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It is hereby notified that during the year 1951, in lieu of the usual four numbers of the journal, a Souvenir Volume to commemorate the Silver Jubilee of the Indian Geographical Society will be published. The matter for this Souvenir volume is now in the press and it will be released shortly.

The cost of publication of this volume of approximately 400 pages, is more than double the annual printing costs of the Journal. Members are requested to give a donation to the Society to meet this increased expenditure. Donations, however small, will be gratefully acknowledged.

Members and subscribers are earnestly requested to remit their subscription as early as possible to enable the Secretary to despatch the copies of the Souvenir volume. Copies will not be sent to members who are in arrears.

GEORGE KURIYAN,
Hony. Secy., The Indian Geographical Society,
and
Editor, "The Indian Geographical Journal."

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The Editor takes no responsibility for the views expressed in the Journal. Authors alone are responsible for their respective statements.

PHYSICAL ENVIRONMENT AND HUMAN RESPONSES IN ASSAM

BY

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INTRODUCTION

During the period of British political control over India, Assam was treated as a large, and sound, tea plantation; the economy of the whole province was directed towards the maintenance and development of this super money-crop as the back-bone of the province; TEA, then, commanded first consideration in all economic schemes of the province. So great was TEA that all the main communication and transportation lines passed through tea-plantations and collecting centres rather than centres of human concentration; thus large towns like DIBRUGARH, SIBSAGAR, JORHAT and NOWGONG failed to come in the main railway line; even today they are reached only by branch lines. Apart from plantations, other aspects of the economy of the province like agriculture, industries and commerce remained comparatively undeveloped. The whole province, with a population of some ten millions and an area of 72,300 sq. miles, remained economically backward as compared with other provinces in India.

The partition of India and the associated independence affected Assam rather strangely; while the new Government of India was bound to take greater interest in the welfare of the people of the province, the province itself lost about 22,000 sq. miles of territory and some two million people as a result of the partition. Further, the province was, very inconveniently, isolated from the rest of India by Eastern Pakistan. Since August 1947, the province has had to face the additional problem of dealing with Hindu refugees from Eastern Pakistan. With an already undeveloped economy, Assam has had to face the post-partition period with a reduced area, an increasing immigrant population and a geographic isolation from the rest of India. While these are serious man-made problems that will tax any Government, there were other problems which have challenged the ingenuity of the provincial and central governments

for many years—problems set before the people of Assam year after year by NATURE in all her glorious and rebellious moods; it is about this latter type of problems this paper is concerned.

PHYSICAL ENVIRONMENT

The physical environment in the province expresses itself most dynamically through surface relief conditions and climate. These two expressions of the physical environment need to be understood clearly before human responses to them can be appreciated or criticised.

Surface Relief Features: The whole province can be divided into four physical regions: these are:—

(a) The Brahmaputra Plain,

(b) The Surma-Barak Plain,

(c) Shillong Plateau and associated mountains and hills, *

and (d) Manipur Plateau and associated mountains and hills; *

It is necessary to note here that these four regions are essentially very broad ones which could be further subdivided into distinct parts; for example region 'd' includes the Naga Mountains, the Manipur Plateau and the Lushai ranges, with all the associated drainage basins.

THE BRAHMAPUTRA PLAIN: This is surrounded by mountains and hills on all sides except the west; it is a little over four hundred miles in length and has an average width of sixty miles. It is essentially a large alluvial plain with a piedmontal region around Sadiya, in the extreme north-east. The Brahmaputra river flows through this plain eroding its banks and depositing material wherever it could. Small and large stretches of sandy banks and islands occur repeatedly in its course from Dibrugarh right down to Dhubri. From about Tezpur the river begins to meander more markedly as it flows westward.

So many ranges of mountains all around it (ranges of the Eastern Himalaya, the Patkal, the Naga, the Khasi-Jaintia and the Garo mountains) provide for a very large supply of tributary streams, which receive most of their water-supply from monsoon precipitation. During the second half of the monsoon period, middle of July to end of September, the main river rises by about ten to fifteen feet, near Gauhati. Such a rise in level may not appear great if one forgets the general dimensions of the river, viz., an average width of fifteen hundred yards and a minimum depth of fifteen feet in the main stream; with such dimensions an increase in the level by about fifteen feet within four months is very significant.

The major tributaries of the main river are:—

east to west, from the right, the DIBANG, DIHANG, SUBANSIRI, BHARELI, DHANSIRI, BARNADI, MANAS and CHAMPAMATI;

east to west, from the left, NOA, BURI-DIHANG, DISANG, DIKHO, JHANZI, DHANSIRI, SONAI, KALANG and KRISHNAI

* Regions c and d are generally referred to as HILLS, as, for example, Khasi Hills, Naga Hills and so on. Geographically many of these ranges must be termed mountains because of their high elevations, often over one thousand metres.

THE SURMA-BARAK PLAIN: A large part of this plain lies within East Pakistan; only about ten thousand sq. miles come within Assamese territory. The area within Assam is made up of a narrow and long corridor, to the south of the Garo and Khasi-Jaintia mountains, with an average width of fifteen-twenty miles and an overall length of about 120 miles, and an irregular polygon extending from Agartala to the eastern borders of the Cachar District; the latter portion extends from south-west to the north-east for about one hundred and forty miles, broken by many spurs of the Lushai ranges.

The Barak river has its source in the Naga ranges and flows southwards east of the Barail range, which is itself the westernmost range of the eastern mountains of Assam; south of the Barail range the river turns westward and northwards to flow, finally, in a south-westerly direction. The Surma has its origin in the eastern ranges of Khasi-Jaintia system and flows in a westerly and southerly direction to join the Barak some ten miles west of Habiganj, a town in Sylhet, East Pakistan. The Surma-Barak is, thus, different from the larger Brahmaputra because both the Surma and the Barak derive their head-waters from the mountains of Assam, which are nowhere high enough to be snow-feeders. Consequently the Surma-Barak system is essentially monsoon-fed and has high seasonal fluctuations; the period of hot weather is a period of low water in this system; the monsoon period produces very marked increase in level of all the streams associated with the Surma-Barak drainage because of two factors, viz., the monsoon precipitation is the only major source of water for these rivers and monsoon operates with great vehemence because it is on windward side of the central and eastern ranges of Assam.

The parts of the Surma-Barak plain that come within the territory of Assam are essentially piedmontal in character and contribute much to agricultural activity in these limited areas. The havoc wrought by floods in the Surma-Barak is also mainly beyond the scope of the province, in the low level areas of East Pakistan where the plain is less than thirty feet above sea level.

THE SHILLONG PLATEAU AND THE ASSOCIATED MOUNTAINS AND HILLS: This region, extending over 250 miles in an east-west direction, has an average width of forty miles and presents an elevated tract of land between the Brahmaputra plain and the Surma-Barak plain. The whole region has an average elevation of 4,000 to 4,500 feet above sea level and forms a transverse barrier to monsoon winds that blow from the Bay of Bengal during the May-September months. Geologically, the region is composed of Archaean gneisses and granites, which are overlain by sedimentary rocks in the southern sections. The sedimentary beds include sandstones, shales and coals; in the Garo Hills the coal seems are "estimated to contain thousand million tons within a depth of thousand feet from the surface." *

This elevated region presents a steep face to the south and a gentler sloping face to the north; this is particularly so in the central Khasi area where, to the south of Shillong, the southern front of the Shillong Plateau rises from the Surma-Barak plain very abruptly; Cherrapunji perches on this steep slope very precariously. It is between Cherrapunji and Shillong that the highest elevations of this central mountains of Assam are found; the Shillong plateau reaches an

* GEOLOGY OF INDIA AND BURMA by M. S. Krishnan, The Madras Law Journal Press, 1949, (page 469.)

elevation of 6,400 feet five miles south of Shillong town. Valley slopes are of the order of 1/1 to 1/5 in this region; erosion is at a tremendous pace because of the combination of steep slopes and deluging precipitations.

THE MANIPUR PLATEAU AND THE ASSOCIATED MOUNTAINS AND HILLS: Here, in the eastern part of Assam, lie a series of N-S ranges connecting the Eastern Himalaya Mountains and the Burma Yomas. These connecting ranges begin with the comparatively narrow Patkai mountains of the north-east and pass on into the wider Naga ranges and Manipur Plateau to end up in the Lushai ranges of Southern Assam. The Patkai, the Naga and the Manipur regions form the elevated land that separates the Upper Brahmaputra Valley from the Upper Chindwin Valley. The highest elevation is reached in the Naga ranges where Mt. Japvo exceeds 9,800 feet above sea level. Structurally, these ranges are believed to be young fold mountains of the Tertiary times.

The steep valleys with a north to south trend form very effective barriers to communications between the Brahmaputra and the Surma-Barak plains, on the one hand, and the Chindwin valley, on the other.

Climate: Three broad climatic periods may be distinguished in a year for the province of Assam; these are (a) the hot dry season, (b) the rainy season and (c) the cool dry season. These seasons, however, differ much in their duration, the cool dry season being longest in duration, while the hot dry season is shortest.

The hot dry season begins in the month of March and reaches its full force in April; this is the month of frequent fires in Assam. Day temperatures rise above 85 degrees F. The bamboo, that forms 85 percent of the material used in the construction of buildings, becomes bone-dry; the smallest spark is enough to set a whole section of a town burning. Scorpions fall from the roof and meander across the floor to seek refuge in the bamboo walls of the house. Fortunately for the people of Assam this hot season is quite short in duration, about two months, and is cooled down by the irregular precipitations that introduce the regular monsoon; the month of May is thus a transition period from the hot dry season to the rainy season.

The monsoon sets in in the month of June and continues right upto the middle of September, often reaching into November. In the Brahmaputra plain the precipitation varies from sixty to one hundred and thirty inches; in the Surma-Barak plain the variation is from one hundred to one hundred and eighty inches; the southern slopes of the Khasi-Jaintia ranges and the Shillong Plateau receive very heavy rains, generally exceeding two hundred inches. Cherrapunji, on the southern slopes, receives an average rainfall exceeding four hundred inches per annum ; Gauhati, to the lee of the Khasi-Jaintia ranges, receives an average rainfall below seventy-five inches a year. Sylhet, in the Surma- Barak plain, receives a mean rainfall of one hundred and sixty inches.

The rainy season, extending over four months, while tending to keep the temperature down, creates a 'hot-house' atmosphere that is very trying. Relative humidity goes up above 80% ; roads do not dry up and remain slushy for the whole period of the rainy season ; clothes do not dry easily even when exposed to the sun ; the washerman, usually irregular, takes a long vacation and rests at home. The landscape, everywhere, turns green and plants sprout up on every inch of the soil ; frogs start such a row in the night that it is impossible to sleep unless one is dead-tired.

The best season in Assam, the cool dry season, follows the trying rainy season and makes one forget the trials of the previous season. Fortunately this season is long and therefore completely compensates for the rigorous trials of the rainy season. Settlements in the Brahmaputra plain experience delightfully cool days and nights, the diurnal range being fifteen to twenty degrees. Night temperatures go down to the low fifties while the day temperatures are in the seventies. This is the season when people can do a lot of work if they choose to, particularly in the plains. * On the mountains the cold atmospheric conditions become somewhat more trying and uncomfortable to man and beast; both migrate down to the plains, the tigers often becoming a regular nuisance to the people of the plains.

HUMAN RESPONSES : In general the people of Assam seem to have responded to their environment rather tamely, accepting Nature's rulings in a submissive spirit. It is, however, not correct to assume that the physical environment in the province could have been completely overcome by human efforts ; nor would it be correct to assume that the people of the province, by themselves, are fully responsible for the submissive part they play against their environment ; under the British rule the people never received guidance or encouragement to respond boldly to their environment. The following are some arresting examples, which indicate where the human responses have been strong and where they have been weak or unwise.

UTILISATION OF NATURAL RESOURCES : In this respect evidence of strength and weakness appear together, with weakness leading.

Topographic, climatic and soil conditions are favourable in many parts of the province for tea-plantations ; the human response has been remarkable ; TEA forms the major money-crop of the province. In 1941 over 430,000 acres were under tea, yielding approximately 290 million lbs. The credit for this magnificent development of a valuable plantation crop goes mainly to the European planters.

Abundance of water is another characteristic feature of the province ; if man had attempted to utilise this valuable gift properly the province would have

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* Climatic Data for some typical towns of the province :

Station		Annual Rainfall	Rainy Days	Mean Daily Max. Temp.	Mean Daily Min. Temp.
Aijal	...	82.72	123.9	—	—
Cherrapunji	...	425.16	158.3	68.6	52.2
Dhubri	...	97.9	95.1	82.7	68.2
Dibrugarh	...	209.91	135.1	81.2	65.2
Gauhati	...	63.46	89.3	84.7	66.6
Imphal	...	58.01	103.2	—	—
Kohima	...	74.97	122.1	—	—
Shillong	...	84.64	121.9	69.9	53.5
Silchar	...	129.7	137.0	86.1	67.4

(Rain in inches ; temperature in degrees fahrenheit ; a day with more than 0.1" of rain is considered a rainy day ; all data kindly given by the India Met : Office).

excellent urban water-supply systems, a net-work of navigable canals and many hydro-electric generating stations; none of these exist over a large part of the province. Gauhati, the biggest town of the province, suffers from water scarcity even fifty yards behind the banks of the mighty Brahmaputra ; while fires consume house after house in the town, the waters of the Brahmaputra flow by placidly unable to stop the fires because man has failed to utilise this natural supply of water so close at hand. Other smaller towns are in worse position.

Hydro-electric potentiality of the province is very great; the Khasi-Jaintia and the Garo ranges possess, particularly in their southern valleys, some of the ideal spots for the generation of hydro-electricity ; some of these valleys are deep and narrow and receive annual precipitations exceeding 200 inches. Power produced in these valleys would be quite near the larger settlements of the Surma-Barak plain and the Brahmaputra plain. Excepting for a small hydro-electric station at Shillong, supplying power to that town, the whole area is significantly lacking in such power stations.

The waterways of the province could be improved and made more dependable throughout the year than they are at present. The Brahmaputra itself seems to have lost the traffic it used to have in the pre-war years ; regular passenger service does not exist to-day ; it is impossible for a tourist to take a comfortable trip up the river, or down it, at short notice; the vessels themselves are in poor shape, having been maintained in a careless fashion. The Surma-Barak plain can improve its system of waterways by constructing a broad net-work of canals fed by reservoirs at the eastern margin, the same reservoirs producing power at their bases.

Coal occurs in the Garo and Khasi-Jaintia region in mineable strata; while the quality may not be such as to encourage transport over long distances to other parts of India still the quantity (over thousand million tons in the Garo area alone) and nearness to the surface are encouraging enough for the production of electricity near the areas of occurrence; since these ranges and the Shillong Plateau are centrally located in the province the problem of power distribution would not be very serious. Unorganised mining is being practised at present, particularly between Shillong and Cherrapunji. Coal is being exchanged for rice and other commodities from Pakistan. Coal also occurs in the Naga ranges, to the north-east of the Dayang. *

Limestone, sandstone and state occur in the Garo, Khasi-Jaintia and the Naga sections of the province. These building materials are rarely used for constructional purposes in the province. Instead of these the bamboo is used for constructional purposes. It would be better to restrict the use of bamboo for pulp and paper industries and adopt more solid building material for constructing houses. Japan has given up bamboo construction even though it is in a highly seismic area. The loss by damage to solidly constructed buildings during an occasional earthquake (serious one), occuring once in three decades, may not be more than the loss sustained during the same period in the shape of bamboo structures sacrificed to the fire; one must also reckon here the value of paper that could have been manufactured with that total amount of bamboo lost in the burnt-down houses.

* Actual mining of soft coal is being carried out in this area, particularly about Margherita, Ledo and Nazira, approximately between 27 and 28 deg. North Latitudes.

There is not one large up-to-date cement factory within the province even though limestone is available for feeding it. Production of cement within the province will encourage the construction of more and more reinforced concrete structures, which have proved their worth against Japanese earth-quakes. An ideal situation for a large cement factory would be Shella, south of Cherrapunji, at the southern foot of the Khasi-Jaintia ranges. The mechanically driven rope-way from Cherrapunji to the plains would prove a great help for the transport of the limestone from the Shillong Plateau to the factory.

Bamboo grows over most parts of Assam, thriving particularly along the banks of the numerous streams of the province. The people of the province use this valuable materials either as fuel or as a constructional medium. The coal of the Garo-Khasi-Jaintia region could be used as fuel and bamboo could be released for paper industry; limestone, sandstone and cement would replace bamboo as constructional medium. Paper and pulp industry would prove a very valuable addition to the economy of the province, yielding a substantial income to the state and the investors.

Soils of Assam are another natural resource neglected by the local people ; the soils suffer not only indifference from the people but, often, positive cruelty at the hands of some of the tribal people. Broadly the soils of the province may be divided into two groups : the alluvial soils of the two plains and the forest soils of the two mountainous regions ; the first type is very good for agriculture and can be extensively utilised for rice cultivation ; the forest soils, rich in humus, will suit development of plantations, like tea, sal and teak. It is the latter type of soil that is being cruelly treated in some places ; soil erosion is helped by 'UP AND DOWN' ploughing, burning down trees for charcoal, and jhum cultivation (a nomadic type of land utilisation, jumping from plot to plot). Better land utilisation will result if all the lands in the two plains are placed under the supervision of the Department of Agriculture and all the lands in the mountainous regions under the supervision of the Forest Department. The experts from the two departments will be able to advice the land-holders and the cultivators on the proper utilisation of the different soils under different topographic conditions.

The animal life within the province forms another gift of Nature ; among all the provinces of India Assam, probably, possesses the largest variety of animals. Elephants, tigers, rhinoceroses, wild-boars, bears and wild-buffaloes are some of the larger animals known to exist in the province. Deer, jackals and hares form the typical small animals of the province. Floricans and vultures are among the more common larger birds to be seen in the province. With such a variety of animals and birds, the province has not instituted many game sanctuaries and zoological gardens. Game sanctuaries, at regular intervals, along the banks of the Brahmaputra would prove a great attraction to tourists and help the province to preserve the many species of animals it possesses. While one must realise the scope for such utilisation of the animal and bird life in the province, one should not forget the serious problems that these animals set before the people. The elephants and the tigers become a regular menace to man, his agricultural crops and domesticated animals.

COMMUNICATIONS: The very heavy precipitations and the consequent surface streams prove a serious obstacle to the development of railways and roads in the province. Railways and roads need to be kept at a high level in the plains,

the level varying from three feet to seven feet above the general level of the surrounding land. But with all these difficulties a better system of road and rail communications can be maintained. Good roads, like the GAUHATI-SHILLONG road, are rare and limited in scope ; even the GAUHATI-SHILLONG road is, for the most part, an one-way road and provides for restricted traffic. More roads, and better roads, will encourage bus traffic between the many settlements that are as yet unconnected by railways.

The railways of the province suffer from one general constructional blunder, viz. the metre gauge tracks. As a result of this gauge the Assam Railway remains disconnected from the other railways of north-eastern India ; through travel between Assam and Bihar, for example, is not possible. Within the province itself through travelling is made impossible by the absense of a railway bridge over the Brahmaputra ; the change-over from the train at the north bank (Amingaon) to the waiting train at the south bank (Pandu) is usually a matter of very great confusion and delay, the ferry steamer crossing the river being generally packed to the gills with a restless and motely crowd. Turning to the maintenance of tracks and carriages one has to express the same dissatisfaction with existing conditions ; at the time of the recent great war some routes were double-tracked and now the railway authorities are neglecting one track, allowing grass to grow over the track ; excellent refrigerator cars are parked in the sidings rusting and rotting in the humid atmosphere ; first class compartments leak at their roofs when a heavy rain sets in.

If one turns to the natural waterways, particularly the perennial Brahmaputra, there also the same stupour exists. Good passenger steamers, which used to ply up and down the river regularly before 1947, are moored at Gauhati and one is told that there is no regular service for passengers and tourists, who wish to avoid a cargo vessel.

A significant development in the communications of the province has been, however, the civil air routes, providing for dependable and regular flights between Calcutta, Gauhati, Jorhat, Dibrugarh and Agartala. Since other communication facilities are poor, the number of people taking to planes is increasing : the scope for further extension of air-routes in the province is good ; a lowering of rates may produce a remarkable increase in the number of travellers by aeroplanes.

MENTAL ATTITUDES: The people of Assam, generally, seem to prefer a civil service job or work in their own lands to anything more adventurous or commercial. Investment in industries or commercial concerns is very small because of this attitude towards commerce and industry; handloom weaving is preferred to factory weaving, typing as a clerk to sawing as a carpenter; carpenters and masons are, as a result of this attitude of the people, mainly Biharis. Only a small number of Assamese have gone beyond the frontiers of the province. This strong attachment to 'home-towns' and the so-called 'dignified jobs' is keeping the people of the province extremely conservative. Discontentment and ambition have been the causes of progress in most countries; a good amount of this will force the province forward.

It is, however, necessary to note here that the sense of contentment and the long confinement to their home-towns have made the people of the province friendly and tolerant; the people are free of that narrow provincial feeling

so characteristic of other provinces, that have had many years of inter provincial competition in education, industries and commerce. In short, the people of the province, tribal and otherwise, may be described as comparatively 'unspoilt' by, and ignorant of, modern ideas and practices of human responses to physical environments.

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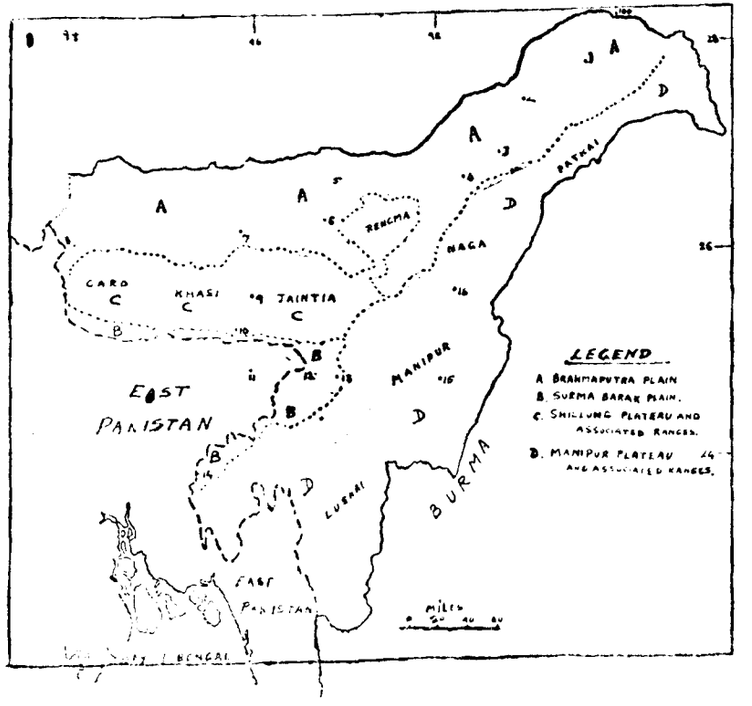

Reference numbers in the map:—

i.	Sadiya	ix.	Shillong
ii.	Dibrugarh	x.	Cherrapunji
iii.	Sibsagar	xi.	Sylhet
iv.	Jorhat	xii.	Karimganj
v.	Tezpur	xiii.	Silchar
vi.	Nowgong	xiv.	Agartala
vii.	Gauhati	xv.	Imphal
viii.	Dhubri	and xvi.	Kohima.

GEOGRAPHICAL LANDSCAPE IN CHOTANAGPUR

BY

Prof. P. P. KARAN

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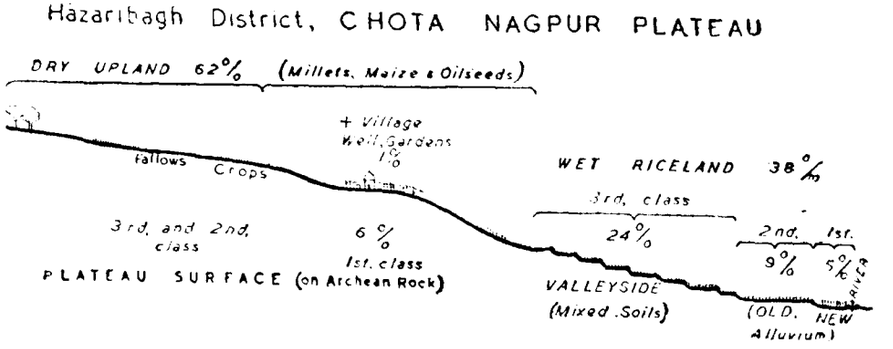
The southern half of Bihar which comprises the region of plateaus, hills and intermontane valleys is usually called Chotanagpur. The Chotanagpur region provides a fascinating field of study both to the geologist and to the geographer. The morphology and the development of landforms of the region is an interesting study for the geomorphologist. The influence of the physical geography and environment on the present activities and achievement of the peopie in this region furnishes another field of study. The cultural landscape of Chotanagpur likewise forms an interesting study in human ecology. The object of the present paper is to put on record some of the observations in the geographical landscape made by the author. It is hoped that a record of these observed facts of the landscape of Chotanagpur will stimulate further and more detailed work by others.

PHYSICAL GEOGRAPHY AND LANDSCAPE

Chotanagpur plateau is the easternmost continuation of the plateau of peninsular India. The present surface features of the plateau are the reflection of the long and complicated geological history of the area. The sketch of the geological evolution is thus a preface to its present topography. The geological foundation of the plateau consists of a series of batholithic intrusions of granite into ancient sedimentary strata known as Dharwars which were highly metamorphosed into quartzites, phyllites, schists and slates. Over high plateau much of the Dharwar cover has been eroded away and remnants are found in patches within the central area. The central gneissic region has been peneplained more than once. Ranchi plateau has two erosional surfaces (1) above 2000 ft. from the foot of the western laterite-capped higher plateau (30 miles north to south) from Lohardaga eastward for 60 miles, and (2) above 1000 ft. slopes down to Gangpur State south of Simdega and eastwards to Manbhum plain. The central 2000 ft. plateau of Hazaribagh occupies a small area and represents an old land surface. Towards the west of Ranchi plateau is a higher plateau cut up by tributaries of North Koel, into many isolated mesas having average height of 3000 ft. locally known as 'pats' capped with laterite. The upper surface of the Ranchi and Hazaribagh plateaus have the appearance of old land surface with broad and meandering valleys, while near the margins the topography is juvenile, the rivers actively downcutting their beds and reaching the plains below with steep gradients and waterfalls such as Hundru Falls, Johna Falls, Dessan Falls, Hirni Falls and the Kakolat Falls. There has been volcanic action and lava flows which form hills. Dalma hills at Jamshedpur consists of lava flows. The Damodar basin occupies a faulted belt in which were deposited wastes of the adjoining highlands and large quantities of plant debris from the dense forest of the time which gave rise to the rich beds of coal.

HUMAN OCCUPANCE

For centuries man has used this segment of the earth's crust. The first inhabitants of the Chotanagpur plateau were driven from the Ganges plain by the Aryan invaders. They practised hunting and migratory agricultural economy. Later on the primitive folk were forced to retreat further into the forests by sedentary agricultural people, spreading due to population pressure in the surrounding areas. These primitive folk termed "aborigines" like the Mundas, the Hos, the Santhalas, the Oraons are found mostly in the forested and interior areas of Ranchi, Palamau, Singhbhum, Manbhum, Saraikella and Kharsawan. The latest episode in the occupance of Chotanagpur has come with the utilisation of the mineral wealth. This has brought about in its wake a great increase of population. The dense population in the Damodar Valley is associated with the emergent landscape of coal. The urban population is the outcome of the industrialisation. This is well illustrated in the case of Jamshedpur, where the steel works has led to the growth of a population of more than 1.75 lacs in what was formerly known as Sakchi village. With the growth of mica mining, population has increased over the northern part of Hazaribagh district in Kodarma, Tisri and Domchanch regions. The growth of population in Singhbhum parallels closely with the development of the iron ore deposits of Kolhan and the copper mining and smelting in Dhalbhum. Mining of bauxite deposits had led to the occupation of the inaccessible regions of western Ranchi.



FOREST LANDSCAPE

Forest landscape is representative of a large area of Chotanagpur. The forests constitute a great natural resource of Chotanagpur. The full value of Chotanagpur forest wealth is not to be assessed merely in terms of money, timber output, fuel and innumerable by-products. In Chotanagpur the forest land serves other ends, by breaking the force of the heaviest rainfall. They thus prevent floods and devastating erosions, awe-inspiring examples of which may be seen in certain areas devoid of forest protection. Agriculture cannot attain its fuller and proper development without the requisite amount of forest in close proximity. Forests are a slowly maturing asset with little early return on the investment. The temptation to exploit them is thus too great to permit of any large scale forest control by private enterprise. To check the ravages caused by erosion it is necessary that afforestation should be undertaken in deforested parts of Chotanagpur plateau. Forestry is still the commercial occupation in many parts of Chotanagpur. In the western part of Ranchi plateau, Palamau, Hazaribagh and Singhbhum roads have helped in the exploitation of the forests. Timber is now transported to many parts on trucks. In Manbhum (Jhalda

region) lac and shellac industry has developed on the raw materials derived from the forests of Chotanagpur. One of the handicaps to the increased utilisation of the forest has been the poor transportation facilities. The only means of communication to exploit the forests in the interior parts of Kolhan, Palamau and Hazaribagh is the bullock cart with solid wheels.

AGRICULTURAL LANDSCAPE

The landscape of Chotanagpur over a wide area is still rural, the main occupation of the people being agriculture. The major crop of the farmers is rice. It is favoured by the monsoon climate high temperature and summer rainfall. The cultivable land of a large part of Chotanagpur falls into two classes, the terraced lowlands on which rice is the important crop and the uplands which produce coarse rice, millet, pulses and oil seeds. The lowlands are prepared by levelling and embanking the slopes. The most valuable are the lower terraces which remain continually wet and where double cropping is possible. The middle terraces are second in value and the highest terraces are of least value. The uplands are also divided according to their productiveness. The farmer is practically entirely dependent on a good rainfall for his crop. If the monsoon ceases in the latter half of August or early September the rice crop on the highest terraces perishes and the cultivators are unable to get a good crop of rice, pulse or oil seeds from the uplands. The upland crops are usually sown in rotation. Market gardening has become important in some areas. The aboriginals sometimes grow vegetables such as brinjals, potatoes, onions and pumpkins. The fruit trees play an important role. In nearly every village a grove of mango trees and jack trees are common.

The peasants live in village which are generally built in the less fertile areas and are often surrounded by trees. Majority of the villages are small and consist of a cluster of mud huts huddled together. Winding pathways from the only thoroughfares in the villages. Mud built houses have roof of tiles or thatch. Generally the house consists of two or three rooms, one of which is the sleeping apartment, one a kitchen and the third a cattle shed. The house is kept clean and a coating of cow dung and fine mud forms a plaster over the walls and the floor. Weekly markets are held in the bigger villages in which the farmers sell their small surplus of vegetables or grain and buy clothes, salt and other necessities. The living standards of these people are lower and greater efforts will have to be made in order to elevate them to the higher standard. The measures required are mainly the land development; but there can be no real progress in the rural areas without improved communications, extension of medical and health services and better facilities for education. The backward state of agricultural areas makes it difficult to get educated people, such as teachers, doctors and nurses to go and work in the villages. A solution may lie in selection of centrally placed villages as culture centres for groups of surrounding villages. Doctors, nurses, teachers, could live and work in them and keeping these centres as headquarters, visit surrounding villages on specific days. The cultural centre system would put all essential facilities within easy reach of every village.

MINING AND INDUSTRIAL LANDSCAPE

Upon the old pattern of rural landscape has been super-imposed a modern cultural landscape expressed in the chimneys and head gear of collieries, blast furnaces and coke ovens, pit heaps, quarries, engineering works and

modern factories, flat-roofed bungalows, clustered bazars, railway sidings and the sprawling industrial towns. This modern landscape is in striking contrast to the simple forest and agricultural landscape. This new cultural landscape is a relatively recent feature in the geography of Chotanagpur. The development of mining and industrial activities have been associated with the extension of transport facilities. In Damodar valley the numerous collieries industrial works and the magic carpet of railroads are the most impressive features of the cultural landscape. The coke-manufacturing and bye-product works at Jharia, Lodna, Loyabad, Jhalgera, Giridih and Kusunda, fire-clay and silica works at Kumardhubi, refractory and ceramic works at Mugma, Oxygen and Acetyline works at Kargali, engineering and foundry works at Jharia, Jamdoba, Ekra and Katrasgurh and the fertiliser factory at Sindri are only a few examples of the industrial landscape of the Damodar Valley. The blast furnaces and coking ovens at Tatanagar with their associated engineering workshops, the copper smelting and metal manufacturing at Ghatsila, Mushabani, Dhobani, and Maubhandar are the major features of landscape in Eastern Singhbhum. Dalmianagar and Japla are important industrial centres in the Son Valley. Mica mining has given rise to small mining settlements and factories at Kodarma, Domechanch Giridih and Tisri. The development of the rich iron ore deposits of Kolhan has given rise to a rapid wave of settlement in south Singhbhum.

The exploitation of the hidden mineral wealth and the consequent industrial development is continually changing the face of Chotanagpur and is adding new features to geographical landscape. The development of industrial centres has not only modified the physical landscape but also the settlement and old pattern of human occupation. The labour force of the industrial centres are drawn from the countryside, some of whom come from much further away. Acute geographical and social problems concerning the health and housing of the workers have sprung up in some of the industrial nuclei, and there is need for adequate sanitation and good water supply for maintaining a permanent and healthy labour force. The development of mining has likewise modified the old pattern of settlement. New mining settlements have sprung up and have become important trade centres. Mushabani (Singhbhum), Gua (Singhbhum), Bagru (Ranchi) Kodarma, Bermo, Ramgarh and Rohtas owe their origin mainly to the development of mining activities. One of the effects of the developments of modern landscape is seen in the decline in importance of old trade centres on the roads like Chatra, Gumla, Gola, Hunterganj and Barabazar and the rise in importance of new trade centres near the railways like Dhanbad, Purulia, Jhalda, Chandil, Chakradhpur and Lohardaga. The construction of the railway lines have changed the trade hinterland of many centres.

THE AGRICULTURAL REGIONS OF BIHAR.[1]

BY

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In a previous paper[2] the writer has already given in brief outline the physical background of Bihar, and we may therefore, start straightaway with a discussion of the agricultural regions into which the state may be divided. On account of the transitional character of Bihar climate the crops grown are a curious mixture of those cultivated in the drier regions towards the west and those found in the wetter region of deltaic Bengal. Rice is the dominant crop almost everywhere, but there is also a considerable variety of other crops grown over wide areas in various parts of the state. Further, there is diversity as regards the character and intensity of rice cropping itself. These differences are directly related to the relief, soil and climatic conditions found in particular areas, and reveal the subtle way in which apparently small differences in physical conditions have caused variations in agricultural response. It is needless, however, to point out that there is no hard and fast line which may be said to demarcate a particular region, for the change from one region to another must necessarily be gradual and even imperceptible, and there must be in every case certain debatable ground — a no man's land — which may as well be included in one region as in another. It may nevertheless be observed that each region into which the state has been divided is fairly clearly defined, and is unified by some well-marked features which give it a distinctive quality and mark it out from the rest. These regions are (Fig. 1) :—

1. The Wet Lowland 'Dhanhar' Tract,[3] lying for the most part north and east of the Burhi Gandak river and dependent mainly upon rice, especially 'aghani' rice, grown almost without irrigation.
2. The 'Bhith' (including 'Diara')[4] Tract, formed by the remaining portion of the North Gangetic Plain and a small ribbon of lowland immediately south of the Ganges subject to deep and regular flooding during the rains. This is characterized by the predominance of the 'rabi' harvest and the growth of the more valuable 'bhadai' crops which are here far more important than the rice crop.[5]

[1] A paper submitted to the Indian Science Congress, Allahabad session 1949. Maps owing the distribution of rice and maize and the area under irrigation are based on the average figures for 1934-5 to 1943-4.

[2] See Ind. Geog. Jour., Vol XXV, 1950, p.7

[3] For settlement purposes agricultural lands are classified into 'dhanhar' and 'bhith' the former meaning lowland on which paddy is grown, and the latter signifying up and which grows crops other than rice.

[4] Strictly speaking, sand and silt deposits formed along the bed of a river but loosely applied to all such deposits whether in the bed or over the banks and subject to annual inundation.

[5] There are three agricultural harvests in Bihar, namely, 'bhadai' (autumn), 'aghani' (winter) and 'rabi' (spring). For details see Ind. Geog. Jour., Vol. XXV, 1950, pp. 7—15.

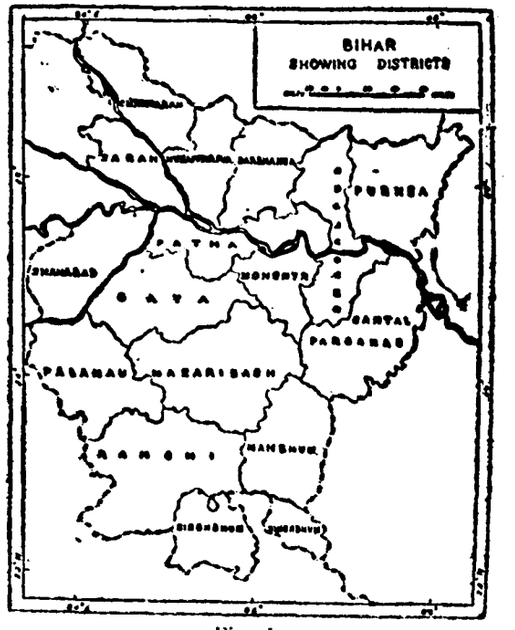

Fig. 1.

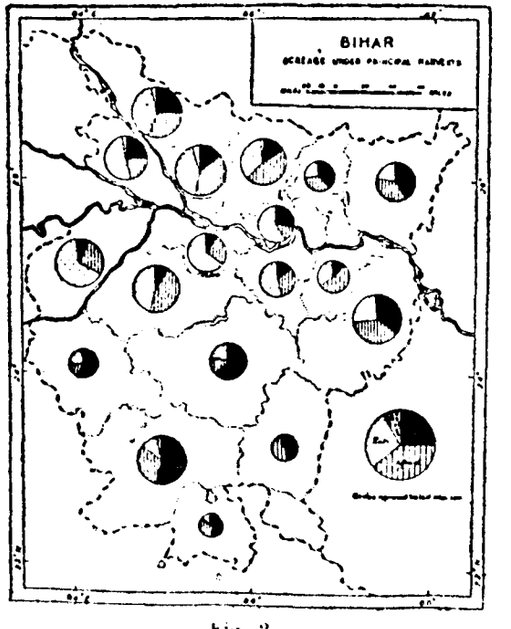

Fig. 2

3. The South Gangetic Irrigated Tract, comprising the whole of the South Gangetic Plain except the portion included under 2. Its distinguishing feature is its almost complete dependence upon irrigation for the success of its principal crops. Though rice is the predominant crop, a number of valuable 'rabi' crops are also grown.

4. The Chota Nagpur Plateau Tract. The whole of the Chota Nagpur Plateau forms one distinct region characterized by an essentially similar agricultural pattern throughout, namely, rice in the valleys and on the terraced slopes, and maize, millets and a crop of oilseeds on the uplands. Such differences as exist are merely of degree and not of kind.

THE WET LOWLAND 'DHANHAR' TRACT

This forms one of the most distinct agricultural tracts of Bihar. It consists of almost the entire North Gangetic Plain north and east of the Burhi Gandak. This river forms the southern boundary of this region right from the north-west corner of the State to its junction with the Ganges. From near Mansi the southern boundary may be said to be formed by the Oudh-Tirhut railway embankment running along the Ganges till we reach the Purnea boundary. Since the Kosi shifted to North Bhagalpur, the south-western portion of Purnea is no longer swept by its floods. The land is comparatively high in level, thickly overlaid with sand and silt and now being cultivated with maize and 'rabi' crops. This portion has, therefore, been excluded from this division. The entire 'dhanhar' tract comprises one vast low-lying plain, interested by a network of rivers and marshes and subject to annual inundation.. The lowness of the country, the very high water table, the comparatively high rainfall (above 50 inches), and the overspill of rivers all combine to make this area a veritable paradise for rice (Fig. 2). The soil, except on the ridges, is mainly clay or clayey loam with a very high lime content [6] and is retentive of moisture. It is essentially a region of wet cultivation, little irrigation being practised. But though ordinarily blessed with abundant water supply, in years of deficient or badly distributed rainfall the winter rice crop is endangered. There are parts which are subject to recurrent floods resulting at times in the loss of the rice crops. North Bhagalpur which is now a network of river beds, running from north to south, all formed by the evershifting Kosi, is such an area. During the rains it is sometimes one channel and sometimes another which carries the main stream of this vagrant river. Much of the countryside is under water for a fairly long time, and boats ply across both cultivated fields and waste lands.

Though rice, especially winter rice, is the staple crop, some 'bhadai' and 'rabi' crops are also grown. The main 'bhadai' crops, apart from rice, are millet (marua) and jute. If winter rice be grown, only a catch crop of pulses, chiefly 'khesari' can at best be obtained, but the land which grows autumn rice yields as well a good crop of oilseeds or pulses. There is, however, no attempt at high culture. Fine crops are, indeed, obtained, but mainly because nature is bountiful.

While throughout this region, the comparatively well-to-do eat mainly

[6] Davis, W.A.—A study of the Indigo Soils of Bihar, Indigo Pub. No. 1 (Agr. Res. Insl., Pusa), 1918

'aghani' rice, the poorer people depend to a large extent on coarse 'bhadai' rice, millets and barley, and the diet changes as we move from west to east. In North Champaran the poorer cultivators live mainly on 'bhadai' rice and barley. In

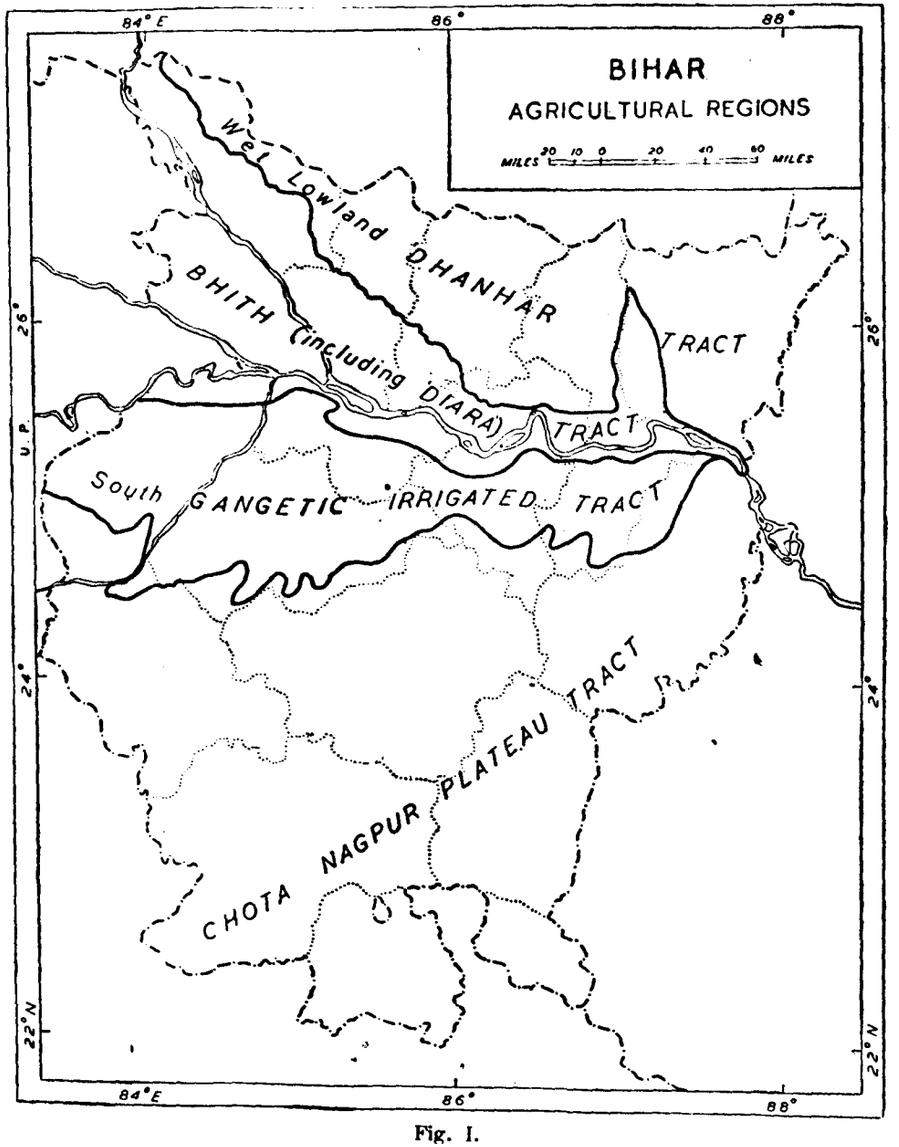

Fig. I.

North Muzaffarpur the place of 'bhadai' rice is taken by millets, but the chief supplementary food crop is formed by barley. In Darbhanga barley and 'marua' are almost equally important. Both are crops of the inferior higher lands between the richer lowlands cultivated with rice. In North Bhagalpur

'marua' and 'bhadai' rice are supplementary food crops, and in Purnea mainly 'bhadai' rice.

The predominance of rice cultivation has resulted in a high density of population. In Muzaffarpur and Darbhanga the density almost everywhere exceeds 1,000 persons per square mile and is even more in some parts.[7] But the high density which its very fertility has engendered co-exists with great agricultural insecurity, for the region is essentially dependent upon a single crop and suffers from periodic floods. Any serious failure of the rice crop at once spells disaster.

Champaran, though scantily populated in comparison to Musaffarpur and Darbhanga maintains a high density compared to any other standard. In Adapur and Dhaka, where the soil, extremely fertile in itself, is rendered still more productive by small but valuable systems of canals, the density reaches nearly a thousand. In the extreme north-west, however, the density declines to less than 400 in Shikarpur where a fairly large area is covered by uncultivable hills and jungles and considerable tracts of fertile land have not been brought under the plough on account of unhealthiness of the climate.

Towards the east, North Bhagalpur and Purnea are comparatively thinly peopled. In the former the population density is intimately bound up with the vagaries of the Kosi river, and the areas affected by its oft-changing course have shown a progressive decline. During the decade 1921-31 thanas Kishanganj and Pratapganj showed a decline of about 1 and 8 per cent respectively. As the Kosi moved further westward, these thanas recovered and showed an appreciable increase, but, on the other hand, Supaul and Bangaon recorded a decrease of about 20 and 19 per cent respectively in the decade 1931-41.

The comparatively low density of population in Purnea (less than 500) is, at first sight, surprising, for here a greater proportion of the cultivated area is devoted to rice than in any other district of North Bihar, and, in addition, jute forms a valuable money crop. Further with the westward migration of the Kosi river, large tracts of land, once barren and sandy, have now been made available for cultivation. The chief reason for low density seems to lie in the unhealthiness of the climate and in particular the prevalence of malarial fever.[8]

In this region generally on account of the overwhelming importance of the rice crop, there is heavy work during a small part of the year, and comparatively little to do during the cold and hot weather months. The importance of the sugar factories (in Tirhut) whose working period roughly coincides with the slack season in agriculture cannot be exaggerated. In the rice-jute lands of Purnea, however, the cultivators' hands are much more full.

THE 'BHITH' (INCLUDING 'DIARA') TRACT

This region includes the remaining portion of the North Gangetic Plain and a narrow ribbon of low-lying land south of the Ganges which is annually fertilized by its overflow or by that of one of its tributaries whose waters are held back when the Ganges itself is in high flood. It contains two distinct land features, firstly, the 'Bhith' properly so called, that is, the upland consisting mainly of older alluvium and lying usually beyond the reach of floods, and secondly, the land in the immediate vicinity of the Ganges which is annually enriched by the deposition of silt and consists mostly of newer alluvium. While

[7] Throughout this paper, unless otherwise stated population figures are those for 1941

[8] Census of India, 1931, Vol. VII, Pt. I, pp. 28—29.

these two land features differ markedly from one another, they are used essentially for the cultivation of the same types of crops. On both of them the cultivation of rice is of comparatively small importance, and they are usually

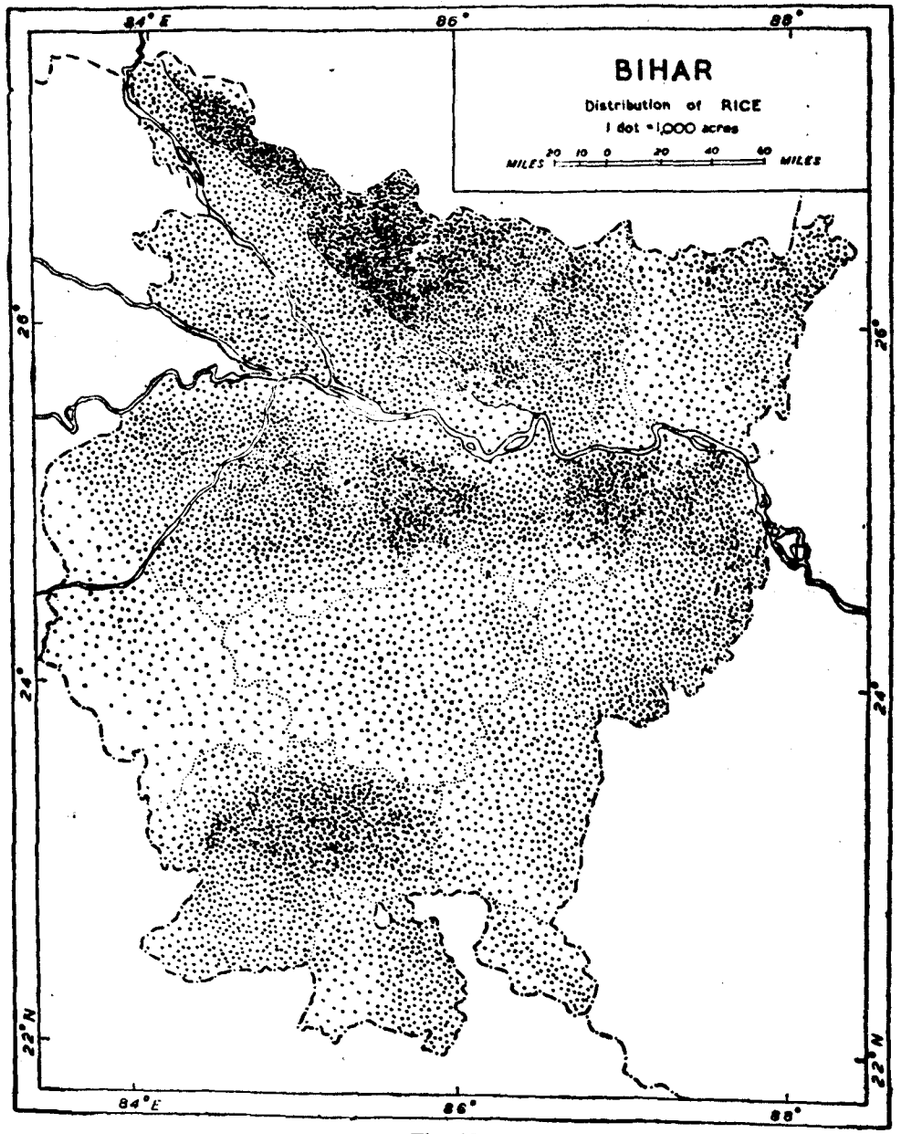

Fig. II.

given to a 'bhadai' crop of maize and for a 'rabi' crop of wheat, barley, oilseeds and pulses. While, therefore, the tract north of the Burhi Gandak (region 1) is a predominantly rice producing area, this tract is characterized by a great variety of valuable 'bhadai' and 'rabi' crops.

Apart from the land bordering on the Ganges this region comprises one large stretch of upland broken here and there by shallow depressions and marshy lands suitable for rice. The predominant soil is rich sandy loam ('balsundari') varied by stretches of clayey soil in the low-lying rice lands. In the 'Tal' area of Patna and South Monghyr [9] which is also included in this region, the soil is heavy clayey loam and clay (locally called 'kewal'), but on account of its being deeply inundated is not generally cultivated with rice except in small areas. On the 'diara' lands the soil is principally sandy loam, though it varies from pure sand to rich loam. In Western Purnea the soil has slightly larger admixture of sand, but both 'bhadai' and 'rabi' crops can be grown in it.

The predominance of 'balsundari' soil which can quickly absorb the surplus water and the comparatively light rainfall (less than 50 inches) make this region exceptionally suited for maize, the most valuable of the 'bhadai' crops, which is therefore, extensively grown (Fig. 3). In Western Purnea, the higher rainfall is offset by a more open soil. In the low lying 'diara' lands, however, which are subject to annual inundation from the Ganges, the 'bhadai' crop is liable to be destroyed by the early floods, but in a moderately dry season good crops are obtained.

More important than the 'bhadai' are the 'rabi' crops grown in this region, and they are luxuriant alike on the high lying lands, or on the 'diaras' or in the 'Tal' area. The silt-renewed 'diara' lands with sufficiency of moisture are particularly favoured in this respect, and grow magnificent crops of wheat, barley, peas and gram, thus sufficiently rewarding the cultivator for the loss of his 'bhadai' crop. The high lying soil too, except in parts of Saran, is retentive of moisture, and little 'rabi' irrigation is practised. In Saran, however, where the soil does not retain moisture so well and the ranfall is also less, irrigation by wells is extensively practised for the cold weather crops.

Considering the fact that this region grows comparatively little rice, its high density of population (about a thousand) may cause some surprise. But the explanation lies in the greater agricultural productivity and security that this region enjoys as a result of the variety and wealth of the crops grown. Inspite of the heavy pressure on the soil, the people are better off here than their neighbours towards the north. This is, in fact, the richest, the best cultivated and agriculturally most prosperous portion in the whole State.[10] But while in region I the fertility of the soil is maintained by annual inundation, here, except in the 'diara' and 'Tal' areas, it is aided by the assiduous care of a hard working peasantry. Valuable crops like sugarcane, tobacco, fruits and

[9] The low tract extending from Patna to Surajgarha through which the united streams of the Punpun, the Phalgu, and the Sakri flow and join the Kiul under the name of Harohar before falling into the Ganges at Surajgarha. As these rivers cannot empty themselves when the Ganges herself is in high flood, water is held up and spread over the adjacent areas.

[10] A land which has grown a 'bhadai' crop earlier in the season can almost invariably be used for growing one of the more valuable 'rabi' crops in the same year. This type of double cropping is much more productive than that in the 'aghani' rice areas. Agricultural security is also greater, for the 'bhadai' is much less susceptible to rainfall deficiency than the 'aghani'.

vegetables are extensively grown under intensive systems of cultivation, and in bad years the population is always ready to emigrate.

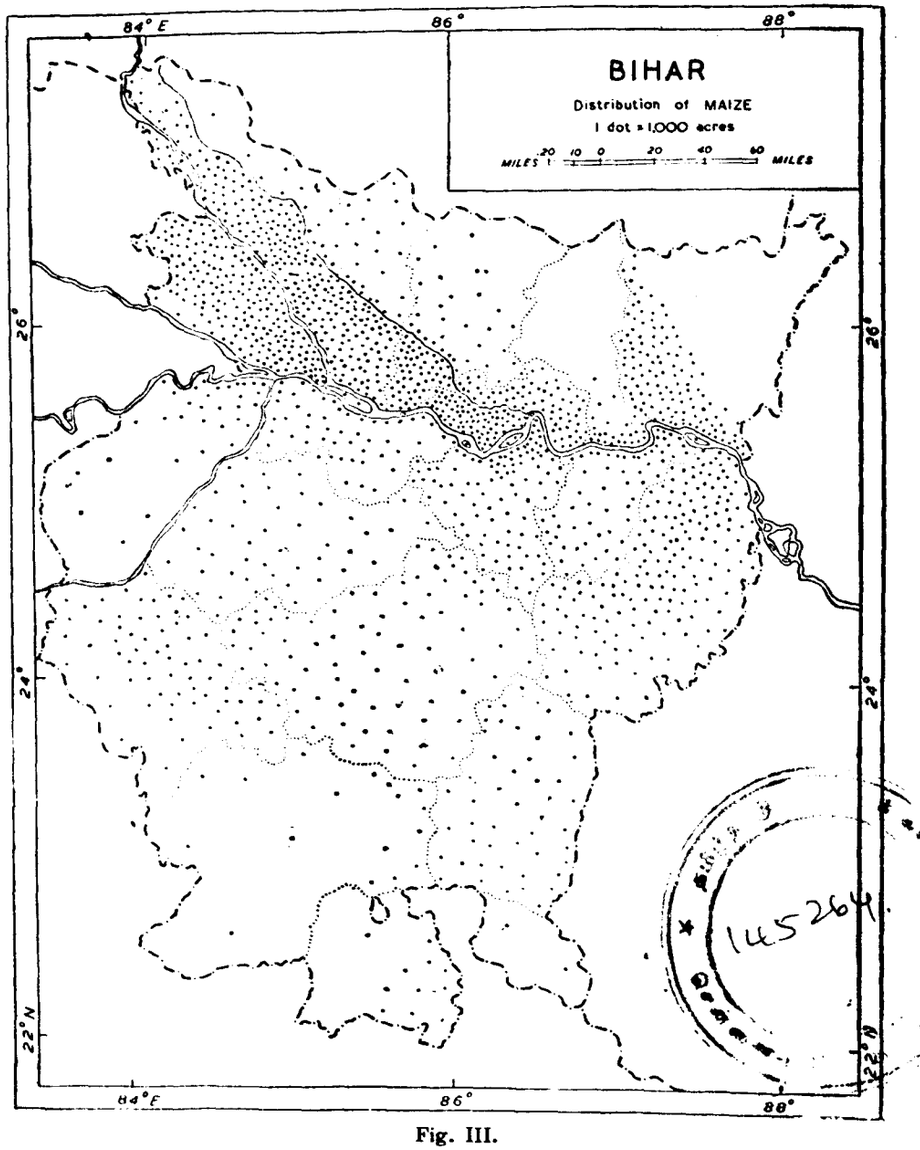

Fig. III.

THE SOUTH GANGETIC IRRIGATED TRACT

The agricultural prosperity of this region depends to a unique degree on an extensive system of irrigation works (Fig. 4). Towards the west the cultivators have the benefit of the Son canals which, irrigate approximately 625,000 acres. But over the rest of this region the people are dependent on methods of irriga-

tion which have been practised from time immemorial. Irrigation is necessary to overcome the difficulties placed in the way of cultivation by the physical and climatic conditions, and these conditions have in their turn influenced the particular forms of irrigations in use. The rainfall throughout the region is insufficient and variable, and the water runs quickly down the steep slopes, on which the soil is generally unretentive of moisture. The nature of the country and the comparative scantiness of the rainfall would seem to make it unsuited for rice cultivation. But both the difficulties have been overcome by the ingenuity and the industry of its inhabitants who have devised a system by which the natural drainage is blocked and the water impounded in extensive reservoirs called 'ahars'. They have also brought the rivers into their service by diverting the water they bring down into narrow artificial channels called 'pynes'. But for these devices the rain as well as the river water would flow rapidly down unchecked, and the cultivation of the rice crop, on which the people depend, would be impossible. The two systems are inter dependent, and it is difficult to say whether a particular area is irrigated by 'pynes' or 'ahars'. The water from an 'ahar' is sometimes distributed through 'pynes', while 'ahars' are sometimes filled by water from 'pynes'. "The whole forms a most remarkable and ingenious system of artificial irrigation, which is admirably supplemented by the manner in which the water is distributed from field to field and retained in them by a network of low banks."[11] The system provides irrigation principally for the rice crop, but in addition 'ahars' supply moisture in the early stages of the growth of 'rabi' and sometimes their beds are cultivated with 'rabi' when they dry up in time for the sowing of the cold weather crops.

The construction and maintenance of these small irrigation works is a matter of first rate importance, but unfortunately there is a tendency for them to be neglected. The landlords, whose obligation it is to construct and maintain these works, are not always alive to the necessity and advantage of doing so, and the gradual disintegration of the proprietary interests has made it more and more difficult for them to combine for the purpose. Generally speaking, no large 'pynes' are now excavated, and many of the old ones are falling into disrepair and disuse.

The main crop is, of course, rice, the predominance of which coexists with a high degree of agricultural insecurity because of the nature and present state of the irrigation works. On these rice lands a 'paira' or catch-crop of 'khesari', gram or linseed is also grown in the cold weather season. But while rice and pulses form the chief food of the people in this region, wheat and barley form important supplementary foods, and good crops of these cereals are obtained from some lands. In contradistinction to region 2, this tract shows a comparatively small 'bhadai' area and low valuable double cropping. The percentage of the net cropped area to total area is also low owing to presence of hills and jungles. The ricelands are, however, double cropped, the second crops on such lands being catch-crops of 'khesari' and linseed sown broadcast before the rice is reaped. The lands which grow more valuable 'rabi' crops like wheat, barley, gram, rape and mustard are rarely double cropped except on the more open soils These 'rabi' crops, except on lands which remain flooded during the rainy reason and are sufficiently moist during the cold weather season, depend, at least partly upon artificial water supply.

The land towards the south of this tract is intersected by hills and ravines. The soil is infertile and contains a large proportion of sand. It is indifferently cultivated and sparsely populated. Comparatively little rice is grown, and the

[11] Gaya Gazetter, 1906, p. 127.

country is given mostly to 'marua', gram and 'til'. As we move northwards, the surface gets more and more level and fertile, is easily irrigable by 'ahars' and 'pynes', and is intensely cultivated and densely populated.

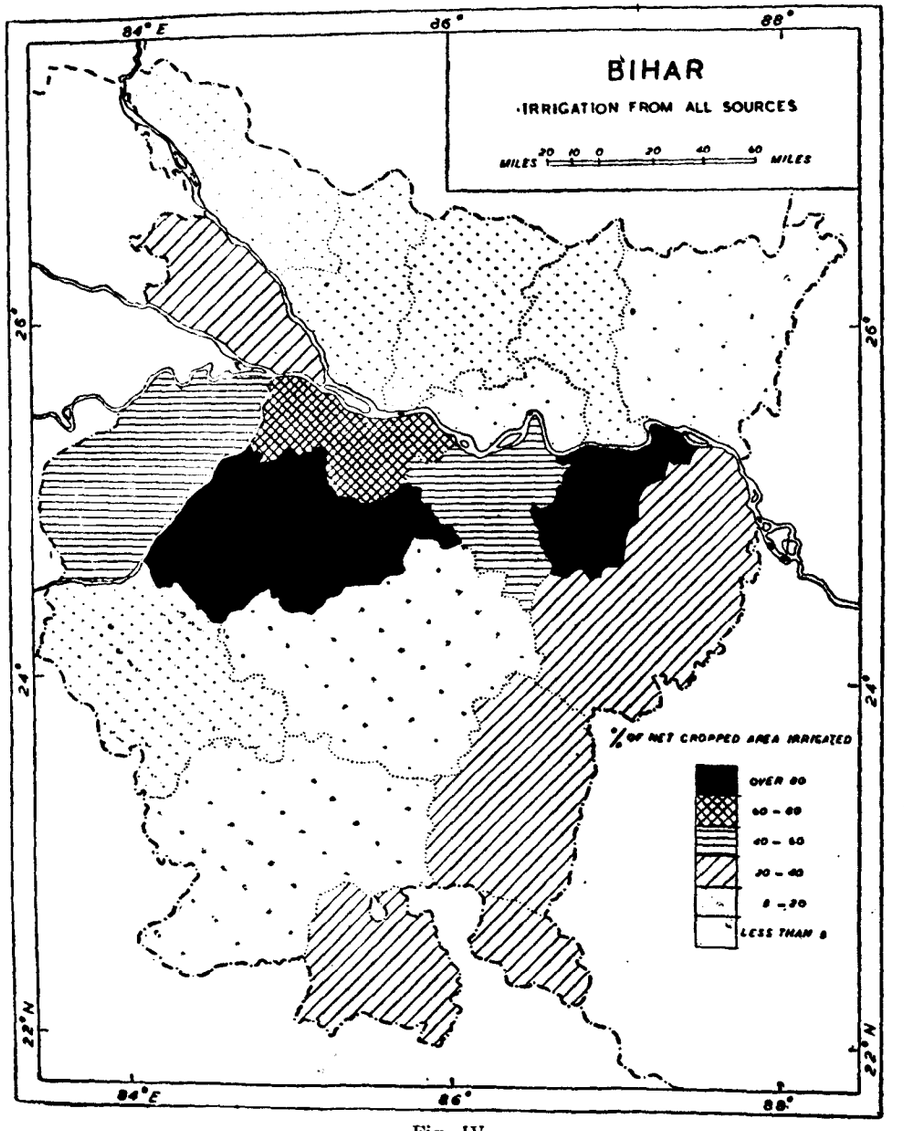

Fig. IV.

One striking though not a very important feature of this region is the extensive use, on account of their strength, of buffaloes for the plough, especially when the land is being puddled for the transplantation of rice, a direct result of the comparatively heavy soil found over a large part of this region.

THE CHOTA NAGPUR PLATEAU TRACT

The agricultural landscape of this tract presents features entirely at variance with those that we have discussed so far. In contrast to the regions of the Gangetic plain, it is a tract of irregular surface and poor soil. There are no doubt large stretches of comparatively level country such as the Ranchi tableland, a large part of Manbhum, and the saddle separating the Rajmahal Hills from the Hazaribagh plateau. They are extensively given to the cultivation of crops. But except in the more open and wide valleys, the plateau presents an undulating or hilly appearance, and a large part is still covered by scrub or badly mutilated jungle. The upland soil is generally thin, poor and highly leached, and where the natural vegetation has been removed is much affected by erosion Rice, the chief crop, is grown in the river valleys and the depressions between the ridges, and laborious terracing makes its cultivation possible on the slopes. Though the rainfall is higher than in the Gangetic plain, owing to the hilly character of the gneiss country, it runs off rapidly, and artificial irrigation is necessary to bring the rice crop to maturity on the terraced slopes. The uplands suffer from an even greater scarcity of retained moisture. The rapid drainage and the unretentive character of the soil leave them more or less dry even after heavy rainfall. They are, therefore, cultivated with quick maturing 'bhadai' crops and only in special cases where irrigation from wells is available with the more valuable 'rabi' crops. The 'aghani' or the main monsoon harvest which is so important elsewhere is here not quite so important.

The proportion of wet rice land to dry upland varies greatly, but there is on the whole a preponderance of the latter (Fig. 5). 80 per cent of Palaman's cultivated area is for example, of this kind, while the two main plateaus of Ranchi and Hazaribagh have each 62 per cent of their cultivated area under 'tanr' or dry upland. The lack of moisture, the poverty of the upland soil and the extensive character of cultivation are responsible for a considerable amount of fallows, the lands being left uncultivated for two to five years at a stretch. The 'bari' lands or the lands situated near the homesteads are, however, an exception. They are the most fertile parts of the upland. They are fenced, continually manured and regularly irrigated by wells. They usually grow two crops in a year—a crop of maize in the "bhadai' season, and mustard, barley or sometimes even wheat in the 'rabi' season. Lands contiguous to the 'bari' lands but unfenced and much less manured than the latter are the second class uplands. They grow 'marua' in the 'bhadai' season followed by a crop of pulses such as 'kurthi', and are sometimes cropped only once in two years. The third class lands are formed by the outlying parts of this upland furthest from the village and are cropped with 'bhadai' millets and pulses followed sometimes immediately by 'surguja' or 'kurthi'. On these lands, as also on the second class uplands a regular system of rotation may sometimes be followed, care being taken to introduce a legume between two cereals. But more often, and in addition to the growing of legumes, the land is left fallow for 2 to 5 years to allow the soil to regain its fertility.

Little rice is grown on the uplands, the only variety cultivated being 'gora' rice. On the other hand, the lands in the valleys and along the slopes are cultivated almost entirely with rice. The best rice lands are those which lie lowest, being found in the alluvial valley bottoms. These receive the washings from the higher lands, are naturally moist and can be easily irrigated. Above this are the second class rice lands formed by the natural river, terraces readily adapted as rice lands. Above this level the cultivator must cut and bank up artificial terraces for retaining moisture, if he is to grow rice, but the outturn is poor

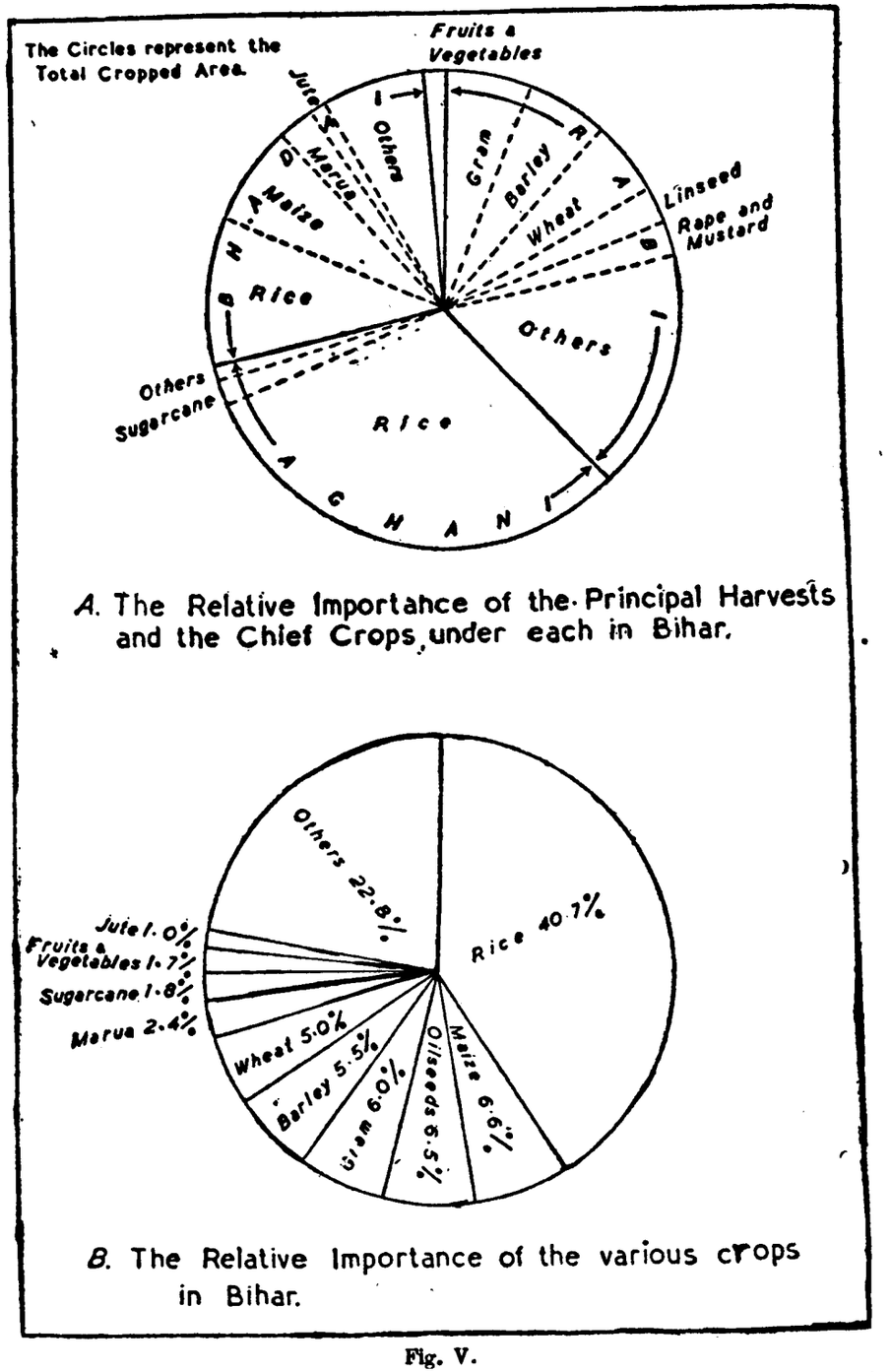

Fig. V.

The kind of rice grown becomes coarser and more quickly maturing as we move from the moisture retaining low lands to the less moist and more precarious higher terraces. The harvesting time for the crop grown on the first class lands is usually December, on the second class lands November-December, and on the third class lands November.

The great need of the plateau is for the extension of irrigation facilities, both on the uplands and on the terraced rice lands. Though natural facilities are great, little has been done to develop 'bund' irrigation in Ranchi, Hazaribagh and Singhbhum. 'Bunds' or 'ahars' however, form valuable source of irrigation in Santal Payanas, Palaman, and Manbhum. In districts not protected by irrigation, failures of the rice crop occur periodically though they do not make themselves felt as much as in the plain, for the people are more hardy and can subsist under conditions which would result in famine among the cultivators of the plain, and have also recourse to edible forest products especially 'mahua'.

While rice is the staple cereal, it is supplemented to a great extent by 'marua' and 'gondli,' the two most commonly grown millets in this tract, and by maize. The importance of rice, however, appreciably declines as we move from the wetter east and south to the drier west, until in Palaman rice becomes the food of the comparatively well to do while the poor subsist mainly on maize, gram, barley and 'gondli.'

The main cash crop throughout this tract is oilseeds consisting mostly of sesame and niger grown during the monsoon period and rape and mustard in the cold weather season. 'Rabi' cultivation is almost everywhere unimportant, for 'rabi' crops can be grown only on soils which are deep and retentive of the late season rains. It is only in the more open and fertile valleys of the North Koel and Amanat in Palaman or the Lilajan and Sakri in Hazaribagh that they are raised to any appreciable extent. Elsewhere they consist mainly of catch-crops of 'khesaru' grown on the wet rice lands. The cold and hot weather seasons are, therefore, periods of agricultural inactivity over a large part of the plateau, and it is here that the influence and importance of the mining and industrial centres are felt. The more energetic of the inhabitants move further afield either to the tea gardens of Assam or the industrial region round Calcutta.

The population though much less in actual density than the plain, presses no less heavily upon the resources of the soil. If we calculate the density on the basis of total cropped area, it works out at about 1,170 per square mile for Saran and 1,060 for Hazaribagh. Even if we take into account the mining and industrial centres and game and forests products accessible to the people of the plateau, we have to remember that only a small proportion of the cultivated area is first class and a large part of the rice crop is unprotected by irrigation and liable to periodic failure. Thus inspite of the supplementary sources of employment and food supply, the apparently low density of population in the plateau co-exists with even greater rural poverty than in the plains.

GYPSUM AS A POSSIBLE SOURCE OF WESTERN PAKISTAN INDUSTRIES

BY

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The mineral resources of Pakistan present a great scope for further development in all the provinces. if a proper and thorough investigation of available resources is undertaken with the help of experts. A few prosperous industries can, however, be started with the raw materials already available. There are certain minerals, which are sufficient in quantity and good in quality and are best suited for certain chemical industries. Pakistan possesses inexhaustible supplies of minerals which are important from the viewpoint of chemical industries and can commercially be used in the manufacture of heavy chemicals.

Gypsum is one of the minerals, which is found in abundance in Western Pakistan and can easily prove to be an asset to the state. It is a soft rock, which can easily be scratched with a finger nail. It mostly occurs in the beds which are parts of Rock-salt or lime-stone rocks. The deposits of gypsum show that the climate of those areas was once dry.

Pakistan is leading in the production of gypsum, and exports much of the product to other countries. It also occurs in U. S. A., France, Canada, England (Nottingham, Cumberland and Sussex) and in Spain. Italy, Germany, U.S.S.R. and Japan are also self-sufficient gypsum-producing countries. In India gypsum is found in Jodhpur, Bikanir, Jaisimer and Trichinopoly, where it is quarried and is mostly consumed in the cement factories of the dominion.

During the last few years, the interest in gypsum deposits has increased in the Indo-Pakistan sub-continent, due to the manufacture of artificial fertilizers and specially the preparation of Sulphate of ammonia and other acids. The production of gypsum went on increasing every year, till its annual output reached 50,000 tons in the year 1944, out of which 26,000 tons was produced in Pakistan.

The production in Pakistan area was as follows:

* PROVINCE.	OUTPUT IN TONS.	VALUE IN RUPEES.
1. Sind (Karachi)	2,100	4,200
2. W. Punjab (Jhelum)	17,560	51,628
3. Baluchistan (Sibi)	5,861	26,375
Total ...	25,521	82,203

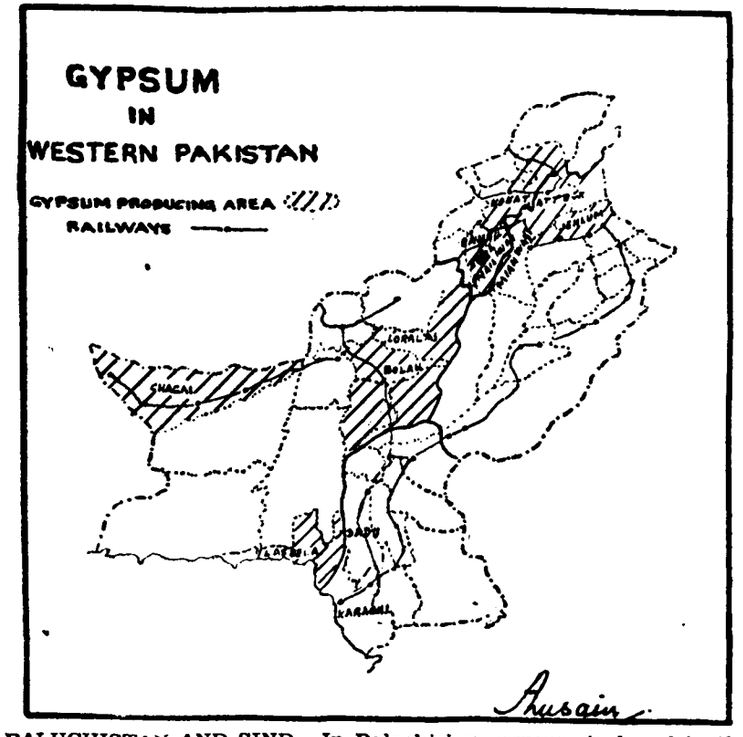
W. PUNJAB. Gypsum beds of varying thickness occur at several places in many parts of Pakistan. The largest deposits are found in West Punjab in the Punjab saline series of the Salt Range, where many millions of tons of high quality gypsum is estimated. The most important deposits of gypsum are the

* Mineral Information Bureau, the Geological Survey of India (1944).

deposits of Khewra and Dandot areas, where they form massive deposits under the Salt Range. In the Jhelum district the mineral occus in large quantity and extends further in the Shahpur and Mianwali Districts. Most of the gypsum deposits are found north of the Railway line passing through Jhelum right upto Peshawar. The percentage of gypsum contents quarried at Dandot and Khawara are 98 per cent and 95 per cent respectively. It is opaque white in colour. The Punjab gypsum has somewhat greater hardness.

The chemical analaysis [1] of West Punjab gypsum quarried at Dandot is as follows:—

Ca $S0_4$	95.00	P.C.
Insoluble	1.12	,,
$Si0_2$	.78	,,
Al_20_3	.74	,,
Fe_20_3	.26	,,
Mg0	.13	,,
Ca0	.93	,,
Loss	1.04	,,
	100.00	P.C.



BALUCHISTAN AND SIND. In Baluchistan, gypsum is found in the form of selenite and is commonly associated with the shales and clays of Tertiary age.

[1] Dalmia Cement Factory, Karachi Laboratory.

But it is found here only in small quantities. Mr. Gee in his paper "Mineral Resources of North West India" points out, "Gypsum of high quality valuable from the Commercial standpoint occurs, however, interbedded with the shales and limestone in the spintangi (Kirthar) stage of the hill tracts of the North-Eastern Baluchistan". Here it forms a thickness of 5 feet to 10 feet and at some places the thickness varies from 10 feet to 15 feet. "The quantity available is considerable. In the same stage further North-East massive gypsum 40 ft. in thickness occurs just outside the Baluchistan Territory in Dera Ismail Khan. This deposit is almost regular and probably continues southwards into Baluchistan. In the south of above described area, gypsum occurs in the foot-hills overlooking the plains about half a mile south of Sanni; Karachi District, Kalat State and further in Sind it occurs near Kotri."[2] Gypsum beds are also found in Las Bela State. In Sind it is quarried at two stations, namely, Bholara and Meting in the District of Hyderabad. Its colour is translucent white and it contains some impurities, which are separated by crushing and sliving. The gypsum rocks of Sind contain 83 per cent CaS but this gypsum is softer in comparison to the Punjab gypsum.

The chemical analysis of Sind gypsum is as follows:—

$CaS0_4$	83.00	P.C.
Insoluble	3.5	,,
$Si0_2$	2.3.	,,
Al_20_3	2.3.	,,
Fe_20_3	0.8	,,
Mg0	0.4	,,
Ca0	2.8	,,
Loss	4.9	,,
	100,00	P.C.

N.-W. F. P. An immense quantity of gypsum deposits exists in the Trans Indus Salt regions of the Kohat District of the North-West Frontier Province. The thickness of the gypsum beds near Babdur Khel is estimated over 100 ft. In the same direction gypsum is found in the salt regions in an East-West direction and is well exposed around the salt quarries of Kharak and Jatta. "The gypsum deposits are of high quality; but its value is estimated by the fact that transportation costs to industrial centres would be very high as compared to the gypsum found near the boundary of the Bannu District and the Punjab."[3]

Gypsum has proved to be of great economic and industrial importance and in a period of industrial expansion it can be classed among the minerals, which offer better possibilities of being commercially developed. In the case of gypsum there is obvious scope for its development in different lines and to start various additional industries in Western Pakistan.

1. PLASTER OF PARIS INDUSTRY. Plaster of Paris, being a quick setting material, is the most valuable and useful product of gypsum. It is manufactured when it is heated at 100°—120° and it quickly gives up three-fourth of its water contents; but to expel the remaining water it requires temperatures of 200°F—250°F. When calcium sulphate thus dehydrated is pulverised and mixed

[2] "Mineral Resources of N. W. India" By Gee; page 28

[3] Gee — Mineral Resources of N. W. India, p. 28, 29.

with water it absorbs two molecules of water and solidifies to a considerable hardness. When gypsum is heated over 200° F it becomes dead burnt and takes up water very slowly and without hardening. Plaster of Paris is prepared on a large scale by "Burning" gypsum. Its good quality mostly depends upon the choice of raw material as the bearier and denser varieties yield the best commercial results. Pakistan gypsum is considered to be the best for the preparation of Plaster of Paris and such industries can be started on a large scale in West Punjab and N. W. F. P., where this mineral is found in immense quantities and is of high commercial value.

2. CEMENT INDUSTRY. Most of the gypsum is consumed in cement manufacture, as it serves as an agent to control the setting of the finished product. The chief raw materials for the manufacture of cement are lime-stone and clay, but gypsum is the most important; though it is used in very small quantity. It is mixed in small quantities with the purpose of setting the finished product. At the time of the industrial expansion in Pakistan, the cement industry can easily be established in each province.

3. PAINTS AND PIGMENTS. Pure grounded gypsum known as "Mineral white" is used in the preparation of certain kinds of paints. The white pigments such as gypsum, China Clay, and barytes can be called "Inert pigments". Though their covering power is small, they are extensively used in the paint industry. Gypsum like other chemicals is mixed with insoluble pigments to increase the body or covering power of the lakes.

4. MANURES AND GYPSUM. This mineral product may be in great demand as a fertilizer, as it is considered best for the soils in the Indus basin. Gypsum is an excellent type of manure for top dressing the land. It has been experienced that crops and particularly the wheat crop are better on the soils of the gypseous clay than elsewhere.

5. OTHER MINOR INDUSTRIES. Pure gypsum is generally applied as filler in the paper, rubber and in cotton industries. It finds a wide application in the manufacture of tiles, slabs for roofing and in a variety of plaster boards. Imitation ivory products, plastics, polishing powder, baking powder and self-raising flours can also be manufactured.

It will be quite clear from the above description that gypsum can be of great use in the industrial expansion of Pakistan and can offer great possibilities of being commercialy developed. In Baluchistan and Sind, gypsum can prove itself of great importance, as long as limestone and clay are available in the manufacture of cement. In N.-W. F. P. gypsum and limestone are of proved importance and can be fully utilized also by establishing cement factory, and the plants for the production of the plaster of paris can be installed.

For an industrial expansion three things are essentially required viz. (i) Power, (ii) Transport, (iii) Labour.

POWER. On account of low and scanty rainfall in the provinces of Sind and Baluchistan, we have no chances of getting hydro-electric power, but petroleum can be used as a source of power, being available in great quantity. In the Provinces of West Punjab and N.-W. F. P., hydro-electric power can be had in sufficient quantity, which can be generated from the rivers.

TRANSPORT. Low freight charges by rail are necessary if industrial development is to have reasonable chances. "Moreover, in any scheme of road-construction, the mineral potentialities of the area concerned should be carefully considered.[4] In the provinces of Baluchistan and N.-W. F. P. gypsum is quarried on a very small scale due to the over expensive freight or due to the communication difficulties. Wherever gypsum is quarried, narrow gauge rails have been laid to connect the quarries from one to the other. By means of this transport, gypsum is brought to store houses and from there it is sent by trucks to railway stations for export. At several places quarry railway lines have been connected on the main lines. The narrow guage railways for carrying gypsum from the quarries are of peculiar type and are drawn by small caterpillars, which can carry a load of 100 tons at a time.

LABOUR PROBLEM. The labour in the quarries consist of men and women. The latter are only employed to carry small loads, while the former are employed for quarrying. In each quarry, generally 50 to 100 persons are employed, but the number of labourers employed in Sind quarries is generally less as the rock is of softer nature.

In short, gypsum deposits will either continue to prove of great importance for the industrial expansion of Pakistan or at least offer possibilities of being commercially developed in other ways. It can help in forming various products, such as, Plaster of Paris, cement, sulphate of ammonia, sulphuric acid and their manufacture can rapidly be carried on a large scale. When its importance is realized as a raw material for these industries, its annual production will also be increased and the part played by it in industrialising Pakistan shall be great.

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[4] "Mineral Resources of N. W. India" by Gee; page 48.

PROSPECTS OF BEE CULTURE IN SIND AND KARACHI

BY

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Like poultry farming, bee culture not only depends upon the human factor, but also on environments. It can easily be carried on, where we can have nectar bearing flowery plants and trees. The Tropical and the Mediterranean lands are considered to be the best "Bee Lands" as the rainfall permits abundance of vegetation and moreover majority of trees are nectar bearing. Bee-keeping is also carried on in the temperate regions where it is done on a commercial scale. Throughout the civilized world and especially in the United States of America and Canada bee culture has developed on scientific lines, as one of the animal industries.

HISTORY OF BEE CULTURE IN SIND

Bee-keeping in Sind was first introduced in Karachi in Aug. '39 with a modest number of two hives, imported from Madras. As the right species of bees suitable for keeping in modern hives, were altogether absent in the province the bee colonies had to be imported from Travancore, Dehradun and Kashmir. The great difficulty in bringing them from outside was that of speedy means of transport. They were brought by rail and steamers. With the result that a large number of bees were lost during the journey. This was the first time when bee-keeping was started on scientific lines in Sind at Bee Culture Station, Karachi ; and later on in the interior of the province. From the experiments at Karachi and other stations it was gathered that imported bee colonies could be enlarged successfully under proper care. On the whole, this experiment, however, was a failure owing to the negligence of Zamindars, who were required to keep them, and thus a good number of colonies were deserted.

The Government of Sind tried its level best to popularize bee-keeping in the province. The department concerned organised demonstrations at various places in Hyderabad and Nawabshah, but on account of the dis-interestedness of the people and want of scientific knowledge it ended in a fiasco. At last in the year 1950 the department had to wound up its organization and handed over the entire charge to the Agriculture Department of Sind.

CLIMATE AND BEE-KEEPING

Climate in general has very little effect upon the bees, as bees have a marvellous natural tendency, unlike any other insect, to maintain temperature in their hives which gives them relief and comfort. Thus bee-keeping can be carried on both in cold and hot regions of the world, provided that they get ample supply of food and nectar bearing flowers. From the commercial point of view, the most suitable climate of keeping bees is a moderate type which is conducive to large scale keeping.

WEATHER CHANGES exercise a good ideal of influence on the insect's activities. Thick clouds, hot sunshine, and high and violent winds slacken the activities of the bees and they gather little nectar during such weather.

Climatically Sind ranks among the hottest and the arid part of the subcontinent, where hot and scorching winds blow in summer are accompanied by dust storms in some parts of the province. But the climate of the sea coast, which is comparatively mild and healthy, is considered suitable for bee culture.

The sky in Sind is cloudy during the monsoon season and also during the months of December and January ; but in other months it is very clear. As a rule, afternoons are more cloudy than the rest of the day. Karachi has seventeen cloudy days, while Hyderabad and Nawabshah have nine and seven respectively. The speed of wind in Karachi region never exceeds 12 miles per hour even on windy days.

NECTAR-BEARING FLORA OF SIND

In the larger part of the province, due to the aridity very little vegetation is found. The chief natural vegetation of the province is the desert type. But with the advent of irrigation, much of the arid part is reclaimed for cultivation. Extensive cultivation is carried on wherever water is available through canals. This has provided abundant vegetation, which is needed for keeping the bees. A lot of oil seeds fodder crops, maize, burseem, 'ghuar,' and cotton are grown in the Province of Sind, which are considered as the best nectar bearing plants Besides these, there are also certain flowery plants like portulocas, Sunflower daisy, etc., which are generally grown in the province in general and Karachi in particular, provide ample supply of food and nectar and honey to bees. 'Babul,' 'mithimli', drum stick, 'bari', citrus plants, mango trees 'flasa', 'neem' are other tropical trees which are nectar bearing and found in the Province in abundance. Extensive plots set apart for fodder growing, vineyards, guava plantation, tamarinds, palms and the trees of the "neem" have made Malir valley the best suited bee-culture ground. The weather conditions in Malir valley always remain favourable. It is neither too sunny nor too shady.

BEE-HIVES FOR SIND

Generally one hive keeps 1,000 to 1,500 bees during the spring season and in the autumn season the number goes down from 10 to 800. For during this period of the year bees cannot get sufficient supply of food and nectar flowing trees. If there is plenty of good nectar, the queen bee lays a good number of eggs. The size of the hives generally used in. Sind is 9" x 11" x 7" which is the most suitable size for plains.

YIELD

In Sind the average yield of honey per hive is 10 to 15 lbs. The yield of honey per hive can be greatly increased by cultivating suitable bee pastures or by moving hives from one orchard to the other, but more than two hives should not be kept at one place. It has been estimated that the yield of honey can be increased upto 21 lbs., at this stage, if proper attention is paid to it. A bye product of bee is wax, which is the building material of bee's home.

The bee-keeping in Sind can be done only as a hobby or a subsidiary industry provided people take keen interest in the maintenance of hives. If this industry is organized with zeal and enthusiasm we shall have a food of a high nutritive value.

An extension of bee-keping will have other advantages as well. The primary service which the bee renders to man in pollinating fruits and crops needs no explanation. Experiments conducted at various places in Sind and Punjab of bee-keeping in Orchards and in oil seed crops resulted in the increase of its yield by about 10 per cent. Further work in this direction is necessary and will repay itself. Honey bees, necessary for pollination purposes can be made available in sufficient number at required places and at the required time.

The pollination activites of the honey bees can be turned to account accelerating on food production and so Sind stands to gain a lot by this industry.

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THE MADURAI MUNICIPAL SEWAGE FISH FARM

BY

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To the common man the very idea of eating fish grown in a sewage pond will appear to be revolting, but he will realise on further consideration that it is really not so for the reason that the fish cultured in such ponds do not feed direct ly upon the sewage. The inorganic nutrient substances such as phosphates, nitrates and potash which are contained in abundance in sewage are used up by the minute chlorophyll-bearing plants in the presence of bright sunshine for their growth and multiplication. These plants form the food of certain fishes and also of the infusorians and crustaceans which in turn constitute the food of some other species of fish. Thus the inorganic nutrient substances found in sewage are used by fish indirectly at second, third and fourth stages through the intermediation of plants and animals. This food cycle has been described by several workers including Lloyd (1947) and Pillai etal (1947).

In Germany which is a highly industrialised country, 'sewage use' and not 'sewage disposal' is the main object. In that country, where the soil is not suitable for "sewage farming" purification of sewage is effected by resorting to "fish ponds", which are also employed as a secondary treatment for effluents from percolating filters. It has been found that these fish ponds are more profitable than land farming, as poor land can be made more productive in this way, and that sewage from about 800 to 1200 persons can be handled by one acre of pond producing 1600 pounds of fish (carp) per annum (Modak, 1938). This method of utilisation of sewage waters for fish culture is now being practised in many other countries; and the present average harvest of carp from such waters in China, Germany, Austria, Hungary and Poland is estimated to be two tons per acre (Hall, 1949). Even the Rainbow Trout, a fish known to require the most rigid conditions such as clean and pure water, is now being grown in such ponds attached to the sewage disposal works at Munich (Butcher and Thompson, 1947). Worthington (1940) has recorded that it was a striking fact that before the second world war nearly all the rainbow trout on the British market were imported from Munich where they were grown in ponds fertilised with sewage effluents at prices with which poachers could hardly compete.

When used for fish ponds raw sewage has to be diluted sufficiently such that the concentration of dissolved oxygen in the diluted sewage is kept just above the critical level for fish. Ganapati and Chacko (1950) have shown the effect of fresh sewage and its aerobic and anaerobic decomposition products on fish life. Septic sewage containing sulphides and free hydrogen sulphide in sufficient concentration will be toxic to fish. So, large quantities of freshwater (about four to ten times the volume of the settled sewage liquor) are required for dilution and gradual oxidation of the putrescible organic matter into simpler inoffensive substances through bacteria which drive their supply of oxygen from the dissolved oxygen contained in the diluting water. One acre of fish pond with a depth of about 5 feet can receive the settled liquor from domestic sewage from a population of about 1000 people. From the experience at Munich it is stated

TABLE I, SHOWING RESULTS OF ANALYSIS OF THE RAW SEWAGE AND EFFLUENT OF THE MADURAI MUNICIPAL AGRICULTURAL SEWAGE FARM, EXPRESSED IN PARTS PER 100,000.

PARTICULARS.	9th May 1949		17th October 1949		9th June 1950		6th December 1950	
	Raw Sewage.	Effluent.	Raw Sewage.	Effluent.	Raw Sewage.	Effluent.	Raw Sewage.	Effluent.
Total Solids	210.0	170.0	164.0	157.0	222.0	182.0	172.0	151.0
Suspended Solids	57.0	Nil	43.0	9.0	42 0	2.0	41.6	8.0
Chloride	35.5	46.9	32.7	41.2	48.0	56.8	41.2	36.5
Am—N	3.360	0.134	3.92	0.31	2.8	0.175	4.52	0.028
Alb—N	0.476	0.020	0.64	0.098	4.4	2.1	0.240	0.078
Oxygen absorbed 3 minutes	0.640	0.300	3.3	0.2	5.0	0.21	3.8	0.28
Oxygen absorbed 4 hours	8.000	0.740	8.3	0.8	13.2	0.66	3.875	0.94
Dissolved oxygen	Nil	0.460	—	0.47	—	—	—	0.48
Nitrates	—	Marked	Nil	0.9	Nil	Nil	Nil	2.2
B. O. D.	—	0.12	—	0.8	—	1.45	—	1.1
Nitrites	Nil	0.460	Nil	Marked	—	Marked	—	Marked
pH	—	—	—	—	—	—	7.9	8.3
Alkalinity to Phenolphthalin	—	—	—	—	—	—	6.6	5 6
Alkalinity to Methylorange	—	—	—	—	—	—	75.2	59.2

ROUGH PLAN SHOWING THE PROPOSED FISH FARM NEAR SEWAGE FARM IN R.S. No 169/2 (EXTENT 3 AC. 12 CENTS.)

NOT TO SCALE.

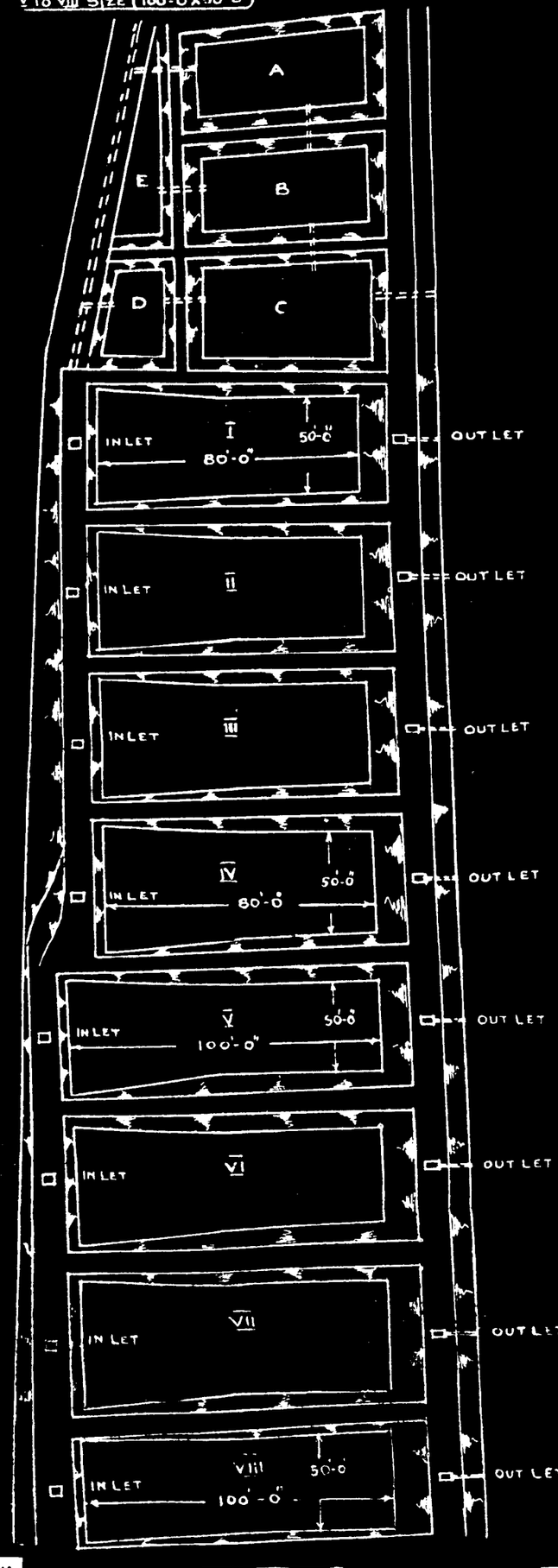
N

REFERENCE:-

A.B.C.D.E. NURSERIES (40'-0" x 20'-0")

I TO IV FISH PONDS (80'-0" x 50'-0")

V TO VIII SIZE (100'-0" x 50'-0")



V. VENKATASUBRAMANIA AYYAR 12.3.91

PREPARED BY
F.E. SUPERVISOR, MADRAS.

P.I. CHACKO
12.3.91

ASSISTANT DIRECTOR FISHERIES
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S.V. GANAPATI
12.3.91

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(F.W.B.) MADRAS.

that a flow equivalent to a period of retention of the diluted sewage liquor of about 40 hours in fish ponds brings about a purification of 40—50 per cent as measured by the test for oxygen absorbed from potassium permanganate. Thus fish ponds are useful to purify sewage to the extent of 40—50 per cent. Attempts should therefore be made in India with the object of assessing the possibilities of growing fish and of treating the sewage liquor. The possibility of purifying sewage in fish ponds is worth consideration as it would make use of a valuable resource not exploited at all by other methods of treatment (Macan, et al, 1942).

Where natural deposits of sand and gravel occur, such as the glacial drifts of New England, sewage is disposed of on land, about 15 acres being sufficient for one million gallons of sewage per day. The levelling of the natural surfaces into beds separated by low embankments and underlined by tiles laid in trenches, as is now being done in Madurai, is the common practice. The volume of sewage applied to land varies from 45,000 to 25,000 gallons per acre daily depending upon the character of the soil. Modak (1938) had described the current practice at the Stahnsdorf Plant, Berlin as follows: "Fish ponds are in use in connection with activated sludge plant. The effluent is stored in the ponds to produce fish and duck flesh. They are large shallow ponds and are stocked with fish each year. It was reported that fish in the course of three years grew to a weight of about four pounds, and this is considered the right time for its sale. Care is taken to avoid sludge deposit in ponds. It is usual to stock these ponds with fish in spring and to empty and clean them in winter. It has been held that the ponds require only one-tenth the area necessary for broad irrigation and they do considerably improve the effluent. The rate of dilution is about three parts of pure water for every one part of treated sewage. Schinninger claims that one acre of pond will treat sewage from about 810 people provided the detention period is two days and the velocity through the ponds is sufficiently low to prevent the plankton being washed out. The pH of the water in the pond can vary between 7.2 and 8.0".

Sewage fish ponds, in spite of their utility as producers of fish food are not very common because either the required space for pond construction or sufficient dilution water is not available. Besides, their use requires a thorough knowledge of fish cultural procedures. Fowler (1944). Hora (1944, 1949) and Pillai et al (1945) have advocated pisciculture as a final method of completing the Nitrogen cycle and thus increasing fish production in the country. Mention may be made here of the valuable sewage-irrigated fisheries near Calcutta (Bose, 1944; Nair, 1944).

Ganapati and Chacko (1949, 1950) have referred to the possibilities of profitable pisciculture with sewage and sewage effluents in the Madras State and have also made out a case for the starting of a fish farm for the utilisation of the effluents of the sewage irrigated agricultural farm belonging to the Madurai Municipality. On our recommendations, the Municipal Council had acquired a plot of land, 3.10 acres in extent, for the purpose of construction of a fish farm. The details of this farm are given below.

The quantity of effluents from this agricultural farm is 10—12 lacs gallons per day resulting from "broad" irrigation and "intermittent downward filtration" of 2 million gallons of raw sewage of the town. The intention is to use the fertilising elements in these effluents without any dilution for raising fish crops.

The effluents are clear but brownish generally. Sometimes they are yellowish in colour and hazy in appearance. A study of the chemical conditions of

the effluents, as revealed by results of analysis on four different occasions (Table I) shows that the effluents are quite satisfactory from all aspects except for 'suspended solids,' which on two occasions were above the standard set by the Royal Commission on Sewage Disposal. On 10th March 1951 special samples of the effluents were collected by us for estimating the amount of nutrients present in them and for finding out the changes they undergo on storage under strict anaerobic conditions. The results are furnished in Table II from which it will be seen that the quantity of putrescible organic matter in the final effluents is very low as is evident from the quantity of oxygen present even after ten days' storage at the air temperature, and that the nutrient substances of biological significance such as silicates, phosphates and nitrates are present in fairly large amounts. An idea as to how the effluents will change in quality on storage will be seen also from the results of samples Nos. 4 and 5. The supersaturation of oxygen at the surface is striking; and it indicates intense photosynthetic activity of chlorophyll-bearing organisms. The amount of each of the three nutrient substances is also lower indicating their utilisation by the algal flora. It would thus appear that the effluents on storage in fish ponds are not likely to become inimical, even though dilution is not contemplated in our proposals.

The biological conditions of the effluents were also studied on 10th March 1951. Altogether 76 plant and animal organisms, including four species of fish, were recorded and listed as shown below :—

Myxophyceae (Blue-green algae): **Amphithrix, Coelosphaerium, Gloeocapsa, Gloeotrichia, Microcystis, Oscillatoria, Spirulina** and **Tetrapedia.**

Chlorophyceae (Green algae): **Chamydomonas, Cladophora, Closterium, Cosmarium, Desmidium, Genicularia, Gonatozygon, Oedogonium, Pleurococcus, Scenedesmus, Spirogyra, Stichococcus** and **Zygnema.**

Bacillarieae (Diatoms): **Achnanthes, Amphora, Cyclotella, Cymbella, Fragilaria, Gomphonema, Melosira, Nitzschia, Surirella** and **Synedra.**

Archigoniatae (Flowering plants): **Wolffia arrhiza, Alisma reniforme, Ottelia alismoides** and **Commelina salicifolia.**

Protozoa (Unicellular animals): **Acineta, Amoeba, Carchesium, Colpoda, Epistylis, Euglena, Glaucoma, Gonostomum, Lacrymaria, Paramaecium, Phacus, Prorodon, Stylonichia** and **Vorticella.**

Rotifera (Wheel animalcules): **Philodina, Polyarthra** and **Brachionus.**

Oligochaeta (worms): **Nais.**

Mollusca (clams and snails) : **Lamellidens marginalis, Corbicula striatella, Melania tuberculatus, Ariophanta bistrialis** and **Pila virens.**

Polyzoa (Moss animalcules) : **Hislopia lacustris.**

Ostracoda: Stenocypris.

Decapoda (Prawns and crabs): **Caridina nilotica** and **Telphusia leschnaulti.**

Insecta: Chironomus larvae, Anopheline larvae, Metrocoris nepalensis, Gerris nitida, Corixa hieroglyphica, Gyrinus convexiusculus, Cybister confusus and **Sarcopila cinerea.**

Amphibia: Rana cyanophlyctis.

Pisces (Fishes): **Barbus sophore, Rasbora daniconius, Lepidocephalichthys thermalis,** and **Ophicephalus gachua.**

Ophidia (Snakes): **Natrix piscator.**

TABLE II. SHOWING RESULTS OF ANALYSIS OF FIVE SAMPLES OF EFFLUENTS COLLECTED FROM THE MADURAI SEWAGE AGRICULTURAL FARM ON 10TH MARCH 1951, EXPRESSED IN PARTS PER 100,000.

Sample number	1	2	3	4	5
Source	Effluent channel	Effluent channel	Effluent channel	Oorani (surface)	Oorani (bottom)
Date of collection	10-3-51	10-3-51	10-3-51	10-3-51	10-3-51
Date of examination	10-3-51	19-3-51	19-3-51	10-3-51	10-3-51
Temperature °C	27.4	27.4	27.4	26.9	26.2
Turbidity (cm.)	21.0	23.0	25.0	14.0	8.0
Dissolved oxygen (cc/l)	3.709	2.513	1.675	9.283	5.440
Percentage of saturation	64.9	43.3	28.8	158.6	91.8
pH	7.4	7.3	7.3	7.6	7.6
Free CO_2	6.44	1.61	2.42	1.56	1.41
CO_3	nil	nil	nil	nil	nil
HCO_3	87.84	86.01	89.67	91.81	89.37
SiO_2	4.0	3.36	3.28	3.08	3.08
P_2O_5	0.125	0.119	0.119	0.114	0.104
NO_3 - N	15.78	13.15	15.96	6.85	10.13

As observed by Pillai **et al** (1945) the effluent is of high quality as is evident from the fact that it supports fish life and a variety of other forms of life. An interesting feature of the biota of the effluents is the occurrence of the vorticellid infusorians (**Vorticella, Epistylis** and **Carchesium**). Pillai **at al** (1945, 1946, 1948) have shown the importance of these protozoans in the purification of sewage under aerobic conditions and in the fish food cycle. These organisms have been recorded from the stomach contents of fishes such as **Barbus hexagonolepis, Labeo fimbriatus, Catla catla** and **Lepidocephalus thermalis** (Chacko **et al**, 1948, 1950). Another interesting feature is the occurrence of large numbers of the blood worm, **Chironomus**, which not only plays an important part during the aerobic purification of sewage (Pillai, 1945) but also contributes to the diet of fishes like **Barbus curmuca** (Chacko, 1950). A female specimen of **Ophicephalus**

gachua, 150 mm in length, netted by us from the effluent channel on 10th March 1951, had its stomach gorged with chironomus larvae. Specimens of **Rasbora daniconius, Barbus sophore** and **Lepidocephalus thermalis** also obtained from the channel on the same day, varied in length from 15 to 90 mm and had their gonad in all stages of development indicating thereby that they are breeding in the effluents. Their stomach when examined revealed the algal flora already listed above. These observations show that the conditions of existence in the effluents are conducive to the growth and breeding of fish.

Several kinds of fish such as catfishes (**Clarias, Saccobranchus, Wallago** and **Macrones**), murrels (**Ophicephalus**), carps and minnows (**Labeo, Barbus, Girrhina, Catla, Rasbora, Nuria** and **Amblypharyngodon**), Gourami (**Osphromenus goramy**). Tench (**Tinca vulgaria**), Mullets (**Mugil**) and prawns and crabs flourish in sewage waters. But the species to be stocked in the Madurai farm should be of the non-predaceous varieties so that maximum output is obtained. It is suggested that about ten thousand fingerlings of the Milk fish (**Chanos chanos**), Pearl-spot (**Etroplus suratensis**), carps (**Catla catla, Labeo fimbriatus, L. kontius, Girrhina mrigala** and **C. cirrhosa**) and the Gourami are stocked in the farm every year. The fingerlings of the Milk-fish can be obtained in large numbers from the tidal creeks near Pamban during April-June, fingerlings of the Pearl-spot from the Tambraparni and its connected tanks, and the carp fingerlings from the Tanjore delta during August-December. Gourami fingerlings will have to be imported from the demonstration tanks in Tanjore or from the Chettinad fish farm. The Pearl-spot and the Gourami might breed in the farm provided the necessary breeding facilities are given. At the initial stage a single species be stocked in each pond. An annual crop of 3000 pounds per acre can be expected from this farm. Attempts may also be made to culture Mirror Carp (**Cyprinus carpio**) and Golden carp (**Carassius carassius**) in this farm. The fingerlings of these cold water species are available in the Kodaikanal lake, where they have been introduced by the Madras Fisheries Department.

Certain experiments were recently conducted for rearing fishes like **Etroplus suratensis, Barbus sarana, Labeo fimbriatus, Cirrhina reba** and **Osphromenus goramy** in a section of the effluent channel, 130 feet in length. This section of the channel was partitioned by wire-meshed screens so as to retain a depth of 3 to 3½ feet of effluent. The results obtained were very satisfactory. The fishes were stocked in February and March 1950; and they flourished in the channel till 15th September 1950 when they escaped due to the breaching of the screens. The Gourami, 6 to 9 inches in length, attained 18 inches during this brief period of 6—7 months. The carps, 3 to 5 inches in size, doubled their growth during the period.

A typical plan and section of the proposed sewage fish farm is shown in Fig. I. The present area of the farm is 3.12 acres; but it is proposed to acquire the Oorani or a low-lying pond, 0.75 acres in extent, which is located further south. The farm will consist of four ponds of 80 x 50 x 4 ft. and four ponds of 100 x 50 x 4 ft. in dimensions and of five nurseries with about 4,500 sq. ft. of water surface. The depth of water in each pond increases from 1 to 4 ft. in one half of the pond, and 4 ft. uniformly in the other half. To facilitate independent manipulation of the ponds separate outlets and inlets are provided for each pond. Provision has been made for draining a pond either entirely or partly through outlets placed at sill level and at one foot above sill level. It is suggested that the entire water of each pond is drained periodically for sunning and aeration. All the water so drained can be collected by a common drain and led into the Oorani, which can also be used for fish culture.

In order to provide necessary shade for preventing undue rise in temperature of the pond water, suitable trees are to be planted along the bunds. Submerged and floating macrovegetation such as **Hydrilla, Ceratophyllum, Vallisneria** and **Nymphaea** are to be grown in the ponds. Harvesting of the crop can be commenced from the sixth month so that over-crowding of larger fishes are avoided. A drag net and a cast net would be required for this purpose. The staff of the farm is to consist of one Farm Inspector and two fishermen-cum-watchers, who should keep watch over the development of the farm. Care has to be taken against the depletion of oxygen in the water and over-production of floating algae and other undesirable matters. In case the pH of the water goes below 7.0 necessary adjustment should be made by the application of lime in the form of ground chalk, limestone, slaked lime and quick lime. It is important to study the nature of the bottom and its flora and fauna both in the shallow and deeper portions. It would be interesting to compare the fish food cycle in a sewage pond as against a pure water pond and a temple tank.

This sewage fish farm at Madurai would be the first of its kind in India. It is an instance of controlled production where there is no need to apply any fertiliser, as the sewage affluents contain both organic and inorganic nutrient substances. It is hoped that the several other municipalities in the State would follow this example.

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THE ROLE OF A GEOGRAPHER IN A FREE INDIA

BY

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As Geographers, what part do we play in governing our country? That is the question which every geographer should put to himself.

First let me take up the part to be played by a Geography Teacher in Free India. Of course, we, teachers of geography, play our part in training the boys and girls under our care to become the citizens of India and ultimately the citizens of the world. The panorama of power has passed into our hands and from our hands it is passing into those of the young growing citizens. So we will have to enable the youngsters to contribute their utmost to the governance of the country. This we can achieve only through right geographical education. How? By introducing the children of this generation to the country in which they live and also to the countries and peoples with whom it seems inevitable that they must have ever-increasing contact. The whole world is tired of war and shudders at the thought of another war. Every country longs for peace and world peace depends upon sympathy between peoples. Sympathy is proper understanding. Understanding among the different peoples create world peace; Prejudices bring friction and war. So to create good relations among nations misconceptions regarding foreign lands and peoples must be corrected. The misconceptions or prejudices against other countries very often spring from ignorance. So an adequate knowledge of people involves first, an objective grasp of their common characteristics stressing their similarities rather than their differences. That there are people living, working and thinking, each in his own way, but each within the same general framework as our own, and that we neither can nor ought to remain indifferent to them is a fact to be realized by the students. In inculcating these ideas into the minds of the children, we, geography teachers, must develop the greatest idea that despite the diversity of peoples and their customs, despite sometimes tragic differences of a political nature, there nevertheless exists a human community, and world unity is possible. So by teaching the subject Geography we create 'Understanding'. We present to the child the fact that men in foreign lands are different from ourselves. We create the desire in the child to understand why those people are different and we do not leave him to develop prejudice against the foreigner out of ignorance.

I have stressed much upon the latest aim in teaching Geography—namely creation of 'international understanding' which leads to effective co-operation and peace. To quote the words of 'UNESCO'—'The recent world war threw into sharp relief the contrast between two kinds of geographical knowledge, one confined to nomenclature and the other based on broad contrasts with the real world. The war renewed our curiosity about geography and almost everyone admitted and regretted his ignorance of the subject... But it is surprising that after two world wars there should still be so much ignorance of geography and that it is assigned such a relatively minor place in the education of young people. So we must emphasise what geography can do much to promote better international understanding."

With the aim of creation of international understanding in view, we, teachers of geography, must make the boy realise that his country is a country

that might change for the better—a country of progress and that Government is a creation of Society. Let us make the boy realise that when he grows up into a man 'he should leave off the idea of puncturing his fellowman with a rapier or a bullet, but should work together with a large group of people within national boundaries and across national boundaries towards better living and better civilisation in this world which is so rich, so very rich in resources.' The constant aim of the geography teacher should be to emphasise not only the increasingly close relation between man and his geographical enviroment, but the growing interdependance of peoples and nations.

But is this aim significant of the Geographer only? Cannot the scientist, the historian, and our other colleagues in other fields of knowledge inculcate this aim in moulding the boy into a future citizen? My answer is that though all of us, teachers in general, discharge our common duty of training the boys and girls into citizens, the geographer gives a characteristic and distinctive view of the nature of the world and of man. "The modern scientific geography has a distinctive point of view and a philosophy of its own, and it does contribute to insight as well as to knowledge."

Let me now examine the curriculum of geography studies in schools and colleges through the teaching of which we try to create better international understanding.

Elementary school is the place where a Geography teacher may render his greatest service to modern society as he has to prepare the children for the new Citizenship. The High School career of a boy is considered now as the end of the student's general education as very few boys take up to higher education and a majority enter life after the conclusion of High School education. Hence the responsibility of a High School geography teacher is greatest. But the Geography teacher in a secondary school is confronted with the difficulty of choosing the real standardised type of geographical education in the frequently changing schemes of reorganisation. Late Mr. N. Subramanyam, called' the Father of Geography' left no stone unturned in placing geography with a status of an ' A Group' subject in the S.S.L.C. Curriculum but it is a matter of deep regret to note that the subject geography has lost its individuality by being merged with some other subjects in a new course called 'Social Studies'. The idea of 'Social Studies' has been borrowed by our government from the curriculum of studies in America and England. But what have those progressive countries to say after experimenting this new studies in their schools for some years?

The Memorandum prepared for the Council of the Royal Geographical Society by the Education Committee, published in Dec. 1950 issue of 'The Geographical Journal' reads as follows: —"It is felt that Social Studies will destroy the value of Geography as an important medium of education, and the Education Committee is concerned at its spread in schools under the name of 'Social Studies'. This new subject is increasingly being taught in schools, where it displaces geography and history as separate subjects in the Time Table. There is however much evidence of a strong tendency to breakdown the barriers between subjects and to teach an amorphous hotch-potch of geography, history and civics under the heading of 'Social Studies'. The course contains a little geography but in a disjointed and attentuated form, insufficient to preserve the characteristic outlook and discipline of the subject, which in recent years have come to be regarded as indispensible in the education of citizens. The curriculum omits aspects of local study that the geographer regards as essential in any school

geography course. Submergence of geography in Social Studies cannot make its characteristic contribution to education. An attempt to study a group of subjects together introduces such complexity that children cannot see any general patterns or gain a clear and memorable educational experience. History and geography, for example, are distinct branches of study, and each is recognised as having a unique contribution to make to the intellectual equipment of the educated citizens of to-day. But these contributions are different, and cannot be made unless the recognised content and characteristic method of presentation of each subject are preserved. This is impossible, if the two, with others, are merged into a single subject—Social Studies. The emphasis placed on human affairs in Social Studies and the complexity of this subject matter leads to a neglect of the natural environment in which man lives. It is the geographer's aim to balance these two aspects, the human and the natural, and an essential contribution of geography to education is the appreciation of the relationship between man and his environment throughout the world.

And now what have the American educationists to say about this new subject ? In an investigation into the status of geography in some city schools in U.S.A. conducted in 1947 and published in the 32nd Yearbook of the National Society for the study of Education on 'The teaching of Geography' we are informed that out of the 63 cities submitting outlines of course of study, 6% have Social Studies with no distinct Geography ; 26% have Social Studies in which Geography has a distinct place ; and 68% give geography as a separate course in the curriculum. This information clearly shows that in American Education Social Studies is introduced but Geography 'is taught as a seperate subject' in addition to Social Studies in most of the schools. The Year Book says further " Though Social Studies is admirable in its purposes and aims, it fails in making plans for the achievement of a goal which is outstanding in Geography; namely, a knowledge and an appreciation of the likenesses and the differences to-day in the problems of people in the various sections of our country and among the various nations of the world, as related to the natural environment."

These then are the opinions of the British and American educationists on the place of geography in Social Studies. The Society of Geographers, jointly with the Indian Geographical Society, had submitted a Memorandum to the Director of Public Instruction, Madras, in the year 1949 offering its criticism on the position of geography in the reorganised scheme of education and pleading for the betterment of its status in the new scheme. I have nothing more to add than reminding the Education Department about the appeal submitted already and pleading for the separation of the subject Geography from the scheme of Social Studies.

As regards the collegiate curriculum in Geography I am not competent to make any comments upon the courses of studies. Thanks to the efforts of the Indian Geographical Society, Geographical Education in the State is spreading as is evident from the fact that more and more colleges are offering geography in their courses. In this connection I should not fail to express our deep gratitude to Dr. George Kurien, Professor of Geography, University of Madras, who assisted by Miss A. R. Irawathy, Lecturer in Geography in Queen Mary's College and Prof. B. M. Thirunarayanan, Professor of Geography in Presidency College, Madras and by some others, have raised the status of Geography to Honours standard in the University of Madras,

In teaching the right type of geography it is a matter of regret to note that suitable Text-books for use are not available. Apart from the common criticism that text-books are out of date objectives are not clearly defined in the Text-books. It is a pity to note that Professors and Lecturers in Geography in South India have not come out with their productions of suitable Text-books while North-Indian Geographers are noted for their authorships.

The geographical knowledge imparted by a Geography Teacher will have to be tested suitably. Geographers should determine what should be measured. The measurement of geographical knowledge shall include (1) a knowledge of vocabulary, (2) a knowledge of places and (3) a knowledge of geographical relationships. A Test in geography should be constructed to discover whether a candidate is geographically-minded. . Scientific testing in Geography is not yet developed in our country. The American method of New Type Tests has been introduced in the Secondary Schools. It is too early to say whether such tests are suitable for our boys and girls I refrain from commenting upon those tests as we will be seeing the results of such tests only at the ensuing S.S.L.C. Public examination in March 1951.

Let me now pass on to the role of a student of geography in Free India. After taking degrees in Geography some students might take up the teaching line; and some might knock at the doors of Government services .Such of those who want to try for Government services, let me tell them that a person trained in geographical knowledge could fit into any department of work connected with the administration of our country. The Physical Geographer plays his part in work connected with meteorology, climatology, physiography, soil science and oceanography. The Human Geographer renders his scientific services to the Government in the Census, Agriculture, and Commerce departments. Unfortunately our country does not offer much scope for utilising the services of geographers like the advanced countries of America or England. Regional Geographic Surveys and Soil Surveys—as are systematically conducted in western countries must be organised by our Government for constructive planning of the future. In this work the Geographer is found to be most suitable and well equipped Industries in our country may be classified as 'Extractive,' 'Conversion' and 'Distributive.' In extractive occupations like agriculture, lumbering, mining and fishing a geographer fits in correctly with his knowledge of the natural resources of the world. In 'conversion' industries of changing the raw material of the earth into the manufactured article of use, the Geographer is found useful with his knowledge of location of industries. A Salesman who has studied local geographic conditions cannot but be a geographer who is the only one who could carry on effectively the 'distributive' side of work. In meteorological work, weather bereau, census work and agricultural statistics the geographer is handy with his capacity in the preparation of Maps. So trained Geographers can go into all kinds of public and private enterprises. To quote the words of the American Year Book "If Geography is to be the tool of the businessman, the exporter, the domestic distributor, or the statesman, he must know the science of Geography itself."

'KNOWING GEOGRAPHICALLY AND THINKING GEOGRAPHICALLY' PLAY YOUR PART IN FREE INDIA.

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