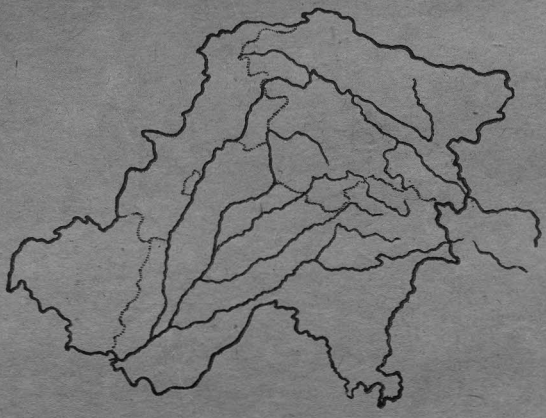
THE PANJAB GEOGRAPHICAL REVIEW



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CONTENTS

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EDITORIAL

"NOT as men plan, nor as women pray, do things happen." We first appeared in March 1942, but did not live up to our expectations. The difficulties created by the war and the unavoidable delay in organising the Post-Gradua'e Geography department of the University could not get us a chart and compass through these four years of heavy seas. The war made people geographically minded; at last we found our bearings.

The post-graduate department was inaugurated in October, 1944 with Miss C. L. H. Geary and Messrs. A. N. Kapur, Abdul Haye and E. T. Dean from local colleges as lecturers participating in University teaching. Dr. Kazi S. Ahmad was later appointed as Head of the Geography Department and Mr. Om Parkash Bhardwaj as Demonstrator, and it was not till March, 1945 that the classes were in full swing. In October, 1945 Messrs. O. N. Kapur and M. P. Thakore joined the team. The enrolment about 35 in each class has been very encouraging. Soon after the reorganization of the Department a number of students from the second batch were put on investigating geographical problems connected with our province and we hope to have a larger contribution from the students in subsequent issues.

Up till now we have hardly seen the end of the preparatory or empirical stage. There are still major geographical problems to be solved. The Punjab Geographical Review is intended to introduce to the public and to the students of Geography the wider implications of geography—man's relation to the surface of the earth, soil, air and weather, plants, animals and minerals involving also his home, his clothes, his food, his customs, and his work.

E. T. DEAN

PHYSIOGRAPHY OF THE PUNJAB PLAIN

By Kazi S. Ahmad, Ph.D., Department of Geography, University of the Panjab

General Physical Conditions

South of the Himalayan and the Salt Range lies the great plain of the Punjab which constitutes by far the larger and more important portion of the province. It presents a vast extent of level country from the Jumna on the east to the Suleiman on the west. The only break in the monotony of this level plain, if we exclude the outlying spurs of the Aravallis in the south-east and the Kirana Hills in the centre, are the widely-eroded sandy channels of the rivers and the high banks which confine them, together with a number of petty ridges of wind-blown sand and the mounds which represent the accumulated debris of ancient village sites.

As there is no ridge of high ground, a very trifling change of level might cause the affluents of one river to flow into another. In no part of the Indo-Gangetic plain have more important changes taken place in the course of rivers than in the neighbourhood of the divide between the Jumna and the Sutlej.

From the condition of the great rivers, it is at once apparent that the plain has been and is being formed by the deposits of the rivers which flow over it. The configuration of the plain corresponds to the mode of formation as suggested by the cross-section at the rivers. All the streams, big or small, issue from their more or less steep and confined channels in the hills variously charged with detritus in time of flood. As they can immediately expand in the open country, their carrying power is rapidly reduced and much of the heavier and coarser detritus becomes deposited at the edge of the plains, only the finer sediments being carried to a distance. In this way, a surface is formed having on top a considerable slope (more than 50 ft. in a mile), which diminishes rapidly at first and then very gradually towards the final point of discharge. This is in general the form of the Panjab Plain away from the Himalayan region.

"From the foot of the hills the plain country slopes southwards till it approaches the southern border of the province, when it begins to rise again towards the Peninsular area. From the watershed of the Jumna the slope is uniformly westwards towards the Indus basin, broken locally by successive steps which part the catchment basins of the Panjab rivers, and which, often almost imperceptible to the naked eye, always lie close to the right bank of the channel." The combined result of these two slopes is a fall in a south-westerly direction at right angles to the mountain ranges and parallel with the general course of the rivers; but the fall is

exceedingly gentle, seldom exceeding two or three feet in a mile. The fall is, however, more rapid than in the Gangetic Valley. Owing probably to the greater fall in the Panjab rivers the deposits are very sandy and their character tends to diminish the fluvial denudation of the surface by allowing water to sink into the soil.

The whole of the plain consists of alluvium of great thickness. There are no stones save at the immediate foot of the hills, and the only mineral is nodular accretions of limestone which are produced in *situ*. Overlying the aluvium, wind-blown sand, mainly in the form of sand-dunes, covers a large area of the plain in the west. The high banks of the rivers are also frequently capped by hills of wind-blown sand, known as *Bhur*. "The action of winds upon sand of the river the formation of Bhurland and the elevation of the ground in the neighbourhood of the river banks above the intervening tract through the deposit of blown sand are exhibited in Panjab to a greater extent than in the Gangetic Plain."

Structurally the Punjab Plain consists of two distinct troughs—part of the Gangetic trough in the east and the Indus trough in the west. The former is traceable close to Ferozepore and Lahore and appears to terminate near the Salt Range, while the latter runs along the foot of the hill ranges of the western frontiers of India.

The Punjab Plain, from the point of view of both physical and cultural landscape, may be divided into four parts: (*i*) the Himalayan sub-montane districts, (*ii*) The Sutlej-Jumna divide or The Ghaggar Plain, (*iii*) The Sutlej and Jhelum-Chenab interriverain lands or doabs, (*iv*) The Thal-Derajat Sandy Desert.

(i) The Northern Himalayan sub-montane regions

This area includes the districts of Ambala, Hoshiarpur, Gurdaspur, Sialkot and Gujrat.

The outer margin of the Siwaliks is fringed by a band of gravelly deposits forming the Bhabar. It consists of the gravels deposited by streams which drain the hills. Its coarse deposits absorb water copiously by percolation. As much of it as does not penetrate to the deep water-bearing strata finds its way to the surface again along the outer edge of the gravel beds, where also an abrupt change of slope occurs. In this way is formed the second peculiarly swampy ground known as the *Terai*. Although the gravel zone is of course found everywhere, the Terai is not distinctly represented west of the Jumna and is practically absent west of the Ravi. This corresponds to decreasing rainfall, but even fifty years ago it was recognised that deforestation, much more extensive and complete, here than to the east, was an important contributing factor.

Further south, there is a strip of undulating country, broken at short intervals by the beds of hill torrents called *chos*, which form the most characteristic feature in the physical aspect of the country. The *chos* pour down into the plain in the rains at almost every mile. A *cho* generally rises in the hills below the watershed and widens on its way to the plains until it breaks up into a number of branches. Without exception the *cho* beds in the plains are broad rivers of sand with a very slight fall. Banks are often non-existent or, at the best, composed of unstable sand liable to be washed away by

any flood. The mranches of adjacent *chos* frequently unite, forming a network of sandy beds. This net-work becomes gradually less marked and the beds narrow down and finally die out at distances from fifteen to twenty miles, as the crow flies from the hills. The wind helps to spread the *chos* sand far and wide doing great damage to the soil. South of the strip overlain by *chos* sand the land is very rich and fertile. The rainfall is ample, (30 to 40 inches) and the water-table being high, wells are easily sunk.

(ii) The Eastern or Ghaggar Plain or the Sutlej-Jumna Divide

Between the Sutlej and the Jumna, the Panjab plain forms an important area of inland drainage. Excluding the sub-montane district of Ambala, it embraces the districts of Karnal, Rohtak, Gurgaon, Hissar, Ferozepore and Ludhiana, and the large central area of Patiala State. In Ambala the divide is about 75 miles wide, but as the Sutlej takes a course north of west up to its confluence with the Beas near Sobraon, the area in question widens rapidly so that on a parallel through Delhi the Jumna and Sutlej are 230 miles apart. The banks of the Jumna actually form the summit level of this plain, which slopes southwards and westwards. In the extreme south-east in Gurgaon there is a reversal in the direction of the drainage, where the ground slopes north-east from the Aravallis. The Ghaggar, the Saraswati and the Markanda are the chief rivers. The Saraswati is a tributary of Ghaggar. The Markanda and the Ghaggar and many other minor streams lose their water by evaporation or seepage before reaching the southern boundary of the Punjab and entirely disappear in the desert of Bikaner. The whole work done by these rivers is expanded within the area. None of the detritus from the Siwaliks is carried beyond this area. All the southern part of this area where the final evaporation takes place is extensively impregnated with saline matter, so that good drinking water is scarce. At Bhiwani, south of Hissar, ground water has been found to be brackish to a depth of 400 ft.

In the extreme south-east, the streams from the Aravallis have broad sandy beds. They contain water for only a few hours after heavy rain, except where it is artificially retained by embankments. Practically none of them reaches the Jumna, for their drainage is absorbed or flood the low country in Gurgaon, but they serve to raise the water level in their vicinity, and so permit the considerable amount of cultivation that is carried on by means of well irrigation.

This eastern plain may be roughly sub-divided into three separate regions: (*a*) A fertile strip which runs along the eastern boundary of the province, parallel with the Jumna River. It has an average breadth of about 35 to 40 miles, and includes the low riverain tract along the Jumna itself, where well irrigation is easy. It enjoys a fair average (about 22″) rainfall. The Saraswati and its tributaries inundate a considerable area, and much of it is watered by the Agra and Western Jumna Canals. It is therefore for the most part well protected against famine. (*b*) Along the southern border of the plain lie the Hariana and Bhattiana tracts, which constitute the most infertile portions of the eastern plain. A large part of it skirts the great Rajputana desert; the soil is often

inferior; the rainfall always scanty and precarious; while, except in the south-eastern corner where alone wells can be profitably worked, irrigation is almost absent, save where the Jumna Canal enters Hissar. A certain area is also inundated by the precarious floods of the lower Ghaggar. (*c*) The remaining central portion includes the larger part of the great Sikh State, Patiala, and portions of Ludhiana and Ferozepore. It occupies an intermediate position in respect of fertility between the two preceding tracts, the rainfall generally being highest and the soil best in the east, west and north, in the direction of the Jumna, the Sutlej and the hills, and lowest and worst in the centre and the south. To the north-east the Ghaggar system of hill streams inundates a certain area and well irrigation is practised along the Sutlej and the northern border. Recently the opening of the Sutlej Valley Canals has greatly benefited the western border of the districts of Ludhiana and Ferozepore.

(iii) The Central Plain or Sutlej-Jhelum Doabs

The Central Plain of the Panjab, lying between the Sutlej and the Jhelum rivers, is divided into four Doabs; (*a*) Bist Jullundur Doab, between the Beas and the Sutlej, comprising Jullundur and Hoshiarpur districts; (*b*) Bari Doab, between the Beas and the Ravi, comprising the major portion of Gurdaspur, and the district of Amritsar, Lahore, Montgomery and Multan. It is divided longitudinally into two portions by a high bank marking the course of the old bed of the Beas; (*c*) Rechna Doab, lying between the Ravi and the Chenab, comprising the Sialkot, Sheikhupura, Gujranwala and Lyallpur Districts and parts of Gurdaspur, Jhang, Montgomery and Multan; and (*d*) Jech (or Chaj) Doab, lying between the Jhelum and Chenab and comprising Gujrat and parts of the Shahpur and Jhang districts.

The greater doabs have certain generally similar features. In each, the level gradually and almost imperceptibly rises from the river towards the centre of the tract, and then falls again to the level of the next river. The slight rise in elevation causes a series of important differences of soil.

Each river has carved out for itself a wide valley, whose banks mark the extreme limit of the river course on either side. Within this valley the stream meanders in a narrow but ill-defined and ever-shifting channel. "Every Punjab river-bed is a considerable strip of country—a stretch of land partly occupied by sand and alluvial mud, with channels here and there, some dry, some with water in them; while the "deep stream" runs somewhere in the midst or at one side of the area.

Valleys (sometimes 100 feet deep) trenched in the former deposits, are characteristic features of the central plain. They must be in part a result of rejuvenation consequent on slight uplift, but there can be little doubt that deforestation in the hills has greatly increased the seasonal erosive power of the rivers. The summer flood rises much more rapidly and reaches a greater height than under natural conditions, and at the same time the load of the debris derived from the erosion of bare, baked hillsides by the monsoon rains is usually greater.

A moist area accompanies the actual bed of the river and may be divided into two strips. There is, first, the area actually flooded and subject to soil erosion and to change in the course of the river. This is known locally as *Sailaba* or *Kachchi*. Beyond this flooded area the land is still comparatively low in level, moistened by percolation, so that wells, often more or less holes in the ground, can be dug and water can be found at the depth of only a few feet. This variously called the *Dhaya, Khadir*; it is easily cultivated but does not give the best results. Beyond that, the land rises and the country becomes more healthy. Wells are still sunk but their depth increases away from the rivers. Generally a masonry lining is required. Expenses of cultivation become much greater. This higher tract is called *Bangar* or the *Manjha*. Beyond this the ground level is higher still and a larger part of the area consists of grass prairie and open jungle of deep-rooted trees. This tract is called the "Bar."

The Bar uplands before the introduction of canal irrigation, like the Thal, formed a country of rolling sand-dunes patched with grass and of hard unfruitful plains, glistening with salt. The canals have completely changed the landscape of this area.

(iv) Western Plain — The Thal and Derajat

The part of the Punjab Plains to the west of the Jhelum-Chenab-Panjnad-Indus line is a sandy desert. The Thal desert occupies almost the whole of the Sind-Sager Doab between the Jhelum-Chenab and Indus, stretching for about 150 miles from the Salt Range towards the apex of the Doab in Muzaffargarh District. In places its width exceeds 50 miles. It includes Muzaffargarh, Mianwali (except Isakhal) and a large portion of Shahpur.

A scanty rainfall, a treeless sandy soil and a precarious and scattered pasturage mark this out as one of the most desolate tracts now remaining in the Punjab. Much of it is a real desert, barren, lifeless and devoid not only of bird and animal life but almost of vegetation. At first the Thal appears a uniformal monotonous desert, but its character varies. The northern Thal has a sub-stratum of hard level soil, the surface of which is covered by a succession of low sand-hills with a general north and south direction. Between the hillocks hard sub-soil appears in strips and patches. The general appearance is that of sandy rolling prairie, covered in the rare years of good rainfall with grass and stunted bushes. Cultivation is carried on in small patches. Water is from 40 to 60 ft. below the surface and is generally brackish. In the east of the Steppe, the part called the Thal Kalan or Great Thal, even the narrow bottoms between the sand-hills are usually sand-covered. Towards the west the hills become lower and less sandy. Agriculture here replaces pasturage as the occupation of the people, and in the Mianwali district a broad strip of nearly level ground runs down from Fatehpur towards Mihran. This tract is known as *Daggar* in the north and *Jandi Thal* in the south. The main feature of the Daggar is the central core—a narrow strip of firm, flat, cultivable soil, which runs from north to south down its centre. From the line of wells in this portion the Daggar derives its name. The good land ends near

Khanpur in a region of smooth sand, to be succeeded near Karor by another fertile strip, which forms a core similar to the Jandi Thal. There is little doubt that the Indus once flowed down the middle of the Thal. Lastly we come to the *Dowah*, a strip of upland some three miles broad, forming the high bank of the Indus. In the north this bank rises abruptly 40 ft. from the river level, but towards the south it gradually gets lower, until it disappears at Kot Sultan. Large villages, whose lands lie in the riverain tract below, are built on the Powah, for security from floods.

The tract between the Thal desert and the Salt Range is for the most part a flat barren plain of hard soil, impregnated with salt and producing hardly even a bush or blade of grass. It is known as the Chachh, and is celebrated for its mirage. Near the hills, however, the character of the soil changes. The mountain torrents, in the course of ages, have brought down immense quantities of detritus from the sandstone and limestone rocks of which the uppermost part of the range is composed and have covered the nearer portion of the salt and sterile plains with a fertile soil sloping gradually outwards from the base of the precipitous hills and requiring only a sufficiency of moisture to make it productive. In years of favourable rainfall, the torrents rush down from the gorges and spread in deltaic fashion over the moraines they themselves have formed, being brought under control soon after they leave the hills by an elaborate stem of embankments erected and maintained by industrious peasants.

The Derajat consists of the trans-Indus territory. In Panjab, it makes the district of Dera Ghazi Khan. Here it is divided into two distinct parts. One is called the *Pachad* and consists of a high rainless tract running along the Suleiman Range. It is seamed by hill torrents. The other is called *Sindh* after the river Indus, and includes all the land under the influence of that river and so capable of irrigation, either by canals or wells or by inundation, direct from that river.

The highlands between the Pachad and Sindh make the arid Danda tract. It lies beyond the reach of the canals on one side and the hill streams on the other, and cultivation in it is effected with much trouble and labour by means of wells.

Kirana Hills.—In the interior of the plain of Panjab there are found a few small straggling outliers of the same rock series as the Aravallis. They constitute the low deeply-weathered hills lying in four separate groups at Kirana, Chiniot, Sangla and Shorkot. The first lies between the Chenab and Jhelum rivers; the Chenab flows through the second group; and the third and fourth lie between the Ravi and the Chenab. They extend over sixty miles from north-west to south-east and contain some ha-ematite, but agriculturally are completely barren. The rocks, all along exposed surfaces, are coated with a thin, black shining film of iron oxide, which has been precipitated from aqueous solutions brought to the surface by the heat of the sun, and which the rainfall is too scanty to remove.

The hills lie on a subterranean ridge, which is supposed to extend from Delhi north-westwards up to the Salt Range, and which is sometimes called the Shahpur-Delhi Ridge. This ridge divides the Panjab Plain into two basins, the north-eastern of which holds most of the sub-soil water.

THE INDUS VALLEY IN CENTRAL LADAKH

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THE Indus valley in Central Ladakh presents a number of interesting problems in geomorphology, the solution of which would throw a good deal of light on the glaciation and recent movements of the Himalaya.. In the following pages, an attempt is made to describe the valley between Ugu and Khalatse, and to offer some explanation of its most important features.

The Indus enters eastern Ladakh about 800 miles from its source in Lake Mansarowar, and flows westwards between the Ladakh Range and the Zaskar Range in a valley whose floor varies from 8,000 to 10,000 feet above sea level. In the ninety miles between Ugu and Khalatse, where the bridge over the Treaty Road marks the boundary between Ladakh and Kashmir, the valley falls into three well-marked physical divisions.

From Ugu, a small village on the right bank of the river east of its junction with the Chimre nalla, up which the road runs from Leh to Lhasa, the Indus flows swiftly in a series of bold curves at the bottom of a narrow, almost vertical-sided gorge, excavated to a depth of 100 to 200 feet, in soft beds of sand and boulders. These conglomerate beds fill the two-mile wide valley between the granite Ladakh range to the north of the river, and the steeply folded sandstones and shales of the Zaskar range to the south; they might, from their appearance, almost equally well be coarse alluvial deposits laid down upon the floor of a mature river valley, or beds of boulder clay dumped by a vanished glacier. In this part of its course, the Indus hugs the Ladakh Range, cutting back the granite spurs that run down to the river between Kharu and Ranbirpur into steep cliffs crowned with inaccessible gompas.[1] The strip of terrace left by the down-cutting of the river is wider on the south bank, and it is here that the occasional village of flat-rooted, two-storied houses, surrounded by barley fields and willow baghs,[2] is to be found.

A mile above Ranbirpur the whole character of the valley alters. The mountains on either side of the river recede, leaving between them a flat floor from five to seven miles wide; the slope of the valley becomes markedly gentler; the speed of the Indus slackens, and for twenty-five miles it meanders westward across a wide open plain in a series of shallow, braided channels over thick deposits of fine alluvial mud. This is bordered to north and south by a half-mile wide strip of coarse scree, beyond which the bare purple ranges tower above the basin floor.

The contrast in relief between the two sections of the valley above and below Ranbirpur is emphasised by the change in vegetation. From Ugu to Ranbirpur, the Indus flows through a barren

[1] Monasteries. [2] Plantations.

gorge, but from Ranbirpur downwards it waters wide grassy meadows dotted with villages and cultivated fields. At the eastern end of the shallow basin are the villages of Tikse and Sheh, the old capital of the kings of Ladakh; in the centre is the Balti settlement of Shushot, whose fields and houses cover more than five miles on the south bank of the Indus, and at the western end is the village of Spituk, on whose green pastures the Treaty Road turns its back to climb over five miles of hot sand to Leh.

The 20,000-foot mountain wall bordering the valley between Ranbirpur and Spituk is broken many times by the entry of tributary streams. These are all snow-fed, and have little water in them except in early summer. Many of them are lost in the coarse gravels and sands near the rim of the valley, and send no water into the Indus; all have built alluvial cones at their entrance to the main valley, the most striking of which is the great alluvial fan of Stok,

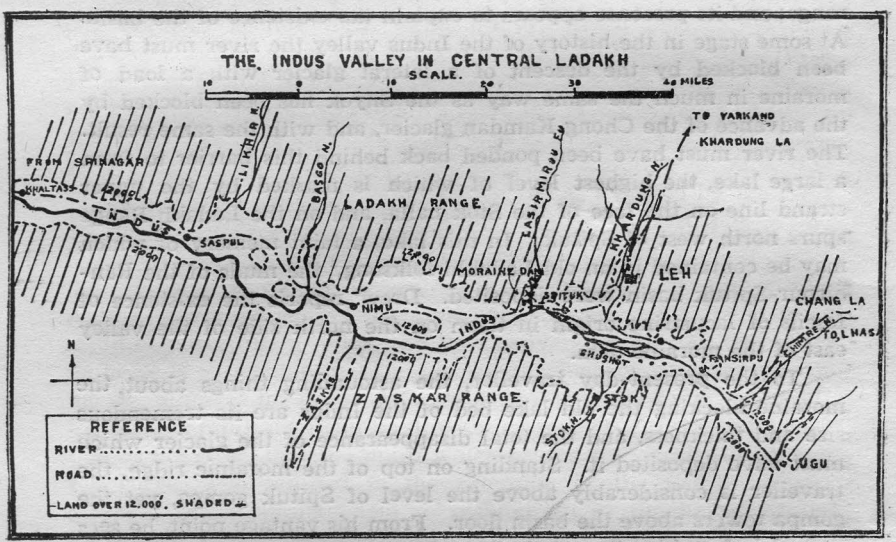

Fig. 1.—The Indus Valley in Central Ladakh.

a mass of gravel, with a basal circumference of five miles, lying steeply at the foot of the Zaskar Range opposite Leh. This fan has been built by the diverging channels of the Stok nalla, which carries so large a load of debris from the Zaskar mountains that the cone built by it projects out a considerable distance across the valley floor. Its base has been truncated by the shifting meanders of the Indus, and much of the material removed in this way has been redeposited in long sinuous banks of gravel on top of the river alluvium. The truncated base of the cone has very marked strand lines running horizontally along it at heights of about 50 and 100 feet above the present main valley floor.

On the right bank of the Indus, low crumbling ridges of granite run southwards from the Ladakh range, and between two of them, just opposite the entrance of the Stok nalla, is the sand and gravel-choked valley of the Khardung, in which stands Leh. Above the town, which controls the routes over the Khardung La to Yarkand

and Lhasa, the Khardung valley is flanked by lines of unmistakable lateral moraine, rising on the west to a height of 300 feet. The moraines run down to within two miles of Leh, and then disappear in a series of shapeless hummocks. These, and similiar formless masses of sand and gravel below the town may well represent old ground moraine.

Down in the main valley, two miles below the Khardung junction, the Ladakh and Zaskar ranges once more converge, and the space between them is blocked by a mass of moraine, 500 feet high and quarter of a mile broad, which debouches from the valley of the Lasimiroufu, a stream parallel to the Khardung. This mass forms the western boundary of the twenty-five mile long basin between Ranbirpur and Spituk; projecting south across the course of the Indus, it swings the river southwards to the face of the Zaskar range; and its presence appears to explain the existence of the basin. At some stage in the history of the Indus valley the river must have been blocked by the descent of a lateral glacier with a load of moraine in much the same way as the Shyok has been blocked by the advance of the Chong Kamdan glacier, and with the same result. The river must have been ponded back behind this barrier to form a large lake, the highest level of which is marked by the upper strand line on the face of the Stok nalla, and on the Ladakh Range spurs north west of Spituk. In this lake, a faint memory of which may be contained in an old Ladakhi folksong,[3] the muds of the Ranbirpur-Spituk basin were deposited. Drew[4] reports the existence of fossils of lacustrine origin in them on the north side of the valley east of the moraine dam.

To the present-day traveller, the astounding things about the moraine blocking the old lake bed of the Indus are its tremendous size and thickness, and the total disappearance of the glacier which must have deposited it. Standing on top of the morainic ridge, the traveller is considerably above the level of Spituk gompa, yet the gompa towers above the basin floor. From his vantage point, he sees spread before him the whole Indus valley; the wide green floor of the lake basin tilted towards him; the string of villages; the line of alluvial cones; the frowning purple and grey masses of the Ladakh and Zaskar mountains, their sides scored by nallas, their tops dappled with flecks of snow. The one thing conspicuously absent from the scene is ice. There are small patches of snow on the Zaskar range, but practically none in summer on the south face of the Ladakh Range; yet it is the nallas entering the Indus valley from the north;—Lekhir, Basgo, Lasimirou, Khardung;—that are markedly glaciated.

Below the Spituk moraine dam, the Indus flows once more in a narrow gorge, the depth of which gradually increases till the river is nearly 800 feet below the level of the surrounding country at Khalatse. Just east of Nimu, the Indus is joined by the Zaskar river, also flowing in a deep gorge, and from the junction strips of high level terrace 300 feet above flood level border the river down to Khalatse. These terrace strips are usually alternating; rarely pair-

[3] The "Song of the Girl of Sheah" trans. Francke, A. F.
[4] Drew. F. "Jammu and Kashmir Territories", India 1875.

ing; and are all made of coarse sand and conglomerate. Where they are not crossed by tributary streams, they are utterly barren, like the terrace which carries the road from Saspul to Alchi monastery, but where they can be watered from a side nalla they provide welcome stretches of cultivable land, elaborately irrigated by a system of long kuls,[5] and producing the barley and wheat, the apricots and apples that are the common crops of Ladakh. The side nallas, used for irrigation, flow down from the Ladakh and Zaskar ranges with considerable force, which is utilised to drive the water mills by which every Ladakhi villager grinds his flour. In spite of their speed, they carry a much smaller load than the main river, and their clear blue water makes a bright trail in the muddy reaches of the Indus for some hundreds of yards below their entry.

One of the most curious puzzles in this lower section of the Indus basin in Ladakh is the existence of a high valley to the north of the present gorge, parallel to the main river, but cut off from it by low, discontinuous granite hills. This valley, which has no through drainage, and no stream of any size in it, is utilised by the Treaty Road from Saspul to Spituk. Its floor is so covered in recently disintegrated granite and wind-blown sand, the result of rapid weathering under Ladakh's arid conditions, that it is impossible to tell what may underlie the surface deposits. But it is tempting to think that this may be the old lower valley of the Indus, followed by the river before the building of the Spituk moraine dam diverted it to the south, and caused the cutting of the present gorge.

The general picture presented by the Indus in Ladakh is of a mature river, its valley much modified by ice, rejuvenated as a result of fairly recent uplift, and now actively engaged in deepening its bed. It is possible that the glaciation which was responsible for the deposition of the moraines in the Khardung valley and the building of the Spituk dam can be directly correlated with the rejuvenation of the river; that the uplift which caused the excavation of the two gorges also resulted in the extension of the Ladakh Range glaciers, which shrank again to nothingness as the height of the range was reduced by weathering. It appears more probable, however, that the damming of the main valley and the glaciation of the tributaries took place before the cutting of the lower gorge. If this is the case, can the disappearance of the ice on the Ladakh range be ascribed to a continuing rise of the outer chains of the Himalayas, with a resulting drop in annual snowfall in Ladakh? The Indus is obviously still deepening its valley between Ugu and Kalatse; is this because it has not yet reached the new base level of erosion produced by the Himalayan uplift, or because the whole region is still slowly rising? No conclusion can be reached on these questions till the geography of the Himalayas is more fully studied, but it is interesting to see that what is happening in Ladakh is in accordance with what has been observed in other parts of the Himalayan region.

[5] Water channels.

RIVER PROBLEMS IN BENGAL

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BENGAL is a land of rivers. Three of the world's mightiest rivers—the Ganges, the Brahmaputra and the Meghna have raised this part of India from the bed of the sea, and are still engaged in extending its land surface towards the Bay of Bengal. It is these rivers that deposit millions of tons of fertilising silts on their flood plains every year, and thereby enrich the soils of Bengal, which, otherwise, would have got completely exhausted by now, due to over-cropping. It is along the banks of these rivers that we find the greatest concentration of rural population in the whole world, and some of the largest cities and ports of ancient and modern India. Some of the world's longest waterways are also provided by these rivers.

There is a dark side of the picture as well. In a deltaic tract rivers seldom stick permanently to their beds. They not only swing from side to side, but sometimes leave their original channels, and take to new ones. The surface of North and Central Bengal is simply littered with old river courses, some completely silted up, others converted into *bīls*, *khāls*, *bāors* and *hāors*. It is these stagnant waters that constitute defective drainage systems, and are also the breeding grounds of anopheles mosquitoes and other malaria carriers. Because of heavy rainfall in the monsoon months, widespread water-logging would be the inevitable result in an area, deprived of its former flowing rivers.

We also know to our cost that rivers of West Bengal, especially the Damodar, have been a source of eternal trouble to those who live in the districts of Burdwan, Hooghly and Howrah, due to devastating floods during rains almost every year. Rivers of East Bengal also cause destruction when strong currents impinge with terrific speed against one bank at a time. That is why the Padma is known as the Kīrtināshā in the Bikrampur pargana. The Sundarban rivers give rise to another kind of problem for those who live on their banks. No longer sweet water of the Ganges flows into them. Hence, their waters are brackish and cannot be used for drinking and culinary purposes. It is reported that the women folk there have to carry their pitchers by relays to fetch water from a fresh-water tank which often is situated at a distance of ten or twelve miles. The salinity of these tidal rivers is continually increasing up stream, and may in future give rise to a serious problem for the Corporation of Calcutta, as the city is at present dependent on the Hooghly river for its water supply.

In a geographical study of the rivers of Bengal, the Ganges takes the first place. It has built up in the past, parts of West and North Bengal, the whole of Central Bengal, and has now given its attention to East Bengal. On entering Bengal, the Ganges soon changes its name. The east-flowing channel taking the name—Padma, carries the bulk of the Ganges water, the maximum flood discharge near Hardinge bridge being twenty lakhs cubic feet per second. The south-flowing channel, known as the Bhagirathi, was the main channel of the Ganges before the birth of the Padma. It now hardly carries eighty thousand cubic feet of water during maximum flood. On its eastward march the Ganges had proceeded by stages and gave rise to a number of active channels, the Bhairab, the Jalangi, the Matabhanga and others, which were at one time or other flowing majestically southwards. That was the glorious age for the people of Central Bengal. The easternmost main channel of the Ganges is to-day known as the Arial Khan. It is the principal river of the eastern part of the district of Faridpur, and of the northern part of Barisal. There are reasons to believe that the Dhaleswari, with its offshoot the Burhiganga on the left bank of which stands the city of Dacca, was once the main channel of the Ganges. The Dhaleswari now issues from the modern Brahmaputra, locally known as the Jamuna, and enters the Meghna a little below Munshiganj. But up to the time of Rennel (1764—1773), who was the first to prepare a more or less accurate map of the rivers of Bengal, the Dhaleswari used to draw its bulk of water from the Ganges. It is clear, therefore, that the Ganges even after establishing its easterly course used to swing like the pendulum of a clock between the Burhiganga on the north-east and the Arial Khan on the south-west until it was stopped by the Brahmaputra. The same swinging movement of the Ganges from north-west to south-east had also occurred in the west between two of the ancient capitals of Bengal—Gaur and Rajmahal, and perhaps is still happening in the districts of Malda and Murshidabad. The tendency of the Ganges and of the Bhagirathi is to move south-west in recent years, and as a result of this movement we find that the right bank is much steeper than the left bank.

The Ganges flows almost due east from Bhagalpur to near about Sahibganj, and then turns south with a sharp bend before entering Bengal. Below the bend the Ganges forms the provincial boundary for a distance of about 27 miles, between Bengal and Bihar. On the east lies the district of Malda and on the west, the Santal Parganas of Bihar. The surface features of the surrounding area indicate the probable existence of a depression in between the Rajmahal hills on the west and the undulating upland of the Barind tract on the east. This depression must have induced the Ganges to change the direction of its course from east to south, and got filled up in a course of centuries with sands brought down by the river. While flowing through this sandy *diara* plain the Ganges has been continually changing its bed. Because of this continual change in the course of the river, a stretch of land, comprising several *khas mahal* estates, has been thrown like a shuttlecock from one side to the other, between Malda and Santal Parganas. The easternmost channel is

perhaps the Kalindri of to-day and the Mahananda below Malda. The westernmost channel is now being followed by the Ganges. Due to this westering, the former channels of the Ganges in the district of Malda, now known as the Pagla and the Bhagirathi south of English Bazar have completely silted up. Gaur is thus no longer on the bank of any flowing river.

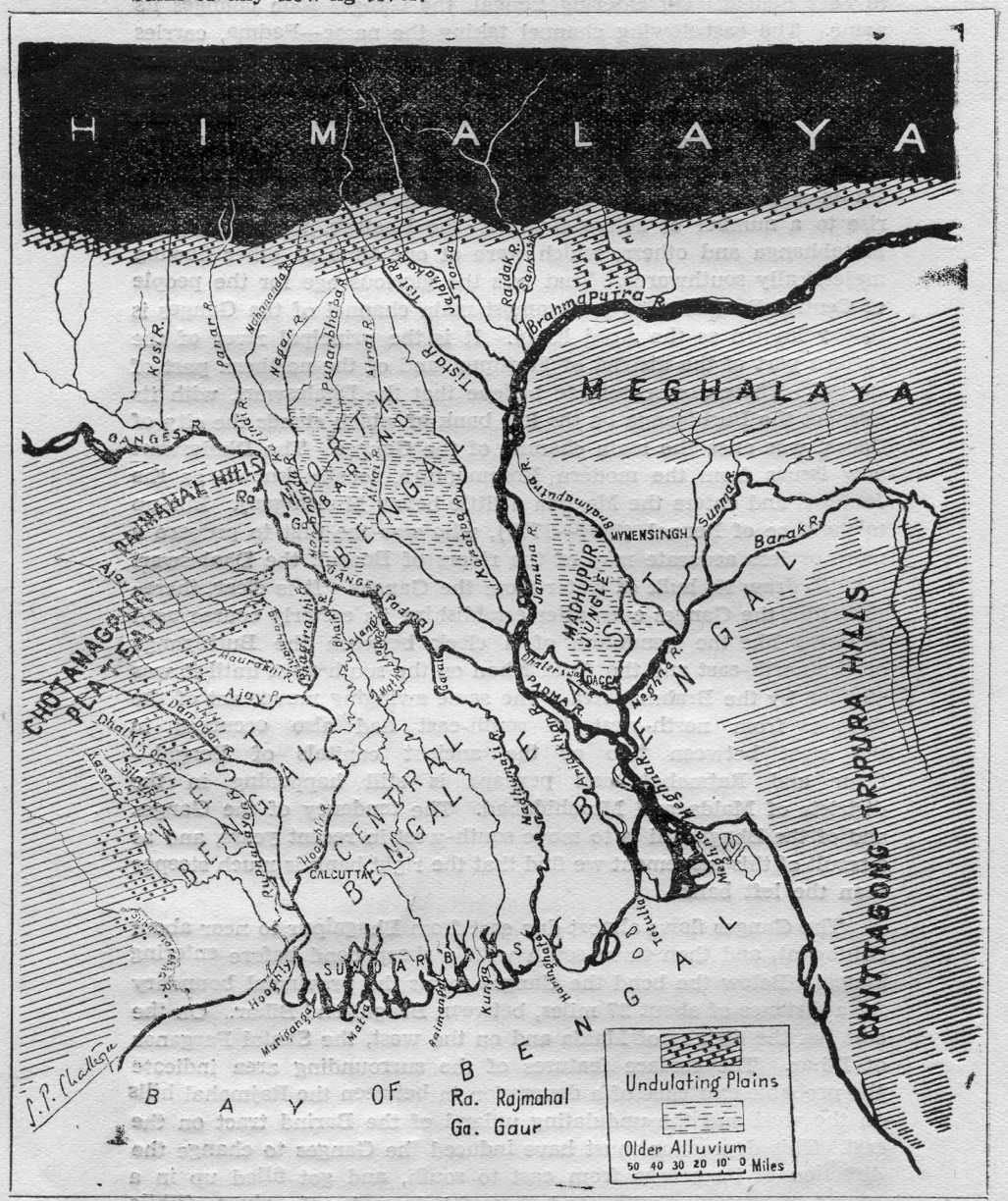

Fig. 2.—The Bengal Rivers.

After leaving the provincial boundary the Ganges turns south-east and enters Bengal proper. South of the Ganges lies the district

of Murshidabad, whereas the district of Malda continues northward. The total length of this reach of the Ganges is about 45 miles. The Ganges in this part receives near Godawari one of its important tributaries from the north—the Mahananda, and throws out near Samserganj one of its most important distributaries—the Bhagirathi or the Gangā proper. After the separation of the Bhagirathi from the main body, the Ganges loses all its sanctity and becomes known as the Padmā until it joins the Meghna near Chandpur. A map of Bengal prepared from surveys dating 1847 to 1868 shows that a big loop was formed by the Ganges between Dhulian and Suti. This loop is not shown on a sheet based on surveys during the period 1915 to 1929. The river evidently has cut through the narrow neck of the meandering curve, thereby straightening its course and adding a considerable portion of the district of Murshidabad on to the Malda district. The Ganges, as surveyed by Rennel between 1764 and 1773 was found to flow through many other broad curves, which no longer exist. This is, therefore, another convincing proof that the present main channel of the Ganges or the Padma, was much weaker in the past and that it grew stronger and stronger at the expense of its former main channel—the Bhagirathi.

The Ganges continues its south-easterly course for a distance of another thirty miles until Charghat is reached and then it flows again due south for some distance. Rampur Boalia (Rajshahi), the only town of some importance on the bank of the Padma is to be found here. Wherever this river changes its direction, a distributary is thrown out, which maintains the original direction. This accounts for the origin of the Baral which issues from the Ganges near Charghat, flows through the district of Rajshahi and Pabna before falling into the modern Brahmaputra through the Hursagar. From the southern bank of the Padma issued one of the oldest rivers of Central Bengal—the Bhairab. It served as the main channel of the Ganges for some time in the past. There are reasons to believe that through the channel of the Bhairab flowed seaward some of the mighty rivers of North Bengal in ancient time, either the Kosi or the Atrai. This ancient river must have been cut into two parts at the time the Ganges began to flow at right angles to it. It was then that the Ganges finding a ready passage flowed through the southern reach of that ancient river, which is now known as the Bhairab. To-day the Bhairab receives very little of the Ganges water, as its connection with the Ganges has been practically cut off. As a matter of fact in summer the channel of the Bhairab dries up so completely in the district of Murshidabad that the bed is cultivated at places.

The Padma has given rise to two more rivers, the Jalāngi and the Mātābhāngā, which together with the Bhagirathi had provided the only trade routes between Calcutta and the Upper Ganges valley for a long time before the opening up of the railways. The Jalangi issues from a point more or less opposite the mouth of the Baral and flows in a direction opposite to that of the Bhairab. A few miles east of the mouth of the Jalangi rises the Matabhanga. It flows more or less parallel to the Jalangi. These rivers have deteriorated considerably in recent years, and are not used as navigable waterways.

East of Udaynagar the Padma flows once again in the south-easterly direction, which alternately becomes easterly and southerly until the present Brahmaputra is approached, the total length of this reach being some 90 miles. The two rivers, the Padma and the Brahmaputra join in the Munshiganj Sub-Division of the Dacca district about ten miles north-east of Goalundo of Faridpur. Before its confluence with the Brahmaputra, part of the Ganges water flows north through the Ichamati river of Pabna, and part flows south through the Garai river of Nadia, Jessore and Faridpur. Of the distributaries of the Ganges, the Garai is the most important at the present time. It is comparatively of recent origin and its importance increased with the advent of the Brahmaputra. What happens is this : the Brahmaputra flood comes earlier than the Ganges flood, and hence, the rise of the level of water in the Brahmaputra acts as a barrage to the Ganges water, which is forced back and seeks some channel westward. The Garai provides the first passage to this back rush of the Ganges water and gets more and more deepened and widened every year. As a result of this, the Padma declined considerably east of the town of Pabna, so much so that by the middle of the last century it could be forded by elephants in summer months. It was a mighty river at the time of the creation of the district of Pabna in 1829. The district then comprised all the indigo-growing areas on both sides of the river.

Below the confluence the river is still known as the Padma, indicating that the original channel belonged to it, and not to the much larger river—the Brahmaputra which has joined hands with it much later. The Padma discharges into the Meghna, through a channel more than two miles wide. In this reach the Padma is very turbulent, and spares nothing on its banks. Once flourishing towns with beautiful palaces and temples were situated on its banks, especially during the reign of Raja Rajballabh, which fell like a pack of cards before the onrush of the river and got washed away. It is, therefore, natural that the river should be called the Kirthināshā, that is to say, the destroyer of all glorious deeds. Even now one can see prosperous villages on its banks struggling with the river to save their very existence. The same factor that attracts Italians to come and settle around the Vesuvius can also be taken into account in explaining the concentration of population along the banks of such a dangerous river like the Kirthināshā reach of the Padma. It is the extreme fertility of soils in both the regions of widely differing types, that outweighs all other considerations.

The total length of the Kirthināsha form its confluence with the Jamuna (the Brahmaputra) down to its junction with the Meghna comes to about 85 miles. It is in this reach that the last distributary of the Padma leaves the parent stream near the town Faridpur. The channel of this distributary, now known as the Bhubaneswar or the Arial Khan, was a bed of the Ganges before its union with the Brahmaputra. The Ganges was shown to flow into the Bay of Bengal through the channel of the Arial Khan in the maps prepared by Rennel and previous surveyors like Thornton and Van de Bucke. The name 'Arial', which was given to the old bed of the Ganges in recent years, suggests that the river formerly flowed along the western edge of an upland tract, which probably was connected with the

Madhupur jungle area through Dacca. Because of the growth of delta, this tract must have subsided and caused the combined waters of the Padma and Brahmaputra to move eastward into their present channel. That the eastering of the Padma took place within the last two centuries is a well-known fact. All the older maps show to that effect. Besides, the Bikrampur pargana of Dacca once a continuous area of historic importance, has now been cut into two parts by the Padma, part of it lying south of the river in the Faridpur district.

To conclude, the Ganges or the Padma is by far the most important river to the people of Central Bengal and, more recently, of the south-eastern part of East Bengal. But, unfortunately, practically the whole of Central Bengal, comprising an area of some 16,000 sq. miles has now been deprived of the use of the silt-carrying Ganges water with disastrous consequences. Most of the rivers of Central Bengal have silted up. The estuaries in the Sundarbans are getting more and more brackish and the salinity of their waters is increasing upstream. Agriculture has considerably deteriorated. Water-logging has spread over an extensive area. Malaria and other diseases have depopulated the countryside and still are taking their heavy tolls of human life every year.

A strip of land in West Bengal adjoining the Ganga (the Hooghly river) through which once flowed the Saraswati shares the fate of Central Bengal. Another wide belt of land extending northwards from the left bank of the Ganges in North Bengal especially in the district of Pabna, also needs very badly a good drainage system and resuscitation of distributaries of the Ganges, which now flow sulggishly through it.

The inhabitants of the south-eastern part of East Bengal, comprising the districts of Faridpur and the Bikrapur parganas of the Dacca district and Bakerganj, receive the full blessings of the Ganges in the way of fertilising silts, but they have their own problems. They have to fight constantly with water so as to protect their homesteads from being washed away due to river erosion. Their land is not sufficiently raised so as to provide good sites for erecting factory buildings. In such an area agriculture will remain for long as the main occupation of the people, and any attempt to industrialise the area is bound to fail. There is also the potential danger of the Padma moving further east towards the Tripura hills. If that ever happens this tract will lose all its agricultural prosperity. Let us now describe briefly the other important rivers of Bengal.

The Brahmaputra

What the Ganges is to Central Bengal, the Brahmaputra is to the northern part of Eastern Bengal. The Brahmaputra rises in Tibet, and like the Ganges it gathers its waters first from the melting of snows, and then from rain water. Before entering Bengal it flows through only one province of India—Assam, which is thinly populated and is one of the rainiest regions and hence will not have very much demand on the waters of this river. Hence, in any scheme of planning in which water resources have to be tapped, Bengal can count more on the waters of the Brahmaputra than on the waters of the Ganges. The Brahmaputra changes its

course from west to south on entering Bengal. As on the west there was a depression on the east. This low-lying tract in between the Meghalaya (Garo-Khasi-Jaintia Hills) and the undulating Barind upland must have induced the river to flow through it in a southerly direction. The Bengal Brahmaputra of to-day which is known as the Jamuna in its lower reach, maintains its southerly direction throughout its course in the province. On the west of the Brahmaputra lie the districts of Rangpur, Bogra and Pabna, and on the east the Mymensingh and Dacca districts. The river flows for the first seventy miles through the district of Rangpur, where it receives four of the Himalayan rivers, the Sankosh (Gangadhar), the Torsa-Raidak (Dudhkumar), the Jaldhaka (Dharla), and the Tista. It is these tributaries that enrich the soils of Cooch-Behar and the northern part of the Rangpur, when they spread over their flood plains during rains and deposit fertilising silts. The gradient is sufficiently steep so as to allow the flood waters to return to the river channels in normal years without causing much damage to the homesteads which throng along their banks. This year (1945) the Tista floods, however, have been unusually severe, thousands of poor peasants in Cooch-Behar and Rangpur have lost their homes. The inhabitants of the eastern parts of the districts of Bogra and Pabna have also suffered considerably due to heavy floods in the Brahmaputra below its confluence with the Tista. The Tista regulates, therefore, the flood water level of the low reach of the Brahmaputra. As a matter of fact this very reach developed since the Tista has been pouring its waters into the Brahmaputra. It was in 1787, that the Tista left its allegiance to the Ganges and took to its present course after very severe floods. Before that, the Tista, or Trisrota, as its name indicates used to flow southwards through three of its main channels—the Karatoa, the Atari and the Punarbhava. After the diversion of the Tista eastward, its original channels deteriorated considerably, and hence practically the whole of North Bengal lying within the triangle formed by the Tista-Jamuna, the Ganges and the Nagar-Mahananda lost its former agricultural prosperity. No longer it receives fertilising silts from any of the Himalayan rivers. Because of relatively steeper gradient, it is true that water-logging there is not so widespread as in Central Bengal. Nevertheless, there exist a number of alluvial lakes and marshy tracts, which undoubtedly were connected with one another when the river system was at its zenith.

The diversion of the Tista also brought untold sufferings to the inhabitants of the district of Mymensingh. It was through the middle of this district that the Brahmaputra used to flow for centuries south-eastward to meet the Meghna near Bharab Bazar. This old bed is still known as the Brahmaputra, though very little of the water of that river flows through it now. The main cause of the diversion of the Brahmaputra westward was the inability of the old bed to carry the whole water of the Brahmaputra when it was supplemented by the Tista water. It was becoming increasingly difficult for the Mymensingh-Brahmaputra to maintain its course due to the deterioration of its bed under the influence of the Meghna. Then came the Tista with its tremendous volume of water, and the

old Brahmaputra gave in. A new channel was developed which is now known as the Daokoba in its upper part and the Jamuna in its lower stretch. Still earlier the Brahmaputra used to flow independently towards the sea, through a number of distributaries, the Lakhya, on the bank which stand the industrial region of Dacca, being one of them.

The Meghna

Unlike the Ganges and the Brahmaputra, the Meghna is fed entirely by rain water. The excessive rains on the southern slopes of the Meghalaya, in the northern slopes of the Tripura hills and in the Surma valley find their way into this river. The Meghna has a number of headwaters, such as the Kalni, which in Sylhet is known as the Surma and the Dhaleswari which is called the Barak in Habiganj of Assam. The Meghna, or rather the Kalni and Dhaleswari form the boundary between Bengal and Assam for some distance and on entering Bengal it divides the district of Tippera from that of Dacca. It receives the Ghorautra and the Dacca Dhaleswari on its right bank and the Gumti on its left. Its direction from north-east to south-west forming almost a right angle with the main axis of the Padma suggests that the original depression which it occupied was running in that direction in between the Tripura hills and the Madhupur jungle. This river also prevented the Padma from moving further east and provided the combined waters of the Brahmaputra and the Ganges a passage to the sea. It is in the mouth of the Meghna that the delta building process is very much active to-day. Sahabazpur, Hatia and Sandwip are some of the islands formed by sediments brought down by the rivers in course of centuries. These islands will be connected with the mainland in future, and then the delta face will advance southward.

The Damodar and other rivers of West Bengal

In West Bengal, a number of rivers come from the Chota Nagpur plateau in the west. They are known as follows from south to north:— the Subarnarekha, the Kasai or Kansabati, the Silali or Silabati, the Darakeswar, the Damodar, the Ajay, the Mayurakhi and the Brahmani. Of these the Damodar is the largest and the type river. These rivers remain practically dry in the summer months but they are fed by monsoonal rains, and hence liable to sudden floods. The Damodar is the worst in that respect. It takes its rise in the Chota Nagpur plateau and flows for about 360 miles before joining the Hooghly river opposite Falta. This river before its present southern march with a sharp bend near Falta used to flow eastward its old courses being locally known as the Behula. Every year floods descend down the river and inundate a large area in the districts of Burdwan, Hooghly and Howrah, but the floods of 1942 had no parallel in history. Thousands of acres of arable land were submerged under water, thousands of men, women and children were drowned and a very large number were rendered homeless. The main marginal embankment on the left bank of the river near Manikhati was breached, and the flood water rushed northward, probably through its former channels, especially the Behula, taking away with it portions of the Grand Trunk Road and the East

Indian railroad. Since the construction of the present embankment the flood water could not spill over its left bank and remained confined towards the right bank with the result that there was a gradual rise of the bed, sloping towards the north. This northward slope added strength to the flood water which ultimately overpowered the embankment. Because of the absence of any embankment on the right bank of the river and because of the fact that the channel below the town of Burdwan is not sufficiently deep and wide to carry the excess of flood water, thousands of acres of arable land between the Damodar and the Rupnarayan get submerged under water during floods. The authorities have now realised that the multi-purpose control of the Tennessee and the social and economic benefits which accrue from it are of immense significance like the Damodar and it looks like it that the Damodar valley project will be taken up seriously like the T.V.A. plan. The Damodar valley project will have provisions for the control of soil erosion, flood, afforestation, navigation, generation of electricity, and irrigation. Apart from the direct benefits the projects will help in the rehabilitation of rural life which was once constantly threatened by devastating floods. The hydro-electric power stations will make available cheap electricity to the agricultural countryside and help in the development of cottage industries. Moreover, chemical manures can be manufactured at the power stations as at Muscle Shoals on the Tennessee. Irrigation from the reservoirs near the dam sites, about seven in number, will also benefit the agricultural countryside.

It has also been pointed out very clearly that the Damodar project, if undertaken immediately, would greatly solve the problem of unemployment of thousands of people in the post-war period. The planners have estimated that the controlled reservoir capacity would amount to 47,000,000 acre feet, and that about 760,000 acres would be irrigated from the reservoirs, and further that 300,000 K. W. electrical energy could be easily generated very cheaply in the valley.

Conclusion

The above study of rivers of Bengal though far from exhaustive, at least points out very clearly that the health and welfare of the people of Bengal depend to a large extent on river conditions. It is absolutely essential for us that we must know everything about the present conditions of our rivers. We must have a clear picture before us relating to all the rivers—rivers that are active, rivers that are decaying and rivers that have ceased functioning. And if we could indicate our present and silted up river courses on a large scale map of Bengal, the close relationship between agricultural prosperity and river conditions will be apparent. The maps prepared by the Survey of India are hopelessly inadequate and out of date. For this type of work the services of river geographers should be sought by Government and other non-official organisations interested in planning and schemes. When we know our rivers, the help of river engineers and river physicists and even river mathematicians will be needed for solving specific problems. The placing of the cart before the horse should be avoided in this case.

AGRICULTURAL DEVELOPMENTS IN INDIA

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IT appears to have become a fashion to disparage agriculture as an occupation of a primitive people; and the extent to which it forms the mainstay of a people is supposed to measure the proportionate degree of their backwardness. A more mistaken notion there never could be, knowing as we do, that agriculture, as the chief food-producing industry, has from times immemorial sustained the race of man. Industrial communities may keep gloating over their so-called progressive role in the world. The very fact, however, that industrialisation has grown apace makes the position of agriculture unequivocally indispensable as a key-industry, a supplier of raw material to manufacturing industries.

From these considerations Indian agriculture emerges with a still greater importance. Nearly three-fourths of her people depend directly or indirectly on agricultural and pastoral pursuits. About 52 % of the total area is under cultivation. Whereas Indian agriculture thus provides means of subsistence to one-fifth of the human race, its importance as a mother industry of the world's huge industrial structure is no less. India enjoys the monopoly of jute and lac, ranks as the world's largest producer of sugar and in cotton and tea is second only to U.S.A. and China respectively. In view of all this it would be no idle task to explore the possibilities of her agricultural developments.

Modern agricultural developments have a knack of closely corresponding to the natural character and properties of the country in which they occur. This is a peculiarly modern feature, the result of efficient means of transport. Things were different fifty years back. Each country had to produce most, if not all, of its foodstuffs, sometimes under difficult and trying conditions.

This close adaptation of agriculture to local conditions has made cultivation more amenable to scientific control. It is necessary to study first the local conditions, then out of various possibilities to devise a system of agriculture suited to them and acceptable to the local people; finally to make various adjustments, somewhat altering the conditions to make them more suitable to the crop and altering the crop by plant breeding and selection to make it better for the local conditions.

Thus like agriculture in every country, Indian agriculture is determined by four factors *viz.* (*a*) geography, (*b*) climate including rainfall, (*c*) soil, and (*d*) the type of population.

India's physical conditions are in the main simple. On the north and north-east lie the greatest mountainous border lands and separating them from the plateau of peninsular India is the wide Indo-Gangetic depression.

Except indirectly the Himalayan region is of little agricultural importance. The physical difficulties facing the cultivator are many. The soil is rough, hard and rocky, in some places means of communication are practically, if not entirely wanting. There are extensive tea plantations round Darjeeling and some of less importance on the lower ranges farther to the north.

The Indo-Gangetic plains may be considered as consisting of the basins of the Indus and the Ganges below the 1000-foot contour line. The earth movements which led to the upheaval of the lofty Himalayas in the north led likewise to the formation of a great depression farther south. This depression has gradually been filled up by the alluvium carried down by the rivers draining into it. The process of land building is still being carried on in different parts of the region, thus rendering it an ideally fertile place for agriculture.

The Peninsular plateau has a gradual slope from west to east. The surface is generally an area of open valleys and wide plains broken by a number of ridges running eastwards from the Western Ghat. Over the greater part of this region, the rocks, hard and crystalline, are of Archaean age, but the great volcanic outbursts which took place at the end of cretaceous and in early tertiary times have covered in the north-west an area over 200,000 square miles in extent, with igneous rocks generally known as Deccan Trap.

The Himalayas and the Western Ghats excluded, the average rainfall over the whole of India has been estimated at 42 inches in the year. Taking India as a whole again the rainfall varies but little from year to year, amounting to never more than seven inches in excess or defect of the general average. The really serious factor that counts, however, is the unequal distribution of rainfall throughout the seasons and its still more irregular distribution over various parts of the country and the possibility of its failure or alarming deficiency. Eastern Bengal and Assam and the country between the Western Ghats and the Arabian Sea are more or less assured of an abundant rainfall every year.

On the basis of rainfall the following four agricultural systems may be recognised:—

(1) Wet Farming (2) Humid Farming (3) Dry Farming (4) Irrigation Farming. Wet Farming belongs to the regions having more than 80 inches of rainfall. Here crops which require heavy rainfall, like rice, jute and tea, can be cultivated. We may include the Malabar Coast, the Lower Bengal and the Central and Eastern sub-Himalayas in this region.

Humid Farming is carried on in regions getting from 40″ to 80″ of rainfall. Two and often three crops of somewhat drier type are usually grown. The region embraces the Central Ganges Plain, the Deccan and C.P.

Dry Farming is carried on in regions getting less than 20″ of rainfall. Not more than one crop can be cultivated.

Irrigation Farming is characteristic of regions getting less than 40″ of rainfall. The more favoured areas in this respect are the Punjab plain, portions of Sind and Upper Madras and Upper Ganges plain. Irrigation renders double cropping (Rabi and Kharif)

possible. In 1939-40 more than 22 % of the gross cultivated area enjoyed the benefits of irrigation. Where nature has withheld her bounties from the peasant, these great irrigation projects have granted a large measure of protection. Produce per acre has definitely stepped up. The Chinsura Agricultural farms researches show that the average yield of paddy grown without irrigation is as low as 15 mds. whereas with irrigation as many as 28 mds. per acre can be raised. V. S. Mathur's estimate of increase per acre in the yield of irrigated crops is as follows :—

Wheat	..	150 lbs.	per acre
Barley	..	150 ,,	,, ,,
Finished Rice	..	100 ,,	,, ,,
,, Cotton	..	70 ,,	,, ,,

In 1940-41 out of the total irrigated area of 85.8 million acres of land 30 million acres were irrigated by canals, 13 million by wells, 6 million by tanks, and 6 million by other sources. Utilisation of the underground water with the help of tube-wells worked by electric power is a valuable asset though quite a recent one. With cheaper electricity available in the days to come it should be possible to derive the maximum benefit from tube-wells.

The important part that the nature of soils plays in determining the extent and prosperity of agriculture in a certain area cannot be overestimated. The four main types of soil recognised in India are, (1) the alluvial soils (2) black cotton soil (3) red soil and (4) the laterite soils. Apart from these there are the sandy soils of Rajputana.

(1) The alluvium of Indo-Gangetic valley and of the coastal plain is, as a general rule, the most productive. It covers an area of about 300,000 sq. miles in the country although in character it varies from driftsands—where rainfall is deficient on which nothing can be grown, to clays—where rainfall is heavy—so stiff that they cannot be drained. Cultivation on alluvial soil is easy and responds to irrigation and manuring. Results are naturally quick and prompt.

(2) Overlying the Deccan Trap and embracing an area of about 200,000 sq. miles is the Black Cotton Soil. Concerning its origin there has been a lot of controversy and it is not yet certain whether it has been derived or has been transported into the region by some mechanical energy. Most probably it has been produced by the weathering of the lava covering the area. The soil, as its very name implies, is specially suited to the cultivation of cotton and is believed to have been under cultivation for more than 2,000 years.

Red Soils.—They cover the whole of peninsular India outside the area of Deccan Trap (described above under black soils) and the narrow strip of coastal alluvium. They comprise the whole of Madras, Mysore, and south east Bombay and extend through the east of Hyderabad and the Central Provinces to Orissa and Chota Nagpur. Northwards the red soil area extends into and includes the greater part of Sonthal Parganas and the Birbhum district of Bengal, the Mirzapur, Jhansi and Hamirpur districts of the United Provinces, the Beghelkhand States of Central India, the Aravallis and the eastern half of Rajputana. In this widely-dispersed tract, the red soils

differ greatly in consistency, depth and fertility. They vary by intermediate stages from the poor thin and gravelly, sandy or stony and light coloured soils of the arid uplands, where only a poor crop of bajra can be grown, to the rich, deep, bright-red, dark-brown or dark-coloured fertile loam of the lower levels, and the valley bottoms which under irrigation produce a wide range of crops, sometimes as good as the product of the yellow loam of the alluvial tract of Northern India.

(4) Agriculturally the lateritic soils are poor due to their acidity and the main problem is to correct or ameliorate this acidity. For tea, however, the soil may actually have to be made more acidic. In this category may be included, the summits of plateaus and hills of South India, Central India, Central Provinces, the Eastern Ghats, Bombay Presidency, Malabar and Assam.

Soil deterioration is an alarming problem of Indian agriculture. The Royal Commission on Agriculture made an elaborate inquiry into it and arrived at the conclusion that where land is cropped year after year and no manure replaces the exhausted fertility of land, a low but permanent standard of fertility is established. Dung at present is used up, by the peasant, for fuel purposes while it can be very profitably used as a manure.

Soil erosion is no less a menace to our agriculture. Deforestation is directly responsible for it. The loss of soil on a single acre of even moderately sloping land has been anything from 50 to 150 tons per annum. Spectacular evidence of this loss is to be had in the United Provinces. Chambal floods have brought still more disastrous consequences. The total erosion of the Jamuna-Chambal basin has been estimated as equivalent to the removal of one-half ton of soil per second for the last 1,000 years. Wind erosion is very prominent in northern areas especially around Attock and Campbellpur and in Southern Panjab. The process of erosion was going on unchecked in the plantation districts of Bengal, Assam, Madras and Mysore till afforestation was resumed.

India is very much disappointed in her ignorant, backward, conservative and poverty-stricken peasantry. The ryot's chronic indebtedness is proverbial and the usurious activities of the village moneylender, coupled with the evil of sub-division and fragmentation that prevents all manner of scientific cultivation, leads to a high cost of production. The same age-old agricultural implements are in use. Credit supply is a difficult problem. There exist no proper facilities to provide the cultivator with good seeds and to sell his produce at remunerative prices. The parasitic chain of middlemen eat up the whole of his return, leaving the poor peasant the more destitute. This high cost of production has made Indian agriculture a gamble in the world prices. The Bengal Famine Enquiry Commission has recently made a minute survey of the agricultural problem as a whole and recommended the institution of multi-purpose co-operative societies to look after all the difficulties of the cultivator. The removal of the Permanent System of land tenure in Bengal and Zamindari System as a whole is one of its foremost recommendations.

An account of the agricultural conditions of India would indeed be incomplete without a mention of her staple crops, their present problems and tendencies.

Rice.—The Indian crop of rice accounts for about 60 to 65 % of world's production (leaving out China). In India rice cultivation occupies 80 million acres every year. Bengal along with Bihar, Orissa and Madras claims about 80 % of the total rice in India, whereas Bengal and neighbouring deltas on the eastern coast claim 75 % of the total cultivated land under rice. In western U.P. and Punjab rice is mostly grown with the help of irrigation. The average yield of rice in India as compared with Italy's average of 2,903 lbs. per acre and Japan's 2,276 lbs. per acre is 728 lbs. per acre—a very low figure indeed. Only about 5.1 per cent. of the total area is under improved crops. The acreage under rice shows the following variations during the last few years.

Years	In millions of acres	Years	In millions of acres
1932-33	69	1940-41	73
1935-36	83	1941-42	73
1939-40	73		

It is difficult to account for variations in acreage between one year and another. The production of rice in tons also shows remarkable variations as indicated below :—

Years	Tons in Thousands	Years	Tons in Thousands
1930-31	31,277	1936-37	27,824
1933-34	29,745	1939-40	25,364

The problem of quality—nutritive not market quality—deserves the attention of nutrition experts.

Wheat.—Wheat occupies less than 11 % of the total area under cultivation i.e., about 34 million acres. About two-fifths of the total wheat crop in British India is irrigated and Punjab claims 50 % of it as its share. Compared with U.S.A.'s average yield of 846 lbs. per acre and Australia's 714 lbs. India's average yield per acre is 636 lbs. The table given below shows the acreage and production of wheat during the last fifteen years:—

Average of	Area in thousands of hectacres	Index No.	Production in millions of quintals	Index No.
1925-29	12,700	100	87	100
1930-34	13,600	107	97	101
1938-39	14,100	113	109	125
1939-40	14,200	112	100	115

The figures would show that even in wheat production there has not been any remarkable improvement in methods over these last 15 years.

Sugar-cane.—The cultivation of sugar has made enormous progress in recent years as a result of the protection given to sugar industry. The area under cane has increased from 2,800,000 acres in 1925-26 to 3,800,000 in 1937-38. The production increased from 24 million quintals in 1931-32 to 34 million in 1940-41. U.P. is the largest producer. Their share averages from 53 to 54 per cent. of the total production. The Imperial Council of Agricultural Research must be credited for spending as many as Rs. 35 lakhs on the

development and growth of improved varieties of cane. India has stopped her imports of sugar from Java. There has been a tremendous increase in the number of sugar factories—from 27 in 1929-30 to 148 in 1940-41. Similarly there is a considerable increase in the quantity of manufactured sugar—from 310,918 tons in 1929-30 to 1,345,000 tons in 1940-41. Compared with other countries however the average yield per acre of sugar in India is very low :—

Java	..	54·91	Tons per acre
U.S.A.	..	20·06	,,
India	..	12·66	,,

About 60 % of the total area under sugar-cane is irrigated.

Tea.—India claims ½ of the world's total area devoted to the cultivation of tea. Of the total production in India 80 % is contributed by Bengal and Assam. Tea industry employs about 877,000 hands drawn mostly from U.P. Bihar and Orissa. Local consumption is very poor; only about 12 % of the total is consumed in India. United kingdom is by far the largest importer attracting, as it does about 300 million lbs. out of a total export of 350 million lbs. Of the total world's exports 42 per cent. goes to India's credit. The present war gave a considerable stimulus to the demand for Indian tea.

Cotton.—India stands next to U.S.A. alone in the world production of cotton. More than 50 % of the Indian cotton was exported in normal times before the war, Japan being our chief customer. About 40 % of the total production is absorbed by the mills and the rest by our cottage industries in spinning and weaving. The Imperial Council of Agricultural Research and the Indian Central Cotton Committee have been busy with the vital problem of improving the methods of cultivation and the quality of production. The following figures indicate the variations in production during recent years:—

400 lbs. bales	1932-33	1935-36	1936-37	1937-38	1938-39
(000 omitted)	4,647	5,728	6,307	5,779	5,120

The following table indicates the trend of our exports in cotton in normal years:—

Years	Bales of 400 lbs. (000's)	Value in lakhs of Rupees	Years	Bales of 400 lbs. (000's)	Value in lakhs of Rupees
average	2,407	3,328	1937-38	2,732	2,319
1932-33	2,043	3,495			
1934-35	3,490	4,441			
1936-37	4,268	2,386			

Jute.—India enjoys a virtual monopoly of Jute as a commercial crop. Bengal produces over 90 % of the total yield. Its importance lies in the fact that the jute and jute manufactures constitute about 50 % of the total value of Bengal exports and 25 % of the total value of reports from the whole of British India.

The following figures indicate the trend of jute production:—

(In 000's)

	1920	1930	1935	1938	1939	1940
Acres ..	2,169	3,062	1,917	2,521	2,749	3,938
Bales of of 400 lbs. ..	5,915	11,231	7,239	6,694	9,646	13,186

The discovery of substitutes in other countries constitutes a major threat to Indian jute.

ROCK SALT SOURCES OF THE PUNJAB

By Bhag Singh Lamba

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Introductory:

Rock salt is a natural deposit of salt, usually a sedimentary deposit as distinguished from the manufactured product from sea or lake brine or the natural product formed at some brine springs or lakes. Chemically it is sodium chloride and the usual impurities are calcium and magnesium, chlorides and sulphates. The hygroscopic property (deliquesence) of common salt is due to presence of magnesium even in traces. The equivalents of salt in various languages are interesting. It is termed Lavanam (Sanskrit), Nimuck (Hindustani), Lon (Persian), Halle (Celtic), Sal (Latin), Sel (French), Salz (German), Sout (Dutch), Sahl (Russian), and Salt (English). Salt has been considered sacred since times immemorial. Most of the Biblical salt was rock salt. In some parts of India rock salt is termed as Sindhu Salt and some religious people use only rock salt due to its sanctity, inspite of the fact that it is 4-5 times as dear as the sea salt. Perhaps due to its hygienic value it may have assumed a sacred significance. Specific gravity is 2.0 to 2.5; an average sample of Khewra rock salt weighs 132 lbs. per cubic foot. Saturated brine contains 37 parts of salt. Hardness of salt is 2.5 in the Moh's scale. Transparent salt crystals are perfectly diatherminous, i.e., are equally pervious to heat rays of every degree of refrangibility. Rock salt has a remarkable property of conveying sound like metals.

The Cis-Indus Salt Range. Physiography:

The range extending from the Jhelum river on the east to the Indus river on the west constitutes the Cis-Indus Salt Range covering a length of about 150 miles. In the major portion of the range, from Jutana on the east to Mari Indus on the west, salt is exposed in outcrops at many places over a distance of 80 miles. The range is situated between East longitude 71° 30′ and 73° 30′ and between the parallels of 32° 23′ and 33° of North latitude. The Salt Range forms a very prominent feature of the Western Punjab situated as it is between the thal or desert area of Jhelum and Indus in the south and Potwar plateau on the north, forming an escarpment. While the plains at the foot have an elevation of about 800 feet, the average height of the range is 2,200 feet above sea level. There are a number of places with an elevation of about 3,000 feet which can be used as hill stations during the summer. The highest point

on the range is the Sakesar hill, the summit of which has an altitude of 5,010 feet. Sakesar is used as a summer resort by the officers of the three districts, the boundary lines of which meet here, namely Shahpur, Mianwali and Attock. The range runs approximately east to west from Jalalpur to Sakesar. From Jalalpur to Pind Savika it runs from south to north and further takes a north easterly direction. At Pind Savika it is cut up by the Bunhar rivulet and further east by the Kahan enclosing the lofty Mount Jogi Tilla ridge which abounds in Urials—wild sheep. The other ridge to the south east of Jhelum is the Kharian ridge. From the northern end of the range, north east of Jalalpur, shoots off the Bakrala ridge in a north easterly direction for a length of about 30 miles. The western extremity forms the Diljaba mountain and ends on the east in broken hilly ground near Lehri. Average width of the Bakrala ridge is 2.5 miles and of Mount Jogi Tilla ridge 3.5 miles.

From Sakesar at the western end the range turns at about a right angle and runs in a north-north west direction to Mari Indus.

From Jalalpur westward the width of the range increases, the average being about 10 miles. The ground also rises gradually from Jalalpur from the Bunhar river to Diljaba. West of this up to Sakesar, the plateaus form its crest in the following order—Eastern plateau; Dandot plateau, Kahun or Dalwal plateau, Malot plateau. Nurpur plateau and Son plateau.

From west to east, we have the following passes traversing the range—Namal to Musa Khel, Sardhi gorge, Choya Saidan Shah, Pind Savika south and Ghoragali north in Diljaba and Bakrala pass on the Grand Trunk road at the eastern extremity.

There are four salt lakes in the range. Khabaki and Son Sakesar lakes are situated in the northern portion of the Sakesar plateau and the Jhalar lake is situated in the Southern portion. The fourth lake is Kalar Kahar south of Bhon. It is famous for duck shooting.

There are several well-known springs in the range. There are hot springs and sulphurous springs in the Bakh ravine. The brine spring are very common, e.g., Kalar Kahar, Ghoragali pass, Nili Hill and Kalra. Fresh water springs of Choya Saidan Shah and Katas are regarded as very sacred. There are petroleum seepages near Jaba, near which locality a good deposit of Celestite was discovered by the author.

At several localities there are small disturbances at the eastern end but on the west end there are more violent disturbances. As the river Indus approaches, the disturbance is most intense and all the characteristic formations are lost. In addition some big faults traverse the range. The Tilla fault at the eastern extremity brings the Cambrian rocks against the vertical Tertiary beds. The Jalalpur fault extending along the foot of Chambal mountain joins the Tilla fault. The Bakrala ridge follows the direction of Diljaba fault. This fault line is the major one and continues through Karangli in the Choya Saidan Shah valley, where the Siwalik sandstones come against the salt marl. From Makrach (south of Dalwal) the fault branches off and one shoot continues up through the Malkana gorge to Kalar Kahar where the salt marl

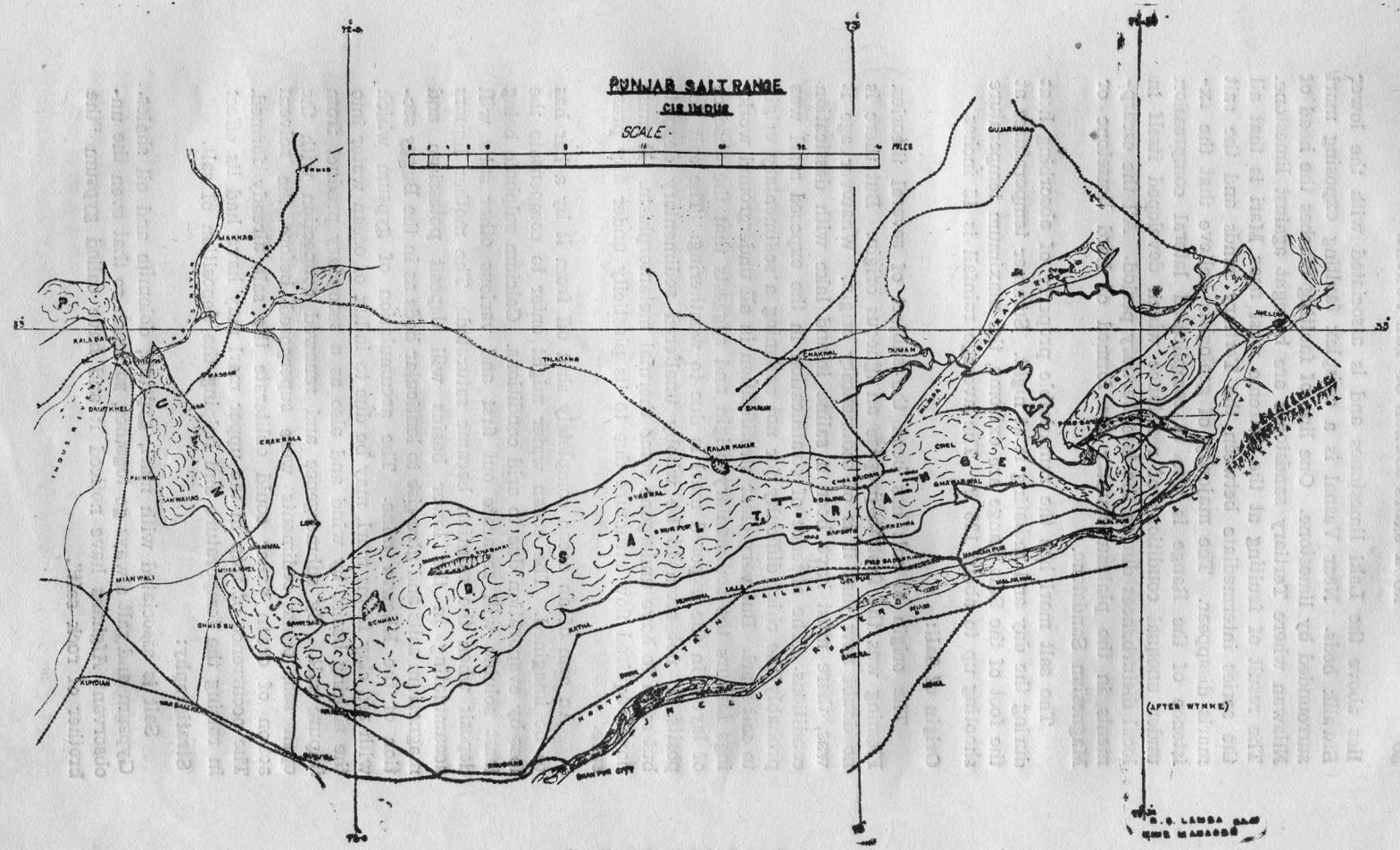

Fig. 3—The Punjab Salt Range.

lies above the Laki limestones and is associated with the lower Siwalik beds. Near Vasnal is a complex faulting exposing marl surrounded by limestone. One line of faulting reaches the head of Nilawan where Tertiary sandstones are brought against limestone. The result of faulting at the extreme west near Mari is that all the series intermediate between the Tertiary sands and the salt marls disappear. The majority of geologists believe that the existence of the Range is due to complicated lateral compression under unequal conditions of resistance which developed itself in local disturbances during the late Tertiary period. All the escarpments in the plateau country are formed of hard limsetone or Magnesian Sandstone.

The salt marl has the remarkable property of absorbing heat during the day and radiating it at night. Summer temperatures at the foot of the Salt Range are extreme, the maximum temperature shooting up to about 125°F. The average rainfall is 15 inches.

Origin of Salt:

The origin of salt has been the subject of several theories. Fleming was the first to propose an igneous origin. But there is no doubt now that it is of sedimentary origin. Whatever age it was, there must have been a saline inland lake with dessication conditions. The absence of stratification in the exposed marl was probably the chief difficulty for not assigning a sedimentary origin to salt marl. But very clear stratification in all underground workings favours the sedimentary origin and suggests that the absence of layers in the exposed marl is due to weathering. The salt deposits do not seem to be wholly unaltered sedimentary deposits but seem to have undergone some thermal metamorphism. It must have required flow structure due to its plasticity under any pressure.

An arm of an ocean completely shut off from it by a bar has to be imagined. The ocean water might enter to compensate the loss by evaporation due to arid conditions. Calcium sulphate being least soluble will separate out first and various other salts will deposit when the solution became saturated. The mother liquors accumulating in the lower basins will deposit potassium and magnesium salts and give rise to lenticular beds as in the Buggy section of the Khewra mine. The accumulation of gypsum which with red clay forms marl, may be due to influx of ocean water into the sinking basin, by wind and also as a secondary product from impure salt. By submergence and renewed connection with the open sea, other sediments were superposed before the solvent action of ocean water could obliterate the salt already formed. The occurrence of trap in the upper marl may have had its effect in raising the temperature and helping the deposition of salt.

Stratigraphy:

Salt is associated with marl, gypsum, dolomite and oil shales. Gypsum and salt always go together, so much so that even the unobservant Afghans have noticed it and have called gypsum "the brother of rock salt".

The stratigraphical sequence in the Punjab Salt Range is given below :—

Pleictocene	21.	Up. Siwaliks.
Miocene	20.	Mid. Siwaliks.
Pliocene	19.	Lr. Siwaliks.
Eocene	18.	Kirthar Limestone.
	17.	Laki Limestone.
	16.	Ranikot Limestone with coal at base.
Cretaceous	15.	Lumshiwal Sandstones.
Lr. Cretaceous	14.	Belemnite beds.
Jurassic	13.	Baroch Limestones and shales.
		Unconformity
Lr. Jurassic	12.	Kingriali Series. Dolomite and Sandstone.
Trias	11.	Ceratite Beds. Sandstones and shales with limestone.
Permian	10.	Productus limestone.
Up-Carboniferous	9.	Lavender clays. Purple and laevender clays with sandstone.
	8.	Speckled sandstone. Red and purplish sandstone and dark red shales.
	7.	Conularia beds. Olive sandstones and shales.
	6.	Talchir Boulder bed. Conglomerates sandstone and shale.
		Unconformity
Cambrian	5.	Salt pseudomorph shales. Red and green shales with salt pseudomorphs.
	4.	Magnesian sandstone. Dolomitic and calcareous sandstones with some micaceous shales.
	3.	Neobolus shales. Greenish grey shales, sandy shales, sandstone and dolomite bands Fossiliferous.
Cambrian or Tertiary	2.	Purple sandstone. Maroon sandstone with shales and flags at base.
		Sheared contact
Cambrian or Tertiary 1. (Lr. Kirthar)	(Saline series)	(*c*) Up. gypsum stage. Gypsum, dolomite, marl, oil shales Khewra trap.
		(*b*) Salt marl and Salt stage. Marl with seams of salt.
		(*a*) Lr. Gypsum stage, Gypsum, Anhydrite, dolomite oil shales, red and gypseous clays.

Eocene (Laki) Limestone proved by borings at Khewra.

The Salt Range has been termed the museum of Indian Geology, and the stratigraphic sequence offers a very interesting study. Most of the beds can be distinguished from a distance due to marked difference in colours of the various series.

The Age of Salt:

The age of the saline series of the Punjab Salt Range has been one of the most controversial problems of Indian Geology. Since a very long time two views have been held about the age of salt in the Punjab.

(*i*) Tertiary and (*ii*) Cambrian or Pre-cambrian.

The age of the Cis-Indus salt has been controversial because of its stratigraphic position below known Cambrian beds. Mr. E. R. Gee who has worked for several years in the Salt Range for the Geological Survey of India was an advocate of Tertiary view up till about 1940, when he changed in favour of the Cambrian view due to some "Critical Sections." That the sedimentary contact in certain places with the Talchir Boulder beds strongly suggests that the saline series are in their normal position having been deposited in Cambrian or pre-Cambrian times. But the Tertiary view has still stronger support as it is based not only on the evidence of stratigraphical and tectonic studies but on the irrefutable evidence of palaeontology. A very voluminous literature has recently developed on the problem of "Age." The tertiary view is chiefly based on the normal Tertiary position of the series in the Trans-Indus Range and that the abnormal position in the Cis-Indus Range is due to an overthrust. Had there been no evidence of overthrusts in the Range and if the important sedimentary contacts were universal, then Mr. Gee's view of Cambrian or pre-Cambrian age was certainly very acceptable. But there is ample field evidence to suggest overthrusts. In fact the most remarkable feature in the geology of the Salt Range is its overthrust structure. The uplift of the Range is related to the uplift of the Potwar geosynclinal basin. Though there is no support for a large bodily thrust of the type of an Alpine nappe, there is certainly a thrust of the Palaeozoic over the southern limb of Eocene rocks in the eastern part of the Range. Near the eastern end the saline series lies below the purple sandstones. Further to the west it lies below Salt Pseudomorph shales, the Talchir boulder-bed and Speckled Sandstone. Near Daudkhel gypsum overlies Nummulitic limestone. Different stratigraphical position of the series in various sections lends support to the Cambrian view. The writer tried to correlate the succession of beds in the oil horizons of the Potwar plateau, the Trans-Indus series and the Cis-Indus and the conclusion was Lr. Kirthar age for the saline series. The borings in the salt mine at Khewra and at the foot of the mine hill have afforded further evidence in support of the Tertiary view. Dr. Col. L. M. Davies who is regarded as an authority on Eocene foraminifera worked out independently Lr. Kirthar age for the series. Dr. B. Sahni has recently brought forth palaeontological evidence by the discovery of plant fossils in salt, marl, gypsum, dolomite and oil shales, in support of the Tertiary view. The palaeontological evidence has been questioned that the testimony of these fossils as age indicators is not beyond doubt, as they could be easily enclosed by flow of salt and marl or in porous dolomite. But it will be hard to refute the evidence of fossils found by the new technique in oil

shales. The persistence of the same forms in samples from several places far apart and in various components of the saline series offers a great problem to the "Cambrians."

The Salt Mines in the Cis-Indus Range:

Although several years ago, salt was worked at places such as Jutana, Kussak, Makrach, Malote, Nurpur and Katha where very good outcrops of salt exist and are guarded these days, the salt is mined at Khewra, Warcha and Kalabagh in the Punjab. Each mine forms an interesting study and will be described in a little detail.

Khewra Mines:

Khewra is situated in the Jhelum district and is the terminus for the Malakwal-Khewra branch line of the N. W. Railway. It is becoming a big industrial place. The Alkali and Chemical Corporation of India Ltd., have set up a plant for the manufacture of about 80 tons of Soda Ash per day by Ammonia Solvay process. The Dalmia Cement Co., Ltd., have established a factory for the manufacture of cement at Dandot two miles west of Khewra. The capacity of the plant is 250 tons per day but very soon it will be doubled or trebled. The Punjab Mineral Co., Ltd., are also carrying out their surveys near about Dandot and may set up some factory in the near future.

Gypsum forms a cap above salt marl on the mine hill. Salt has been mined at Khewra since the last several hundred years. The workings of the Sikh period exist even now but are too dangerous to be examined. There is a mention of salt at Khewra while Alexander the Great visited India. As the salt outcrops on the hillside there is no doubt that it must have been worked since very early times though by open quarries.

The present mine is called the Mayo Salt Mine which name dates back to the time of a previous Viceroy. Although there are a number of mine entrances, there is only one exit for the transport of salt through the Low Level Tunnel. As this main entrance is not altogether safe and in case of any mishap the whole output of the mine may stop, another passage is being driven about a thousand feet to the east. This is called the New Low Level Tunnel. It will connect up with the present mine in a length of about one mile. The length that has been driven passes for about half a mile through gypsum and anhydrite formations and may serve as a gypsum mine as well.

The low level tunnel of the Mayo mine passes through barren strata of marl and impure salt for about half a mile when it enters into the salt seams. There are three main seams of salt, namely Buggy, Sujowal and Pharwala, separated by thick marl from each other. The buggy seam is the thickest having yielded the best quality of "Bugga" (white) salt for a very long period. Its average thickness is about 200 feet in the west. It thins down to about 80 feet in the east. The Buggy and Sujowal seams become one near about Chamber No. 12, in which a height of about 230 feet of salt is exposed with another thickness of 30 feet worked out in the floor and now filled up with 'fines.' This chamber is usually shown to

visitors as a worthy sight. The seams dip to the north and are worked by three main development tunnels which have been driven in each of the seams and run from west to east along the strike. After running for about three quarters of a mile to the east in a regular manner, complications arise and the seams become distorted and dip to the south and east.

There are about twelve different levels one above the other from which the salt was worked or is being worked, five being above the ground level and six below it. The salt is worked by the pillar and chamber system. Each chamber is 50 feet wide from which all the roof and floor salt is worked leaving a pillar 50 feet thick. It is due to such strong pillars that the mine is so stable. Seldom an accident due to fall of unstable strata has been reported. Gun powder is used for blasting salt. The present output of the mine is about 50 lakhs of maunds annually which is about 66 per cent. above the pre-war average output. Electric and compressed air cutters are employed for cutting salt and traction is by electro locomotives. The mine is electrically lit. Not much technical skill was required previously in the working of the mine as the seams were very thick and regular. The working and development of the mine is now carried out in a very scientific manner. Very accurate surveys are carried out for the safe working at various levels and geology of the seams is thoroughly investigated. Mr. Gee of the Geological Survey of India gave valuable advice about 1933 when the Khewra Mine was thought to have exhausted. No estimate about the future reserves of salt has been made but it is presumed that it may last for the next 50 years. At the end of this period only 50 per cent. of the total salt in the mine will have been worked out as 50 per cent. is left in the pillars. Then the problem of removing pillars will have to be faced for which purpose stowing by Jhelum river sand or extracting salt by water may have to be resorted to.

Warcha Mines:

Warcha (village Rukhla) is situated in the Shahpur district about 9 miles from Gunjyal railway station on the Khushab-Kundian Railway line.

The mines are situated on the right of the Warcha gorge. On the other side of the gorge the salt marl is interstratified with purple sandstone beds by a series of strike faults. Speckled sandstones are also seen before passing into salt and marl in the mine. There are land slips on the mine hill and highly fossiliferous Permian limestone rich in chert, overlies the saline series with only a small thickness of lavender clays intervening. These mines are also fairly old and the Sikh workings exist.

The general dip of the beds is 30° in a direction North 30° West. There are four main seams of salt separated by bands of Khallar. Unlike the Khewra Salt seams, the Warcha seams are thin, maximum thickness of the lowest seam being about 50 feet and average 15'. Similarly the intervening marl is not more than 20 feet thick compared to as much as 150 feet thick marl at Khewra. The seams thin down as we go deeper and also from east to west.

The marl between the top most seam and the next lower seam which is only a thin band in the west Chamber 24 gets into a thick layer of about 25 feet in the east the upper seam becoming marly. The thickness of the top seams is reduced to one half about Chamber 24 on the west and the lower seams are marly further west. At the eastern end the seams turn upwards and end abruptly against clay beds. There has been frequent water trouble at this end. The mine is worked by four different levels which unlike Khewra being one immediately below the other are connected by inclined planes, the seam being worked out at variouus levels exposing roof and floor marls. 40 feet chambers are worked out and 30 feet pillars are left. The annual output of the mine is about 8 lakhs of maunds. The Warcha salt is very much prized by the traders as it is of very good quality and is sent out free of marl and 'Sur'. The present Warcha mine is not likely to last for more than ten years.

A tunnel has been driven below the lowest salt seam in chamber No. 20 High level. Here there is a rich deposit of a mixture of carnallite with magnesium chloride and sulphate and sodium chloride. It is remarkable for its richness in potassium chloride.

Kalabagh Mines:

The town of Kalabagh is situated on the right bank of Indus opposite Mari Indus and the narrow gauge railway line runs to Bannu. Though Kalabagh is situated in the Trans-Indus Section of the range, it is situated in the Mianwali district of the Punjab and the hill is a continuation of the Mari hill on the left bank of the river. The Mari hill is composed of rock salt and gypseous marl. It is all broken up and there is no regularity of beds. The gypseous marl is rich in bipyramidal quartz crystals which are termed Mari Diamonds. Recently a few drifts are being put in the Mari hill to locate any workable deposits of salt.

The salt and marl continue on the Kalabagh side. Above the salt and marl are greenish grey sandy and clayey Tertiary beds and coarse conglomerate chiefly consisting of limestone pebbles. Further north the escarpment of mid Siwalik sandstones faces the salt hill.

Although the Kalabagh mines are not very old, the quarries existed since very early times. When Lord Elphinstone visited the Punjab in 1809, he passed through the town of Kalabagh which he recorded was situated on salt beds etc. with lanes having pavements of salt. Even now some of the houses are so situated that the owners can break salt from the outcrops on the hillside through their windows. Fairly thick seams of salt exist near about the town and some years ago some drifts were working to explore the resources. But these have been closed.

The mines are situated about three miles up the river Indus on its right bank where the river takes a turn to the east at Wanda Kukranwala. The mines are situated on the right side of the Luni

gorge. The salt exists in the form of lenticles. There are no systematic workings but salt is worked in chambers which are underground quarries. The chambers have no fixed dimensions. The salt may be thick at one place and suddenly thins out in the next chamber. The best and worst quality of salt is found together at Kalabagh. It is unique in yielding some very dainty coloured salt of orange and lilac. Formerly there was a great variation in the price of various qualities of Kalabagh salt and the traders were given a mixed average quality. The salt from the mines is loaded on donkeys and brought to the depot at Wanda Kukranwala, a distance of about half a mile. From here it is despatched by boats for boat trade to places situated down the river near the river bank or for booking into Railway wagons at Mari. The annual output of Kalabagh mines is about five lakhs maunds.

It is almost certain that the saline series at all the three sources have been brought into place by an overthrust and along the planes of overthrust secondary gypsum has been deposited by the reaction of calcareous material with the sulphuric acid formed by the decomposition of iron sulphide in salt. If salt has been formed from a saline lake as already stated, then it should have been deposited in zones on the analogy of Stassfurt deposits Germany, though later alteration and metamorphism may have changed the chemical composition.

The Khewra salt contains potash salts much more than magnesium sulphate than Warcha salt and so corresponds to Kieserite or something between Kieserite and Carnallite zones. The Warcha salt is rich in magnesium sulphate and corresponds to middle position between the Polyhalite and the Kieserite zones. The Kalabagh Salt shows traces of potash and magnesia and calcium sulphate is common. Therefore it corresponds to something between the Anhydrite and the Polyhalite zones.

Truly the Salt Range, apart from its being a geologically classical region, with such rich reserves of minerals, is important from the standpoint of industrial development and will continue to attract scientists and industrialists alike for very many years.

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THE DAMAN BEYOND THE BRAIDED INDUS

By E. T. Dean, M.Sc., Forman Christian College, Lahore.

THE Indus coming out of the gorge at Kalabagh forms a large alluvial fan and is braided into many branches. The Kurram river joins it at a point 12 miles due west of Mianwali, whence the Indus flows through a broad alluvial flood-plain almost due south, and for about 25 miles running close to the Khasor range. The bed of the Indus is broad and sandy; its numerous channels are continuously shifting. The tract occupied by the main stream is about 4 miles in width and the flood-plain covers a tract about 12-14 miles in width.

The river and its main branches are navigable for country craft throughout their course. Flat-bottomed small steamers and motor launches ply in the main stream and its branches during the hot weather. In winter, a bridge of boats is constructed over the main stream and the several branches. The bridge of boats was first constructed in 1873 and has since then been kept up and dismantled during the hot weather (approximately Baisakhi to Dussehra). This bridge is a great convenience to the Pawindah merchants and graziers, who cross the river every autumn with their numberless camels, horses and cattle and return in spring, some of the Pawindahs trading as far east as Australia with their horses. Both the bridges and the ferry service are under the charge of the P.W.D. and the expenditure is considerable in excess of the income. Excluding the boats belonging to the Government, there are roughly 350 trading boats (freight 600 maunds) and over a 100 small boats (200 maunds). The larger boats go down to Dera Ghazi Khan, Mithankot and Sukkur, and usually make 3 or 4 trips. Most of the trade being in grain and wool.

Inflated skins, known as *sandari* are also used for crossing the streams and professional thieves are never without these.

The river with its everchanging course and its many branches forms the eastern boundary of the Daman. The word *damān* is a local distortion of *damān*, meaning foot-hills. The zone under consideration can hardly be described as foot-hills or even a piedmont plain. The western bank of the Indus is 585 feet above sea-level, while Daraband—a pass in the foot-hills about 40 miles due west of Dera Ismail Khan is 755 feet above sea-level. The gradient hardly justifies the name. The trans-Indus high-plain is popularly known as the *damān* and the flood-plain of the Indus as *kacha*.

The Damān is a long block of country stretching from the foot of the Suleiman to the right-bank of the Indus. On the west it is bounded by the independent territory of the Suleiman ranges, that separates India from Afghanistan. On the north it is bounded

by Nilah Koh (Blue Mountain) with Sheikh Budin as an important hill, which separates Dera Ismail Khan and Bannu districts and on the south by the Shirani ranges of the Suleiman (with Takht-i-Suleiman) and Dera Ghazi Khan. Part of the southern boundary is based neither on the natural features nor on ethnographical distinctions.

The Damān appears like an Indian hand-fan, with the mountain ranges on its sides and the Indus as the handle. It is this handle, the Indus which has handled its political, commercial and strategic destinies to a very large extent.

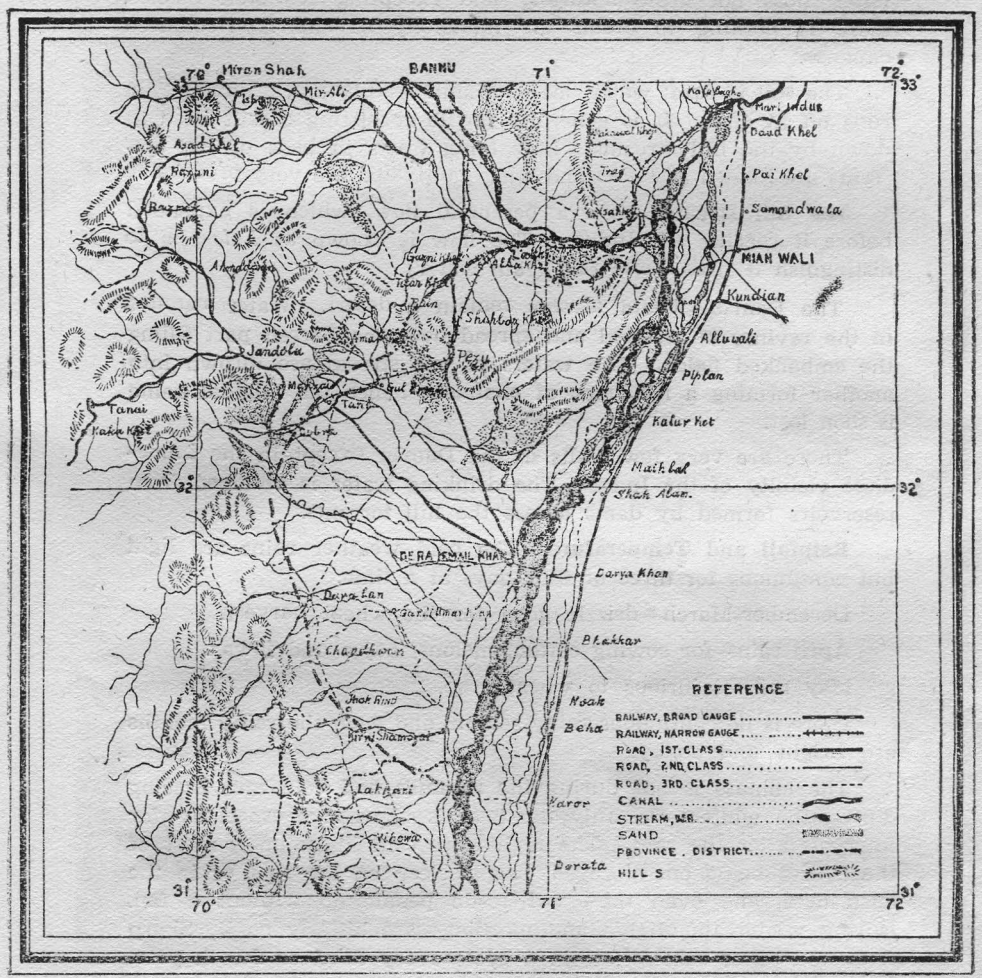


Fig. 4.—The Damān

After the Multan war of 1848, the territories of the Dera Ismail Khan District were annexed by the British Government in 1849. In 1861 the tehsils of Leiah and Bhakkar (the cis-Indus tract) were also part of Dera Ismail Khan. Jointly with this cis-Indus tract (previous to its separation on the separation of North-West Frontier

Province) this district was first in area and 22nd in population amongst the then 32 districts of the Punjab. This works to 8.72 per cent. of total area and 2.34 per cent. of the total population of the British Punjab.

The Suleiman hills present a straight line to the British Frontier. There are 71 passes leading in the hills, of which Vahoa, Zam, Gomal and Tank Zam cross the main Suleiman range.

There is very little variation in the character of the Damān. It stretches out flat as a billiard table and except for the narrow strip of land along the Indus, there is hardly any vegetation. Grass does not grow naturally and excepting scattered bushes, there is nothing to break the monotony of the mud-coloured expanse.

The soil is firm; water does not sink readily and ordinary rain runs off at once. It is generally fertile consisting of silt brought down by the hill streams. Low lying tracts in beds of hill-torrents are known as *Kacha* and when cultivated are very productive.

The hill streams have a perennial flow, which is expended before it reaches the Indus. The flow is known as *Kala-pani* to distinguish it from *Sufed-pani* (rain water).

The Damān, would always remain a desert. Water running in the ravines is arrested and spread over the barren part filling the embanked fields. The waters of one stream are thrown into another forming a net-work of channels, hence the original name is soon lost.

There are very few wells in the Damān except in the immediate vicinity of the Indus. The drinking water is obtained from reservoirs formed by dams across the hill torrents.

Rainfall and Temperature.—The cold weather rains are light but continuous for three or four days at a time.

December-March—drizzle good for the wheat harvest.

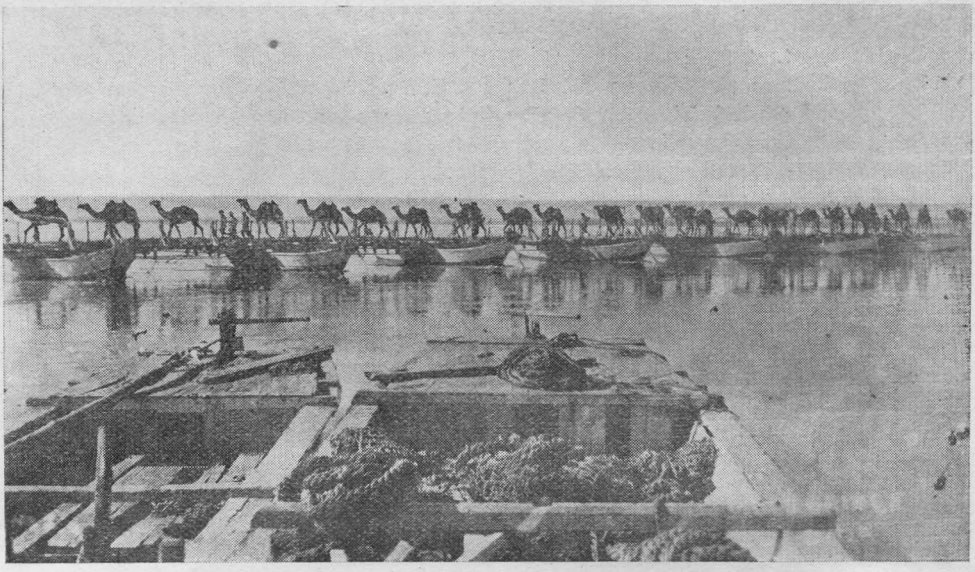
April rain—for sowing cotton, melons, bajra and jowar.

May rain—injurious to wheat crop.

There is no continuous rainy season, and even the rainy months are bright and sunny.

The climate is hot during the summer and cold and bracing during the winter. In July the heat is oppressive especially for intervals after the rain. The nights are cool in summer; most of the houses being one-storeyed, people sleep on the roof or in the open field, and even the well-to-do people do without a fan. During winter the nights and mornings are bitterly cold. Sharp frost and bitter cold follow in a cycle every third or fourth year, when small ponds get frozen.

Minerals.—Iron is produced in Waziri hills. No metals of importance are found in the Damān. Traces of lignite, alum, saltpetre are found in Sheikh Budin hills. Antimony is found in Nilah Koh and the Suleiman range. The Suleiman range has not been explored for its mineral wealth.



The Boat Bridge on the Indus

Pawindah Traders Camping at Dera Ismail Khan

Sajji is manufactured from *lani* by *dhobis* for local use. Limestone is supplied by all the hills and is used for buildings and metalling roads. There are no quarries at present.

Flora.—There are no forests of any importance. *Lani* is the great feature of the vegetation. *Lani* is a saline shrub used as fodder for camels and for making *sajji*. The most common trees are :

Phulah (acacia modesta), *Kas* (wild olive) and date-palm. Date-palm is of great value for the manufacture of matting and fancy baskets.

Fauna.—The fisheries are confined to the Indus. Fishing is free to every one and no revenue is raised, nor is there any export trade in fish. People are not fond of fish; hence the catch is very nominal. Otters are common and are often reared by *Kehals* (a wandering tribe) for hunting fish.

Black duck, tigers, hog-deer and pigs are practically unknown to-day. Fifty years ago cock-fighting and boar-fighting was a common pastime of the Nawabs, but this sport is practically extinct being replaced by tent-pegging.

Crops.—The soil is a hard clay, except for the alluvial land flooded by the Indus and is very uniform in character. Cultivation is carried on in embanked fields and is dependent on inundation canals and wells and to some extent rain (barani) and by Karez in Paniala lands.

The chief crops are jowar, bajra, cotton, wheat, barley and melons. Sarson is extensively grown and mustard flower occupies a prominent place in local literature and love songs.

Industries.—About 3|5th of the population is engaged in agriculture. Of these about 15 per cent. combine other trade with agriculture e.g., artisans, shopkeepers, or shepherds. Of the agricultural class a large number are both proprietors and tenants. The manufactures are very few. Coarse cloth (e.g., lungis, khes or checked cotton cloth) black blankets, turned and lacquered wood work are among the important manufactures. Bed-stead legs, teapoys, round snuff boxes are favourite amongst lacquered work. Shisham wood is used for this purpose. This work is considered the most tasteful and refined, of all lac turnery in the North, as crude and glaring colours are absent and there is definite system of ornamentation with microscopic fineness. The pattern scratching is mostly done by women—who by the way are the most industrious of any class of women in the Punjab or N.-W.F. Province. The production exceeds the demand. The industry has not been commercialised, as the town is out of the way; and it is again the braided Indus, which would be responsible for this industry becoming extinct. The projections in ivory are the weak point of this industry as they are loosely fastened and are most liable to injury.

Trade.—The Pawindah caravans enter the Damān by the Gomal pass during autumn and return in spring. The chief articles imported by them being:—

Dried and fresh fruits, madder, raw silk (Bokhara), wool, *charras* (from hemp) horses, *hing* (asafoetida) and tobacco.

Apart from Pawindah traffic, little or nothing beyond small consignments of ghee and wool leave the district for the east.

Cultural—The people generally live in mud-houses with flat roofs. The women, except those of the Nawabs and Syeds class do not observe purdah. The purdah of even the aristocrats is not orthodox. The women are pretty, have a good figure and a good sense of humour and as a rule make up for the absence of artistic taste in the men folk. As I have said before women are industrious, their chief occupation being needle work, a large share in lac turnery, tailoring, fancy shoe making, pashmina, wool-cleaning, painting potters' toys, fetching water from wells, picking cotton and as domestic servants. The chief food is wheat, bajra, lassi, melons, dates and a little meat.

The common dress consists of a shirt (*chola*),—a fancy *chola* usually studded with beads and coloured glass; loin cloth (*manjila*)—full length down to the ankles; sheet (*chaddar*) thrown over the shoulders and turban—all made from country cloth. Men wear their hair long down to the shoulders—a long bob, similar to the style common in Italian pictures (Balochs of the area go in for long ringlets). Both Hindus and Mohammedans grow their beard; the Mohammedans however clip the moustache while the Hindus let them grow free.

They always wear a charm and a tooth pick. Preparations of snuff with lime and oil, and walnut bark are used for cleaning the teeth and thus keeping away the dentist.

The language spoken is *Derawal* or *Hindko* as it is called by the Pathans. It differs considerably from Panjabi, has a hard accent and in vocabulary in some points is distinctly Sindhi.

The people are quiet, inoffensive folk. Anything untoward that happens is put down as the will of God. Tobacco smoking (as hukka) is common, even amongst women folk. Mullahs as a rule do not smoke but indulge in snuff. Hospitality is lavishly thrown in even to a stranger. Artistic taste is practically absent and there are few lovers of art.

The brass band, so common in the Punjab is entirely unknown. The musical instruments consist of an elongated drum (*dhol*), bag-pipe and *sharna* (clarinet).

Folk dances are spectacular and almost every villager—young or old, man or woman—can dance. Men and women do not dance together but separate rings of men and women could be seen dancing to the beat of the same drum at weddings and other festivals. The popular dance-*dharis*, except for the absence of a fair partner, is very much similar to the Lambeth Walk.

Military.—There is a chain of forts and frontier posts along the western frontier. Fort Akalgarh on the north-west of the town was built by Nau Nihal Singh in 1836 but has greatly been improved since then. There are several bomb-proof magazines.

The cantonment right on the bank of the Indus has always been in danger of being washed away by the Indus. With the construction of the Kalabagh bridge on the Indus and bringing Southern Frontier Province in direct link with Lahore and Rawalpindi, the military forces have been substantially reduced, the military being concentrated further west at Tank or Razmak.

Independent tribes along the frontier are mostly Mahsud Waziris, who are a powerful tribe and occupy the hills drained by the Tank Zam. They hardly remain quiet and at times even plunder the Pawindah caravans, passing through the Gomal pass. It becomes necessary some times to take coercive action against the Mahsuds. Tank occupies the north-west corner of the Daman and is the centre of Mahsud Waziris trade with the British territory. A light railway, built from surplus stock of the first World War connects Tank with Dera Ismail Khan. Then from Dera Ismail Khan after crossing the Indus (either by boat bridge or by ferry) we come to the nearest railway station, Darya Khan (16 miles from Dera Ismail Khan), into the civilization of the Punjab.

ENVIRONMENTAL INFLUENCES ON PUNJAB ECONOMIC LIFE

By Cyril P. K. Fazal, M.A.

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GEOGRAPHICAL conditions largely mould a people's destiny, although at rare intervals economic, religious or political urge makes man to overthrow his environmental handicaps. In fact the purpose of Education, using the term in its widest sense, is nothing but to train human beings to rise above the forces of nature around them.

The situation of the Punjab, her climate and her rainfall have in a large measure shaped her history, and the influences of these geographical factors are still visible in her economic life. Broadly, the Punjab may be divided into two parts, the Mountainous region and the Plains area. There are, however, some local features which affect certain areas and divide the Punjab into seven more or less distinct areas, which are briefly described below taking only the British part of the Province.

The first is the Himalayan region in the north comprising the small district of Simla (81 sq. miles), Kangra, including Kulu and the Murree Tahsil of the Rawalpindi District. In their cultivation these districts present the same feature of small fields resting against steep mountain slopes like ladders. The soil is shallow and has to be "made" annually after the heavy summer showers; the cattle are weak and puny. Until recent times Simla and Kangra were largely cut off from the outside world and offered a refuge to many tribes from the plains in the pre-British turbulent days. In highland tracts where man has constantly to combat the elements in the raw, he becomes intensely superstitious, and these two districts are noted for the large number of gods and goddesses to which each village gives allegiance. The state of nutrition of the people is also deplorably low and osteomalacia (softening of the bones) turns many people, particularly women and children who cannot leave their villages frequently, into misshapen human wrecks.

Murree has however fared better. Lying on the highroad to Kashmir it has had constant contacts with the outside world. In recent years however the population has increased so rapidly that in their effort to find sustenance the people have dealt hardly with land and forest so much so that the bug-bear of soil erosion is now rearing its head ominously there.

The next is the Sub-montane region where hill and plain meet. This comprises the districts of Ambala, Hoshiarpur, Gurdaspur and Sialkot. In olden days these were heavily wooded, but the forests are now no more eaten up by the sheep and goat pushed out from

the plains with the increase in cultivation there. The result is and erosion in the worst form and a good part of the Punjab earth now annually goes to the sea, carried away by 'chos' (flood torrents). Rainfall is plentiful, the soil fertile, and the sub-soil water near the ground surface—the last is perhaps the reason for malaria being found in an endemic form here. The pressure of population on the soil is heavy (except in Ambala which can be grouped with the eastern economic division of the province).

Below Sub-montane, lie the Central Districts, from Ludhiana in the east to Gujrat on the west and Ferozepore in the south. This is the real Punjab watered by *panj* (five), *ab* (rivers). Rainfall is not plentiful and canals and wells have also to be used. The intense summer heat and the biting winter cold have made the fabric of the people tough—a feature which has given the Punjab the name of "The Sword Arm of India."

Next we come to the Canal Colonies, lying west of the Central Punjab. Fifty years back, this was a forlorn area of scrub wood, scorpion and sand storms, "one of the dreariest countries in the world", inhabited by the jackals and the lonely nomad grazier. The canals have changed all this and the colonists originally selected with care for their traditions of good cultivation started a new life from scratch and have made a success of it. Rainfall is very little and the first inhabitants are said to have built roofs without water spouts, although this is perhaps an exaggeration. One disadvantage of canals in the Punjab so far has been that they bring disease in their train and, although the standard of health of these districts has certainly gone down compared with what it was in pre-colony days, the canals have brought at places a disease to the land in the shape of water-logging, together with its attendant, malaria.

The next area is the North-West—Jhelum, Rawalpindi and Attock—a land of rock and ravine. The soil yields little and the great stand-by is the army. Law and Order keep the untamed spirits within reasonable bounds but the Salt Range particularly is notorious for its village fueds. The people make good mechanics—a trait shared by a large part of the province also.

The Eastern Punjab, east of the river Sutlej, is more akin to the United Provinces than the Punjab proper. Rainfall though sufficient is capricious and badly distributed—one part of a village may be green with young crops, and the other lying waste with plants shrivelled for lack of moisture. Gurgaon has been described as "the darkness under the Imperial torch of Delhi." Hissar is noted for its famines, the term these days standing for scarcity of the means to buy rather than the absence of food itself, thanks to the railways. But fodder famines still prevail and these help in weeding out the weaker cattle, thus maintaining a high standard for the Hariana breed for which the tract is famous—some peculiarities in the Hissar soil help in the formation of the big bones of the Hariana cattle.

Lastly, there is the Western Punjab, a dry sandy land, with an actual desert, the Thal. Health in the upper part is excellent but in the lower where the Indus and the Chenab supply irrigation from

flood channels, the people are extremely lethargic. Cut off from the north and south by deserts, but offering a way into the Punjab, the tract has had a chequered history since even before the days of Alexander the Great. In the constant wars, the poor had to take refuge with the nearest chieftain of power, and the feudal spirit still persists under big landowners.

This completes the Punjab, but it may be noted that in all the above Economic Divisions there is one common feature. That is a phenomenal increase in population—a net gain of half a million extra mouths to feed annually. This increase is retarding all economic and social progress and forms a formidable problem to tackle. The only solution seems to lie in Education, again using the term in its widest sense, for then only can the people of Punjab overcome the handicaps around them and rise to fulfil their important destiny in the India of to-morrow.

THE MULTIFOLD ASPECTS OF GEOGRAPHY AND HOW THEY CAN BE INTRODUCED TO STUDENTS

By Miss Nirmal Anand, M.A., Kinnaird College, Lahore

OF all the various subjects taught in schools and colleges, Geography seems to be the most comprehensive in scope. This is so mainly because it is not one subject but consists of the elements of a large variety of subjects, History, Politics, Botany, Zoology, Astronomy, Geology, Meteorology, Mathematics, etc., in addition to topics which are considered purely geographical. One is therefore inclined to remark that to speak of a person as a master of Geography amounts almost to absurdity.

The study of this subject can seldom do more than convert one into an intelligent and interested student of all that there is to learn in the world. This, of course, does not apply to those who decide to specialize in some one or two of its branches. It is in this variety of interests which it creates a taste for, that the real virtue of the subject lies. The world with all its scientific development is too vast a subject to be studied in detail. So the only choice left to the student who wants at least a taste, if not a fuller acquaintance of all its many aspects is to obtain an elementary knowledge of them. This can best be imparted by a study of Geography rather than of any other single subject.

This quality of the subject will appeal to those who study for the sake of knowledge or curiosity alone. To others, all this talk might seem nothing more than just romantic. The latter kind of people are interested more in their mundane day-to-day affairs than in such tasting of life. However, even such people may study the subject with advantage and no regrets.

In these days, when science is making such strides and has wrought immense changes in man's life, the various problems of the world are very closely interwoven. Every single communal, national or international problem has to be studied from the point of view of the whole world if there is at all a serious desire to find out its solution. Not only is it essential to study the similarities in the development, but also the contrasts. In fact it is the contrasts that are more important. It is they that bring home to us so many lessons ignoring which the individual nations might not be able to progress as rapidly as they aspire to. Man would not have advanced very far if each individual had tried to learn from his own experiences alone. So the greater the ambition, the greater is the dependence on the rest of the world and the indispensable need for a better understanding of it. Hence the significance of such subject as would widen the vision until it encompasses the whole world.

Such a subject, then, should not seem dull to anybody even though every single one of its branches may not hold a uniform

appeal for all. But, actually, so far much interest has not existed in this subject.

Geography has been considered a very dull and useless subject until recently. In fact, few knew that it really contained anything beyond a dry list of names of rivers, mountains and so forth. Now, of course, it is becoming better known but still it does not have the appeal for college and school students that it ought to have.

This is so mainly because of the defective approach which the teachers and the taught make according to the present system of teaching. The study of advanced Geography with a good taste of all its interests, has to be based on sound foundations. It is not enough to learn a few facts by rote; it requires a steady and scientific 'building up' of the structure. The foundations have to be laid correctly and carefully from the beginning of the study of this subject but special attention should be paid when students reach the Matriculation and Intermediate stage of examinations. That is the time when the students become mature enough to study the subject scientifically and mathematically. This attention at the crucial stage has been neglected because there is often not only a great dearth of people qualified enough to be efficient teachers but also because the syllabuses prescribed for the different university examinations are much too extensive and full of repetitions to allow real intensive and scientific teaching. Instead of a 'building up' there is a 'cramming up' which takes all the thrill out of the subject leaving the student bored and lost.

Coming to practical suggestions, it is not sufficient to say that 'emphasis should be laid on the causes rather than effects' and so on. It is more important to prescribe courses which would enable the taught and the teacher to practise this precept.

In order to achieve this it is necessary to base the division of courses on two important stages of learning:—

(*a*) The Junior Stage—when students are being taught the foundations on which they are to build.

(*b*) The Senior Stage—when the filling in of details starts and advanced Geography comes into the students' ken.

The Junior Stage should mean the Matriculation and Intermediate classes and the Senior Stage, the B.A. and M.A.

There is very little scope for those who draw up the syllabuses for the Intermediate and Matriculation examinations, to do anything but prescribe courses which are:

(1) Short enough to allow time to students to study intensively, and

(2) exacting enough to lay broad foundations of the subject to build on later.

For the Senior Stage, however, those drawing up the syllabuses can have more latitude in the choice of subjects and extent of information required of the students.

The following suggestions for the Matriculation and Intermediate examinations should give a clear idea of all that is implied in the foregoing discussion.

MATRICULATION

1. The Earth as a Planet.
   The accepted Theory of its origin.
2. **Elementary** Geomorphology.
3. Geography of India with special emphasis on its trade.

If the student is able to know all this well it should be considered a good enough preparation for the Intermediate standard. This can be ensured by having a higher standard of marking examination papers than that which exists now.

INTERMEDIATE

1. Elements of Atmospheric Phenomena.
2. Climatology—the study of which will give the first picture of the natural relationship of one country to another—the similarities and contrasts.

This should include latitudinal and theoretic distribution of temperature, pressure and winds and the actual modified account of the inequal distribution of land and water. This will lead to a study of the climatic regions and the causes of the occurrence of corresponding types on corresponding positions with respect to latitude and the continents.

3. The effects of climate and other factors on vegetation.
4. An Introduction to Human Geography which could be made by a critical examination of the life of peoples living in different natural regions of the world and their relation to environment.
5. Oceanography—the same elementary things as are prescribed in the present syllabus of the Panjab University.
6. Asia excluding India.
7. A short introduction to the making of maps.
8. A few projections.

With some such division of courses for the Matriculation and Intermediate examinations, there will not be any scope left for repetition of courses by those who draw up or for 'cramming up' by the students on account of lack of sufficient time to be able to learn thoroughly and scientifically. The needless extensive nature of the divisions resulting in making the subject heavy and uninteresting will have been done away with altogether.

The students and the teachers will be able to enter upon the senior stage with greater interest and confidence. Those who draw up the syllabuses for the latter stage will also be able to have more latitude in their choice on account of their having allowed the students to have had a foundation, sound enough, to build on at the senior stage.

ARAB CONTRIBUTION TO GEOGRAPHY IN MIDDLE AGES

By Shyam Sunder Bhatia

THE Geographical work of Ptolemy marks the climax of the Greek and Roman contributions to geography and the beginning of a period which can aptly be called the "Dark Age in the history of Geographical discovery and exploration." During this dark age—the early centuries of Christian era—the enthusiastic spirit of enquiry, for the quenchment of thirst for knowledge, which had distinguished the Greeks, gave way to theology. The high intellectual and geographical attainments of Greeks failed to find favour with the advocates of Christianity who deliberately avoided the pre-Christian geographical views. Monk Cosmos in his book "Christian Topography", written about the middle of sixth century, entirely refuted the ancient pre-Christian scientific concepts about astronomical geography. Cosmos attempted to combine the theological view with his conceptions of geography and with the support of Biblical texts he logically concluded the existence of a flat rectangular earth, twice as long from east to west as from north to south, surrounded by the oceans. Further he was of the opinion that in the north stood a high mountain behind which a tiny ball of light, the sun, played hide and seek to produce the phenomena of day and night. Such conceptions of the universe show the great depth of the pit to which the unscientific-theological-minded advocates of Christianity had thrown geography ; and in fact it is in contrast with these conceptions that we are to judge, in the field of the science of geographical discovery, the contributions of Arabs who not only re-introduced the old Hellinistic spirit of pursuance with a hungry eager heart for knowledge, but also carried it much further than the ancient pre-Christian views about geography, which they had imbibed.

The Arabs were definitely the heirs of that Hellinistic thought and culture to which the gate was first opened by the conquests of Alexander the Great and which became widely diffused throughout the eastern parts of the later Roman Empire. The Hellinistic influences were diffused into the eastern lands through the translations of works of noted Greek authors and these translations from Greek to Arabic laid the foundation of that geographical science which the Arabs were to carry so far. Though both the Christian west and the Muhammaden east were the heirs of the same Hellinistic thought and culture, it was only in the Muhammaden east that we find a serious pursuit of geographical science and the creditable outcome of the Greek sources, from which it grew.

The rise of Muhammad, the Prophet of Arabia, is one of the most stupendous events in history. He appeared at a time when the Byzantine and the Persian empires were exhausted by series of desperate campaigns. The Arbabs became believers in a creed which united them and attracted by the love of riches, they founded the

greatest empire the world had seen. The religion of Muhammad, the Islam, gave the Arabs an impulse to diffuse their culture through the spread of their religion. This impulse for the spread of religion and vastness of their empire, gave the Arabs a stimulus for geographical research. Moreover, the journey of the Muslim traveller was facilitated by that brotherhood of Islam which gives the Muhammadan world its cosmopolitan character and enables community of faith to shut out all differences of race and origin. The generous hospitality at the hands of co-religionists could definitely be expected. The vastness of the empire necessitated a first rate system of organisation and in order that there might be rapid communication between the capital and the outlying provinces, a net-work of roads—naturally the shortest links between places—were kept in good order. Another stimulant which furthered the cause of geography through religion was the pilgrimage. It was the duty of every Muslim to go on a pilgrimage to Mecca at least once in his life time, provided he had health and money to meet the expenses during the journey. Consequently, throughout the Muhammadan era, the pilgrims have been setting their faces from every part of the world wherever the Muhammadans lived, towards the holy city, to attain fulfilment of their pious aims. The results of these travels are too obvious to need mention.

The last circumstance—one common to almost every community of the world—which stimulated travelling in the Muhammadan world, is commerce. The merchant enjoys respect and consideration which are closely connected with the origin of his faith in the Muhammadan society, because Prophet Muhammad, the founder of Islam, had been himself a merchant and thus conferred upon the trader a dignity which gained for him access to the highest society. The medieval travellers were interested mostly in the precious stones—pearls, diamonds and corals, etc., the scents—musk, amber and cloves etc., the silk and woollen stuffs, furs, skins and in metals such as copper, lead and tin. The geographical references to places where the articles of trade were found, show the widely extended area in which the medieval traveller threw his net. The extensive commercial activity and the vastness of the Muslim world, in collaboration with the impulse and facilities which the religion gave, along with the personal urge and spirit in pursuance of knowledge, resulted in immense contribution and great advancement of the geographical science in the hands of Arabs.

Arab contributions to Geography fall broadly into two categories:—(*a*) Descriptive geography (*b*) Mathematical and astronomical geography. The contributions to cartography were not many and of high standard as in other branches—in fact no real contributions can be said to be made. The reason usually assigned is the Arabs' love for decoration and the idea of correct visual impression rather than accuracy. The general representation of world on map was based on the old Greek conception of an encircling ocean, though the increased maritime activity resulted in disappearance of the Ptolemic conception of land-locked Indian Ocean.

Arab contributions to descriptive geography include the descriptions of various places and countries, both physical and cultural. The contributions in descriptive geography not only contain the descriptions but also the interpretation of the various facts particularly those related to the human side. The descriptions reveal their superiority over the Greek and Roman geographers in the field of human geography. The credit of separating human geography from the dominating tangle of mathematical and astronomical geography and showing the importance of the study of man's reactions to his environments, definitely goes to the Arabs. We may call Arabs as the originators of the idea contained in Dr. Mill's latest definition of geography. The descriptions of the Arabs apart from the human side reveal that they not only were adventurers on land but also over the oceans, far and near. Arabs' knowledge of oceans was certainly superior to that of Greeks and Romans who had only meagre and incomplete knowledge. Some of the manuals dealing with the Red Sea, the Persian Gulf, Arabian Sea and the Indian Ocean have come down to us. The adventures of bold Arab seamen, who brought back their stories, formed the basis of the story of Sindbad the sailor, in whose delightful company we visit the Spice Islands, we escape from whales, we see flying fish and again we visit the east coast of Africa up to Madagascar and then travel to south India and Ceylon. Much that they reported we know now to be true.

Ptolemy's knowledge about the regions around the Caspian Sea and north-east of Black Sea was scanty. His knowledge about Africa was very meagre and the only well-known area was the Nile Valley which too, was fully known with certainty. To him Africa largely meant the coastal regions of the Mediterranean and bordering desert Fringes and Egypt. The Arabs on the other hand penetrated into Sahara and explored Sudan after the conquest of Egypt. Of the coasts of Africa, Romans and Greeks had, no doubt, some knowledge but these actually were confined only to littoral portions. Arabs claim deep penetrations in these coastal areas and inland as far as the modern Natal. Ptolemy had supposed that the south-eastern Asia extended westward to join Africa thereby making the Indian Ocean a land-locked sea. This conception of Ptolemy evaporated like anything with the advancement of maritime activities of Arabs. About the northern regions, Ptolemy knew little. Arabs claim to be first to show on map the sea of Arab. The Arab traders frequented places into far northern regions but it cannot be said exactly as to which extreme point they reached. However an Arab geographer seems to have collected the information from Arab fur traders that they had been to places where night was shorter than an hour. Probably they went a considerable distance to the north. Ptolemy's knowledge about the east was also not correct, for he believed that beyond China was an unknown land. The Arabs reached China both by land and sea, though the passage through sea is not very certain and it might only be a fabulous story connected with Sindbad the sailor or the like; because many Arab writers had a tendency to mix fiction with fact. Anyway the

Adventures of Arabs were innumerable in nearly all directions. Another thing of great importance, of course next to travel, was writing about their experiences and their preservation. Had this faculty not been present, we would not have come across the immense literature on the geographical science in the Arabic language.

An account of the leading geographical writers and their valuable contributions is of enormous interest. One of the earliest Arab pioneers of geography was Ibn Khordad-beh who was postmaster of the Jibal province, the classical media, in the first half of the ninth century. Being an official he had access to much valuable statistical information and compiled his book "On Routes and Kingdoms", which included an account of his scientific views completely in accordance with the Ptolemic school and a valuable summary of the great trade routes, extending as far as the borders of China. Unfortunately he introduced fabulous stories in his book but still it was considered as an official guide then. Another geographer of the early period was Yakubi who wrote in about 900 A.D., his gazetteer like compilation, "The Book of Countries," giving details of names of places, their distances from one another, their physical geography and what is more important is that he gave a number of facts relating to their human geography. He was an experienced traveller and his works have largely been used by other writers. He unlike other Arab geographers did not mix fact with fable and has been called the Father of Arab geography. The next great geographer is Ibn Haukal who travelled far and wide for over thirty years. He wrote a comprehensive account of his travels in his book, "Of Ways and Kingdoms", which he finished in 988 A. D., furnishing a geographical, political and statistical account of the vast empire of Khalifs. His conception of geography was, in his own words: "It being a science which interests princes and peoples of all classes." Istakhari, the merchant traveller, had travelled widely from India to the Atlantic and from the Persian Gulf to Caspian Sea. Of the accounts of his journeys, he compiled a book, "On Climates," illustrated by maps. More valuable, however, is the contribution of Masoudi who travellled all over the known world from Spain in the west to Turkistan in the east, while Sofala, Zanzibar, Sind and China are all mentioned by him. He wrote in 956 A. D. the "Meadows of Gold," which contains much geographical information. Masoudi was the first Arab explorer to visit and indicate the existence of the sea of Arab.

Idrisi, though not one of the greatest Arab geographers, is most familiar to Europeans since he was a native of Spain. Educated at Cordova University, Idrisi acquired a taste for travelling and travelled through Africa, Asia Minor and Europe where he reached the shores of France and England. He excelled all the Arab Geographers in his knowledge about Europe. He later settled at the court of Roger II, King of Sicily. He made a map of the world in Silver for King Roger II in 1054. He divided the known world into longitudinal climatic zones. He has given numerous maps, navigation charts and a book, "Rogeri," in which

he gives a wealth of information about Christian Europe, not found in earlier Arab Works. Yakut, the greatest Arab geographer and an energetic traveller, flourished early in the thirteenth century. His parents were Greeks but while he was still a small boy, he was carried off as a slave and sold to a merchant at Baghdad. His master gave him a careful education and sent him on long journeys connected with his business. In this way Yakut acquired an extensive knowledge of the various parts of the Muhammadan world. His chief work was the compilation of two dictionaries, Geographical and Biographical, which are rich in detail and include valuable notes of natural phenomena. These dictionaries were largely compiled from writings of earlier geographers but enriched with material, he had himself collected during his travels. Yakut produced books which, because of their aiming at a certain degree of completeness and accuracy, were regarded as models.

In Arab geography are two best-known figures which owe their reputation to the extent of their travel. The first, Albiruni spent his life in travel and study. He spent a part of his life in the country south of the Caspian Sea and accompanied Mahmud of Ghazni on his Indian invasion about 1027 A. D. He spent a considerable time in India too. Accounts of his travels are given in his books, like "Surviving Monuments" and "Account of India". He considerably developed the Mathematical side and carried on geodetic measurements. He explained the occurrence of natural springs and artificial wells by laws of Hydrostatics. His description of India at the beginning of the eleventh century is also a work of great importance. The other great figure in Arab travels is Ibn Battuta who was born at Tangier on the North-African Coast. He set out from home when he was only twenty-two and his travels extended to 75,000 miles and took him to East Africa, India, Malaya Archipelago, Palestine, Arabia, Persia, Syria, Caspian Sea and Black Sea areas and Spain. After these travels, he came to Fez where he dictated accounts of his wanderings which are the most interesting works ever compiled.

But Ibn Khaldun, the greatest historical thinker of Islam, remains a remarkable figure among the Arabs. Besides writing "Universal History," he gave a comprehensive analysis of the human civilization known to him. He has attempted to correlate the environment with human activity, taking into account the physical facts of climate and geography as well as moral and spiritual forces. He traced the effects of both climatic conditions and local environment upon physical and mental qualities of different people. Furthermore, he divided the whole mankind into two classes, nomads and citizens. The nomadic life, naturally precedes and produces the other. In fact, Ibn Khaldun was a great pioneer of social science and it is to his "Muqadamma" or Introductory Volume of his History, that we are greatly indebted.

Arab contributions in the field of Mathematical and Astronomical geography are of very high order and certainly much superior to that of Greeks and Romans. Their religion made it necessary for

them to determine the latitudes and longitudes of places with accuracy since it had to be utilized in making sun dials to indicate the noon-day prayer time and in securing the geographical co-ordinates of Mecca, towards which the face was turned during prayers. The accurate determination of longitudes and latitudes had been a problem for Arab geographers. Albiruni found that the methods adopted by his predecessors were faulty and he put into practice the terrestrial method for calculation of longitudes. The results obtained by him with the terrestrial method are remarkably accurate. His book "Kānun-Masudi", on astronomical geography is well known. The credit of correcting the length of Mediterranean also goes to the Arabs. The method used by astronomers of early Arab period for finding out latitudes was the same as used by Greeks, but Ibn Haitham introduced a new method for finding out latitudes much more accurately. The Arab geographers who contributed mostly to mathematical and astronomical geography were Farghani, author of "Elements of Astronomy", Ibn Yousaf who compiled the famous "Hakimite Tables", and Battani who wrote a book on "Movements of the Stars."

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IRRIGATION AND ELECTRIFICATION IN THE PUNJAB WITH THE MARCH OF TIME

By D. P. Bhutani

THE Punjab is predominantly an agricultural area where agriculture provides means of subsistence for the bulk of the population. The wealth of the province, in an overwhelming degree, or even the entire structure of her economy is founded upon the fields of her cultivator, who is the chief source of greatness to the province. Agriculture, as a matter of fact, forms the basic industry which gives birth to a number of dependent industries, that employ almost 75 per cent. of the population in different departments. And agriculture is but essential to preserve the nation from rapid annihilation on account of unscrupulous exploitation in the era of excessive growth of industry.

The Punjab Government have felt the pressing need of the development of agriculture and have, therefore, given it considerable importance in their post-war plan. The first step towards this end could only be taken by increasing cultivation and giving it better security against drought and famine and, for that purpose, the existing irrigation facilities are being contemplated to be extended and new methods of irrigation employed.

There are still very large areas particularly in the north, south-east and west Punjab, which are dependent for their agriculture on scanty and often erratic rainfall and are badly in need of irrigation. The Forest Department is helping this cause by means of conserving rainfall so as to make more water available for irrigation, but real help can only be provided by the development of hydro-electricity in the province, to materialise tube-well irrigation schemes where canal irrigation is not practicable. In order, therefore, to provide extended irrigation facilities and cheap electric power, the Punjab Government have given a high degree of priority to the schemes relating to the Hydro-Electric and Irrigation Departments in their post-war development plan, which has been prepared to wage war against poverty by exploiting the entire power resources of the province and utilising them for irrigation, domesticity and rural industrialisation, and by introducing and spreading a network of canals throughout the province which will enhance agricultural produce and automatically help restraining the waters of the six mighty rivers that sometimes cause devastation by floods.

And last but in no way of lesser value is the idea behind all other motives of providing vocation to numerous persons, out of at least a million Punjabis, who left their homes in connection with the prosecution of war, and who are returning to their homes, now that the hostilities have terminated.

The first Five-Year Plan is intended to make a beginning so as to ensure steady progress in the giant plan of fifteen years, ahead. The Irrigation Department has obviously set to work very enthusiastically. Four responsible engineers were sent to the most scientifically advanced foreign countries to study the latest designs for developing their schemes and imaginations into practical form.

IRRIGATION SCHEMES :

The Thal Project has been framed to take a canal from the Indus at Daudkhel near Kalabagh about 4 miles below Mari Indus for the irrigation of land in the Mianwali, Muzaffargarh and Shahpur Districts. When the entire project is completed, the canal will command an area of approximately 16 lakh acres and will fully utilise the discharge of 6,000 cusecs authorised under the existing arrangements with the Government of Sind. In addition, 182 miles of branches and 1,000 miles of distributaries will be constructed. A discharge of 10,000 cusecs, if permitted, is contemplated to be utilised either for extension of irrigation or for the generation of hydro-electric power or for both. The total cost of this project is estimated at more than 5½ crores of rupees.

The Mianwali Hydel and Pumping Project.—A 35 feet fall in the escape channel from the tail main line of the Thal canal will be utilised for generating 6,600 Kw. of hydro-electric power, out of which 3,800 Kw. will be used for irrigation, by pumping, an area of 140,000 acres of good land between Daudkhel and Mianwali.

Rasul Hydel Tube-well Project has been introduced to reduce the water table, wherever it has risen high on account of extensive irrigation by means of canals, to a reasonable distance below the surface, because the rise in water table results in deterioration of crops owing to salt brought out to the surface by capillary action. Under the above scheme, plant for generating 22,000 Kw. will be installed at Rasul where an 80 feet head is available, and power will be used to pump water from tube-wells of about 3,000 cusecs capacity to be sunk in the high water table areas. This gigantic project will take three years to complete. The water from the wells will be used for irrigation and will permit the cultivation of about 65,000 acres of additional crops per annum in the province. The project is also designed to fit in with the future development of electric power in the province. The power-station at Rasul will be linked with the grid and there will be an interchange of power between the project and the grid.

Bhakra Dam and Canals.—On the completion of the Thal Project, the Punjab canals will have fully utilised the entire winter discharge of rivers of the province. Its further irrigational development must depend largely on the storage in the hills of surplus water of the monsoon period which, at present, runs waste to the sea. (These dams will help both irrigation and hydro-electric power to be generated in abundance). During the last two years, the Punjab has investigated, in more or less detail, the following storage schemes:

Bhakra Dam on the Sutlej, the Kisan and Kalsi Dams on the Tons tributary of Jumna, the Chandni Dam on the Giri tributary of

the River Jumna, the Dhiangarh Dam on the Chenab and the Larji Dam on the Beas, as well as a number of small storage schemes. Of these the Bhakra Dam Scheme is the most promising. It has been taken up first and work has been feverishly started.

The project contemplates a dam 480 feet high across the Sutlej in a gorge at Bhakra, to store 4.3 million acre feet of water, of which 3.5 million acre feet will be live storage capable of discharging during the 270 days, when annual river supplies are non-existent, a mean discharge of 6,000 cusecs.

The irrigation system will consist of about 200 miles of lined Main line and its distributaries, covering about 4½ million acres. Rohtak, Hissar and Karnal districts will get perennial irrigation. This project will generate 160,000 Kw. of power. The whole scheme is estimated to cost about 42.01 crores over a period of seven years. Net profit after completion of the scheme will be 35.13 lakhs annually. An officer of the Irrigation Branch has already been deputed to U.S.A., for the purchase of essential machinery for this project. Four officers, including one Chief Engineer, were sent to America to study the art of high dam construction and design.

Kalsi Dam.—This scheme involves the construction of a dam 210 feet above river level on the Tons tributary of the Jumna River at Kalsi. This dam will supply power to Ambala, Ludhiana and Karnal districts and to factories at Jagadhri and Surajpur. This scheme will be used only for generating power. This project is going to be constructed with about 548 lakhs.

The Bist Doab Area.—There are two problems of this area:

(1) Sinking of water table in the Jullundur District, because of increase in the number of irrigation wells.

(2) Denudation in Hoshiarpur District by hill torrents coming down from the Siwaliks. Remedy proposed for the first is the construction of a non-perennial canal taking off from the Sutlej at Rupar. This project is going to cost 177 lakhs and will irrigate 80,000 acres. For the second problem, the Forest Department has busily undertaken to remedy by means of various plans in the coming years. Retardation and storage bunds in the "Chos" are in hand.

Gurgaon Project.—One scheme comprises the construction of a 90-day non-perennial canal from the tail of the Delhi Branch of the Western Jumna canal and carrying the discharge through a tunnel under the Delhi Ridge. It will protect an area of 420,000 acres against famine. The proposed discharge is 1,800 cusecs to irrigate 150,000 acres. Three more dams are also proposed to be built, costing 5 lakhs each.

Conservation of Western Jumna Extension to Perennial.—Extensions of Western Jumna canal are desired to be converted into perennial. 526 tube-wells will be constructed for this purpose, which will cost 122 lakhs.

Hydro-Electric Schemes.—For all the above schemes and for the future plans of the Industrial Departments, which initially demand huge hydro-electric power because the Punjab is deficient in coal and

fuel oils, water resources must be tactfully harnessed and exploited. The plan has been carefully worked and work has been started in some cases.

The Uhl River Project.—Among the projects in operation before the war, the most important was the Uhl River project.

The Uhl River is a tributary of the Beas and its waters have been harnessed at a site on the spur of the Dauladhar range in Mandi State.

From the headworks, situated at Brot, water is withdrawn from the Uhl River and its tributary, the Lamba Dag, and made to flow through a tunnel three miles long and then through a pipe line to Jogindernagar, where the main generating station has been set up at a height of 41,000 feet above sea-level. Here the hydro-electric energy is transformed into electric energy at 11,000 volts, stepped up for transmission purposes, to 132,000.

The Uhl River project serves at present an area of 46,000 sq. miles and a population of fifteen lakhs.

Five New Schemes.—Five more schemes are now under consideration which will be taken up simultaneously in 5 years.

(1) The Rasul Hydro-Electric and Sialkot-Gujranwala-Lyallpur-Rawalpindi Transmission and Distribution Project, which is the most important of them, provides for the construction of a hydro-electric power station at Rasul with two 11,000 Kw. Kaplan generating sets. The turbines to be used will be the largest of their kind in the province. Thirty towns in the north-west Punjab, including Gujranwala, Lyallpur, Jhang, Sialkot, Gujrat, Rawalpindi and Sargodha, in different circuits, will be supplied with cheap grid power as a result of the project. Orders for the purchase of material and equipments, required for the operation of this scheme, have been placed with British manufacturers.

(2) The Mangla or Mianwali Hydro-Electric Scheme with a generating station either at Mianwali or Mangla aims at harnessing the water of the upper Jhelum canal, and its execution is not expected to be particularly difficult.

(3) The scheme to link up the Shahdara thermal power station of the Lahore Electric Supply Undertaking with the Uhl River Hydro-Electric project. When this scheme materialises, it is not unlikely that Lahore city will be supplied with power in summer from Jogindernagar direct. It may also result in a considerable saving in coal consumption. Moreover, water power is definitely more reliable, not withstanding the long transmission lines, and equally definitely cheaper to supply than power, generated under a grid system worked by thermal plant.

(4) The Jullundur-Ludhiana-Ferozepore Transmission and Distribution Scheme will be the source of electrification of a number of important villages in south-west Punjab.

(5) Addition of a pipe line with a 12,000 Kw. generating set at Jogindernagar. This scheme will be usefull for generating more power and serving the new towns covered by the new transmission and distribution schemes. Departmental negotiations for materialising this scheme have been started.

These schemes when completed at the end of five years, will augument the present limit of primary power generated in the Punjab, which is approximately 20,000 kws. to approximately 54,000 Kws., and will substantially enhance the power supply to the main grid and enable it to cope with the greatly-accentuated demand for power, which has so far remained unsatisfied owing to shortage of plant and material. To large areas in the Punjab, it will then be possible to supply electricity at comparatively cheap rates.

Since the new projects cover practically the entire province, power would be available through them to urban as well as rural areas, for industrial as well as irrigated purposes, for big as well as small industries. In spite of the huge outlay that the schemes are likely to involve, they are not expected to prove a loss on the capital invested and a few years' working is expected to bring a dividend of upto 4 per cent. Total cost of working the schemes is estimated at Rs. 8,84,49,000.

LAHORE-AMRITSAR INDUSTRIAL REGION

By Vishwambhar Nath

DURING recent years there has been a rapid growth of factories along the railway line between Amritsar, the chief commercial centre of the Punjab, and Lahore, its Administrative capital. The growth of factories has been especially rapid during the war, so that now most of the railway stations on this 35-mile stretch of railway line, have their group of factories. As may be expected the greatest concentration is near the two cities, and the number of factories decreases as the distance from the cities increases.

Nature of the Industries:

Most of the industries are the industries of the cities, re-established in the suburbs. Others like manufacture of heavy chemicals have been originally started here. The factors favouring the shift of the factories from the city to the suburb are:—

1. **Cheap Land.**—Land for factory site and construction of labourers' quarters is cheaply available. Expansion is also easier than in the crowded city.

2. **Cheaper Labour.**—The labourers' cost of living is lower in a suburb than in the city. Besides labourers can be easily recruited from among the people of the surrounding country-side.

3. **Elimination of Haulage.**—Location along the railway line means a great saving in the cost of carrying raw materials and coal from the railway station, and the finished products back to the station. The importance of these costs is great because coal and nearly all the raw materials—all heavy and bulky things—have to be imported.

The Centres.—The accompanying map shows the stations, where factories have sprung up.

They are : 1. **Chheharta.**—Three miles from Amritsar. It is the most important manufacturing centre of this area. It has the most varied, and the largest number of manufactures. These include Cotton, Woollen, Silk and Artificial Silk Textile mills, Steel Re-rolling mills, factories manufacturing small metal goods and wire products as bolts, nuts, screws, galvanised buckets and other metal ware; Pharmaceutical Works, Hosiery and Carpet factories, and flour mills. Some of the industries of the town have simply been transferred from the city of Amritsar. Manufacture of textiles, hosiery, carpets, and drugs belong to this class of industries. Others have been originally started here. Steel Re-rolling, is an example of this type. The number of factories in the town is rapidly increasing, and from the present trend it appears that one day Chheharta will be the outstanding industrial centre of the Punjab. The town has, besides factories, godowns and provincial depots for some of the biggest manufacturers of India.

2. **Khasa.**—Khasa, the next station, is important for its distillery, which is the biggest in the province. The Punjab is deficient both in coal and fuel-oil. There is, therefore, a great scope for the manufacture of power-alcohol in the province. But Khasa, is not well suited for this development. It lies about 50 miles to the west of the chief sugar-cane growing area of the province. It is most probable, therefore, that the distilling industry at Khasa will not expand much.

Between Chheharta and Khasa are Heavy Chemical Works, manufacturing Sulphuric Acid, and other heavy chemicals. The various factories of the province are the chief buyers of these chemicals.

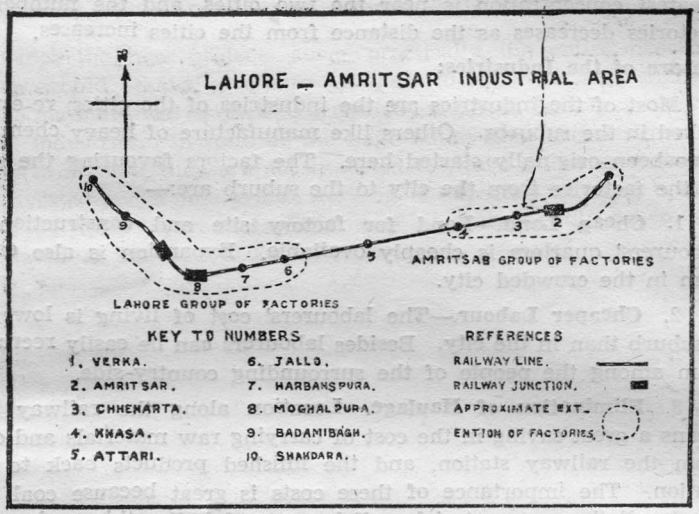

Fig. 5.—Lahore-Amritsar Industrial area.

3. **Jallo.**—There are no factories between Khasa and Jallo, and the country-side is free from any trace of industrialisation. With Jallo begin the industrial suburbs of Lahore. Jallo has Resin and Turpentine Factory. The works are among the biggest in India. The pines of Punjab and Kashmir Hills supply the raw material. A large number of bye-products are manufactured. But a far larger can be profitably manufactured. These works have greatly helped the manufacture of Paints, Varnishes and Boot Polishes in this province.

Bata Shoe Co., Ltd. have recently installed a very large plant at Batapur, near Jallo. The factory is quite modern in all respects and has residential quarters for the senior staff.

4. **Harbanspura.**—Harbanspura has Stationery Works and His Majesty's Mint.

5. **Moghalpura.**—It has the North Western Railway Workshops, one of the largest railway workshops in India.

Factors:

Nearness to the two biggest cities of the province has been the most important factor in the growth of industries in this area. These

cities have furnished markets, capital, enterprise, management and labour,—every thing except power and raw material. Let us analyse these factors in detail:—

Markets.—The industries were primarily concerned, in most cases, with supplying the needs of the population in the cities. Now however their products find markets all over the province. In this too, the influence of the cities is important. Being the cultural centres for the province, they are the radiators of new ideas, and fashions. Thus the products of such industries as Fine Textiles, where design is all important can easily capture the provincial markets.

Capital, Enterprise and Management.—The first capitalists were businessmen who had been dealing in similar goods for a long time. Here we have an instance of the trader becoming the industrialist. Amritsar is, the chief piece-goods market of the province. The cloth merchants took advantage of the experience acquired as traders, in establishing textile mills. Similarly the Druggists of Amritsar have started the Pharmaceutical Works.

Labour.—This is one of the most thickly populated areas of the province, with a rural density of over 300 persons per square mile. Besides, there has been in the two cities, a steady influx of labourers from the overpopulated Districts of Kangra and Hoshiarpur.

The railway workshops at Lahore and railway repair-shops at Amritsar have been of great help because they have created in the two cities a class of skilled mechanics. Skilled labour has also been available from the ancient small-scale industries of these cities. For instance The Handloom weaving industry of Amritsar has provided skilled labour for the textile mills. Thus labour, skilled and unskilled, is easily and cheaply available.

The Pattern:

The linear pattern of the area is likely to persist, and it is not improbable that one day an uninterrupted chain of factories may be visible along this 35 miles tract of railway line. And there is no reason why the factories should only be confined between the two cities. Already they have grown beyond them. Badami Bagh, with its Steel Re-rolling Mills, and Shahdara with its Flour Mills, Match Factory, Pharmaceutical Works, Government Dyeing Factory and Electric Equipment Works, are already two important centres. These two are in the vicinity of Lahore. Verka, with its Textile Mills, is a similar centre near Amritsar. (See Map.)

So long as coal remains the main source of power and the railway remains the chief means of transport, this tendency to cling to the railway line, will remain.

Industry can spread out into the country side only if (1) Hydro-electricity, the only alternative source of power, is as cheaply available as coal, (2) Road transport becomes more important.

The Industries:

1. **Textiles.**—The fact that Amritsar was the chief piece-goods market of the province led to the establishment of the industry. The same fact is responsible for its continuance and is likely to lead

to its future progress. The Punjab is one of the best markets for finer quality of goods, and this area is and will remain the chief centre for finer textiles in the province. Its advantages over any other area are:—

1. Nearness to markets.
2. Readily available trained labour.
3. Ease of importing finer yarns and dyes and other chemicals.

2. **Rugs and Carpets.**—This was an old cottage industry of Amritsar. Now it is being run on factory lines. Formerly it had a great market on the continent. This no longer exists. A market can be created in the U.S.A., or the home market expanded. Otherwise the future of the industry is not very bright.

3. **Steel-Re-rolling.**—The industry uses mostly scrap, and supplies iron and steel to foundries and machine shops all over the province. With greater industrialisation of the province the demand for tools, implements and machinery will increase and this industry will expand to meet that demand. But that is all. A large iron and steel industry cannot be established in this area because it has neither coal nor iron ore.

4. **Flour Milling.**—This is an industry which has a firm basis and a bright future. This area, lies in the heart of the wheat-producing area of the province which is the biggest producer of wheat in India. Situated along the main line of the N. W. R. this area has got the greatest facilities for the export of flour and wheat products, like *suji* and *maida*. Flour milling is likely to continue as one of the major industries of this area.

5. **Heavy Chemicals.**—The industry exists because of the demand from many small factories of the Punjab. Nearness to market is its only advantage. No great expansion is probable in the future, because the industry suffers from the great handicap of having no raw material occurring nearby. The heavy chemicals centre of the Punjab will be Khewra, with its salt mines, and not Chheharta.

Drugs and Fine Chemicals.—This is an industry of great cities. Its growth here is, therefore natural. An added advantage is the fact that Amritsar is the biggest collecting centre for indigenous drugs, in the Punjab.

Rosin and Turpentine.—The industry can have an important place in the economic life of the province if the manufacture of bye-products, especially or dyes, is developed.

Future.—At present we depend upon imports from outside the the province and even outside India for a large number of manufactured goods of daily use. This area, with its advantages of nearness to two big consuming centres, is likely to manufacture most of them. Thus manufacture of such goods as electrical equipment, leather goods, toilet articles, paints and varnishes, hardware, etc., will grow. This area is destined to have the same position in the economic life of the Punjab as the manufacturing area round London has in that of England or New York in that of U.S.A.

It is already to some extent, and will be more so in the near future, the great "consumer's goods manufacturing centre" of the Punjab.

Its industries can be put on a permanent footing by the development of Hydro-Electricity on the Upper Bari Doab Canal. There are a number of rapids on this canal between Madhopur and Gurdaspur. They can be utilized to produce electricity which will be produced within 50 miles of the consuming area and will be cheaper than power generated from coal which is imported from a distance of about 1,000 miles.