square blocks or sometimes plates, which makes for easier handling and transportation. Salt destined for human consumption is scraped from the surface and formed in little piles lined up ready to be carried by truck to the drying furnaces, smoky from the burning of t'ula, a woody plant abundant in the region. The salt lacks iodine, which is added at a small industrial plant before the finished product is taken to the cities.



February, the rainy season... tranquillity of the sunset reflecting in the still mirrors of brine bathing the salt mounds.



Terrorists on the salar?

Nothing of the sort, of course, but the reflection of the light is so strong, like that from snow, that it is essential to protect one's eyes. This lady, who helps her husband to load the truck, has found the perfect way to protect herself from the sun and the roughness of the cold and wind at the same time.

The lithium problem

The Tunupa salt lake contains the biggest reserve of lithium in the world. This metal comes from the southern volcanoes via the Rio Grande de LÍpez and concentrates in the southeastern region. The extent of the lithium deposit was determined by geologists in 1987. Very soon after, exploitation was requested by foreign companies. The local population, aware of the ecological risks and meagre benefits brought by this kind of project (They have never forgotten the sad experience of their ancestors in the silver mines of Potosí), has been resisting successfully¹, but for how long? Those who have visited the salar intuitively feel that this unique site on our planet is very special. It awakens sensations that are difficult to define, but one is never left indifferent. What will become of Tunupa?



A bicycle and a shovel. For this salt worker, nothing else ...

¹ In 2018, the government has launched the construction of a lithium extraction plant. Production is expected to begin in 2019.

The wool of the llamas

Slipware and textiles have always been a speciality of Andean people. To appreciate this, it is sufficient to examine the incredible workmanship of the fabric found in pre-Columbian, or rather pre-Incaic, tombs on the Peruvian coast. One can also admire the variety of designs which are still being used by artisans.

Sixsiwa (Sejsihua), is a village hidden in the mountains to the west, on the road to Chile. In a large house the weavers are busy, and one can hear the manual looms operating. Skilful women have joined together in a cooperative, in order to improve their economy. Here one of them prepares the dye, over there another forms the wool into balls, while her companion readies a loom. In an adjacent room several women use scissors to trim the stray fibers off a heavy carpet.

Ideas and the will to work are in plenty. But, what to do with the product? How and where to sell it? The women of Chakoma, a neighboring village to the north, have the same problem.



A timid experiment was initiated in 1999, which consists of putting textiles on sale at the tourist-frequented island of Inkawasi. "Will they like what we make?" they ask themselves with anxious expressions. Then they laugh again...

How is the wool dyed?

The dyes are natural and they are extracted from local plants, with which the people have long been familiar.

The plants are boiled for a couple of hours in a large pot, together with pieces of old tin cans, the oxide of which accentuates the colors. Salt and sometimes alum is used to fix the dye to the soaked wool.

For how many centuries has this method been used?

“We have twisted the wool into thread, made balls of it, washed it, and re-twisted it until the wool is ready to be used”

Dressed in the traditional axsu, Edit, president of the Sixsiwa cooperative, shows us how to spin the wool while explaining how to obtain the finest quality. Only the wool selectively shorn off the backs of llamas less than 3 years old is used because, the older the llama, the coarser and itchier the wool on the skin.

The wool of the alpaca is finer, but this animal is far less rugged than the llama and is not bred in this arid region.



What plants are used to dye?

The women of Sixsiwa use three plants, each yielding a different color. A whole ranges of shades may be achieved adjusting the amount of oxide used.

Qiñwa (*Polylepis* sp.) is an attractive knotty tree reaching 6 m or more in height, which grows at altitudes of up to 5000 m. Its reddish paper-like bark has healing properties and dyes with ochre tones. Lamp'aya (*Lampayo medicinalis*), as its name implies, is also medicinal. This woody plant dyes wool a dark brown color. Chiqarwaya (*Parastrephia* cf. *lepidophylla*), used as firewood and medicine, gives off a greenish grey color.



Qiñwa

Lampaya

Chiqarwaya

In Chakoma, ñaka is also used to obtain green coloring, and the seed of the small cactus Ayrampu, dyes a deep pink color.



Past and present...

The giant cacti, guardians of Tunupa



Immobile statues standing on the slopes of the volcanoes emerging from the salt lake, the giant cacti stand vigil over the horizon. Could they be shipwrecked sailors of Lake Tauca awaiting rescue, or are they guardian spirits of Tunupa's milk? Perhaps they are both.

Besides embellishing the landscape, the cacti offer their flowers and trunks to birds and other animals. To the people they provide material for shelter, furniture and food.

The giant...

The most imposing living thing on the salt lake, the giant cactus, called jach'a q'iru, "huge mast", or also wanq'ara, is the first to draw attention when arriving at the island of Inkawasi.

This giant belongs to an American plant family (of which only one genus occurs outside this continent, in the tropical forests of the old world), and is perhaps the tallest of the so-called columnar cacti. In the photo below, Don Alfredo is measuring one individual 10.18 m tall and 1.5 m in circumference.

It is not uncommon to find one of these fragile giants brought down by strong winds, attacked by plagues, or lacerated by unenlightened visitors. This gentle "witness of lost worlds" deserves our respect.



Older than Christopher Columbus?

How fast can a cactus grow? It depends on the species, varying from a few millimeters to more than one meter per year.

As for this giant, nobody knows. Some local people say 5 cm per year, others say no more than 1 cm. Its growth may depend on the soil, the humidity, and other factors. We just do not know, but it is interesting to make a small calculation: if our 10 m high cactus grows at a rate of 1 cm per year, it would be 1000 years old! ... in other words it would be older than the Inca Empire. If we assume a rate of 5 cm per year, it would still be 200 years old. Bolivia was not even born yet...



Jach'a q'iru, wanq'ara

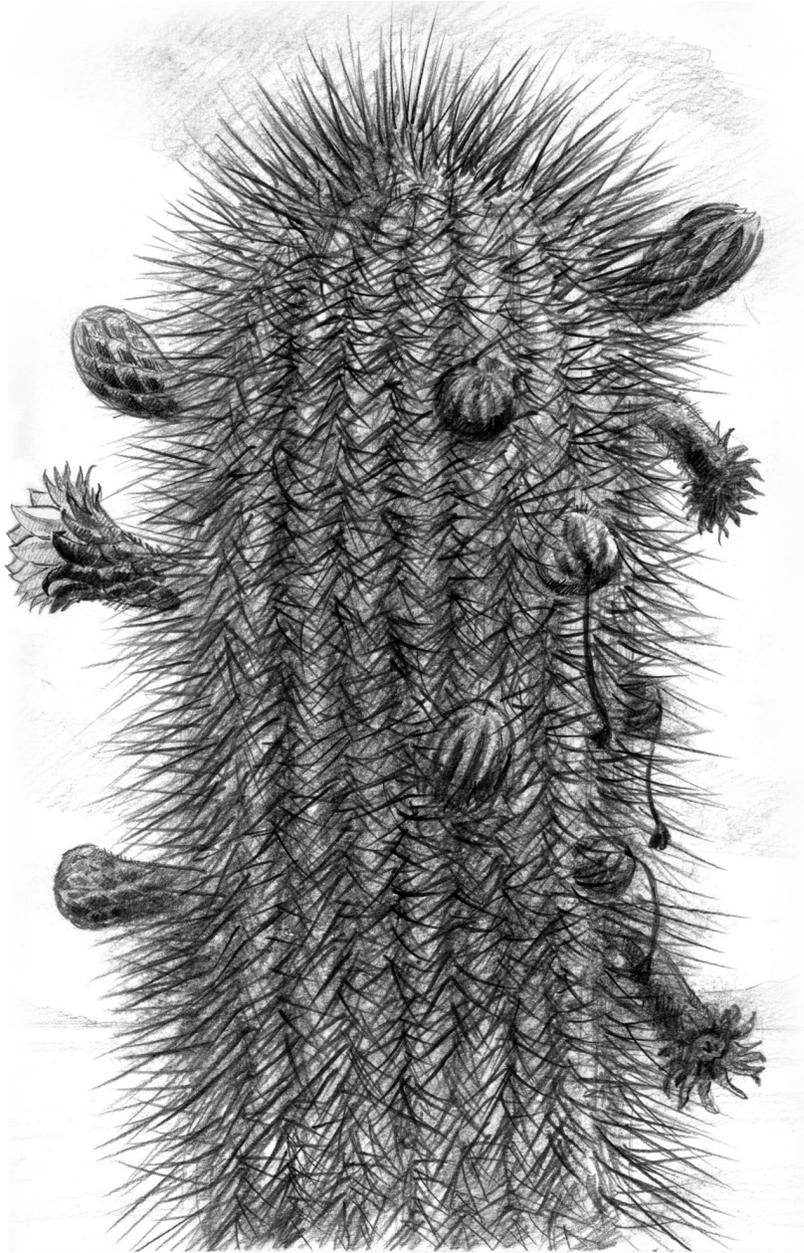
Trichocereus pasacana (*Echinopsis pasacana*, *E. atacamensis*)

Family: *Cactaceae*



The flower of the giant cactus measures about 15 to 20 cm, and grows from the top third portion of the trunk. It is a diurnal flower so as to be pollinated by a hummingbird, the aptly named Giant Hummingbird (*Patagona gigas*), so big that it hardly looks like a hummingbird at all. He comes to the islands only when the giant cactus flowers are in bloom, during January and February. The flower makes herself beautiful to receive him, but does not waste any resources on perfume, which she does not need to attract him. Some insects also seek out her nectar, but the chuxt'ala, the Black-Hooded Sierra Finch (*Phrigilus atriceps*), vigilates...

The pencil drawing shows the giant cactus in February, with flower buds, blooming flowers, and green fruits with dry flower remains.



Are the straight cacti and the branched ones the same?

Faithful to their vision of the world, local people distinguish between male and female giant cacti. All of them have fruits (it is only one species), but the male is straight (symbolism?) and the female is said to have "arms". Anyone for a cactus hug?

Can cactus fruits be eaten?

The fruits of many species can be eaten. Who has not had a prickly pear (*Opuntia ficus-indica*), nowadays known all around the world? The giant cactus also gives an excellent fruit, the pasakana. An adult cactus can yield from a few to 50 or 60 fruits.



Between February and April, people would come and camp for some days on the islands in order to harvest pasakana. It was much appreciated for being the only fruit in the region with a high nutritional as well as commercial value, given that it could be exchanged for other products. Today, it is easier to buy in the town market other fruits which have come from elsewhere, and harvesting on the islands has become rare.

Harvesting...

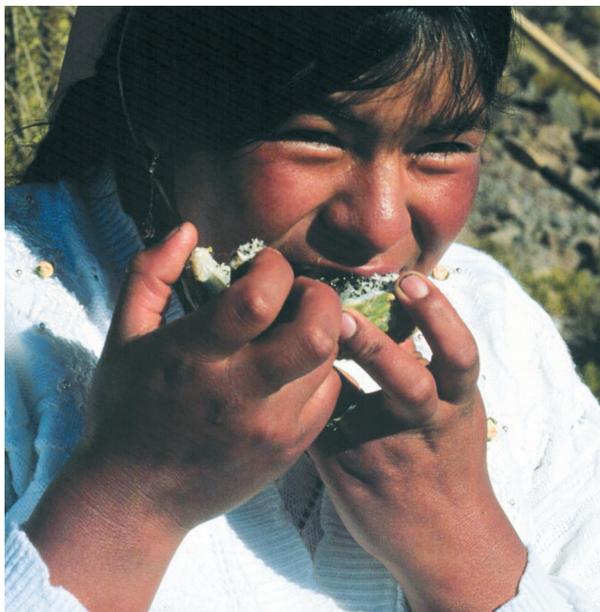
Using a long cane brought from the valleys of Potosi, Doña Aurelia tries to bring down a fruit. It is not an easy task since the long thorns deviate the wooden blade inserted at the tip of the cane, and from down here the fruit at the top does not look big. Finally, with an upward stroke the fruit is separated from the trunk.

What does the pasakana taste like?

Well... it tastes good! Doesn't it show in the expression of Teodosia?

Pachamama does things right and the pasakana is covered by a fine layer of smooth hairs, without any thorns.

The black seeds and part of the white pulp are eaten. It is nice and sweet and tastes like... well... let's see... why don't you try it?

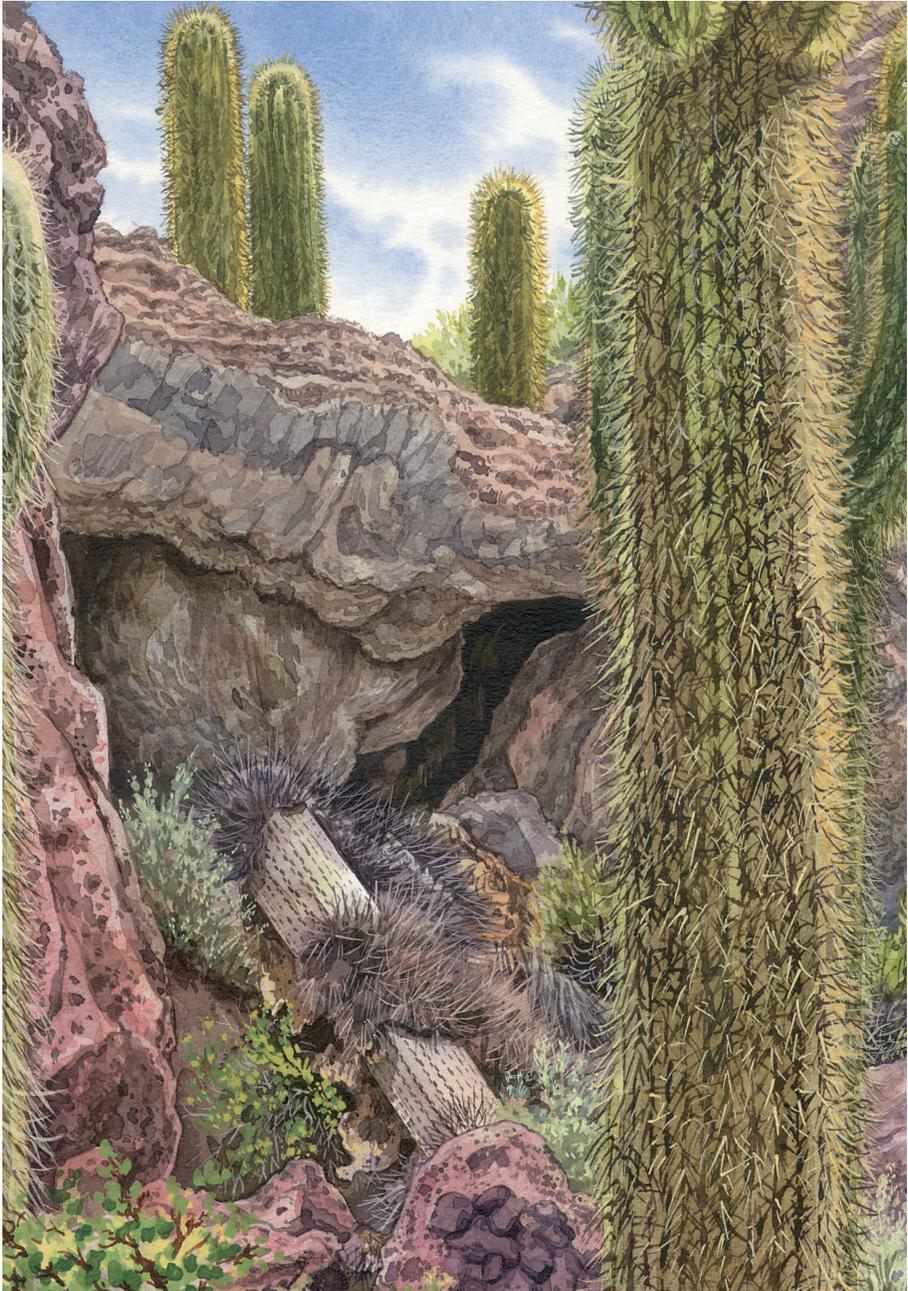


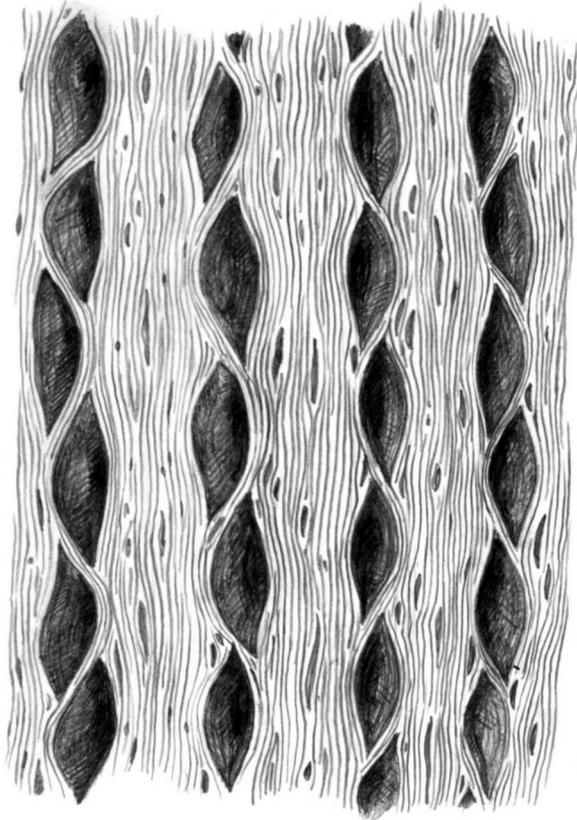
The fruit pasakana is called mut'us when it is still unripe. When mature, the shell softens and breaks in three or four parts, thus offering the black seeds in the middle. As they are lightly stuck together, they do not fall to the ground.



Other species of cactus disperse their seeds through birds, literally speaking, that ingest them. There is a good chance that the same happens with the jach'a q'iru.

Identifying a cactus is not as easy as one may think. One way is to analyze the shape of the seed and the microscopic structure of its envelope (tegument), which varies with each species.





5 cm

The giant has fallen at the entrance of the cave shaded by the fossil algae. The broken thorn tissue unveils the cells of the hollow trunk, weightless and rigid. Death exposes the beauty of the delicate fibre web.



What is it for?

How many times do children ask this question? Those who believe that nothing is entirely useless are right in this case. The giant cactus is used mainly for its wood, which is understandable in a region almost totally devoid of trees.

Don Carlos says: "You know the cactus is mature when the spines are coarse and worn-out at the foot of the trunk. Also, if you poke with a wire and there is not a lot of flesh then it is mature. Once selected, first the

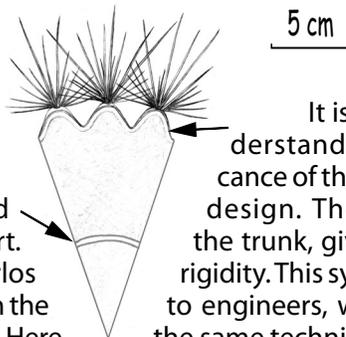
thorns are burnt, then it is chopped down with an axe and the bark is peeled off. You have to split it immediately because when dry it does not cut straight. When it is all split, it is left to dry in the sun".

To the present it is used as raw material to make doors, furnitures, and even beams to bear the mud and straw ceilings of the roofs.

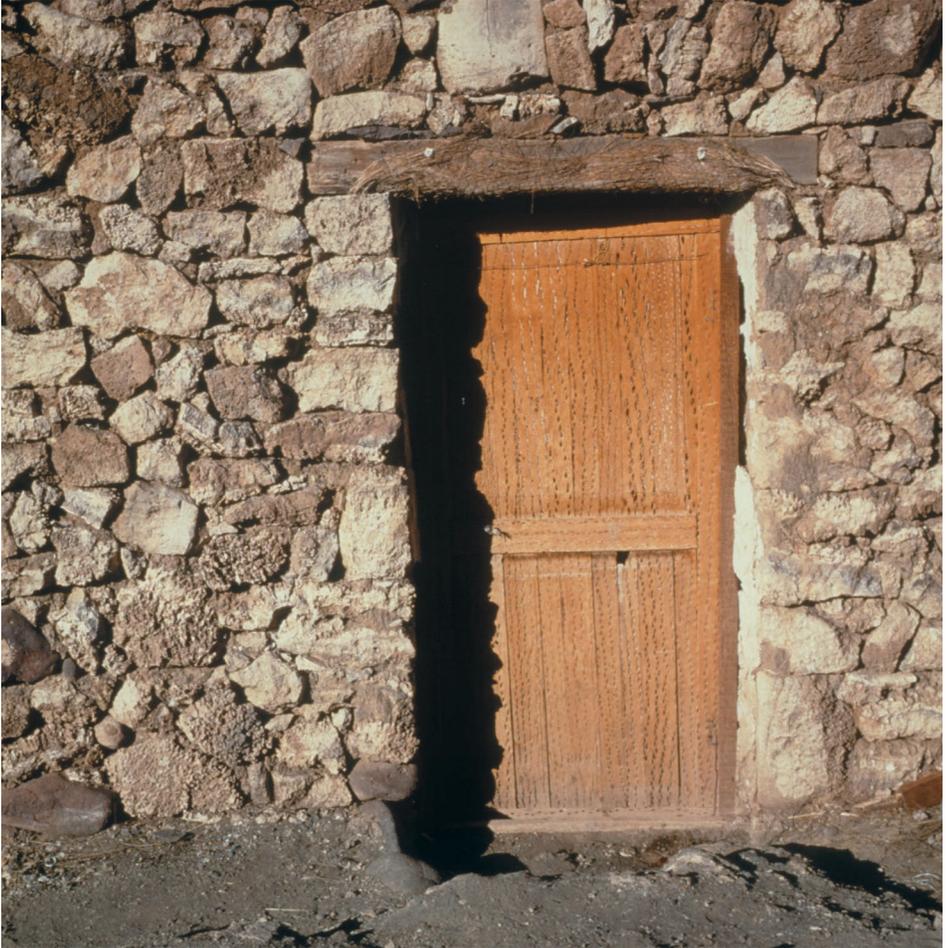
Where is the wood in the cactus?

In this cross section diagram, drawn to scale from a young cactus, we can observe a fine double ring. This, and nothing else, is the woody part.

The flesh that Don Carlos mentions is the tissue between the epidermis and the woody ring. Here the cactus is not mature since its tissue is thick and the wood still thin and soft.



It is not difficult to understand the great significance of the epidermis' rib-like design. These ribs reinforce the trunk, giving it longitudinal rigidity. This system is well known to engineers, who frequently use the same technique, for example in aeronautical construction. The spines have no structural function.



What else can it be used for?

Besides the fruit that can be eaten, the flesh is used as a poultice for skin inflammations. Animals also use the giant cactus. The viscacha eats cactus, but we are not sure whether it would venture to try the giant. The cactus is host of for various parasites: one fly lays its eggs underneath the epidermis so that the larvae may feed off the flesh, and a "red louse" (cochineal?) sucks the sap. And, where else would the restless ch'ina lluch'itu bird make his nest of sticks?

The other cacti



There are many cacti in the region of the salar, for example the beautiful furry ones found along the roadside from Uyuni to Potosi. However, let us stay in the salar, where we see that diversity increases as we approach the shore. That is, cactus diversity increases from two species to four...

Pusk'allu, the hedgehog cactus

On the islands in the centre of the salt lake, the pusk'allu is the only companion of the giant cactus. It looks like a little cushion, decorated with yellow flowers in January, and bristling with either white or reddish thorns. A

variation due to age? Or is it another species? The former is more convincing if we consider that the giant cactus also presents this variation. As in men, they change from "blond and spiky-sprightly" to "white and droopy"...



Phusk'allu

Cumulopuntia boliviana

Family: *Cactaceae*

Other: **phuskalla** (Aymara)

Llawsa, brother of the giant cactus



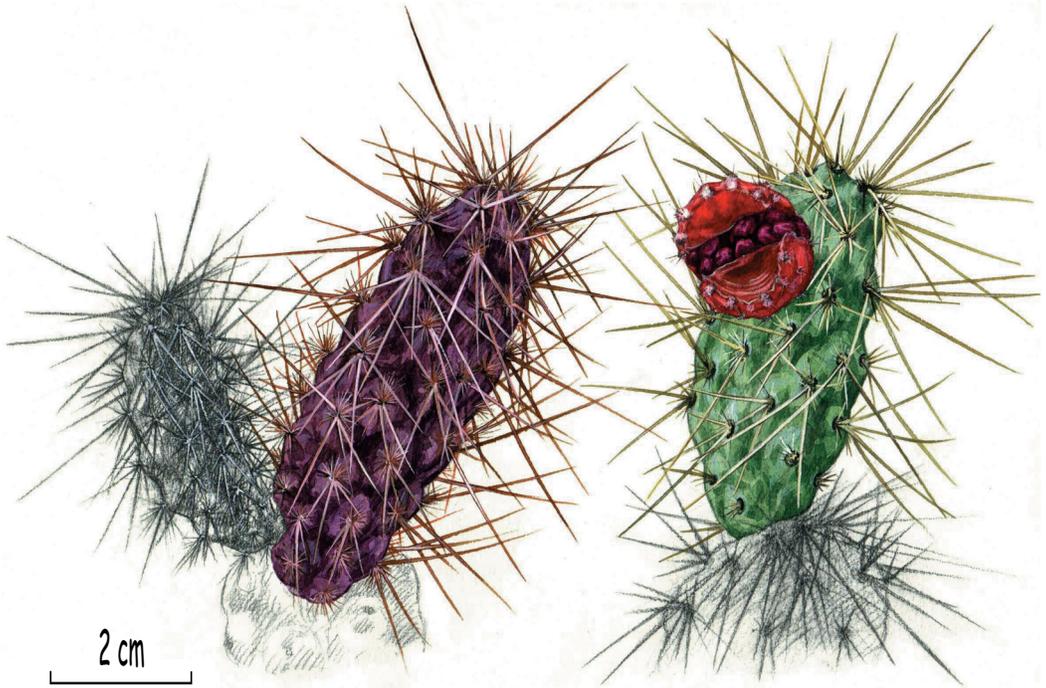
Columnar and also very big, the llawsa (or q'iwalla) looks just like the jach'a q'iru (or wanq'ara). For some reason the llawsa does not dare to colonize the islands, and prefers to stay on the shores of the salar, for example at the Tawa (Tahua) entrance. On the islands it is easy to tell the brothers apart, because only the giant lives there, but elsewhere in the areas where they both occur, how to know which is which?

The specialists say: "It may be distinguished from *T. pasacana* by having more ribs, finer spines set thicker together, and specially for its flowers grouped on the apex, mostly of a dark red color, although there are populations with pink and even cream-colored flowers". The fruit of the llawsa is not appreciated because it is watery, and its wood is of poor quality.

Llawsa, q'iwalla

Trichocereus tarijensis (*Echinopsis tarijensis*)

Family: *Cactaceae*



Ayrapu, he that stains

At least two forms are known under this name (the same in Aymara and Quechua). One is in the valleys of Cochabamba, while the one of interest to us occurs in the Altiplano. Both have characteristically magenta-staining seeds that are used to dye textiles and beverages... or the hands of those who handle them. Look at the painting: the seeds are inside the red fruit, which divides in two parts when mature. Children enjoy eating this small fruit.

In the salar, the local form is found on the islands close to the shore, and not on the central ones. This is a small cactus, 30 to 40 cm tall, growing in violet or green shrubs that expand outwards in circles.

Ayrapu

Opuntia soehrensii

Family: *Cactaceae*

Note: Aymara and Quechua name



Sank'allu, the little brave one

This generic name is given to all small cacti for which there is seemingly no use. This particular little beauty can be found along with the ayrampu, on those islands close to edge of the salar.

Well armed to the extent that it is unapproachable, this cactus is known to science under the name of *ferox*.

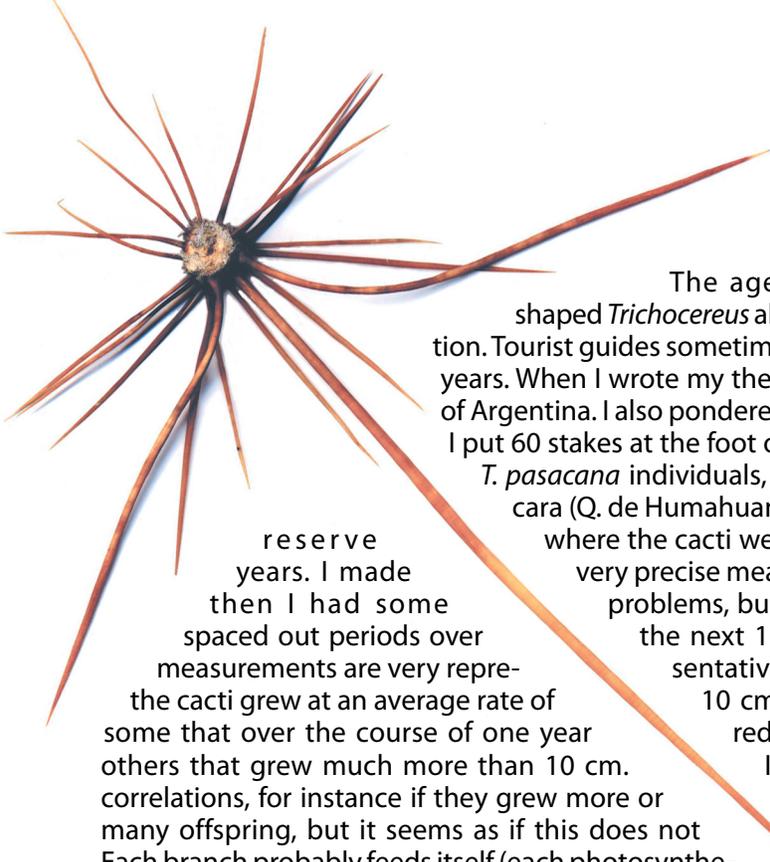
This species is round and emerges from the ground to about 20 cm. The long and hard black spines are mottled white with a touch of red at the base. The fruit is said to be "bitter, tasting like lemon".

Sank'allu, sank'ayu

Echinopsis longispina (*Lobivia ferox*)

Family: *Cactaceae*

Note: generic Aymara name for small cacti



Readers corner

Dear friends,

The age of the candelabra-shaped *Trichocereus* always fires the imagination. Tourist guides sometimes talk of thousands of years. When I wrote my thesis on the *Trichocereus* of Argentina. I also pondered over this. To find out, I put 60 stakes at the foot of the same number of *T. pasacana* individuals, in a locality called Tilcara (Q. de Humahuanca), an archaeological

where the cacti were protected for many very precise measurements for 5 years, problems, but I returned over more the next 15 years, for which the

sentative. The result was that 10 cm per year. There were

reduced their stature, and I carried out all sorts of less when they had

influence growth. sizes for itself),

reserve years. I made then I had some spaced out periods over measurements are very representative the cacti grew at an average rate of some that over the course of one year others that grew much more than 10 cm. correlations, for instance if they grew more or many offspring, but it seems as if this does not Each branch probably feeds itself (each photosynthesizes and this means that the supply of water and nutrients is not a limiting factor. I also made calculations for "height categories", but the average is what I said before. This means that this species, in this location, grows 10 cm per year. We cannot extrapolate this result to other areas with different a climate, nor to other species. However, there has been another study similar to mine with *T. pasacana*, and the same measurements were obtained.

In the USA measurements have been taken for the Saguaro, *Carnegie gigantea*. I think they obtained a greater rate of growth, lets say 13 or 15 cm per year. It is possible that in colder places this and other species grow a little less, so that what the people of the salar say could be close to the truth. In this case a cactus 10 m tall would be 200 years old. It may sound a little exaggerated, but up to 150 years seems reasonable to me and coincides with my data.

We must also take into account that the trunks have a layer of cells that photosynthesize, and that they must bear the high ultraviolet radiation for all those years! That is an almost unique feat in the plant kingdom.

Bye now. Good luck and see you later.

Roberto.

The other plants, humble and tenacious



Freezing nights, blistering sun during the day, winds every afternoon, rains that rarely come... these are the conditions the local flora must face in order to survive. Each species has its own strategy, whether this is to cling to the rocks like this yellow lichen in the photo, to choose a sheltered corner, to wrap itself in woody bark, to develop thick, resin-filled leaves, or simply to disappear until the more temperate climate returns.

What follows is a small sample seen more from an aesthetic angle than from a botanical one, designed to awaken curiosity, or simply to open one's eyes to the humble wonders that await underfoot...

The local names sometimes vary from one village to another, only a few kilometers distant. Look for the people who know, ...and ask!



2 cm

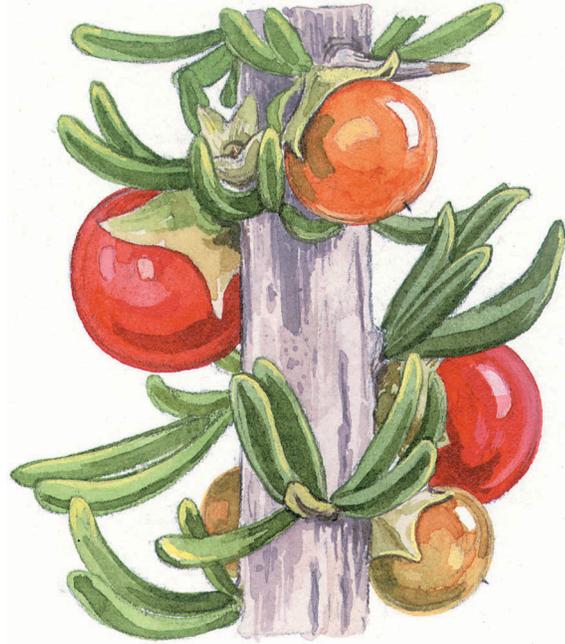
Waxrawaya

Lycium chanan

Family: *Solanaceae*

Also: wilawila, wila wilchaqe

To be pronounced "Wahawaya". It is a shrub up to one meter tall, common in the islands of the salt lake. Its name comes from the Aymara waxra, which means "horns", due to the



1 cm

shape of its thick thorns, strong enough to puncture a tire. This small detail does not bother the llama, which eats it with delight.

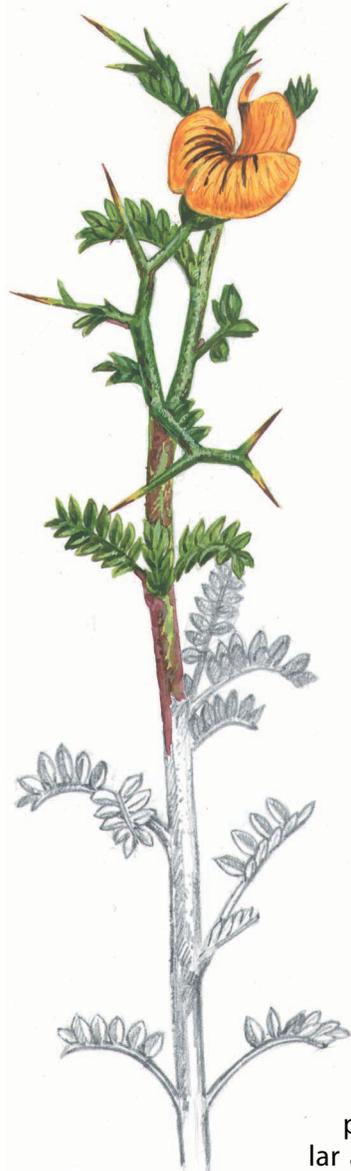
Its tiny red fruits are sweet and tasty. On one of the islands, a small grey lizard feeds on them and the female of the Andean Hillstar hummingbird (*Oreotrochilus estella*), which nests on Inkawasi, searches for small insects or parasites among its branches.



Urqu kasawi is the male, and qachu kasawi the female. For the Aymara people, everything is either one or the other, and plants too are classified according to this generic vision. If we compare this to the scientific classification, male and female plants correspond most of the time to plants in the same family and genus, but of different species.

Urqu kasawi has alternately arranged serrated leaves of a pale greenish grey, the bases of which are wrapped around the only stem, 20-30 cm tall.

Urqu kasawi
Exhalimolobus cf. hispidulus
Fam.: *Brassicaceae* (*Cruciferae*)



1 cm

Qachu añawaya

Adesmia polyphylla

Fam.: *Fabaceae* (*Leguminosae*)/
Papilionoideae

Qachu means female in Aymara. Urqu añawaya (*Adesmia horrida*), the male, has bigger thorns. It is a common shrub, which grows up to one meter tall and serves as firewood. It is easy to recognize this plant due to the particular arrangement of its many thorns. It is in bloom from February to March.

It is taken as a medicinal tea for sore throat.



Urqu itapilla

Cajophora chuquitensis

Family: *Loasaceae*

Also: atapilla, itapallu

58

This is the "urqu" plant, the male. The female has small flowers and is of the *Urticaceae* family.

This dark green plant of 40-50 cm grows in places protected from the wind.

Unless you want to relieve your rheumatism you had better not touch the itching hairs, an effect the llama is indifferent to while eating the flower. The hummingbird starts visiting this delicate Chinese lantern as from February.

After popping out some small black seeds, the plant dries up in a little silver pile.

The root is used to induce abortion and the ground plant is applied as a plaster to cover wounds.



Salwiya

Salvia cf. *gilliesii*

Family: *Lamiaceae* (*Labiatae*)

Also: **kumasa** (Aymara), **salvia** (Spanish), **Sage** (English)

This is a plant highly valued for its healing properties, and it can be found on sale in the Uyuni market. "The most medicinal of all plants" is served as an infusion for the "cold and aching of the bones", for the lungs, or as a tonic for students and convalescents.



1 cm

There are numerous species, this one possibly being the “sage of the puna”, as it is known in Argentina (*salvia de la puna*). In Europe sage has been valued since antiquity as one of the best healing plants, hence its Latin name, *salvus*, meaning “of good health”.

On the islands where it grows wild, sage does not reach more than 50 cm in stature, but in Jirira, where it is tended in the wind-protected and watered patio of Doña Lupe, it can reach a height of up to two meters.



Pillaya
Atriplex imbricata
Family: *Chenopodiaceae*

The pale green of this abundant shrub splashes the shores and the fossil algae cover of the islands. It grows up to one meter in height. Its tiny flower (0.5 mm) is violet with yellow stamen. The black little balls seen in the water-color are grouped seeds.

It is one of the favorite foods of llamas and sheep. People also prepare lye with its ashes mixed with those of the giant cactus.



2 cm

Chinchirkuma

Mutisia hamata

Family: *Asteraceae* (*Compositae*)

Incapable of remaining upright unassisted because of its weak stem this plant always grows inside another shrub.

With the tips of its branches it climbs up towards the light, in order to expose its white and lilac-tinted flowers.

This plant is believed to bring bad luck and the person who touches it loses possessions and love. The female, qachu chinchirkuma, is a medicinal plant, said to be good "for the air".

It cannot be found on the island of Inkawasi.



1 cm

Puqu t'ula

Chersodoma candida

Fam.: Asteraceae (Compositae)

T'ula is a word used collectively for all plants that serve as firewood.

It is a common shrub on all the islands and the shores of the salar. Its pale green leaves are coarse and covered with a fluff that gives them a velvety appearance. The yellowish flowers bloom at the end of May.

It is used to make tea.



2 cm

Wayawaya

Haplopapus rigidus

Fam.: *Asteraceae* (*Compositae*)

Also: bailabaila (Spanish)

The “flower of love”, says Don Alfredo who drinks the tea that supposedly has aphrodisiac properties, besides being good for healing fever and the liver.

A low shrub with flexible stems, sometimes found climbing down rocks, the wayawaya has sticky leaves and cadmium-yellow flowers. It disperses its seeds to the wind like the dandelion.

To make a nice cup of tea, put some pieces of stem in boiling water for no more than half a minute. The yellowish color disappears with some drops of lemon.



The cross-like thorns along the stem make it easy to identify this 50-60 cm tall shrub. If you take a branch and look down its length from the tip, you can see that the thorns are perfectly aligned.

The leaves are the little green balls bunched at the base of each cross. When the plant blooms, its blue flowers scent the air.

All these thorns do not intimidate our friend the llama, which does not waste such a delightful meal.

Kara t'ant'a
Junellia seriphioides
Family: *Verbenaceae*



This little plant, 10 to 20 cm tall, finds shelter from the strong winds, along with other fragile species, in the crevices of the fossil algae or between rocks.

Protected by a long dark lilac case, flowers appear in May and abandon their seeds to the wind in the manner of the dandelion.

It is well known among herbalists for its medicinal and culinary properties (as a condiment).

Suyku

Tagetes multiflora

Fam.: Asteraceae (Compositae)

Also: suico (Spanish)



Ch'axlampa

Chuquiraga atacamensis

Fam.: Asteraceae (Compositae)

According to Don Alfredo this plant owes its name to the crackling sound it makes when burning in the fire.

Ch'axlampa likes the sandy beaches on the edges of the islands, but it is not found on the island of Inkawasi.

It is easy to recognize these bushes, 50-100 cm tall, by their hard and coarse leaves, which taper into sharp spikes. They caution even the llama, which eats only the flowers.

Women use this plant to induce abortion.



Mujlla, añatu t'ula

Phacelia pinnatifida

Family: *Hydrophyllaceae*

Also: **kusqu t'ula** (Aymara),
leña de zorrino (Spanish)

This plant is known for its foetid smell and its sticky leaves. It grows alone or in little clumps about 25 cm high, sometimes reaching 40-50 cm high. It likes to grow mostly at the entrance of caves and in sheltered places.

Local people consider this plant to be useless, although this is not entirely true of course for our friend the llama, which definitely does not have an overly refined palate.

A European gardener says that in his country Mujlla is planted to discourage weeds from growing before sowing.

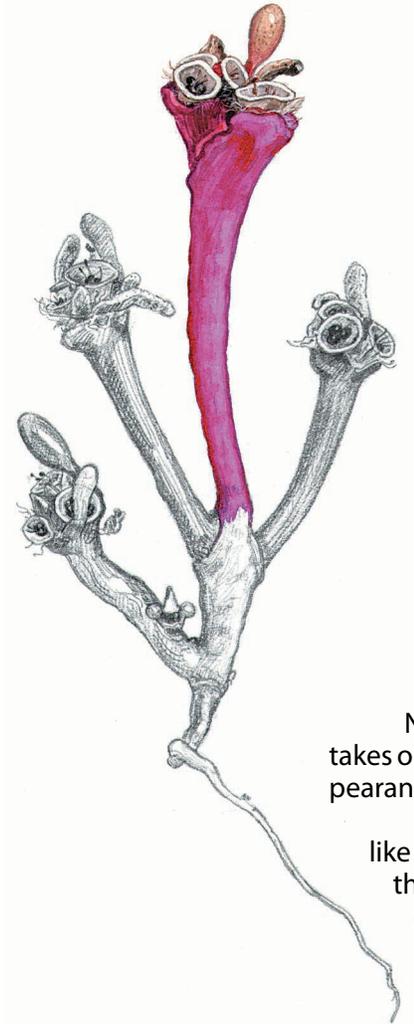


Chawka t'ula

Baccharis boliviensis

Fam.: Asteraceae (Compositae)

Very common dark green shrub less than one meter tall, with small greenish white flowers that bloom in May.



Not only the landscape takes on an extraterrestrial appearance...

Alien in its trumpet-like shape, alien in its color, this tiny plant only a few centimeters tall looks just like a visitor from Mars might look like.

Locally it is known as "rain pasture" for the llamas.

This name is given to several small plants that appear immediately after the rainy season, which lasts from January until the end of April.

1 cm

Malvasa (Spanish?)
Portulaca sp.
Family: *Portulacaceae*



1 cm

Name?
Species?
Family?

As we do not know
its name, we will call it
the unknown beauty...
In this way we are humbly
reminded of how far we are
from knowing it all...
Some say that if some-
thing does not have a name, then
it does not exist. What is your opinion?



These plants grow in isolation or in clumps. In the month of May it is covered with yellow flowers with violet cases. It is recognized by its serrated leaves, but even better by the color of the stem, which is partly violet and partly bluish green-grey.

Besides qachu chachakuma, there is the male urqu chachakuma (*S. graveolens*). Both are considered by some botanists to be variations of the species *Senecio nutans*. The people of the salar also distinguish the chachakuma burro (*S. viridis*) that grows at higher altitudes on the slopes of the Tunupa volcano.

Qachu chachakuma
Senecio cf. *psychrophilus*
 (*S. nutans*)
 Fam.: *Asteraceae* (*Compositae*)



K'unchu, mutuq'ura
Hoffmannseggia minor
Fam.: *Fabaceae* (*Leguminosae*)/*Caesalpinioideae*

This humble little plant prefers the sand. Buried about 20 cm deep below the ground, the single root enlarges into a crisp little potato (left), loved by children. The bean case (right) contains the seeds.



Tulu, p'iqinqara
Ephedra cf. breana
Family: *Ephedraceae*

Tulu, or p'iqinqara, grows in shrubs sometimes more than one and a half meters tall. It is a primitive plant with a green stem and rudimentary leaves.

It has no flower but rather a hardly visible naked ovule, which produces small red "fruits" – seeds actually – composed of various joint corpuscles, which children appreciate for their sweet taste.

It is a medicinal plant, good for the kidneys and the bladder.

And of course, the llama eats it...

Ferns and lichens

Those of you who think the science of botany is boring or uninteresting, should ask a botanist how ferns reproduce, or what lichens are. If the answers do not surprise you, nothing will.

Lichens, which are a symbiotic association between algae and fungi, can live in the most inhospitable environments. It is no surprise therefore, to encounter their yellow, orange, or green patches on the rocks of the islands.

Ferns here are small bushes about 20 cm tall, and of a khaki green color. The urqu chuxrchu (pronounced "chuh'chu") makes the animal which ingests it ill. The long and fine chuxrchu has oily hairs.

It is interesting once again to note the Aymara male-female classification, which corresponds here to two varieties of the same species.



Qachu chuxrchu
Notholaena nivea var. *tenera*
Family: *Polypodiaceae*



Urqu chuxrchu
Notholaena nivea var. *nivea*
Family: *Polypodiaceae*

Chuxrchu
Cheilanthes cf. *pruinata*
Family: *Polypodiaceae*



What are all these green cushions?

On the one hand we have the t'khillas (pronounced "tikilias"), which like the low salty areas, on the other there are the yareta and yaretilla, which prefer the mountain slopes and which, therefore, are not found on the salar.

The qachu t'khilla (female t'khilla), medicinal and also fodder for the llamas, covers large areas with its reddish and succulent leaves.

The yaretilla (*Junelia minima*, *Verbenaceae* family), can be distinguished from the yareta by its soft cushions, which are smaller and of a pale green color (just visible overleaf, to the left of the yareta). Women use its roots as shampoo to wash their hair.



Qachu t'khilla, janqijanqi

Species?

Family?



T'khilla

Frankenia triandra
(*Anthobrium*)

Fam.: *Frankeniaceae*

These hard cushions grow in sandy soils close to the salt and can reach a diameter of one meter. A magnifying glass is needed to see its diminutive flowers. Not to be confused with the "yaretilla" which cannot be found on the islands.

Two plants not found on the salar but all around it, which will surely arouse your curiosity...



At almost 5000 m, the qñwa tree, the “highest” in the world, erects its contorted trunk on the slopes of the Tunupa. Its papery red bark contrasts with the dark foliage. At its feet, the sensual green hillocks of the yareta hug the rocks and exude a delicate aromatic resin. Both are still an important source of fuel and because of this are threatened.

Qñwa

Polylepis tarapacana

Family: *Rosaceae*

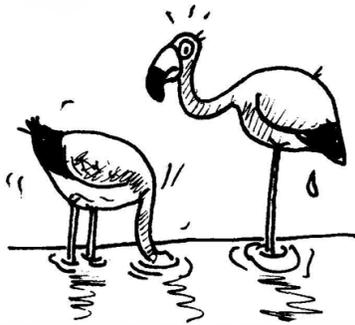
Qiwña (Quech.), queñua (Sp.)

Yarita

Azorella compacta

Fam.: *Apiaceae (Umbelliferae)*

Yarita (Quech.), yareta (Sp.)



Nothing below, nothing above...

What about animals?



Well, they are here too. Some are at home, others are just passing through each year, and yet others are castaways, deviated by bad weather, lost and exhausted.

Diversity is not great. However, just like the plants, the animal species found at the salt lake, whether these be tiny insects or large mammals, have succeeded in adapting to what at first sight appears to be a hostile environment, especially due to the lack of water.

Camels in the Andes?

Not exactly, but there are camelids, the same family as camels. These animals are wonderfully adapted to their environment and cause very little ecological damage because their soft feet do not erode the soil and they do not tear out roots when eating. They are an important part of Andean culture.

The graceful vicuñas sometimes venture out onto the salar bound for the islands, as once used to do the guanaco (*Lama guanicoe*). Today the guanaco is only found across the border, in Chile. Since they have been protected, the vicuñas are easily visible on the salar edges, as here in Jirira. The other two species of this family living in the Andes are the llama (*Lama glama*) and the alpaca (*Lama pacos*), both domesticated for the past five or six thousand years.



Wari

Lama vicugna (*Vicugna* var.)

Family: *Camelidae*

Also: wik'uña (Quechua, used by Aymaras as well), vicuña (Span./Eng.)

Oh! What cute little kangaroos!



...once said an innocent tourist, upon seeing the viscachas leaping gracefully among the rocks. Well señorita, these are not kangaroos but rodents related to the chinchilla (which, incidentally, is now extinct in Bolivia because of its virtue as a plush adornment for certain ladies...).

The viscacha is found in the Andes from southern Peru to the island of Chiloe (lat. 44° south), in Chile. Vegetarian (eating even cactus), and diurnal, it forages in small groups amongst rocks. At night it sleeps snugly in its burrow. Where does the viscacha find water on the islands? It appears that it simply doesn't drink any, obtaining all the moisture it requires from its food.

Outwardly indifferent to all disturbance whilst sunbathing, sitting perfectly still with its eyes closed and tail rolled up, the viscacha utters a shrill alarm whistle at the least hint of danger and flees with astounding agility, fearlessly scaling sheer walls of rock. If you have time, you might try to see the color of its eyes...

Wisk'acha

Lagidium viscacia

Family: *Chinchillidae*

Wisk'acha (Que.),

vizcacha (Spanish),

viscacha

A touch of pink on the whiteness of the salar...

... is the beautiful spectacle offered by the flamingos flying across the salt. There are three species of pariwana (Quechua-Aymara generic name), distributed on the puna of Bolivia, Chile, and Argentina. These birds are experts in using their "inverted" beaks to filter out small organisms from the salt waters.

They make the most of the warmer rainy season to nest upon lagoons and salt flats. It is common to find their eggs, twice the size of those laid by the domestic hen, pushed by the wind towards the islands. In winter the pariwana search for warmer climes towards the north up to Lake Titicaca, where the water does not freeze each night as it does in the south. It is not at all comfortable to awaken with one's legs frozen in place and to have to wait for the sun to melt the ice... Such is not the life of a self-respecting flamingo! In this dire situation, it is important NOT TO GET CLOSE because in trying to escape the bird will surely damage itself.



Pariwana (generic name)

Phoenicoparrus jamesi

Family: *Phoenicopteridae*

Chururu (Que.), Parihuana or Parina chica (Span.), Puna Flamingo

People used to collect flamingo eggs, but now the species is protected. The Chipaya people, an ethnic group distinct of the Aymaras, who live north of the Coipasa salt lake, still hunt flamingos with bolas for their own subsistence.



How to recognise the different pariwana species?

Andean Flamingo: **yellow legs**, yellow bill two thirds of which is black.

Puna Flamingo: **red legs**, red mask, and yellow bill with a black tip.

Chilean Flamingo: **grey legs, red knees**, red toes, and bill without yellow.



Those two photographs of *P. andinus* have been taken south of the Salar de Tunupa.

Pariwana (generic name)
Phoenicoparrus andinus
Family: *Phoenicopteridae*
Jututu (Que.), Andean Flamingo

Pariwana (not illustrated)
Phoenicopterus chilensis
Family: *Phoenicopteridae*
Tuququ (Que.), Chilean Flamingo

It's hard to raise kids!

A good portion of the salar becomes flooded during the rainy season. The resulting shallow brine is ideal for the pariwana to nest. They choose places where the mud breaks through the salt crust, and build with clay crowded cities of hundreds of nests.



Until the chicks, literally balls of fat covered with black down, are able to fly, the nest complex is a giant nursery. This aerial photograph taken in June shows the black "islands" of chicks, with a few adults moving slowly about among their offspring. This is the most critical time for survival. Foxes and dogs lie in wait, as does the covetous dealer who, despite the repudiation of the local people, takes away truckloads of chicks to turn them into..."export-quality oil".

In the end, the profound silence of the salar returns, over scattered skeletons and crumbling earth mounds. How many flamingos will survive this year?





The hunter of viscachas

The eagle often visits the islands in search of prey. On the menu there are lizards, mice, and... tasty little viscachas!

One day, on the island of Inkawasi, Don Alfredo and Doña Aurelia found a fledgling dying by the edge of the salt, and they took care of it. Now this fortunate individual expertly plays with the wind, effortlessly gliding along the island ridge, and returning home for meals, to the delight of the tourists stopping over.

On the salar, one frequently uses the word “águila” (eagle).

Paka (generic name)

Buteo poecilochrous

Family: *Accipitridae*

Anka (Que.), águila (Sp.), Puna Hawk

The cactus tenant

Have you noticed a nest made of sticks, wedged in the fork of the giant cactus? It is the home of the ch’ina lluch’itu, literally meaning “rolled-up behind” in Aymara, due to the fact that this bird always has its tail up. It actively searches for insects between the plants, and perches on top of a rock to loudly proclaim its territory.



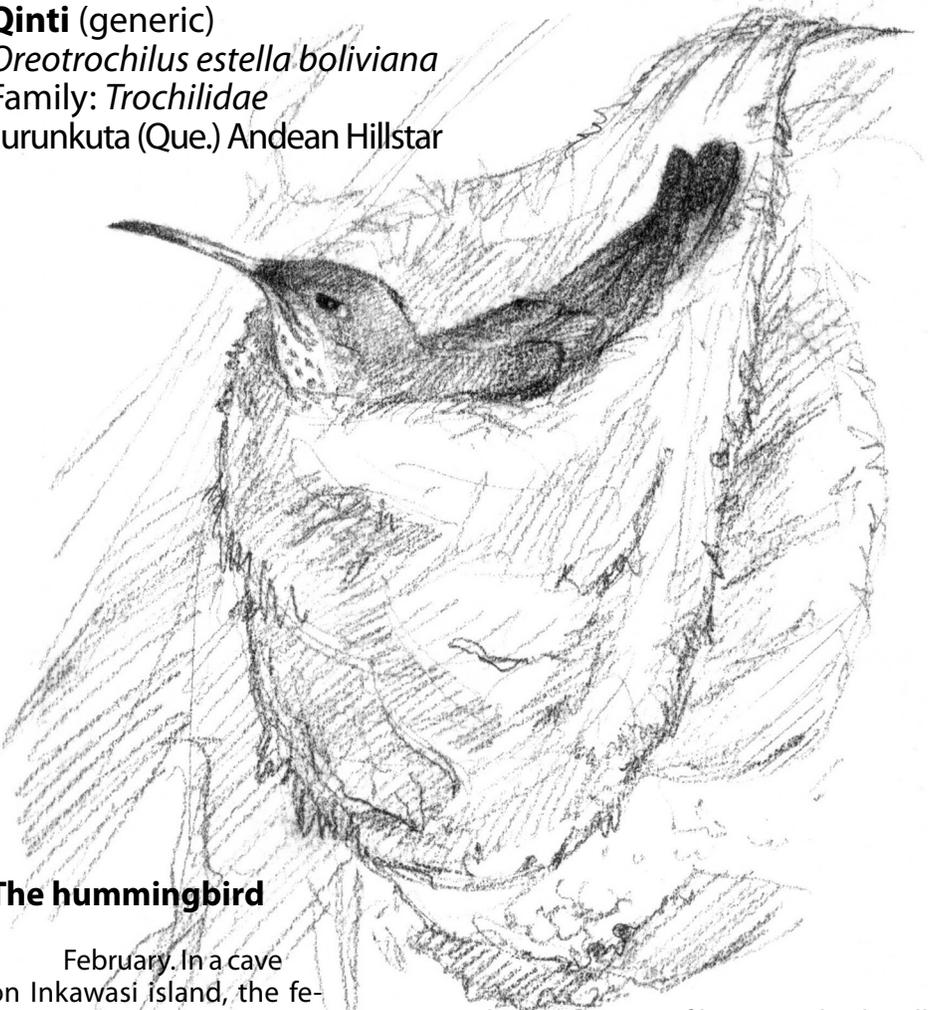
Ch’ina lluch’itu

Asthenes dorbignyi

Family: *Furnariidae*

Rusty-vented Canastero

Qinti (generic)
Oreotrochilus estella boliviana
Family: Trochilidae
Jurunkuta (Que.) Andean Hillstar



The hummingbird

February. In a cave on Inkawasi island, the female hummingbird broods her eggs and only ventures outside occasionally to feed on insects or nectar. Her plumage blends perfectly with the nest fibres and the rock, affording effective camouflage.

The male on the other hand, does not need to hide himself and displays his splendid metallic green

throat. The pair of hummingbirds will be gone before winter.

An even shorter stay is that of the Giant Hummingbird (*Patagona gigas*), which visits the pasakana only in January and February. His call, "piiii... piiii..."; can be heard as he visits one flower after another, clumsy with his large wings.

The “sparrow” of the islands



Of the various small birds that are resident all year round on the islands, none is as common and spectacular as the chuxt'ala (pronounced “tchuhtala”), with its black head and bright shades of orange. On Inkawasi, this bird comes to beg for food just like an ordinary sparrow. It is a seed eater, but will not turn down the occasional insect and is certainly not afraid to squeeze in between the spines of the giant cactus to investigate the inside of the flowers. Chuxt'ala makes its nest with twigs and fibres well sheltered from the wind inside a rock crevice or in a cave, where it also sleeps.

Other small birds which are seen every day, but whose nesting sites remain unknown, include the ch'ijta (*Phrygilus plebejus*, Ash-breasted Sierra Finch), chawka in quechua. It is a poor relative of the chuxt'ala, with its drab grey plumage striped with black. There is also the “wind-caller” (*Muscisaxicola flavinucha*, Ochre-naped Ground Tyrant), known in other parts as monjita (nun in Spanish). The “wind-caller” struts about elegantly among the rocks in his pale grey suit and cinnamon-colored hat, but etiquette is quickly forgotten when an unfortunate insect comes into reach...

Chuxt'ala, pilaq'chuli
Phrygilus atriceps
Family: *Emberizinae*
Black-hooded Sierra-Finch

The spider



Few spiders are found on the islands, which do not provide very rich pickings for these flying-insect predators...

Spiders are related to scorpions, and are not insects.

Kusikusi

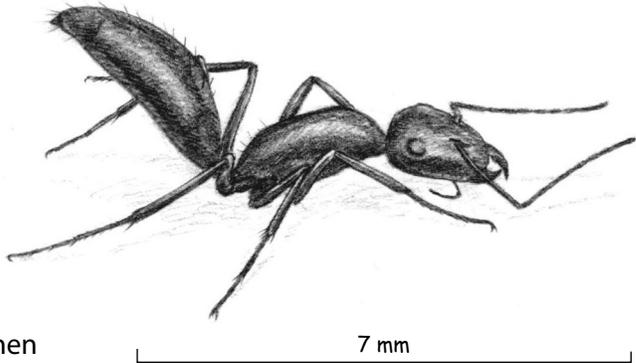
Class: *Arachnida*

Order: *Aranea*

The ant

The black ant (ch'iyara in Aymara) only comes out when there is sunshine. Almost frantic, as if in a race against time, the ant rushes about in search of food within the fossil algae labyrinths. When threatened, it raises its abdomen to impress the assailant, even if he is as large as a human being.

On the islands exists another species, smaller and red (wila sik'imira). Just like the spider, ants of both species are not abundant.

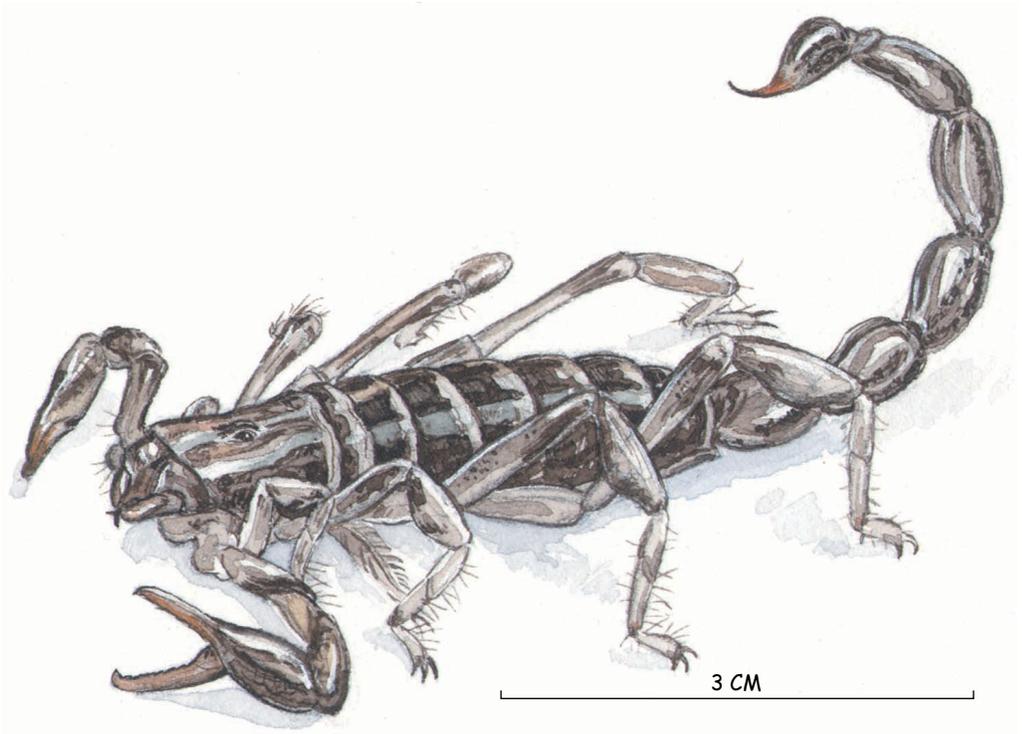


Ch'iyara sik'imira

Class: *Insecta*

Family: *Formicidae*

Also: **k'isimira, k'usiwallu** (Aym.)



The scorpion

This is the only poisonous animal on the islands, yet curiously enough the scorpion is regarded in the region as a “little animal that does no harm if not provoked”, which is entirely true. This remarkable attitude (of the people, not the scorpion), regarding a supposedly dangerous creature reveals a profound respect for nature, and an understanding that “we all have our place”, the basic concept of ecology.

Our friend the scorpion, sure enough, moves about at night peacefully catching insects, and retires under a rock during the day. For some unknown reason, the scorpion appears to have an affinity for the island shoreline where salty water accumulates. The salt kills the scorpions, and dead ones are commonly found littered about on the shore.

Alacrán (Spanish)
Class: *Arachnida*
Order: *Scorpionida*

Other animals, residents or visitors to the islands

Amongst the invertebrates, the smallest are the microorganisms, which live in the salt waters. On Inkawasi, there are at least three species of butterfly, a small brown beetle, many “red lice”, and some flies.

Reptiles are not abundant, but on certain islands there are yellow and grey lizards (*Liolaemus* sp.), whose generic names are jararankhu in Aymara and ararankha in Quechua. These lizards do not exist on Inkawasi.

Of the birds, a regular visitor is the Golden-spotted Ground Dove (*Meriropelia aymara*), with its golden shoulders and pink legs. Many birds use the islands as a resting place when crossing the salar or as a refuge during bad weather. Indeed, after a strong storm off the coast of Chile, a pelican was seen on the top of an island! We do not doubt the guide who made this remarkable sighting, but it is worth mentioning that this bird is not registered in Bolivia. Walking around the edge of the salt, one finds mummified corpses of animals. This is how we stumbled across a Slate-colored Coot (*Fulica ardesiaca*), and a migratory sandpiper from North America (*Tringa* sp.). The edges of the salar are of course much richer in bird life. It is easy to spot the wallata, the Andean Goose (*Chloephaga melanoptera*), black and white with a pink bill, and the kaitikaiti, the Andean Avocet (*Recurvirostra andina*), with its long bill curved upwards. If you are lucky, you might even see a suri, the Lesser Rhea (*Rhea pennata*), which is becoming increasingly rare due to indiscriminate hunting. Bird enthusiasts will benefit by consulting Herzog et al., (2016). Birds of Bolivia Field Guide. Asociación Armonía & Agencia Suiza para el Desarrollo y la Cooperación COSUDE, Santa Cruz de la Sierra, Bolivia.

What about larger animals? Little red riding hood, don't shake, there is no wolf... The puma (*Felis concolor*), the wild cat (*Felis jacobita*), a handsome animal 85 cm from nose to tail, and the cunning Andean fox (*Pseudalopex culpaeus*), all of them roam the mountain sides around the salar, and can occasionally reach an island.

There are still two more animals which are very different, but which have one thing in common: both have been introduced by man. If you sleep on an island one day, the only sound you will hear in this sea of silence could well be that made by a mouse gnawing its food (your food, that is). This small creature is quite tame, and after a while it will comfortably eat out of one's hand. So far, nothing out of the ordinary. Let us travel back in time now to the Argentinian Patagonia of the 19th century. The British colonists were getting bored with their sheep and missed the hunts they loved so much back home, so they started to import European foxes, wild boars, rabbits, and hares. The latter are good at running, so much so that they have by now almost reached La Paz, destroying crops along their way. In 1992 a surprised film crew came across a hare at midnight, running across the salt 30 km from the shore...

A thousand thanks...

This is the result of the contributions, large or small, of a great many people without whom it would have been impossible to produce this booklet. Not only have we greatly enjoyed this project, but we have also made new friends and discovered new horizons.

A thousand thanks therefore,
in the island of Inkawasi, to Don Alfredo Lázaro, his wife Doña Aurelia, their children and their niece Teodosia, for receiving us so warmly, and for their unfailing readiness in answering our questions;

in Jirira, to Don Carlos Nina and his wife doña Lupe for the long conversations by the stove and the refusal to charge for accommodation, us now being considered friends, and to Germán Nina for allowing us to catch a glimpse of the Aymara world;

in Qoqisa, to Don Mario for the visit to the mummies and to Don Toribio for his stories;

in Tawa, to the little girl Norma Quispe for her poem, to Don Alberto Quispe for his memories on the caravans, and to doña Juana for her delicious carrots;

in Qaqina, to Don Favio Gonzáles for the tour of the islands, and to all his family, who allowed us to take photos of the quinua harvest, with special regards for the grandmother;

in Sixsiwa, to the authorities and the women's cooperative, for the incredible reception offered to us;

in Uyuni, to our new friends Iver Aranda and Isabel Verstraete for the legends, the advice, and the ever open door;

in La Paz, to ABTEMA for having kindly supplied the satellite image, to the National Herbarium, and to Foto Linares;

in other places, to Carlos Vedia, David Binet, Stephanie Dammerman, Juana Holguín, Nicolas Teyssier, Narel Paniagua, Patrice Lecoq, Faviani Lino, Gina Zurita, Ignacio Apasa, and all those whom we met along the path travelled during this singular experience.

And of course, to our sponsors, who gave us what to our eyes is worth more than money, their trust.

Finally, many thanks to the "cactus madman", Daniel Schweich, for his contagious enthusiasm, his efforts to find the authors, and his time devoted to this second edition.

To satisfy the authors' egos...

Martin Specht,

French geologist working with the Total Bolivia Petroleum Company, Martin is fascinated by the natural beauty of this country. He obtained the necessary funds, and gave his free time for this project, despite being recently married...



Oscar Tintaya,

Bolivian artist born in La Paz, he lives off his art and is a member of Armonía, where he started to take a deeper interest in nature. With an incredible eye for detail, Oscar took three days to paint one cactus watercolor. Now, after hours of experience in the cold wind, he is a master in the art of painting with gloves on...



Lois Jammes,

French bush pilot, Lois has always been a nature lover and is a founding member of Armonía. He has been flying 40 years over Bolivia before retiring in Brittany, and for many people he lives rather in the clouds...



We did something, now it's your turn...

The Salar de Tunupa is far more than scenic beauty. We are convinced that it should be included in the UNESCO list of World Heritage Sites. Such a status would benefit the local population, avoid the excesses of the mass tourism industry (which seeks only immediate monetary gain), and put pressure on future lithium extraction companies to maintain strict ecological norms. (Note to this second edition: the Bolivian government has initiated lithium extraction at the mouth of Rio Grande)

It does not matter whether you are resident or simply passing through. If you are now on the salar, sit down and look around. What do you see? What do you feel? Is it not a truly special place on this planet? Would you like it to still be this way for your great grandchildren to see? If the answer is yes, then you CAN do something about it. A simple action is to send a letter or e-mail to the following address:

UNESCO
World Heritage Centre
7 place Fontenoy
75007 Paris
France
FaceBook: <https://www.facebook.com/efareport>

What is Armonía?

Armonía is a Bolivian non-profit ecology association of which the members are convinced that mankind is an integral part of nature, and that therefore nature is not at our disposition. With this vision, Armonía operates on a national level by means of various activities including scientific investigations and environmental education, often in a voluntary manner. The focus



is on birds but not exclusively, and Armonía is a member of BirdLife International.

You can contact Armonía at:

Av. Lomas de Arena #
400, Zona Palmasola, Santa Cruz de
la Sierra, Bolivia
tel. 591 – 3 – 3568808
mel <armonia@armonia-bo.org>



Sometimes, people choose to camp on the salar close to the “water eyes” (Cf. page 16)

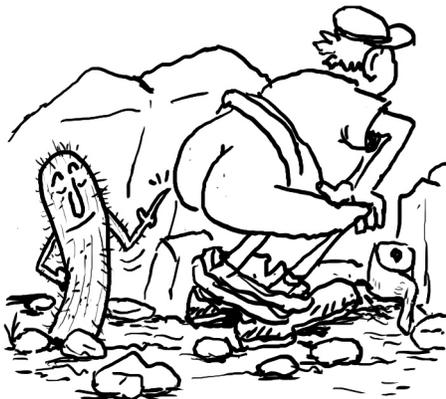


A Chilean pelican makes it to Bolivia but seems to be having a spot of trouble with the authorities (Cf. page 90).

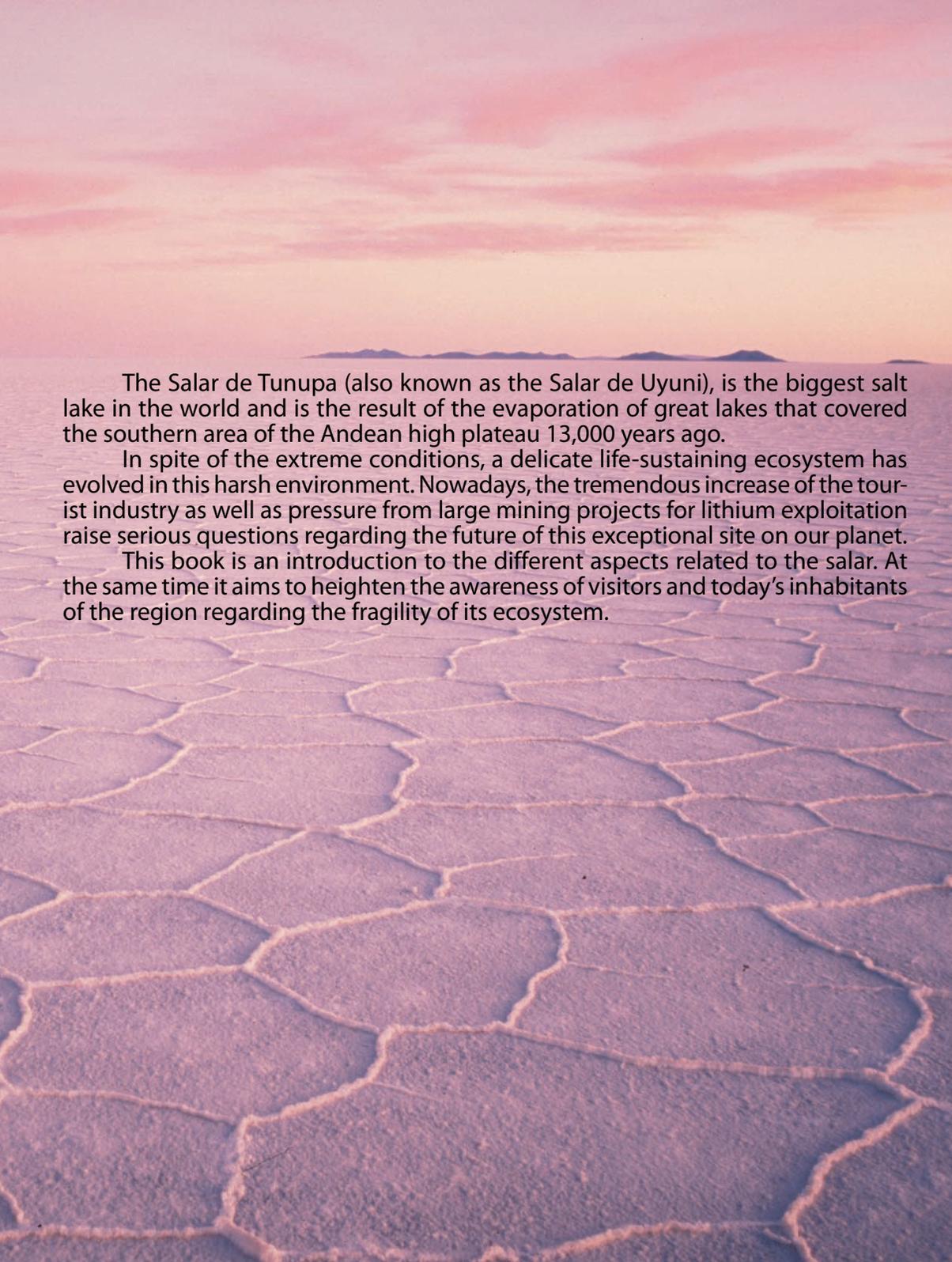


The Tunupa volcano uses her new smartphone to complain about the Lithium situation (Cf. page 33 and 93).

Llama choosing new shoes to cross the salar (Cf. page 26).



A tourist and a cactus exchange gifts (Cf. page 5).

The image shows a wide, flat landscape of a salt flat, likely Salar de Uyuni, under a soft, pinkish-orange sunset sky. The ground is covered in a network of irregular, light-colored cracks that create a mosaic-like pattern. In the distance, a range of low mountains is visible against the horizon. The overall scene is serene and desolate.

The Salar de Tunupa (also known as the Salar de Uyuni), is the biggest salt lake in the world and is the result of the evaporation of great lakes that covered the southern area of the Andean high plateau 13,000 years ago.

In spite of the extreme conditions, a delicate life-sustaining ecosystem has evolved in this harsh environment. Nowadays, the tremendous increase of the tourist industry as well as pressure from large mining projects for lithium exploitation raise serious questions regarding the future of this exceptional site on our planet.

This book is an introduction to the different aspects related to the salar. At the same time it aims to heighten the awareness of visitors and today's inhabitants of the region regarding the fragility of its ecosystem.