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Mrs. Lilly Grove

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THE SCOTTISH GEOGRAPHICAL MAGAZINE.

DESERTS OF ATACAMA AND TARAPACA.

By Mrs. LILLY GROVE.

(Read at Meetings of the Society in Edinburgh and Glasgow, January 1893.)

INTRODUCTORY REMARKS ON CHILI.

THE Spanish-American nations, although they are all of the same origin, with the same feelings and ideas—following the same religion, speaking the same tongue, subject to the same legislation—and though they have been conquered by the same race, nevertheless have not followed the same path when constituting themselves independent republics. Their development has not been equal, and their progress has been very different. While some have increased in population, wealth, and civilisation, others offer an example of stagnation so great that the question arises—have they not rather lost than gained in becoming self-governed?

As an example of the colonies that have progressed Chili attracts our attention. At first sight it might appear that she would have been the very last of them to attain prosperity. She was the poorest and the most backward of them all; her inhabitants did not number above 500,000, her commerce only reached about ten million *pesetas* a year, and the public revenue barely attained 2,500,000 *pesetas*. The celebrated Spanish geographer Torrente bears witness to this condition when he says, "This province has been the costliest and the least useful to the mother-country."

With regard to its mental and moral condition, Chili under the colonial *régime* was even more backward; the poorest and the most distant of the Spanish possessions, it was also the most neglected in intellectual development. Towards the close of the Spanish dominion

there were not ten men in the country who could understand any Latin but that of the commentators on the Laws of Castile, or of the treatises on Theology and Canon Law; nor were they able to read a page of French or of any other modern tongue. While Mexico and Peru had printing presses as far back as the 16th century, and the other colonies from the 18th, Chili was deprived of this aid to the propagation of knowledge until 1812, *i.e.* until two years after the beginning of the Revolution which gave her independence.

However, Chili conquered all these difficulties, and we find the German historian Gervinus unhesitatingly placing her in the first rank amongst the well-balanced republics; he says that peace and order were easily established in this province without despotism, and without an imposed dynasty, this happy condition of affairs being favoured by the influence of a moderate constitution. A regular government was established in Chili when its sister republics were barely organised, and, in 1820, a fleet and an army were formed strong enough to aid in the deliverance of Peru.

From that time Chili gave all its attention to the organisation of the internal government of the country, to the regulation of its finances, the payment of its debts, and the development of public instruction: in a word, the province did all in its power to lay the foundation of a great and prosperous nation. And these efforts have been crowned with complete success. Since 1830 Chili offers an example of what is unique in Spanish America, and rare in any part of the world: a regular succession of legally constituted governments.

Chili owes these boons to the large share which the upper classes have taken in public affairs, to the happy extinction of military despotism, to the patient endurance and aptitude for work of its courageous inhabitants, but, above all, perhaps, to the negligence of the Spanish Home Government—negligence which forced the colonists to rely entirely upon themselves, and which called for exceptional efforts when once the nation had shaken off the yoke. And, further, it must not be forgotten that Chili is indebted to a climate as perfect as any on the globe, to a sky so pure that all thrives beneath it, and to its position between the sea and great mountains, which not only yield a store of metals, but have also protected her in her infancy from the hostile incursions of the turbulent inhabitants of the surrounding countries. Finally, she owes much to the energy of foreigners, especially of Englishmen, who have fought for the Chilians, taught their children, constructed their railways, and established commerce in their harbours. Chili was the first of all the colonies to abolish slavery, to organise state education on a large scale, to grant commercial liberty, and to construct railways, telegraphs, and telephones. Religious liberty, too, has always been maintained; for Chilian law not only protects all Christian worship, but also gives to each sect permission to open schools, and to teach in them the dogmas it prefers. The highest praise is perhaps due to the educationalists, for they had the greater obstacles to overcome in the strong prejudices against the education of girls. Great opposition was encountered when it was proposed to open a school for girls in 1812. It might almost be said that the

ignorance of the women was part of their religion, and the Spanish writer Campomanes was looked upon as a revolutionist when he maintained that a woman might reasonably learn to read. Vancouver says that in the beginning of this century many beautiful ladies of the Chilian aristocracy, descendants of noble Castilians, could not even sign their names, and those who could, made pot-hooks and hangers like children just initiated into the mysteries of penmanship. But now the Chilian woman is not only well-educated herself, but is a source of instruction to all around her, and much credit is due to those first innovators who obtained this result.

The Chilians have shown in quite recent times—in the war with Peru in 1879—that they still retain the remarkable military qualities which formerly aided them so well in procuring their independence. In 1891, when the dictator Balmaceda wanted to overthrow the constitution, they once more gave proofs of their courage and common sense.

Before proceeding to describe the deserts more particularly, I shall venture to give a brief sketch of the region covered under the name Chili. The Republic extends from $17^{\circ} 57'$ to 56° S. lat. To it belong the islands of Diego Ramirez, at the south of Cape Horn, Juan Fernandez, San Felix, San Ambrosio, and the group of Pascua. The provinces of Tacna and part of Atacama were acquired in 1879, in the war with Peru; and according to a treaty between Chili and Peru, Tacna will be governed by the former power until March 1894, when the inhabitants will have the right to choose between the Chilian and Peruvian nationalities, and the republic which remains in possession will have to pay the other £1,250,000. The territory of Antofagasta, formerly Bolivian, is now, according to an armistice of indefinite duration, which was signed on November 29th, 1884, governed by Chili, and will continue to be so governed as long as this armistice, which may be looked upon as a treaty of peace, lasts. The population of the Republic is 2,526,969, the greater part belonging to the Caucasian race. There are about 50,000 Indians of pure blood, between Valdivia and the river Bio-Bio, who have lost their independence since 1882. Aimara, pure-bred Indians, are found in the provinces of Tacna and Tarapaca. The working-classes are a cross between the Spanish and the Araucanians; those of the north are Chilians who have intermarried with the Aimara. The Fuegians, who are very uncivilised, inhabit the southern extremity of the country and the adjoining islands, but their numbers are insignificant. The language of the country is Spanish; most of the Araucanians who come into contact with the Chilians, in agriculture or commerce, either speak Spanish or understand it.

During the war with Peru, in 1879-1882, Chili acquired the provinces of Tarapaca and Antofagasta from Peru and from Bolivia. By this conquest she secured incalculable additions to her national wealth, and, doubtless, for a long time to come, the financial prosperity of the country is assured.

It is only right to state that the development and success of the nitrate industry are due in large measure to the initiative and the courageous efforts of British engineers and British capitalists.

ATACAMA.

To turn now to a more detailed account of the deserts of Atacama and Tarapaca. The former—including the Province of Atacama, capital Copiapo, and the Province of Antofagasta, whose capital is the small port of the same name—has for its southern limit the river Copiapo, and for its northern, the river Loa, which runs into the Pacific at 21° S. lat. The western limit is the ocean, and the eastern the Andes, called the Cordillera Real. Amongst the mountains are numerous volcanoes, such as Licancour, Lindor, S. Pedro, Ollague, etc. To the north of the river Loa lies the desert of Tarapaca, and between the Cordillera Real and the Eastern Andes is the high tableland of Bolivia. In these latitudes rain is extremely rare, many years being absolutely rainless, while snow is found only on the high points of the Cordillera, where, however, it prevents the working of the mines, called “Minas de Temporada,” during four or five months of the year. Between the Pacific and the Cordillera Real, covering an area of about 77,000 square miles, the desert of Atacama ranges up to a height of 14,000 feet in graduated terraces, surrounded and furrowed by numerous *cerros* (mountain chains), forming a sort of irregular network. In the meshes of this network we find dry and sandy plains, over which the crumbled volcanic rocks have spread a sterile felspathic dust. Many of these plains have sunk down and form inland lakes, at the bottom of which are layers of various saline deposits; they are fed by the snow of the neighbouring heights, or by rivers running from the Cordillera. Such are the lakes of Carmen, Carmen Alto, Pampa Central Salinas, Aguas Blancas, Toco, Atacama, Ascotan, etc. The lake of Ascotan—one of the curiosities of the country—is elliptical in shape, about 25 miles long, and $4\frac{1}{2}$ miles wide. The dry salt plain, which was once the bed of the lake, is dazzlingly white to the eye, and is formed in variable proportion of sodium chloride, borax, sulphate of lime and of iron salts, magnesia, and small quantities of aluminium. Among the mountains which surround it, may be distinguished the old volcano Ascotan, whose entire summit was once blown off by an eruption and the *débris* thrown to a great distance. Then Mount Azufre (sulphur), whose yellow crest betrays the presence of beds of the substance which has given it its name; and quite close to the lake, San Pedro and Ollague, which overlook this extraordinary prospect.

Metallic veins run through these intersecting *cerros*, the rocks of which are tinted every shade of red and yellow, blue and green. Now and again some soft water-springs form little oases, covered with such vegetation as can live at that height.

The desert is continued into the high tableland of the Andes, which displays the same characteristics as the region we have just described; it is, as it were, a gigantic laboratory, whence the decomposed rocks, which have been dislodged by frost and ice, are carried down partly as sediment, partly in solution, by great rivers, such as the Rio Grande de Lippez, into immense pampas, over which the saline alluvia are deposited. Such is the Pampa Salina, which lies in S. lat. 20° and 21° , covering an area of nearly 250 acres. This high land was the birthplace of the

Incas ; there, at a height of 14,000 feet, these fabulous warriors founded an empire and cities, and set forth from this gigantic fortress on their conquests in the American continent.

And, now, a few words on the historical and industrial state of Atacama. From the time when the Inca Yupanqui crossed the desert with his armies to conquer the southern regions of the Pacific, following the road which has kept his name—The Road of the Inca—and from the sixteenth century, when the Spanish generals D. Diego Almagra and Pedro Valdivia travelled over the same road with their conquering hordes to monopolise the Chilian gold mines—until the end of last century, the desert of Atacama remained unknown, except through the disasters of those who ventured to penetrate its immense solitudes. No one guessed that this dreaded region contained untold wealth, equal at least to that of the silver mines of Potosi, beneath its burning soil, in its darkest ravines, nay, even in its poisonous lakes. The discovery of the silver mines of Chanareillo by Juan Godoi, son of a poor shepherdess, was a revelation to the Chilian miners ; and suddenly an army of eager and greedy, but brave and enduring prospectors, followed by a crowd of miners and traders, started up at the foot of the desert, and then advanced to the steep terraces of the mountain side. This conquest of the mines was long and difficult, but it was heroically carried out, and bore important results.

In 1848, the silver mines of Cabeza de Vaca, Lomas-Boyas, Garin, Bandurriás, Tres Puntas, etc., were already being worked. Then were discovered the copper mines at Animas, and others in the vicinity of the ports Taltal, Paposo, and Cobre. The guano of Megillones, and afterwards the nitrate of soda found in the lakes of Carmen, Salinas, etc., gave rise to the industry of fertilizers. In 1871, the silver mines of Caracoles were opened, and the working of copper mines was largely extended.

In 1879, the occupation of the desert by the Chilian armies (during the war with Peru) gave a new impulse to the search for riches. Scientific commissions were sent there by the new government, and capital followed science, while security was brought by the Chilian domination. The lakes of borate of lime and of soda at Ascotan and Calcote, the copper mines of d'El Abra, Huantajaita Conchi, the silver mines of Sajasa, Colpa, Coypa, as well as the sulphur mines of the Cordillera, were successively discovered and worked. In many places fresh water was found, which rendered the desert habitable.

In order to foster the new industry, twelve small ports were made, one after the other, in which we find all necessaries collected, such as water condensers, provision stores, goods sheds, cattle markets, establishments of metallurgy, labour, administration, and, finally, railways and drinking-water canals. At the same time, there was formed in the desert, at each working centre, a little advanced post from which further expeditions could start.

Thus the desert of Atacama is not only accessible through twelve little ports, but it is also possible, when passing through it, to obtain, at intervals, shelter and assistance at the inland posts.

The line of railway which runs from Antofagasta to Uyuni and Oruro,

through the desert of Atacama, and which will eventually run up to the high table-land of Bolivia as far as La Paz, is certainly the most interesting example of a high-altitude railway. It provides a rapid and economical means of communication with the Pacific, and with the southern part of the Bolivian table-land, which until lately was accessible only to men hardened to the rigours and dangers of the desert. This narrow line unites a whole nation to the world, by giving it the means of utilizing for itself, and of spreading over the globe, the treasures of its soil—treasures amongst which it had hitherto lived poor and miserable. The railway was begun in 1876, and was at first a private one, its only object being to carry to Antofagasta the *caliche*, or raw nitrate, extracted from the *salars*. In 1890, after several extensions, the railway company obtained from the Bolivian Government the right to run between Uyuni and Oruro, and it is only quite recently that the concession of prolongation to La Paz, in the direction of Sucre, was obtained.

The terminus of the line is Antofagasta, a well-organised station, where English care and vigilance are easily recognised. It is a Chilian port,—Bolivia does not possess a single foot of coast line,—and is the principal outlet for Bolivian exports; indeed it may be said to live upon the trade which passes through it from that country. It is one of the worst ports on the coast; the surf is so great that it is no unusual occurrence for the boat, which conveys passengers ashore from the steamer, to capsize on the way—an unpleasant experience, as the bay abounds in sharks. Antofagasta has a population of 10,000 souls; it is certainly not a desirable place to live in, though cold is unknown, and rain never falls. There is no fresh water, the only drinking water being that condensed from the sea: but recently, the Antofagasta railway company—which is now an English company—has made works to bring water from S. Pedro, 11,500 ft. above the level of the sea. The town lies close to the sea; the houses are built of wood, and are only one story high, as is customary in most parts of Chili, on account of the frequent earthquakes. All the undertakings of the railway company are carried out with a uniform degree of excellence, and it may be interesting to note that this company has its principal seat in London, possesses capital to the amount of £1,600,000 and pays 12 per cent. to its shareholders.

TARAPACA.

Though not so interesting as Atacama, the desert of Tarapaca is nevertheless worthy of notice. This province has been Chilian since the successful campaign against Peru; it is the most important of all the mining districts of the north of Chili. By nature it is subdivided into five distinct zones. The first, the width of which is 21 miles, extends from the coast—the mountains of which are from 1300 to 6390 ft. in height—to the east, as far as the Pampas: these are sandy plains situated at a height of 3280 to 4265 ft., and are absolutely devoid of vegetation. In this zone are found the guano deposits as well as the *salares*, that is, deposits of sulphate of soda and of salt. The *salitre* or nitrate of soda, called in its rough state *caliche*, is only found there in

small quantities, and of an inferior quality. In the mountains there are mines of copper and silver; gold is found on the border of the river Loa, and nickel in the hills of Huantacaya. All the rocks of the coast are covered with guano, but it is now of little value, the rich deposits being exhausted. To the east of this is the second or nitrate zone, extending from the Rio Camarones to the desert of Atacama on the south. This zone is three miles wide, and over two hundred and fifty miles long. We will describe the nitrate deposits further on.

The third zone is formed by the great Pampa of Tamarugal, and is eighteen miles wide in the centre. The name of this province comes from a tree belonging to a species which grows there only, and which is kept alive by subterranean supplies of water. Professor Fed. Philippi says, in his account of Tarapaca:—"This province is even more desert than the desert to which it owes its name. The Pampa of Tamarugal is a plain of sand and of nitrate of soda—quite bare at the north, but towards the south we find some vegetation, the most remarkable growth being the Tamarugo (*Prosopis Tamarugo*, Ph.), the largest specimens of which are 3 ft. in circumference and 65 ft. high. Sometimes they form woods of small extent—sometimes they are found in isolated groups. It is evident that at one time this zone was very thickly wooded, as is proved by trees wholly or partly petrified; now we find only extensive deposits of borax and of sulphate of aluminium."

The fourth zone, to the east of the third, is formed by the buttresses of the Andes. The plains which are found in the various chains of mountains are sandy; it is only where streams run down periodically from the heights that a few spots are cultivated. If the inhabitants were to make canals for irrigation, this region might become an important industrial centre, as the ground is very fertile. In Pica and in Matilla an excellent wine, similar to port, is produced.

The fifth zone is formed by the Cordillera de Los Andes, and its width is 46 miles. Up to the present time these mountains have hardly been explored. This zone begins at a height of nearly 9900 ft., and extends up to a plateau whose height is on an average 13,000 ft.

In the fourth and fifth zones there is plenty of water, and in the third zone there is water close to the surface, but in the first and second zones it is scarce, and what little is found, either in wells or in streams, is brackish and not fit for use. Drinking water is brought from Arica, or distilled from the sea, and so is the water for the railway. This adds greatly to the expense of railways; the Iquique Company spent on water alone, in 1884, the sum of £112,406, 7s. 6d.

The nitrate industry of Tarapaca gives work to 10,000 workmen in the desert. They are occupied in 47 *oficinas*, or works, of which several employ from 500 to 800 men, and produce per day from 23 to 46 tons of refined nitrate.

The Chilean workman is the hardiest and the strongest in the world; he generally works from sunrise to sunset; he is most frugal, living chiefly on beans and ground wheat. He is also most hospitable to his fellow-workmen, but the simplicity of his wants make him rather independent of his employer.

Iquique is the capital of Tarapaca; the situation of this town is by no means inviting, and the bay is full of dangerous rocks, over which the surf breaks with violence, making the landing from the steamers very difficult, and it is no unusual event for the boat which takes you ashore to capsize.

At the back of Iquique are the sandhills, and if you were to inquire what is beyond these sandhills, the answer would be "more sandhills." The town possesses no buildings worth mentioning; the streets are ankle deep in sand; nothing will grow in Iquique—the ground is absolutely sterile. Drinking water is brought from a long distance in pipes, or by steamer from Arica, or it is condensed from sea water. Artificial flower-beds of earth have been made in the square of Iquique, where plants thrive most wonderfully. It is a real pleasure to walk out in the evening in the "Plaza" of Iquique and to enjoy the perfume of the flowers—the only ones in the town; though a few private houses have gardens, or so-called gardens—rather yards—in which a few tubs or cases are placed, and in which plants attain remarkable perfection.

Cattle in Iquique are reared on pressed *alfalfa*, a kind of clover, which comes in bales, mostly from the south of Chili. It is very expensive to keep a cow in Iquique, and water costs almost as much as its food. Fresh milk is a luxury, every one using condensed milk.

It is very surprising to the stranger who lands in Iquique, and who is sadly impressed by the utter desolation of the place and its want of beauty, how Europeans of refinement can live there. Yet we find numbers of English and German people, representatives of large commercial houses, settled in this great nitrate port.

CALICHE.

Much interest attaches to the second zone, where the Nitrate industry is carried on, and the importance of this industry cannot be over-estimated; the capital employed on it is considerable, and the benefit received is exceptionally great. Nitrate of soda is the most active known fertilizer, and is already abundantly exported to Europe and the United States, where it spreads a fertility in marked contrast to the sterility of its native region. Powerful works, dotted about the desert, give a remarkable proof of what can be done by energy and science; finally, this nitrate is a source of unlooked-for riches to Chili and the poor provinces of the Pacific, bringing to them population, civilisation, and prosperity. Every day sees some new development of the nitrate industry, especially in its application to agriculture, in which it plays a part almost as important as water.

Nitrate of soda in its rough state, *i.e.* the saline rock which is called in Chili *caliche*, exists in the deserts of Atacama and Tarapaca at heights of 4000 to 12,000 ft., in vast deposits of almost superficial formation, which cover the whole or parts of the beds of old dried-up lakes, situated at the foot of mountains of volcanic origin. Some layers are found in Atacama; they cover the bottom of old lakes in the zones of Cachiuygal, Cachuial, in the district of Taltal—of Aguas Blancas, Del Carmen, and of

Pampa Central in Antofagasta, and Maricunga in the province of Copiapo. Others dominate in the Desert of Tarapaca, from the ravine of Los Camarones in the north, to the river Loa in the south, including the district of Toco. For the most part these layers extend along the western edge of an old evaporated sea, filled up to the level by rivers from the Andes, and called now Pampa de Tamarugal. This vast deposit continues for 95 miles, and forms the nitrate regions of Pisagua, Iquique, and Patillos. The nitrate beds in the deserts of Atacama and Tarapaca cover an area measuring 555 miles from north to south, between the parallels of 19° and 27° S. lat. The layer of *caliche* contained in these beds has a thickness varying from 4 in. to $11\frac{1}{2}$ ft., the usual thickness being 9 in. to 3 ft.; beds of 3 to 11 ft. are exceptional. The *caliche* contains from 10 to 60 per cent. of pure nitrate of soda; in addition, we find sulphates of alumina, soda, and magnesia, common salt, and iodide of sodium, producing at the most 3 per cent. of metallic iodine.

The *caliche* has a variety of colours, white, yellow, violet, orange-blue, and various shades of grey; its structure is crystalline, and it becomes granular and sometimes porous. It has a slightly saline taste, and is soluble in water; when exposed to the air, it absorbs atmospheric moisture and dissolves. Nitrate of soda dissolves less readily when sodium chloride is present, and requires a high temperature to remain dissolved; so that volcanic eruptions having produced these solutions at a high temperature, large volumes of water, or lakes full of salt, were formed. Then, as these cooled slowly, nitrate of soda was deposited, and through natural chemical action, other salts were precipitated at the same time, particularly sodium chloride, forming *caliche* deposits. Later on, it seems that thermal springs appeared in these parts, charged with silica, which was likewise precipitated, and thence come the rounded fragments of opal, agates, chalcedony, etc., which are found in abundance on the surface, especially in the Pampa Agata at Antofagasta.

The working of the *caliche* is begun by attacking the ground at its most sterile side, and at the lowest part, when the incline permits it. Then rows of wells are made, and filled with powder to detach the soil, and the layer which forms the *caliche* is thrown back. The *caliche* itself is then carefully separated and carried to the *oficina* in carts; its further transport is usually by rail.

The deposits of nitrate were discovered in 1821, but they were not worked until ten years later. At first it was only employed in the manufacture of gunpowder, but, later on, a little more was used in chemical industries, until its usefulness in agriculture was recognised. It can be used with advantage in place of guano and artificial manures to fertilise the ground, for it contains $15\frac{1}{2}$ per cent. of nitrogen, one of the most important elements required for the nutrition of plants.

The total area of Chili is about 465,221 square miles, and more than one-third of this area is occupied by mines. But we may say that mining in Chili is still in its infancy, and that its future is immense; for this country is so rich in mines, and its local conditions are, as we have shown, so advantageous, that whatever industry may be established in time to come, will, with sufficient capital, be productive of great and important results.