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PREFATORY NOTE.

I have to express my acknowledgments to all the gentlemen who have assisted me in gathering the material for this report and in particular to Colonel J. Shakespear, C.I.E., Political Agent in Manipur State, to Rai Madhab Chandra Bardalai Bahadur of Gauhati, and to Srijut Kali Ram Medhi, M.A., Sub-Deputy Collector.

The subject dealt with in this monograph demands in places technical knowledge to which I cannot lay claim and I must apologise for its deficiencies in that respect. Our records also seem to give very little attention to the subject which is almost a virgin field of research.

I have divided the subject into two heads (1) smelting (including in that term the working out of the ore and the preparation of rough iron therefrom) and (2) forging or the conversion of the rough material into instruments by the smith.

Smelting, though formerly general in the hills of the central range and its vicinity in Assam, was apparently unknown in the plains of Eastern Bengal and of the Surma Valley.

Now it only survives in the district of Khasi and Jaintia Hills and in the Manipur State and in those places only to a very limited extent, though it is not improbable that it may also still persist in the northern and eastern hills of which we know little. Forging of instruments for purely local requirements is more or less common over the province though there seems to be little external exchange of ironwork, the smithy generally supplying a particular village or group of villages. Little distinction is made between iron and steel though it is often customary to weld in steel to the more important instruments.

Later on, attempt is made to estimate the profits of the smiths, but it must be remembered that to the greater number forging is more or less of a diversion to be engaged in in the intervals of the more serious business of cultivation.

PART I.

SMELTING.

The earliest record we have of ironwork in the Khasi Hills is in the Khasi Thlen superstition—a superstition which survives to the present day. The story goes that the gigantic man-eating snake, after having his suspicions lulled by repeated gifts of lumps of raw flesh, was slain on a ball of red-hot iron being thrown into his open mouth by a goatherd who was presumably also a smith.

But leaving aside legend, there is no doubt that the industry was very general in the hills in earlier days—a fact probably accounted for by the extreme richness of the ore and the ready manner in which it can be worked. In the most unlikely places in these hills—near Dumpep bungalow on the summit of U Swer, one of the highest hills of the range, and in the Deputy Commissioner's compound in Shillong—amongst others are found lumps of old slag lying about in profusion. Nowadays all recollection of these workings seems to be lost and the chief use of the slag seems to be to furnish missiles for the catapults of children. The shrinkage of the industry seems exemplified in the comparatively recent abandonment of the last of the workings in the Jaintia Hills.

In the next hills of the range proceeding eastward, the North Cachar Hills, ore is also no longer extracted though it was till 50 years ago.

Mallet in his interesting note* tells us that iron smelting was, at one time, an important art in Upper Assam, but even when he wrote (1877) it had been extinct for many years.

In the Assam plains the industry must be presumed to have been carried on to no small extent in ancient times though no traces of it now remain. The massive guns alone which are found in plenty at most former centres of population, to say nothing of other implements of war and agriculture, show that iron must have been in much greater abundance than could have been supplied by the hill tribes on the north and south of the valley with whom relations were anything but cordial.

Indeed Colonel Hannay placed the number of workers in the zenith of the Ahom power at 3,000, but says they did not exceed 100 after the Burmese invasion. Since then with the disappearance of the system which obliged certain persons to work at assigned trades the workers seem to have entirely vanished.

In the Surma Valley Proper and in the whole of Eastern Bengal we have no traditions or record of mining and certainly none survives to-day. Nor even in the Lushai hills and Chittagong Hill Tracts have workings ever been carried on so far as is known.

In Manipur, we are however on firmer ground. There are 3 villages in the State which are allowed to carry on this industry, *viz.*, Kokching, Wairi and New Kokching. The two first adjoin each other and their inhabitants claim to be the descendants of some foreigner who came from Silchar. Their ancestors one day near Thobal noticed a pile of earth thrown out from its burrow by a bamboo rat. He recognised that this was similar to the earth which in Cachar contained iron and collected some. On his way home he met the Raja who, on learning what he was carrying, ordered him to experiment. Accordingly a small bar was smelted out and the Raja being much pleased ordered these people to remove to Thobal. This they did, but later on fuel becoming scarce in the neighbourhood they removed to Kokching and Wairi where fresh deposits were found, later a colony was despatched a few miles south-west to New Kokching where further ore was discovered. The deposits are said to be the work of a local divinity who is able to move them about at will. Hence it is necessary to propitiate him by sacrifice for though one day no amount of digging will produce any ore on the next it may be found in plenty on the surface at the same spot.

The older mines at Kokching and Wairi are situate two miles west of the Burma road, at the 25th mile from Imphal, and the two villages form an endogamous community. New Kokching is a few miles to the south-west. The deposits are found lying at the foot of the slopes of the hills and that at Kokching covers an area of about 4 acres.

The following is an interesting extract from McCulloch's account of Manipur, pages 34 and 35 :—

"Iron, the only metal yet ascertained to exist in Manipur, is found in the form of titaniferous oxydulated ore, and is obtained principally from the beds of small streams, south of Thobal, and the hills near Langatel; its presence in the latter is ascertained by the withered appearance of the grass growing above it, and in the former it is generally sought for after the rainy season, when the soil has been washed away; an iron headed spear is thrust into the ground, and the smaller particles adhering to it lead to the discovery of the bed in which they had been deposited; this employment of the spear furnishes an accidental but very striking illustration of the magnetic property being acquired by iron, which is preserved in the same position for any length of time. The spear of the Manipuri and Naga is almost invariably thrust vertically into the ground, when not in use, and the fact of its being so employed to ascertain the presence of the ore, is a very strong proof of high degree of magnetism or polarity it must have attained. The loss by smelting the ore amounts to nearly 50 per cent., and the Manipuris are perfectly sensible of the difficulty of fusion increasing with the greater purity of the metal."

The people now deny the use of the spear in locating the ore. They say they use a long bamboo skewer and tell when there is a deposit by the amount of residence.

The deposit at Kokching is of a yellowish colour while that at Langathel and New Kokching is of slaty grey. All are a limonite. If pure, this would contain about 60 per cent. iron, but there is probably admixture of other substances. It consists mainly of small nodules $\frac{3}{8}$ th to $\frac{1}{2}$ inch in diameter.

The former produces a smaller quantity of iron than the latter, but the quality is said to be better. It is thought that the best result in every way is obtained by smelting equal quantities of each kind.

The ore is extracted from pits which seldom exceed 9 feet in depth. A party from one of the villages excavates jointly, the fruits of their labour being heaped together and taken off to the village.

In the actual smelting two baskets of earth weighing over two and half maunds are treated at one time. The first process is to wash the ore thoroughly to remove as much of the earth as possible. A special piece of ground is then smoothed and plastered with cowdung. On this several alternate layers of straw and ore are laid, then the whole pile is set fire to. The ore can be picked out from the ashes without trouble and is then pounded.

(In the Khasi Hills system this preliminary burning possibly owing to the greater richness of the ore, is not resorted to.)

It is after this that the furnace work begins. The furnace proper consists of a hollow cylinder of clay 2½ feet in height and 18 inches in diameter at the top, from the bottom of which two pipes or air tubes lead respectively into two smaller wooden cylinders or bellows partially buried in the ground. These cylinders are covered by pieces of the buffalo hide securely bound round the rims and kept wet all the time to make them as air-tight as possible. In the centre of each cover is a hole through which a cord is passed, the other end of the cord being attached to the bent branch of a tree securely buried in the ground so as to keep the covers elevated to the utmost. The bellows-man now takes his stand on these covers, placing a foot over each hole and resting his hands on a cross bar. By alternately rapidly raising and depressing each foot, and thus opening and closing each hole, he produces a strong draft which is driven through the pipes into the furnace proper.

At the bottom of this is placed a layer of live charcoal and when this has been raised by the blast to a great heat a little of the powdered ore is sprinkled on it. More charcoal and ore is added as needed but no flux is used. After the operation has been repeated five times, the furnace is extinguished and the resultant iron extracted. This should amount to about 25 pounds of rough iron, and about 320 pounds of charcoal is required as fuel.

This rough iron is then removed to the forge to be further prepared. I can make no estimate of the total quantity produced which is however not large.

In the Khasi Hills workings were formerly, as already remarked, very numerous throughout the higher plateau of the district. But the use of the cheaper and better imported iron for the forges and the non-application of the modern more efficient methods have almost extinguished the industry which is now only carried on in the little State of Nongspung some 20 miles south-west of Shillong and near Nongrem, the seat of the ruler of Khyrim State, some seven miles south of the station.

Oldham's report on the geological structure of a portion of the Khasi Hills (Memoirs of the Geological Survey of India, Volume I, Part II) contains at pages 152-153 and 201 to 207 a most instructive account of the Khasi workings. He had no opportunity of visiting Nongspung and his account is necessarily incomplete, but it is regrettable that space does not permit of its inclusion. Readers must however be referred to the text of the report for further information.

In both places now worked, the deposit seems of similar nature and formation, a bright black sharp sand found mixed with a fine plastic white clay. To extract it, a channel of water is led near the quarry and the mixed iron and clay is thrown in, the lighter clay is carried down stream and the

heavier ore sinks to the bottom. This washing is repeated several times, till practically pure ore is obtained. In this condition the ore is a magnetite containing 60 to 70 per cent. of pure iron and is taken direct to the furnace, preliminary burning being deemed unnecessary. The smelting house, which is practically the same at Nongspung and Nongkrem, is a small gloomy cone shaped building. On entering one is struck by the enormous bellows in use. They consist of a double wooden cylinder about 6 feet high and slightly tapering towards the top.

Into the sides of these cylinders are let bands of cowhide, which allow the machine to be to some extent extended and compressed. On the summit stand two women behind each other, a foot resting on each cylinder. By alternately throwing their weight from side to side they work the bellows up and down. The woman in front keeps her balance by holding a bamboo suspended from the roof, the one behind by resting her hands on her companion in front. Close by stands a third woman ready to relieve either of the others in turn.

At the bottom of these primitive bellows is a clay pipe leading into the furnace, simply a hole dug in the floor of the house and above the fire is a short flue about half the weight of the bellows.

It does not seem to be considered essential that the flue should be immediately over the fire; as it is, it can only attract a very small draught and seems to be of little purpose. For fuel pine tree charcoal is used, the pine being abundant and reproducing freely in the vicinity wherever it has not been destroyed for *jhuming* or pasture.

The furnace is first filled nearly to the floor level with live charcoal and the bellows set to work. Then the ore which has been moistened and spread over bracken to keep it from caking is thrown on top of the charcoal. As the bracken burns away and the molten iron falls through the charcoal, more bracken and iron is added till the requisite quantity of ore has been used. Now the master of the forge appears and with an iron jumper levers up through the fuel the glowing mass of the iron which he roughly hammers into shape and cleaves in two to test it; should the lump be friable it is thought unfit for use and is discarded. The people aver that they were taught the manufacture of iron by the Creator and stoutly affirm that they have made no changes since a statement which seems the more colourable when it appears that they are ignorant even of the uses of a flux though limestone abounds in the neighbourhood. The writer has endeavoured to induce them to try experiments with lime though with what results it is not known at the time of writing.

The deposits both at Nongspung and Nongkrem and its neighbourhood seems to be extensive. There are large coal measures now supplying excellent fuel for local consumption at no great distance; lime is somewhat nearer and ample pine timber and water power is to be had on the spot more particularly at Nongspung though naturally the water power is more plentiful in rainy season. Probably the most accessible coal is in the British village of Mawbehlarhar about 12 miles south-west of Nongkrem in a straight line and about 10 miles east and south-east of Nongspung in a straight line. Of course a practicable path in both cases is considerably longer. I think there is room, particularly at Nongspung, for a really prosperous working on European lines and extensive scale. It must be remembered that neither place is in British territory proper, but our Government has treaty rights with regard to minerals which make exploitation by no means very difficult. The main obstacle, as to every form of development in these hills, lies in the lack of modern means of transport. Perhaps a solution lies in the monorail and the Nongspung mines are not very distant from the suggested cart road from Mawphlang to the south-west corner of the hills near Lengra Bazar.

PART II.

FORGING.

Unlike the working-out and smelting of the raw material, forging is spread over practically the whole province. In some districts of course it is more in vogue than in others, but no general cause seems assignable.

The material used is chiefly imported pig iron and iron steel bars brought by the local traders from Calcutta. To a less extent, and mainly in the more remote districts, broken instruments and scrap iron in any form are bought up to be re-made while in those places where iron is still produced locally the outturn is made use of to swell the product. In Manipur special forms of hoes and *daos* are made from native iron, differing in shape and name from those made from foreign imports. A particular kind of scrap much in demand in the hills is the metal bands used for baling piece-goods while most esteemed of all are the metal clips with which bundles of corrugated iron sheets are fastened together. Indeed the tribes bordering on the Lakhimpur district have after trial discarded pig iron in favour of the two latter forms of scrap while the Nepalis living in our territory seem to regard with disfavour any *khukris* not made in their own fashion over the border.

Charcoal is the most generally used fuel. In the plains this is preferably made of the green bamboo or in places of ekra, in the hills of pine or other hill woods. But where it is available cheap and its use is known, coal (and coke) is displacing charcoal at least in the centres of population.

No attempt can profitably be made to estimate the number of forges in the hills owing to our scanty information.

Number of forges and persons supported by the industry.

Following are the figures supplied by the plains districts which have dealt with this point. Figures of the numbers of persons are subject to the obvious comment that in some cases they and in some do not include the dependants.

District.	Number of forges.	Number of persons.
Rangpur	710	2,982
Dinajpur	896	3,078
Rajshahi	650	3,500
Malda	550	7,241
Mymensingh	500	1,540
Bakarganj	659	2,430
Noakhali	150	600
Sylhet	400	4,500
Cachar	86	...
Goalpara	166	400
Kamrup	227	918
Darrang	110	...
Nowgong	98	300
Lakhimpur	145	455
Total for 14 districts	5,347	

Dacca gives 262 forges for a portion of the district.

These numbers are of course incomplete, but it may be taken that the above are the districts where the industry is most important. It seems also to flourish in Bogra where there are said to be one or two smiths in every village and where the profits earned are steadily rising.

PROFITS.

It is very difficult to form an estimate of the profits which shall be at all accurate. In many places where work at the smithy is only carried on intermittently, Rs. 5 per month seems to be an unusual profit while the more skilled artisans in places earn Rs. 60. On the whole it seems that an average man working fairly regularly should earn about Rs. 13 per month.

In comparatively few cases is forging the sole occupation of the smith. The end for which his forge is kept is to supply the demands of his fellow villagers as they arise and usually he keeps no stock. Consequently work is intermittent in some places—*e.g.*, in Noakhali, it goes on chiefly at the sowing and reaping seasons when the demand of the husbandman for the repair or renewal of his implements is brisk—in others the master of the forge will flatly refuse to use his furnace when his own cultivation demands his attention.

The most characteristic part of a forge is the bellows. It has been seen that the bellows used where smelting still persists are large instruments which the worker keeps in motion by raising and depressing his feet and thus alternating the weight of his whole body. But the engines used with the forge are nearly always smaller, the workman prefers to sit (except in case of the hill-blowing machine) even when as in Nowgong, he drives with his feet instead of with his arms.

For heating the fire the engines are of two classes A—bellows, B—blowing machines of rigid form and depending on a piston for their power. A is in common use in the Bengali-speaking districts and is, with modifications, of the familiar English type. Generally, however, a string and pulley is resorted to for opening and closing the bellows and variations from the usual pear shape are not uncommon. In some, though less frequent, cases the bellows are two chambered so as to give a double blast. Interesting variations are reported from Kamrup where a collapsible bellows made locally of a whole goat skin, which is worked directly by the hand pressing the leather and covering, during expression, the air inlet is in use and from Nowgong where some of the Assamese use a double bellows consisting of two small leather and wood prisms worked by the feet of a sitting man.

Among the Assamese and in portions of Cachar, the single horizontal bamboo cylinder double action blowing machine figured in Malet's note (Plate I, p. 154, Vol. X, Records of the Geological Survey of India) seems the indigenous machine.

The hill tribes, on the other hand, use almost universally the double upright bamboo cylinder worked by either hand by a standing man (*vide* Plate II of Malet's note) though in Manipur the form of bellows employed for smelting is also used in the forge. For packing the piston, feathers, mouse deer and rat skins, fibre and indeed anything handy may be employed. The defect of the upright cylinder machines is that they do not as a rule possess air inlet valves and consequently in expansion air has to be sucked back through the fire.

The forms which are not worked with a string but require the operator to remain near the fire are usually provided with a low bamboo screen.

The commoner implements of husbandry, domestic use and carpentry, such as hoes, ploughshares, sickles, scythes, harrows, *daos* of great variety, axes, tongs, knives of differing forms, hammers, adzes, chisels, nails, etc., are made almost everywhere, as well as fishing and hunting spears, fish hooks, razors, cart axles and tyres and other miscellaneous objects.

The following lists of implements made in typical districts of Assam, Eastern Bengal, and the Hills are good examples :—

ARTICLES PRODUCED IN KAMRUP.

Assamese name.		English name or use.
Dao	... ..	...
Katari	... ..	Small knife.
Kuthar	... ..	Axe.
Kanchi	... ..	Sickle.
Phal	... ..	Ploughshare.
Bothi	... ..	Fish knife.
Posa	... ..	Fishing spear.
Khanti	... ..	Small spade.
Chach	... ..	Adze.
Botali	... ..	Chisel.
Khadga	... ..	Large sacrificial knife.
Hathuri	... ..	Hammer.
Neari	... ..	Anvil.
Bhangi	... ..	Curved adze (for hollowing dug-out boats).
Jathi	... ..	Large spear.
Shel	... ..	Thin spear.
Dokoha	... ..	Barbed double spear.
Gacha	... ..	Oil lamp stand.
Sarah	... ..	Tongs.
Lep ...	... ..	Pincers.
Ber ...	... ..	Iron rings for <i>dao</i> handles.
Chena	... ..	Chisel for cutting iron.
Khur	... ..	Razor.
Dab	... ..	Folding knife handle.
Hakota dao	... ..	A special <i>dao</i> for bamboos.
Tamoe kotaru	... ..	Betel nut penknife.

ARTICLES PRODUCED IN NOAKHALI.

Bengali name.		English name or use.
	<i>Husbandry.</i>	
Kanti	... ..	Sickle.
Khanta	... ..	Spade.
Kodal	... ..	Hoe.
Hal	... ..	Ploughshare.
	<i>Domestic use.</i>	
Dao ...	... ..	(Of varying kind.)
Kudal	... ..	Wood axe.
Bansti	... ..	Fish axe.
Janti ...	... ..	Betel nut cracker.
Chimata	... ..	Tongs of sorts.
Manna	... ..
Churi	... ..	Knife.
	<i>Carpenters' tools.</i>	
Ret ...	... ..	File.
Batani	... ..	Chisel.
Bais	... ..	Adze.
Haturi	... ..	Hammer.
	BARBER'S IMPLEMENTS.	
Narun	... ..	Nail cutter.
Kshur	... ..	Razor.
	<i>Miscellaneous.</i>	
Chheni	... ..	Iron or plam cutter.
Gotai	... ..	Boat nails.
Kara	... ..	Rings.
...	... ..	Sacrificial weapons of sorts generally inlaid with brass.

ARTICLES PRODUCED IN THE KHASI HILLS.

Khasi name.		English name or use
Ka wait lynggun	}	... .. <i>Daos</i> for various purpose.
Ka wait lyngkut		
Ka wait khmut		
Ka wait prat		
Ka tari dab	... ..	Penknife.
Ka tari sum	... ..	Meat knife.
Ka rashi	... ..	Sickle.
U sum	... ..	Spear.
Ka phar	... ..	Ploughshare.
U sdie	... ..	Pick axe.
U Mohkhiw	... ..	Hoe.
Ka nap-khap-shiah	... ..	Tweezers.
U pliang	... ..	Barbed arrow head.
U sop	... ..	Plain arrow head.
Ka nap	... ..	Tongs.
Thlong khylliat kwai.	... ..	Iron pestle and mortar.

The *dao* the most common cutting implement, differs as might be expected greatly in form from the large weapon of war or sacrifice to the small and universal household tool, but in many patterns the hooked end is pronounced. Like the incurved *kukri* this gives that pulling stroke which the Indian labourer likes in most of his tools as opposed to the push which the European workman values. Striking instances of this preference are found in the prevalence of the hoe in this country for the uses to which the spade is put in Europe and in the form of saw used by the Indian sawyer which has its teeth made sharp on the opposite edge to the European saw.

The hoe too differs greatly in the plains and the hills. Where obstructions are not likely to break the force of the blow the flat edge of the European hoe is preferred, but in stony ground such as is most of the hill soil, the pointed edge serves to turn aside the tool and prevent the blow from being lost. It is a pity that no modern manufacturer is known to turn out these hill hoes and the people are driven to use the inferior locally produced ones. In the Khasi Hills a peculiarity is the high shoulders given to the hoe. I am not able to see any object in this. In these hills little use is made of the plough, most cultivation being done by hand with the hoe which therefore has a much enhanced importance. For the little ploughing there is in the Khasi Hills a peculiar form of plough-share (*ka phar*) a sharpened oval plate of iron is used.

In Mymensingh one workman successfully makes steel trunks, the only case in which they are turned out in this province, and in Old Malda one workman can make locks comparing very favourably with imported ones.

At Barapaika in the Bakarganj district particularly skilled workmen are found who are said to be able to make anything from a knife to a delicate surgical instruments. Some of the products of these Karmakars were specially commended at the recent Calcutta Industrial Exhibition.

Some villages where the industry flourishes.

At Dattapara in Noakhali there are as many as five forges in one workshop. Domestic and agricultural implements are turned out practically continuously and not merely to order especially just before the Durga Pujas when the products are exported to the surrounding districts. The other villages specially noted in this district for their iron work are Kanchanpur, Barhitola and Barahinagar.

At Pachgaon in the Maulvi Bazar subdivision of Sylhet and at Chandpur and Mirdadpur in Malda the industry appears to be carried on with some amount of skill, and generally at the head-quarter stations of many districts a certain amount of attention is devoted to the work though it nowhere appears to attain the prominence which might be expected.