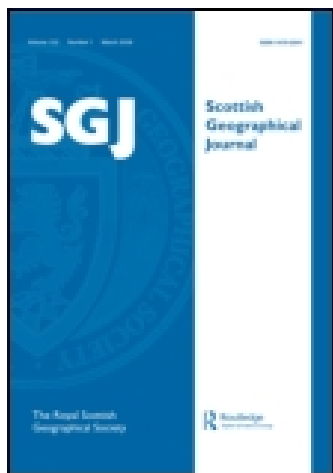


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THE GRAN CHACO.

BY J. GRAHAM KERR.

*(Read at Meetings of the Society, Edinburgh, Glasgow, and Dundee,
January 1892.)*

THE Gran Chaco is a region lying in the interior of the southern portion of South America. The origin of the name is uncertain, but the derivation most usually accepted is that given by Padre Lozano, one of the early historians of Paraguay. He points out that in the Quichua tongue the word *Chacu* means a drive of wild animals, and makes out that this name came to be applied to the Chaco from the wholesale flight of the Peruvians into its fastnesses, on the invasion of their country by Pizarro and his Spaniards. In the older writings we find the name given as "El Gran Chaco Gualamba," but in the present day only the shorter form is used. The extent of the Gran Chaco is, we may say, in the one direction between 20° and 30° S. latitude; and in the other between the Andes and Rio Salado, and the Paraguay-Paraná—in all an area of something like 180,000 square miles.

Physiographically, this region is divided into three sections by the rivers Bermejo and Pilcomayo, which cross it diagonally from the Andes to the Paraguay; and the three sections so formed are named Chaco Austral, Chaco Central, and Chaco Boreal, respectively. Politically, the division of the Chaco is again into three parts: between the republics of Argentina, Paraguay, and Bolivia. Argentina holds the Chaco Austral and the Chaco Central, which form two of her federal territories and are known officially as the "Territory of the Chaco" and the "Territory of Formosa." The Chaco Boreal is divided between Paraguay, which claims the wedge-shaped portion between the Pilcomayo and parallel 22, and Bolivia, which claims all north of this line.

The Chaco is the more northern portion of that great estuarine plain whose southern part is so well known to us as the Pampas, and which forms a large portion of the basin of the Rio de la Plata. In its physical features the Chaco agrees in many points with the Pampas; the sharp line of demarcation between them is due rather to their botanical characteristics. The Pampa is open, grassy, and treeless: the Gran Chaco, on the other hand, possesses luxuriant forests. Its surface is almost uniformly level, broken only by almost imperceptible undulations, and with a general slope of from 8 to 10 inches per mile towards the SE. The mean height above sea-level of the Chaco Central may be taken as about 450 feet.

Upon its western border, many streams pass into the Chaco from the valleys of the Andes. These wind hither and thither on the almost level plain, traversing extremely tortuous courses, and thus exposing an immense surface to evaporation. The effect of this, coupled with the extreme dryness of the climate, is to cause the volume of these streams greatly to diminish during their plain track, and it is only the very largest and

most rapid-flowing which during dry seasons manage to convey any of their waters into the Paraguay. In point of fact, besides the Salado which bounds its southern margin, we may say there are only two rivers which permanently carry water right across the Chaco. They are the two already mentioned—the Bermejo and the Pilcomayo. These pursue a roughly parallel course to the south-eastward across the Chaco plain, until at length, their further progress being barred by the edge of the Paraguayan and Entrerian uplands, they are compelled to turn sharply to the south, along with the waters of the Paraguay and Paraná.

These two rivers, the Bermejo and the Pilcomayo, have been the object of so much interest, and of so many attempts at exploration, that I may say a few words upon each of them. The cause of their having attracted so much interest may readily be apprehended by a glance at the map, for they are seen to connect the Bolivian mountain regions, with their enormous wealth of minerals, with the river Paraguay, and so with the outer world. Pursuing our chain of reasoning, still based on an inspection of the map, we might conclude that the Bermejo and the Pilcomayo, more especially the latter, are waterways destined by Nature to tap the whole trade and wealth of Bolivia, and conduct it into the market of Buenos Aires. Let us now quit the map, and look at the rivers as they are, and we shall see whether such conclusions are sound.

The more southern of the two rivers, the Bermejo, has been navigated on several occasions through the greater part of its plain track, the earliest successful attempt being that of Lieutenant Thomas Page, the well-known explorer of the Paraná and Paraguay. The successful navigation of the river led eventually to the formation of a Bermejo steamship company, of the success of which, however, it is unnecessary to say more than that the remains of its various vessels may still be observed at various points in the bed of the river. The Bermejo is in fact a wild and ungovernable torrent, on which navigation, although it may be possible in the hands of a daring and skilful explorer, will assuredly never be of economic importance.

The Rio Bermejo, or Red River, is formed by the junction of numerous small streams that drain the eastern parts of the Andes between 21° and $24^{\circ} 30'$ south latitude. Debouching into the plains of the Chaco, it pursues a tortuous course of about 1000 miles to the river Paraguay, a distance which, in a straight line, measures only about 450 miles. For considerably more than half this distance the river consists of two branches—the more northern of which, of recent formation (1871-72), now carries about four-fifths of the water, and is known as the "Teuco," from the Indian word "Teuch," meaning river. Besides carrying a much greater volume of water than the old channel of the Bermejo, the Teuco is much less tortuous, and it has therefore been usually selected by vessels ascending the river. The Rio Bermejo traverses a section of the Chaco where the slope is relatively great, and its current is extremely rapid, normally being from four to five miles an hour, and in flood-time far exceeding this rate. The most striking character of the Bermejo waters is their deep yellowish red colour, due to the immense amount of solid matter held in suspension, from which the river derives its name of

"Bermejo" or "Red." In flood-time, in fact, its waters are practically liquid mud, and it has been calculated that the Bermejo annually discharges into the Paraguay 50 million cubic feet of solid matter. The water, when filtered, is quite drinkable, and has a pleasant sweetish taste. The Bermejo has, as I before mentioned, been several times, and will, I have no doubt, be again many times navigated successfully; but I distinctly hold that it will never become a highway of commerce. The great length and tortuosity of its course, the rapidity of its current, the innumerable snags, and the ever-changing sandbanks with which its channel is sown, constitute, to my mind, practically insuperable difficulties. The lands bordering the Bermejo are, with the exception of a few agricultural and wood-cutting settlements, and the chain of forts along its right bank, entirely in the hands of the wild Indians.

The Pilcomayo traverses the Gran Chaco roughly parallel to, and about 180 miles to the north of, the Bermejo. It has hitherto been described as in every way analogous to the Pilcomayo, a statement which, from my own observations, I must venture to contradict. Setting aside the fact that they both rise in the Andes, that they cross the Chaco in a southerly-easterly direction, and that they empty their waters into the Paraguay, it would indeed be difficult to find any points of resemblance between the two rivers. The waters of the Pilcomayo are collected amongst the southern parts of the Bolivian Andes, and just before leaving the high ground they are largely augmented by an important tributary, the Pilaya. The now considerable volume of water enters the plain, and at once begins to wind about in the most erratic manner, and eventually, vastly diminished in volume, reaches the region of the Paraguay, shortly before entering into which the river receives, on its left bank, a small fresh-water affluent, called the Rio Negro. The confluence with the Paraguay is just opposite the prominent hill of Lambaré.

In geological structure the Gran Chaco resembles its southern continuation. Solid rock is but rarely seen, and when it is exposed in the river-bed, we find it to consist entirely of the soft, fine-grained Tertiary sandstones of the Pampean Age. River sections show a horizontal series of these beds topped by fine flood silt, with occasional layers of sand. The soil is, in the inner part of the Chaco, almost entirely composed of this extremely fine-grained silt, true vegetable mould being almost entirely absent, and it is evidently a product of the periodic inundations which the region undergoes. It is so exceedingly fine-grained as to be almost impermeable to water, except under the action of capillarity.

Rain-water scarcely sinks through it at all; but, during the periods of intense desiccation, capillarity causes a continuous though imperceptible upward progress of moisture to the surface, where it is evaporated, deposits the salts held in solution, and is replaced by a fresh supply from below. In this way the amount of soluble mineral matter in the upper layers of the soil goes on increasing continually, and such is, I believe, the explanation of the saltiness of the Chaco soil; and, as if bearing out this view, we find that within the forests, where evaporation is so much less potent, the soil is no longer abnormally salt.

An interesting phenomenon frequently to be seen in this region is, that the surface layer of flood deposit in the dry season exhibits the most perfect division into vertical pentagonal columns. This, again, I attribute to the extremely fine-grained character of the deposit, there being no pebbles or other obstacles to the due working of the physical laws of contraction, which consequently produce the same result as during the gradual cooling and contraction of a stream of basaltic lava.

The climate of the Gran Chaco is essentially one of great extremes. In the forest-band around its margin these extremes are tempered off to a certain extent; it is in the open central portions that they are most felt. The average rainfall at Formosa in the Central Chaco is 54 inches annually. In the more central parts of the Chaco, however, it is probably much less than this, owing to the long-continued seasons of drought. There can scarcely be said to be a true rainy season, for though, as a rule, most of the rainfall is restricted to the summer months—October to March—yet occasionally heavy rains occur at other times of the year. The rainfall over the Gran Chaco, generally, appears to be subject to a curious cycle, the length of which is approximately ten years, the periods of maxima being marked by universal inundation to a depth of several feet over enormous tracts of country. During these inundations the Chaco rivers may rise to a height of 20 feet above the normal, and continue in high flood in any case for several months, sometimes for over a year. Succeeding this period of rainfall, a period of desiccation sets in. The overflow waters contract their limits and become isolated lagoons: these in turn shrink up, and give place to marshes, and the intervening country becomes dry, and parched, and saturated with salt.

The mean temperature of the Central Chaco we may take at about 72° F., on either side of which, however, great variation takes place, so that on a summer's afternoon, with a north wind blowing, the temperature in the shade may frequently go up to 110° F., while in the depth of winter, just at sunrise, it may fall below freezing. The great fall of temperature always experienced in the early hours of the morning is the result of intense radiation taking place from the grass-covered plains towards the clear sky, and, as a natural consequence of this great fall in temperature, the nightly dews in the Chaco are extraordinarily heavy. The prevalent winds are the north and the south. The former is the hot wind; it is comparable with the Sirocco. It parches up all nature, and in animals powerfully affects the nervous system, in some cases even producing insanity. The south wind, which fortunately blows for a greater part of the year than the north, is, on the other hand, cold and refreshing; and it is to its meeting the north wind, and cooling it rapidly, that the rains of the Chaco are due.

The surface of the Chaco generally is covered with vegetation characterised by its extreme sameness and monotony. This is all the more striking when one compares it with the rich tropical luxuriance of regions in the same latitude to the eastward. One finds, as, in fact, in most extensive open plains, an absence of variety and a marked preponderance of what are called social plants.

In the typical interior parts of the Chaco far-reaching grassy expanses

are varied by patches of forest, or *monte*, composed for the most part of small and scrubby myrtaceous trees.

The open grass-lands are frequently dotted with innumerable *Carandai* fan palms (*Copernicia cerifera*, Mart.), and then we have one of the most characteristic types of Chaco scenery—that of the *palmar* or palm grove. The ground is everywhere covered with a thick growth of grass, of four or five feet high, from which arise at intervals the thick and squat stems of the *Carandai* palms. These *palmares* are quite unique in their general effect. In the early morning, when the air is crisp and clear, and not a breath of wind stirs, and the tips of the palm leaves are bathed in golden sunlight, the scene is one of fairy-like beauty. But in the depth of winter, when the grass has all been consumed by Indian fires, when the sky is covered with leaden clouds, and a biting south-east wind causes the dry and withered palm leaves to rustle mournfully, then the scene is one of bleak and inhospitable melancholy.

The Palm Forest covers immense areas throughout the Chaco, and is specially characteristic of the low-lying portions liable to inundation; and one may always see on the palm trunks a dark line some three to five feet above the ground, marking the level of flood waters.

The patches of forest in the interior of the Chaco are not at all of the kind apt to be recalled by the words "South American Forest," but are little more than thickets of small and scrubby trees, so interwoven with lianas and other climbing plants, and mingled with spiny *Bromeliaceæ* and cacti, as to be quite impassable by man or beast.

One does find an occasional large forest tree, but these are comparatively few in number. In the little *montes* one finds the *Guayacan* (*Cesalpinia melanocarpa*, Gr.), the *Quebracho colorado* (*Quebrachia Lorentzii*, Gr.), and the *Palo cruz* (*Tabebuia nodosa*, Gr.), all fine timber trees: while, in the open, one encounters several species of the genus *Prosopis*—the *Vinal* (*Prosopis ruscifolia*, Gr.), the *Algarobo* (*P. dulcis*), and the *Nandubey* (*P. nandubey*, Lor.). Of these, the *Algarobo* bears a long locust-like pod containing a large quantity of sugar, and which forms an exceedingly nourishing and staying article of food. The Indians pound the pods up, and mix them into a kind of paste with the fruit of the *Mistól* (*Zizyphus mistól*, Gr.), so as to form a very palatable kind of cake.

Other important trees occurring in the central parts of the Chaco are the *Palo santo* or Holywood (*Guayacum officinale*), so well known both as a timber and as a drug, and the *Cascarandá*, of which the heartwood forms a timber of extraordinary density, hardness, and tenacity.

I shall not detain you by mentioning any of the smaller plants of the Chaco, with the exception of two. The first of these, the *Uvirá* of the Paraguayans, is a *Bromeliaceous* plant with long narrow leaves, which, with a minimum of trouble, yield a fibre of great tenacity, especially valuable for its power of resisting the effects of moisture. At present its fibres are greatly used by the Indians, who make from it a coarse cloth for their garments, as well as twine and rope: but it yet remains to be exploited by European capitalists, when it will no doubt give rise to an important industry. The other plant is the *Caraguatá ñ*, another *Bromelia*, which, although of little value in itself, becomes an inestimable

boon to the explorers of the salt-saturated region it inhabits, for the hollow axils of its leaves store up the dew and other moisture, and preserve it cold and clear as if for the special benefit of the traveller.

I have said that the vegetation of the Chaco is poor and monotonous on the whole, but I must qualify this statement by mentioning that on the borders, where the climate is more equable and the country better drained, we find a band of luxuriant vegetation. Towards the western border this takes the form of a continuous strip of absolutely impenetrable forest; on the eastern, of rich woodland, interspersed with luxuriant pasture. It is this peripheral zone, and narrow prolongations of it along the banks of the fresh-water streams, that I believe to be the only parts of the Chaco destined to become of great economic value.

Animal life in the Chaco is varied and characteristic. The marshy regions are the haunt of the Tapir (*Tapirus Americanus*), the Great Marsh Deer (*Cariacus paludosus*), the *Carpincho* or *Capibará* (*Hydrochaeris cabybara*), the *Coypu* (*Myopotamus coypus*), and a large otter (*Lutra paranensis*). By the forest margin one encounters large troops of Peccaries (*Dicotyles labiatus* and *D. torquatus*), an occasional Great Ant-eater (*Myrmecophaga jubata*), and numerous Armadilloes; while here and there one comes across one of the large carnivora, such as the Jaguar (*Felis onca*), the Puma (*F. concolor*), or the *Aguará guazú* or Maned Wolf (*Canis jubatus*). Bird life is abundant and varied, flocks of shrill-voiced parrots fly hither and thither, woodpeckers of all sizes and varieties are heard busily at work, and by the margin of a lonely lagoon one may see the great Jabiru (*Mycteria americana*), standing motionless on one leg, as if buried in contemplation of the silence around him.

It is perhaps at night that the explorer becomes most impressed with the presence of animal life in the Chaco. If it is summer-time, the whole air is filled with the sounds of insect life—high above everything else rises the metallic hum of the mosquito, and the chirp of innumerable crickets; while this is broken in upon every now and then by the heavy hum of a large beetle, or the shrill railway-whistle of the Cicada. In winter-time, however, the nights are excessively cold; the insect world is still; and there reigns over all Nature a silence deep almost to oppressiveness, broken only at intervals by the cry of the *Nacurutú Owl* (*Bubo virginianus*), or the loud roar of the *Aguará guazú*, or the fearful and blood-curdling screams of the *Paca-d* (*Aramides ypecaha*). The intense wildness and eeriness of these night-sounds of the Chaco must be heard to be appreciated; but the wildest and most eerie of them all is the voice of its human inhabitants, when heard chanting at dead of night a war-song, or a wild lament for their dead, or a night-long incantation to drive away the evil spirits from their sick ones.

The human inhabitants of the Chaco are, considering its immense area, few and far between. The entire Indian population has been very variously estimated, and at the present time it is rapidly diminishing, owing partly to the merciless persecution which the aborigines undergo in the parts of the Chaco adjacent to the Argentine frontiers, partly to the ravages amongst them of imported diseases, and, according to many authorities, to the systematic practice of infanticide. This latter cause I

believe, however, to be non-existent. The Indians are divided into a very large number of distinct nations, distinguished by well-marked differences of language and of customs. Azara, whose statements on this point have been much called in question by D'Orbigny and other later writers, reckons them—and I believe perfectly correctly—at some seventeen, named as follows :—Chiriguano, Aquitequedichagás, Ninaquiguilás, Guanas, Mbayas, Payaguás, Guaycurús, Lenguas, Machicuis, Nimkás, Guentusés, Tobas, Pihlagás, Aguilots, Mocovís, Abiponés, and Vilelas. The most important of these at the present time are the Chiriguano, a branch of the Guaranis, a peaceful agricultural race who inhabit the north-west frontiers of the Chaco, and the warlike Mocovís and Tobas, the latter of whom hold possession of the lower parts of the Pilcomayo and Bermejo and the region lying between, and the former a large stretch of country to the south of the Bermejo. It is these last, the Tobas and the Mocovís, who suffer most from the frontier warfare. They are brave and patriotic, and they are therefore shot down on every opportunity.

In manner of life the various nations differ much from one another. Some, such as the Chiriguano, follow agriculture, form fixed settlements, and are quiet and docile in disposition. Others, such as the Nimká, adopt a mixture of agriculture and hunting; while others again, more especially the Tobas, live entirely by the chase, and are, as a natural consequence, absolutely nomadic in their habits. It was with the Tobas of the Pilcomayo, who had never before seen a white man, that I had most experience, and I shall therefore say a few more words regarding them.

The Tobas of the Pilcomayo inhabit both banks of that river from about $24^{\circ} 40'$ south latitude, and also the country to the south-west over a considerable area. Their neighbours are : to the eastward, the Machicui; to the north, the Nimká; to the north-west, the small nation of Pihlagá; and to the west and south-west, tribes of their own nation. With the Nimká a constant and inveterate warfare is carried on, in which the Tobas are allied with the Pihlagá; and with the Machicui and the other Toba tribes matters are very similar, although the warfare is less constant. Indian warfare in the Chaco is for the most part a desultory guerilla, and it is only rarely that large bodies of men meet in open battle.

The Tobas are divided up into a large number of small tribes, varying in size from ten up to a couple of hundred able-bodied men. Each tribe is under a chief, who, however, possesses little authority, and who plays a prominent *rôle* only in time of battle. Under normal conditions the various tribes are split up into small hunting parties, who traverse the country in all directions in search of food, and who, on the appearance of an enemy, can be collected together in a very short time by means of special signals, made by the smoke of large camp-fires.

Such an itinerant hunting party of Indians, when on the march, forms a very picturesque spectacle. First come the able-bodied men, in single file. They are tall and magnificently proportioned, their skins of a deep coppery red colour. The only clothing they wear is a strip of

coarse cloth, tied round the waist like a kilt. Their long, glossy black hair hangs free over their shoulders, and contrasts with the waving white ostrich plumes with which it is decorated, and their faces are painted bright red. In his left hand each carries his bow and arrows. At the head of the procession there is usually some old and experienced pathfinder, and after him comes the chief. The rear is brought up by the women and children. The men, as we have seen, are unburdened, save by their bow and arrows. The women, on the other hand, are bent low under enormous burdens, for, on their shoulders, they support all the domestic properties of themselves and their husbands. Their dress resembles that of the men, except that they do not wear feathers in their hair, and their faces, instead of being painted red, are tattooed with a diamond-shaped pattern of dark blue lines.

On a halt being made, under the shade of a spreading *Algarobo* tree, the men recline on the grass, while the women hasten off to collect water from the *Karaguatá* plants, and to extract palm-cores for their lords' refreshment.

At night an encampment is made usually by the edge of a thick *monte*, which would afford a retreat in the event of a surprise. There are no huts or tents, and the Indians merely spread out their garments on the ground, and sleep without any covering, or at most sheltered merely by a mat strung up between two sticks.

Living such a life as the Tobas do, constantly liable to attack from enemies and wild beasts, their sensory powers are developed to a state of high perfection, their sight and hearing being remarkably keen: their higher intellectual powers, on the other hand, are but little developed. As regards the mathematical faculty, for example, it is rare to find an Indian able to count higher than six. Their *morale* is, on the other hand, remarkably high. They are exceedingly honest, faithful, generous, and brave; but it must be remarked that their entire moral code relates exclusively to dealings with their friends, and they do not consider any action can be wicked if directed against an enemy.

Having given a brief sketch of the Gran Chaco in its main physical aspects, I proceed now to say something of the history of Chaco exploration. It is a sad record in many respects, showing an enormous expenditure of human life, with but very slight resulting gain to our knowledge. Exploration in southern South America may be said to have commenced in 1506, when Juan de Solis discovered the estuary of the La Plata, which was for some time afterwards known by his name. Twenty years later Sebastian Cabot again entered its waters. On its banks he found Indians with a profusion of silver ornaments, and from this he christened the estuary in which he was the *Rio de la Plata*—"the River of Silver." At its upper end he found the mouths of two distinct rivers, and the western of these he followed as far as the mouth of the Bermejo. Cabot was thus the discoverer of the Paraná and Paraguay Rivers, and, we may say, of the Chaco. He planted settlements on the Rio de la Plata, and also on the Paraguay River, and colonisation at once began. In 1537, Juan de Ayolas navigated the river Paraguay to latitude 20° 40', and was told by the Guarani Indians that there existed to the westward a

nation possessing great stores of silver. He thereupon resolved to march across in search of them. He penetrated far into the Chaco, and on his return, whilst traversing a marsh, was fallen upon by the Payaguás, and massacred, with all his men. Almost immediately after the tragic end of Ayolas, Alvarez Nuñez de Vera Cabeza de Vaca was appointed Governor of La Plata, and he, in a military expedition against the Guaycurús (1542), may be said to have inaugurated that policy of Indian extermination which is carried on to the present day.

Twelve years later we find the Chaco attacked from its north-west side, when the Viceroy of Peru despatched one of his officers, Andreas Manso, at the head of an expedition to attempt the conquest of the Chaco. He, however, merely managed to cross the Pilcomayo into the Chaco Central, and was surprised during the night by the Chiriguano, losing his life with those of all his followers. Hence this central part of the Chaco received the name of Llanos de Manso. During the following century (the seventeenth) there is little to chronicle, save that the Jesuits, from their headquarters in Paraguay, sent numerous missionaries into the Chaco, whose efforts towards the permanent conversion of the Indians were quite fruitless, and many of whom lost their lives in the attempt. This and the eighteenth century were also characterised by several military attempts at Chaco exploration and subjugation, mostly at the instance of successive Governors of Tucuman, such as Angelo Peredo (1670), Urizar (1710), Espinosa (1759), Matorras (1774), and Arias (1780). These, however, I pass over without further comment, and I shall now restrict myself, from time considerations, to the exploration of the river Pilcomayo. We again find the Jesuits first in the field.

In 1721 Padre Patiño succeeded in penetrating a long way up the river, but was compelled ultimately to beat a rapid retreat by an attack from the Toba Indians, in which he lost several of his men. Twenty years later Padre Castaños made a somewhat similar journey up the Pilcomayo, and with similar result. And in 1785 Don Felix de Azara, the celebrated traveller and naturalist, ascended the river for a short distance.

The expeditions of the present century have been numerous, and I shall mention only the more important. Four of these started from Bolivia, and attempted to descend the river. Those of Magariños and v. Nivel (1843-44) were forced to return owing to the immense numbers of hostile Indians who menaced them on all sides. That of Crevaux, the celebrated botanist and traveller, has an especially sad interest attached to it. He started from Tarija in Bolivia early in February 1882, with only fourteen companions. They encountered large numbers of Indians during the early days of their journey, who appeared exceedingly friendly, and so inspired Crevaux's confidence that, it is said, he removed the strikers from the locks of his men's rifles to prevent them from alarming the Indians by firing. All went well until the afternoon of April 27th, when, as they were marching along in single file, a large number of Indians sprang on them from an ambuscade, and clubbed them to death, only one of their number, a boy, surviving to tell the tale. The last of the Bolivian expeditions was that of 1883. This consisted of nearly 200

well-armed men, and was accompanied by Dr. Thouar, a French explorer. It marched down more or less parallel to the Pilcomayo, and reached the river Paraguay after undergoing great privations, and a severe battle with 800 Indians.

The later expeditions of the river Pilcomayo have been those of Thouar, of Fontana, of Feilberg, and of Storm. The three latter have been all by steamer, and they have each succeeded in penetrating for a greater or less distance up the river, being eventually brought to a halt by want of water. I shall not dwell on them further, except to say that the last mentioned, that under Mr. Olaf Storm, has been the most fruitful in results. It entered the Pilcomayo on January 1st of 1890, and left it in the autumn of the same year.

I now come to the expedition which I accompanied, that of Captain John Page. Captain Page had been appointed to the command of the Pilcomayo-Bermejo river squadron by the Argentine Government; and one of the first works with which he was charged was the exploration of the river Pilcomayo. He left Buenos Aires on January 1, 1889, having under his command a flotilla of four vessels. Two of these, the *General Paz* and the *Caa Guazú*, were large stern-wheelers designed for patrol duty; a small screw-steamer, the *Perseverancia*, was furnished with powerful centrifugal pump, winches, and other apparatus for the removal of obstructions to navigation; while the fourth vessel, the *Bolivia*, was that destined for the actual work of exploration. The *Bolivia*, built in Paisley, had been constructed throughout with regard to the work that lay before her. Although nearly 80 feet in length, she drew only 18 inches of water; and her shallow, flat-bottomed hull was subdivided into numerous compartments so as to make her practically unsinkable. Accommodation for those on board was found in large deck-houses, which culminated in a tall wheel-house from which a clear view could be had all around, and on the summit of which was mounted a Maxim machine-gun. As the Indians of the Pilcomayo bore the most unamiable and bloodthirsty reputation, the *Bolivia* further carried a heavy armament of Winchester repeating rifles.

The expedition started, then, from Buenos Aires on New Year's Day of 1890. The first few weeks were spent on the voyage up the river Paraná, a muddy, rapidly-flowing stream, on an average from 2 to 3 miles wide. It is dotted with innumerable islands, low-lying and marshy, and reeking with malaria; and the absence of objects of interest, together with the myriads of mosquitoes, made this portion of the voyage very tedious. At length we arrived at Barranqueras (or Puerto Juarez Celman), on the Chaco bank, opposite Corrientes, where a pause was made to complete final preparations—time which I occupied in making various short incursions into the Chaco in its neighbourhood, sometimes by land, sometimes along the winding Rios Negro and Tragadero, which here enter the Paraná.

All arrangements being completed, we took on board the vessels our military detachment, consisting of fifty men of the 6th and 9th Regiments of Cavalry, under the command of Lieutenant-Colonel Racedo. Our bows were now turned northwards, and we entered the river Paraguay.

Leaving behind the immense expanse of the Paraná, and entering the narrower Paraguay River, one is at once struck by a curious distinction in the waters of the latter. Those on the western or Chaco side of the river are intensely muddy, and of a reddish yellow colour; those on the eastern or Paraguayan side are, on the other hand, dark coloured and clear. The explanation of this curious difference is soon found, for shortly after passing the Argentine village of Nuevo Timbó (Puerto Bermejo), we see a muddy torrent pouring into the river from the Chaco side, the waters of the Río Bermejo. The engines are put to "full speed ahead," and we slowly forge our way through the entrance of the Bermejo, up which we are to make a trip for the sake of thoroughly testing the soundness and handiness of our steamer.

The entrance past, we find ourselves in an extremely tortuous stream some 120 yards broad, with its red waters rushing along at a rate of about six miles an hour. The banks are at first low, flat, and muddy, backed by a dense growth of the poplar-like composite tree known to the Argentines as *Palo boba*. For about 15 miles they remain so, clad with the vegetation characteristic of lands liable to inundation. The banks then increase in height. They are quite precipitous, and are crowned with luxuriant forest consisting of *Urunday* (*Astronium juglandifolium*, Gr.), *Lapacho* (*Tabebuia Avellanæ*), and many other fine timber trees. Progress up-river is slow, owing to the terrific current, and on the morning of the 4th we pass Ñacurutú Island about 72 miles from the mouth ($26^{\circ} 26' \text{ S.} : 59^{\circ} 41' \text{ W.}$), and a little later arrive at our present destination "Puerto Expedicion," one of the line of forts along the banks of the Bermejo, which at present form the advanced line of defence against the Indians. A short halt here, and then the *Bolivia's* bows are put down-stream. Owing to the rapidity of the current, and the extreme tortuosity of the river, it is necessary to have as much command over the vessel as possible. This involves keeping our engines going full speed, and so we shoot down the river at the rate of nearly 20 miles an hour, occasionally grazing the bank by a few inches; and in six hours we are again on the Paraguay.

The Paraguay River, in this lower portion between the Pilcomayo and Bermejo, is very picturesque. Its waters are bounded on the western side by the dark, almost continuous forest of the Chaco, on the eastern by rich, open pastures alternating with patches of woodland, and here and there one of the characteristic Paraguayan villages of charming little cottages with low red-tiled roofs, often nestling in a grove of banana or orange trees, affording an intense relief to the eye so long accustomed to the monotonous architecture of Argentina.

On the afternoon of March 12th the *Bolivia* steamed into a quiet-looking creek on the western side of the river—the mouth of the Pilcomayo. We had seen this river marked on the maps as rivalling the Paraguay in point of size; we had read in the works of Argentine authors of its "copiosas ondas" rolling majestically along between its distant banks;—what, then, were our feelings on finding ourselves on an insignificant stream only some 60 yards in width, and with almost an imperceptible current. And small as was the river, yet the observant

eye might detect that it was far above its normal level. Intense tortuosity was its chief characteristic, far exceeding that of the Bermejo. Geologically speaking, and comparing it with the Bermejo, we may say that the Pilcomayo is a dead river. The Bermejo is continually hard at work as a geological agent. Its torrential waters cut and carve at its banks. At every bend the outer bank shows how it is constantly undermining and carrying away immense quantities of material; while the turbidity of its waters betokens the enormous quantities of solid matter which it transports to the Paraguay. Very different is the Pilcomayo. Its current is normally almost *nil*. Its waters are clear. Its banks are steep, but entirely covered with vegetation. The bare escarpments characteristic of erosion are here entirely wanting. The Pilcomayo, as a geological agent, has practically ceased to act.

For a week the *Bolivia* steamed along this winding creek. The high banks were crowned with luxuriant forest. Each morning a stoppage of an hour or two was made, and all hands put ashore to cut fuel. By ten o'clock or so a sufficiency of wood would be on board, the vessel would get under weigh and continue steaming till sunset. In this way the *Bolivia* made rapid progress; and on March 21st the expedition reached "Las Juntas," the meeting point of the two supposed branches of the Pilcomayo. Here, however, a serious blunder was committed, and the *Bolivia* entered the northern branch instead of the southern, which bore many signs of being the main channel. Almost immediately great difficulties beset our further progress: the river was now only about 20 yards wide, large trees sent their branches across, almost meeting those of the opposite bank, while the channel itself was sown with submerged tree-trunks. The axe and the differential hauling-gear had to be kept constantly at work removing these obstructions, and so our progress was of the slowest. But now a more formidable difficulty made itself apparent, for it became evident to every one that the amount of water coming down the river was rapidly diminishing in quantity. The water had up till this time been fresh and drinkable, but it now became salt and bitter in proportion as it diminished in volume. On the 1st of April, all the soldiers except six were put ashore in order to lighten the vessel, and with instructions to construct a stockade fort (Fortin Nueve).

The resulting diminution of the *Bolivia's* draught enabled her to make a little further progress, but still the water kept diminishing, and the *Bolivia* was brought to a full-stop. Captain Page now resolved on a rather novel method of enabling us to proceed in our progress along this majestic river. A stout embankment of earth, backed by palm-trunks and brushwood, was constructed with great labour right across the channel of the river. In a few days' time the level of the water had risen a couple of feet, and the *Bolivia* was able to steam triumphantly on her way. This operation was repeated in all seven times, and by its aid we achieved a distance of about 18 miles as the crow flies. Other difficulties now began to beset us. Our military escort had rejoined us on May 11th. They were at once set to work to construct a new fort which was named "Fortin Donovan" (lat. $24^{\circ} 52'$ S., long. $58^{\circ} 40'$ W.). We steamed on, leaving the soldiers to finish their labours, and

with instructions to be with the *Bolivia* again by a certain date. However, they did not turn up. Midshipman Page and a couple of men were sent down in the canoe to see how matters were getting on, and they found that the entire escort, including their officers, had vanished utterly. Supplies of provisions were by this time beginning to run low, and some opined that this might have something to do with the sudden departure of our gallant "escort."

As time went on the stores rapidly ran lower and lower, and rations had to be reduced all round. Various signs began to appear which betokened the presence of Indians hovering around the neighbourhood, and our armed watches were doubled, all of us taking the duty by turns. By June 14th lat. $24^{\circ} 47'$ was reached. Provisions were now running very low indeed, while the country all around consisted of palm forests, dry and parched, and saturated with salt, and so contained but little game. Captain Page now perceived the urgent necessity of at once despatching a commission down-stream to hurry up the relief-supplies which were said to be on their way to us. The construction of a canoe was set about, and on June 27th Leon Zorilla, Page's second, set off with a couple of men. Shortly after this Captain Page himself became seriously ill through the hardships and worry, and on July 30th he also left us in the sole remaining canoe, in the hope of being able to reach the outer world and recruit his strength. This, however, he was not destined to do, and, as we afterwards heard, he died on the river's bank fifteen days after leaving the *Bolivia*.

There was now but a little party left with the *Bolivia*, numbering ten all told, and utterly unfit in their then condition to offer serious resistance against an attack by the Indians. We knew that there were Indians all round us, but up till now we had received no indication of their presence close at hand. On the second morning after Page left, however, we discovered in the mud within twenty yards of the ship numerous foot-prints, with the wide-spreading toes characteristic of the savage. A number of axes and other carpenter's tools were also missing, and we knew that we had had a visit from the Indians during the night.

We had, as usual, been keeping an armed watch all night, but had heard or seen nothing to excite our suspicions. With this demonstration of the presence of the enemy we were compelled to redouble our vigilance, and to remain close by our ship. The provisions on board were now almost expended, and we lived almost entirely off our guns—very precariously, owing to the scarcity of game. Fortunately we killed an occasional deer, and this helped to keep body and soul together. One of our chief hardships was the want of fresh water. The soil was saturated with salt, and wells dug in it gave only undrinkable brine. At length, by making a well on the site of a dried-up marsh, we managed to obtain a little water—muddy but sweet; and when this ran out we had resort to the *Karaguatá* plants, of which there were fortunately a few in our neighbourhood. The men, however, became thinner and weaker every day. Dr. Vignoli, whose system had been weakened by a severe attack of malaria, and by subsequent hardships, gradually sank, and on September 8th he died. His comrades buried him by the margin

of the forest, and some of them wondered whose turn would come next. The whole party sank into a condition of gloomy apathy after this; but on the 18th of the month they were thoroughly roused up by the sudden appearance, as if from space, of twelve Indians close by the ship. Fully armed and in full paint and feathers, they made signs of friendship, which, after hastily snatching up our rifles, we replied to, and bade them advance. Two or three of us stepped ashore to meet them, and after a confab, carried on by signs and a few words of Guaraní, and greatly facilitated by the peace-pipe which we handed round, they left us apparently good friends. They stayed in our neighbourhood a couple of days, and brought us most welcome proofs of their friendship in the shape of an abundant supply of game, and then went off, saying they would return again another moon and bring with them many of their "little brothers."

The next event in our existence occurred on the morning of October 4th, when our ears were startled by a strange sound, which, so incredible did it seem, it took us a second or two to recognise as a distant bugle-call. A few minutes later the jingling of accoutrements was heard, and there rode up an officer and a long file of troopers in the familiar red cap of the Argentine cavalry; and we knew that we were rescued.

Our rescuers told us how they had reached us after a month's marching; of our leader's tragic end; how another expedition of thirty men had been despatched to relieve us three months before, and had not since been heard of; and also they brought us news of the outer world from which we had been cut off for so long a time.

The expedition, as an expedition, was thus at an end, and I will not occupy your time with telling you of the five months spent in the hope of a rise occurring in the waters of the river; how their tedium was relieved by many enjoyable experiences and stirring adventures amongst the Toba Indians; and how finally, in March 1891, I left the *Bolivia* and made my way across to Paraguay on muleback.

Thus the Page expedition, like so many of its predecessors, ended only in disaster. Its purely geographical results were comparatively small. It demonstrated, however, that the Pilcomayo is of no value as a waterway; it showed that, of the two branches that unite at Las Juntas, the southern is the more important, and that the northern branch is normally only a surface-drain, which receives water from, and communicates with, the main channel at its upper end only in time of flood. We are also forced to conclude that in a normally dry season the large volume of water coming down from the Andes *via* the Pilcomayo undergoes a continual decrease from evaporation during its journey across the Chaco, until at length, in about 24° 40' S. latitude, it has become almost *nil* in quantity, and at the same time extremely salt and bitter; and that finally, as it passes through the comparatively well-watered and better-drained region bordering the Paraguay, its waters again undergo an augmentation in volume, while their saltiness is diminished.

And now it only remains for me to say a word or two in conclusion: and first regarding the future of the Chaco. Most writers on the Gran

Chaco, basing their statements on a knowledge of only its peripheral portions, have sung its praises in unmeasured terms, and proclaimed it to be the "El Dorado" of the Argentine Republic. This judgment, confined to the zone bordering the fresh-water rivers is, I believe, perfectly just: we have there a beautiful climate, a magnificent deep alluvial soil, good drainage, and facility of access. Magnificent forests of most valuable timber alternate with pastures of the richest quality. This zone is pre-eminently fitted for colonisation. But the interior, and by far the larger part, of the Chaco is totally different. The usual utter absence of fresh water and the poorness of the soil and of the pastures make the country unfit for the agriculturist or the stock-raiser, while timber is comparatively scarce. Probably the Holywood and the *Cascarañá*, as timbers, and the *Úvira* as a textile plant, will be found almost the only productions of value in the interior of the Chaco.

Lastly, as to communication with Bolivia. Navigation of the Bermejo and Pilcomayo is, as I have shown, out of the question. A railway has been proposed along the banks of the Pilcomayo, but this would be prevented by the large expanse of country liable to inundation. There are, I believe, only two feasible projects of opening up communication with Bolivia through the Chaco: the first of these is by a railway along the northern margin of the Chaco, where the ground becomes higher and less liable to flooding, and the second is by the diversion of the waters of the Pilcomayo into a straight canal running roughly parallel to its course. Whether either of these will ever be carried out remains to be seen.

THE PRINCIPLES OF GEOGRAPHY.

BY HUGH ROBERT MILL, D.Sc.

(*Abstract of a Paper read at the Anniversary Meeting, Dundee Branch, R.S.G.S., November 1891.*)

IN connection with the recent new departures of the Education Scheme of the Royal Scottish Geographical Society, and having regard to the general recognition in England—though not in Scotland—of geography as a subject worthy of study in universities, it is appropriate to explain what modern geographers understand by the Science of Geography. It is no exaggeration to say that, when the idea of Geographical Chairs in our Universities was first mooted, many men, well-informed and eminent in science and literature, supposed, and some stated in modified words, that a Professor of Geography would be required to discourse solely on the countries of the World, the provinces, counties, parishes, cities, towns, villages, and hamlets thereof, together with the rivers, mountains, railways, canals, roads, and footpaths pertaining thereunto.

Readers of the *Scottish Geographical Magazine* well know that this is in no sense the conception of geography which now prevails. Geography