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Recent Changes in the Course of the Lower Euphrates

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Source: *The Geographical Journal*, Vol. 28, No. 3 (Sep., 1906), pp. 266-277

Published by: geographicalj

Stable URL: <http://www.jstor.org/stable/1776733>

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of "aguardiente," or rum, and a great deal of drunkenness is encountered among the Indian labourers.

On the morrow I began my last day's journey in the saddle. The road left the pleasant valley and wound up on to a high, cold plateau. Fourteen leagues lay between Jauja and my objective point, Oroya, the terminus of the famous Oroya railway, where I should take the train for Lima. It is a remarkable thing that the inhabitants of Jauja and of the numerous towns of the valley have been content to live through the many years since that railway was constructed without making any attempt at a road for vehicles which would give them cheap and comfortable communications therewith. The existing trail is simply a track over the limestone strata, where the wearied pack-trains stumble ceaselessly, in the same condition almost as when the Andes were upraised from chaos. However, this is now being remedied by the construction of a branch railway from Oroya.

The altitude of the latter place, where I arrived in the late afternoon, is 12,178 feet above sea-level, and the railway thence rises at the summit of the Andes to the west to 15,642 feet, the highest in the world, and doubtless the only existing instance where the traveller is carried from the limit of the perpetual snow-cap to sea-level in a few hours. Near Oroya great activity is being displayed upon the Cerro de Pasco mines, which are said to be the largest copper deposits in the world.

The region which I traversed is but little known outside the country. It is embraced between the parallels of  $11^{\circ}$  and  $14^{\circ}$  S. lat., and  $77^{\circ} 10'$  to  $74^{\circ} 45'$  meridians west of Greenwich. It is a region of great resources, and will undoubtedly be the scene of an early development, for the dawn of an era of progress is upon the old empire of the Incas, awakening it from its years of stagnation, and giving it a place among the progressive nations of its hemisphere.

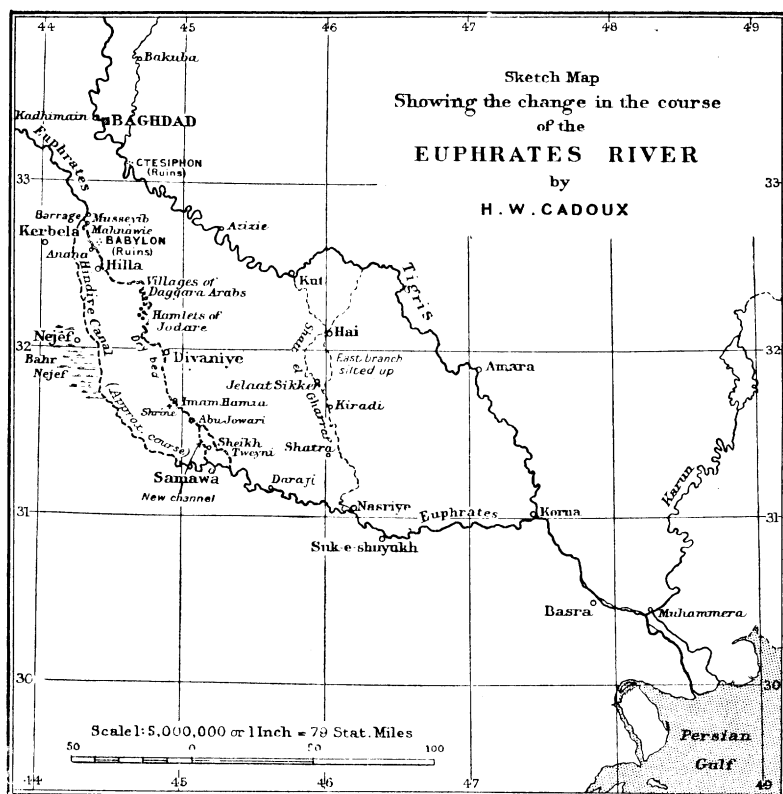
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## RECENT CHANGES IN THE COURSE OF THE LOWER EUPHRATES.

By H. W. CADOUX.

IN the various descriptions which have been written during the last few years concerning the country which the so-called Baghdad or Persian Gulf railway is to pass through, there has been a somewhat marked absence of information about the country south of Baghdad which must be traversed by the railway to its ultimate destination on the Persian Gulf. The following notes of a journey made down the lower Euphrates from Baghdad in September, 1903, may therefore not be altogether devoid of interest.

Recent events have transpired in that portion of Chaldæa between Musseyib and Samawa which, besides being of the gravest local importance, are of general interest, throwing as they do a certain amount of light on the way in which large tracts of country, the scene of former activity and cultivation, come to be abandoned, and are to-day buried many feet deep in the sand of the desert.



Few people who have read Mr. Ellsworth Huntington's stirring description of the upper Euphrates in its headlong course through the gorges below Harput, or who have watched the powerful sweep of the middle Euphrates through the basalt-capped hills that hem it in at Halebeche, would recognize in the dry and sandy bed that now stretches from Musseyib to Samawa, the original course followed by these historic waters in their never-ending journey towards the sea.

From Baghdad to Musseyib on the Euphrates, the road, which goes almost due south, crosses a flat and in summer very dusty plain, scarred with the remains of many ancient irrigation canals, a few

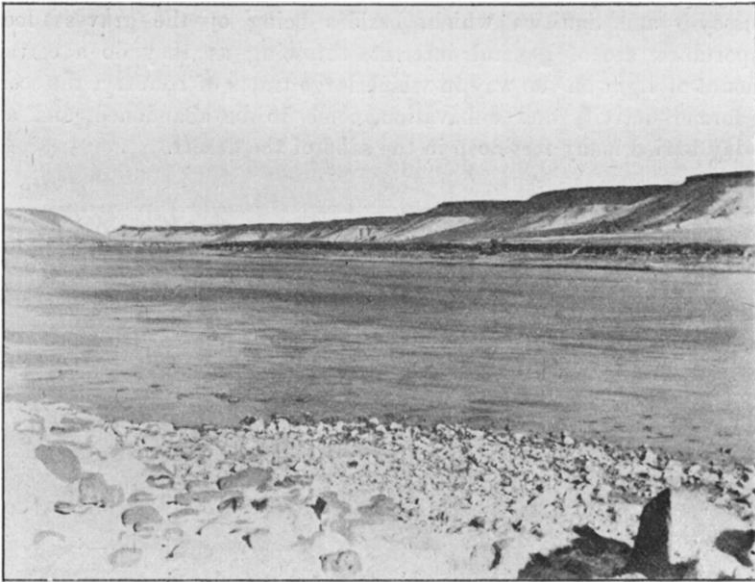


FIG. 1.—EUPHRATES FLOWING BETWEEN BASALT-CAPPED HILLS AT HALEBIYE (HALEBCHÉ), 30 MILES NORTH-WEST OF DEIR-ES-ZORR, LOOKING NORTH.

of which are still utilized during flood-time. It is otherwise devoid of any special feature of geographical interest.

This main road from Baghdad to the pilgrim shrines west of the Euphrates crosses the river by the bridge of boats at Musseyib, hundreds of pilgrims passing over the river daily to Kerbela and Nejef. The river flows here in a broad placid stream 175 yards or so in width, with a maximum depth of 14 feet in the dry season. Its banks are from 8 to 14 feet in height, composed of alluvial sand of varying degrees of fineness and with little or no cohesion. This lack of cohesion has doubtless had considerable influence in bringing about changes in the lower parts of the river's course. The current during the dry season is about 1500 yards per hour, and this increases to quite 4 miles per hour during flood-time, when the river, swollen by the melting of the snows in the highlands of Turkey, rises to 10 feet above the low-season level.

A detailed account of the way in which the waters of the Euphrates have abandoned their original bed below Musseyib would be a long one, involving a good deal of local history. Briefly, the causes contributing to this unfortunate occurrence may be divided into those of a natural origin and those directly attributable to the hand of man.

The chief natural cause has been the gradual heightening of the bed and banks of the river above the level of the surrounding country

by the silt and sand brought down, especially in flood-time. From almost time immemorial the waters of the Euphrates have escaped during the flood season to the lower country west of the river, forming large marshes, amongst others the Bahr Nejef. According to the unvarying account of natives who have visited the Bahr Nejef in recent years, a great part of it has dried up, and palm gardens are now planted in many places where its waters held sway. No doubt this is due, in a measure, to better drainage by the Hindiye canal, and also by a diminution of flood water from the Euphrates.

This formation of marshes in a direction roughly parallel to the rivers from which in flood-time they derive their waters, is a very noticeable feature in the country traversed by the lower Tigris and Euphrates. Their existence would seem to indicate that the rivers in question have, in the main, kept to their present beds for a time sufficiently long to allow the deposition of enough silt to raise them appreciably above the original plain through which they flowed.

The first blow dealt at the lower Euphrates was the opening of the Hindiye canal, the entrance to which has been changed a good many times, but always kept somewhere near Musseyib. Probably in its origin only an irrigation canal, it had attained a breadth of 85 yards twenty years ago, and to-day is some 200 yards broad in the same place. Its course being fairly straight and running along the

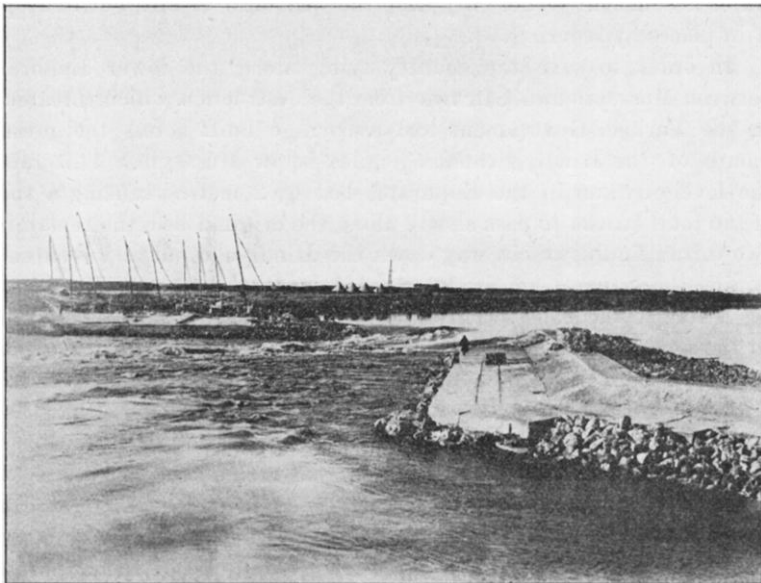


FIG. 2.—BROKEN BARRAGE AT MOUTH OF HINDIYE CANAL, 5 MILES BELOW MUSSEYIB. TO THE LEFT, HINDIYE; TO THE RIGHT, EUPHRATES, LOOKING NORTH-WEST.

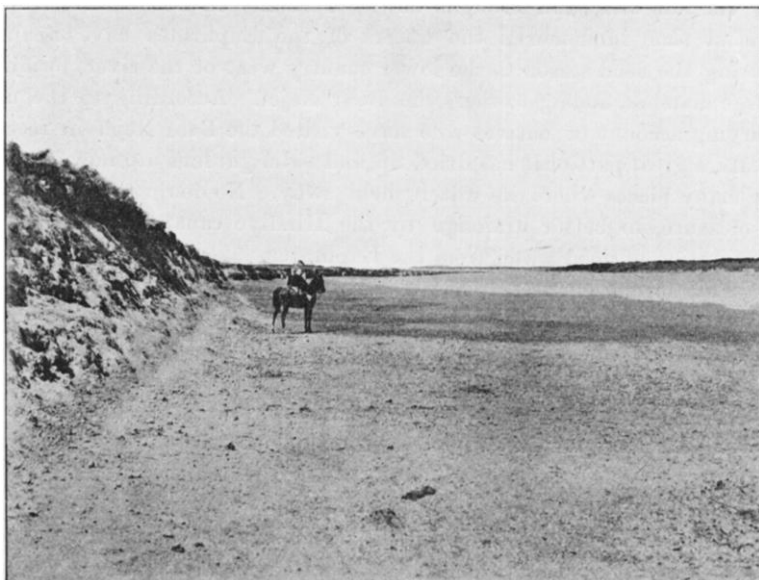


FIG. 3.—BED OF EUPHRATES AT MAHNAWIE, BELOW THE BARRAGE, LOOKING WEST.

ground west of, and roughly parallel to, the Euphrates, the current of water is sufficient to not only keep the bed clear of silt, but to deepen it in places by scouring.

In order to save the country lying along the lower Euphrates between Musseyib and Samawa from the destruction which threatened it, the Turkish Government had a barrage built across the present mouth of the Hindiye canal  $5\frac{1}{2}$  miles below Musseyib. This raised the level of water in the Euphrates bed by 2 metres, causing a third of the total stream to pass slowly along the original bed, the remaining two-thirds finding their way down the Hindiye canal and eventually joining the Euphrates near the town of Samawa.

Amongst the causes attributable to human agency, and leading to the present disastrous condition of affairs, may be mentioned the irrigation methods adopted by the Arabs dwelling near the river from Hilla downwards. Noted for their lawless character, they have effectually resisted all attempts on the part of the Turkish Government to regulate the use of the river for agricultural purposes. By means of large canals, one of the most noted being the Daggara canal below Hilla, the Arabs have for many years past led away a very large proportion of the water to the low ground east of the Euphrates. Using a part of this water for their rice and grain-fields, they, with the improvidence which characterizes their daily life, allow a vast amount to run away into the marshes. This lessening of water in

the river has had the effect of increasing the deposition of silt in the river-bed. The Arabs on the Euphrates below Divaniye, unable to irrigate their fields with this diminished stream of water, resort, during the months of June and July, to the building of "sukurs," or dams, across the bed of the river. The sukurs, which are composed of baskets filled with clay, faced with the same material, and protected in parts with matting, are put down in sets of three. The first sukur has a gap of about 8 feet, and the last down-stream three outlets of about a foot each. This artificial slowing down of the current must tend to increase the silting-up of the bed above the sukurs. Another factor not without importance is the great quantity of wind-borne

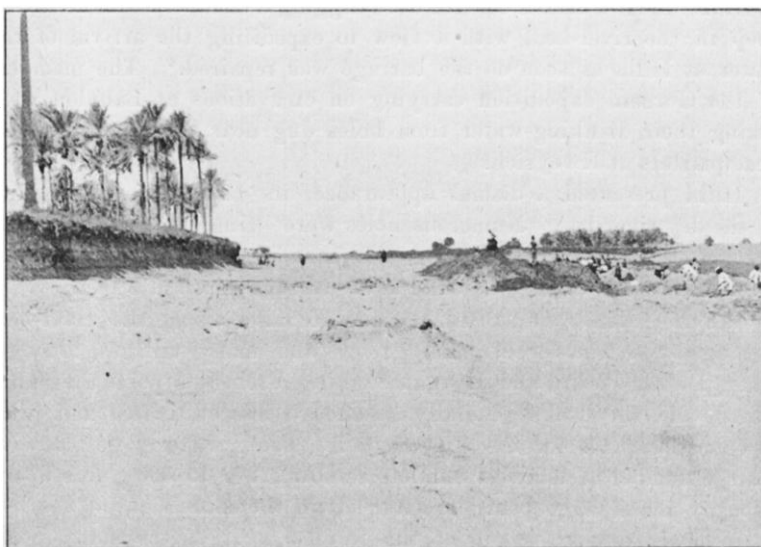


FIG. 4.—BED OF EUPHRATES AT ANANA, NEAR BABYLON. WORKMEN DEEPENING THE BED, LOOKING WEST.

sand deposited in the river when its transporting power has been reduced to a minimum.

The final *coup de grâce* was dealt by the breaking of the barrage at Musseyib in July, 1903, the immediate result of which was to leave the lower Euphrates river-bed dry for a distance of nearly 150 miles, the whole volume of water passing down the Hindiye canal. Only during the few weeks of high flood does a very limited amount of water find its way down to Hilla and the villages below, and it is doubtful whether any would find its way down as far as Samawa.

Such is the brief and sad history of a tract of country where for centuries stately palm trees waved their heads over the fertile waters flowing at their feet, and where sailing-craft with their burdens of grain and dates moved slowly down, praying that Allah would give

them favourable winds to carry them without mishap to Basrah. A few more years under the conditions now obtaining, and the great Chaldæan plain will claim its victim. Of a once populous and cultivated area little will remain but a barren steppe, dotted with heaps of sand-covered ruins, where the desert robber will prowl by day and the jackal by night. Such is one phase of the river's influence in the history of man.

Our route from the Musseyib barrage to Hilla, where we arrived September 14, was *viâ* Mahnawie and mainly along the dry bed of the Euphrates. At Anana, not far from Babylon, a large number of Arabs under Turkish control were digging a channel about 20 inches deep in the river-bed, with a view to expediting the arrival of the water at Hilla as soon as the barrage was repaired.\* The members of the German expedition carrying on excavations at Babylon were taking their drinking-water from holes dug near the river by their headquarters at Kweyrich.

Hilla presented a dismal appearance, its bridge of boats lying on the dry river-bed. Numerous holes were being dug in the deepest part of the bed for supplying the inhabitants and soldiers with drinking-water, which was found at an average depth of 3 feet.

Leaving Hilla, we travelled some 15 miles along the river-bed, passing by a number of palm groves and many villages, amongst others Dubla, Jerboa, and Heygan Saghir. From this point the palms ceased, and the banks generally assumed a less cultivated and prosperous appearance for the next 10 miles, being latterly dotted with a large number of fortified hamlets standing 200 to 300 yards apart. In many places large pools of water left in the depressions of the bed were slowly drying up under the intense heat of the sun. Some contained fish, which were often lying dead in an advanced state of decomposition on the edges of the shallower pools. At one large pool we came on a score or more of naked Arabs with conical fishing-baskets, busily engaged, with much shouting and laughter, in trying to catch the fish which dashed about in the muddy water in their efforts to escape. All along the way the universal cry that greeted us was "Ish wakt yeji mai?" ("When is the water coming?"), and the women would often come down the banks and run after us with ever the same question on their lips.

For the next 5 miles the river-banks, as well as the desert beyond, presented a more desolate appearance, many of the hamlets were deserted, and the fighting towers were beginning to show signs of decay. We were told that these mud towers with loopholes for

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\* It is hardly necessary to add that their expectations regarding the repairing of the barrage were not fulfilled.



fighting had been brought into use on this part of the river only during the last few years. The fortified hamlets of this and the preceding section were mainly inhabited by Daggara and Wisama Arabs, both of whom bear an unenviable reputation, the stopping and blackmailing of loaded craft having been one of their favourite occupations before navigation on the river ceased.

At a distance of about 30 miles by river from Hilla, we left the bed and rode southward across the desert to a hamlet belonging to the village of Jodare, and bordering on the river-banks. We were considerably impeded in our progress by a severe dust-storm, blowing from the south, and with some difficulty found, amid the many deserted

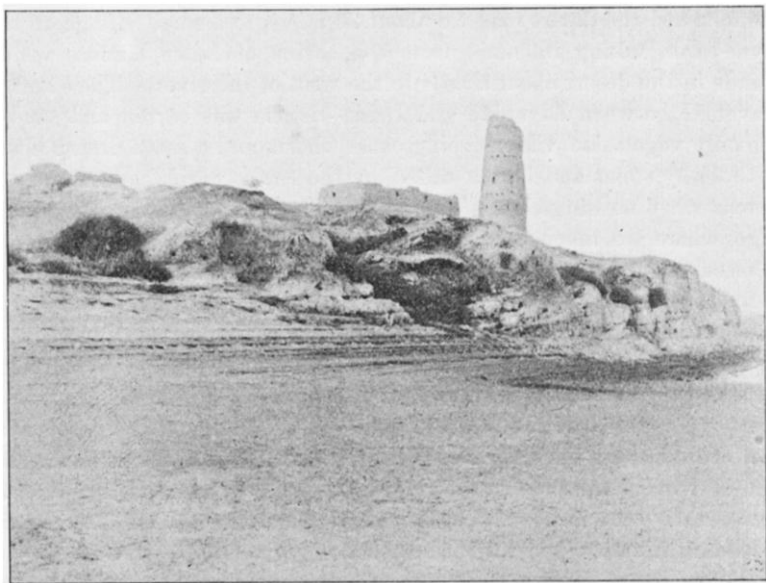


FIG. 5.—DESERTED HAMLET AND FIGHTING TOWER OF JODARE ON BANKS OF EUPHRATES, BETWEEN HILLA AND DIVANIYE, LOOKING SOUTH.

hamlets, one which was surrounded by a hedge, and bore signs of being inhabited. The Arabs occupying it showed considerable reluctance in responding to our call, but we were glad enough to eventually find shelter from the blinding dust-storm inside the square-loop-holed tower, where they shut themselves up at night or in time of danger. The state of the country may be well judged from the fact that an Arab from another small village, whose services we had temporarily enlisted as guide, insisted on getting well away into the desert before we called out the occupants of the hamlet where we intended passing the night.

The following day, September 17, we journeyed on to Divaniye, keeping mostly to the desert road, which touches the river at points.

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The nearer we approached Divaniye the more barren became the plain. The hamlets bordering the river were here and there occupied, but most of them seemed entirely deserted, and we were glad at last to catch sight of the palm groves of Divaniye through the dusty atmosphere.

The river-bed in this part has an average breadth of 90 to 95 yards, with banks between 13 to 16 feet high. The deepest part of the bed is almost invariably within 10 feet of the steep bank on the outside curves. Much tamarisk was growing on the inside curves. Divaniye looked even more forlorn than Hilla, and the bridge of boats, which in ordinary times gave it an appearance of importance, was lying ignominiously on the sand of the river-bed. From Divaniye to Samawa we followed the desert road for about 20 miles, to a small village on the river-bank, taking its name from the shrine of Imam Hamza, which stands in the desert about a mile to the west of the river. The country traversed between Divaniye and Imam Hamza was barren and sandy, the only vegetation visible being camel thorn, and a small desert plant with fleshy stems and leaves called by the Arabs "arid," and eaten by camels when nothing else is available. The hamlets along the river's edge, where we touched it, were nearly all abandoned, the inhabitants in most cases having trekked westwards towards the Hindiye, in order to find water for their cattle.

The desert just north of Imam Hamza was the nearest approach to the conventional desert that we had seen anywhere. Its surface, furrowed by the strong southerly wind that had been blowing for some time, was covered with miniature sand-dunes, and depicted a desolation that could almost be felt. Near the village of Imam Hamza the deposition of wind-borne sand in the river-bed was very marked, heaps of it between 18 to 30 inches in depth lying against the banks. It seemed, indeed, as if nature had turned her back on this unhappy river.

Below Imam Hamza the river-bed narrows down in some places to 40 to 50 yards, with banks over 18 feet in height. A further 14 miles by road, skirting the river, brought us to the small village of Abu Jowarir, where we passed a miserable night on the top of a mud parapet, tormented by sandflies, which were more vigorous and aggressive here than in any place we had yet seen. The desert south of Abu Jowarir towards Samawa loses its desolate appearance, and around the fortified village of Sheikh Tweyni we rode through some pieces of excellent pasturage. The ground was netted with both new and old irrigation canals. Below the village of Sheikh Tweyni we saw dari growing, the first we had seen since leaving Musseyib, and the broad expanse covered with its green leaves was a pleasant contrast to the barren country we had traversed on the previous day.

Samawa has the appearance of a prosperous Arab town. It has a large bazaar, and is visited by many Arabs from Nejd. According

to the maps, Samawa stands on the Shatt-i-Ateshan, or lower end of the Hindiye canal, some 5 or 6 miles before its junction with the Euphrates. To-day, however, the whole of the Euphrates water, including that which was until this year carried down in the original bed of the Euphrates, passes Samawa, the junction of the lower end of the Hindiye with the Euphrates being above Samawa. We were unable to visit the actual junction, but careful inquiry of a number of men who frequented the river revealed the fact that boats formerly ascending the river for Divaniye and Hilla passed up the Hindiye above Samawa, and entered the old Euphrates bed some two hours' journey (5 or 6 miles) above the last-named town. This passage from



FIG. 6.—BED OF EUPHRATES NEAR IMAM HANZA, SHOWING TWO MONTHS' DEPOSITION OF WIND-DRIVEN SAND AGAINST THE STEEP BANK, LOOKING NORTH-WEST.

the Euphrates to the Hindiye canal above Samawa would seem to have been formed since Colonel Chesney's expedition, although it may have existed then in the shape of an irrigation canal.

Our voyage from Samawa to Nasriye by boat was a pleasant relief after the dust and extreme heat of the journey from Musseyib. Below Samawa, the Euphrates flows in a broad turbid stream with a breadth varying from 60 to 120 yards, between banks of alluvium 7 to 14 feet in height. Lower down towards Nasriye it broadens considerably, being about 300 yards across in front of that town. On our way down we passed extensive fields of dari near the river. Beyond them the desert and its scrub vegetation held unbroken sway. Large herds of

camels would come down occasionally to the river to drink, sometimes as many as a hundred animals at a time, the property of the powerful tribe of Montefig Arabs, who occupy the country south of the Euphrates here, but also pasture their flocks across the river.

Nasriye is destined to become an important town if the Baghdad railway extension to the Persian gulf is ever constructed along the course originally planned, *i.e.* crossing the river at Musseyib, passing Kerbela and Nejef, along the right bank of the Hindiye to Samawa, and the right bank of the Euphrates to Korna. Its position at the lower end of the Shatt-el-Gharraf makes it the natural centre for communication with the country lying between the Tigris and Euphrates, and it is, in addition, in the middle of a rich grain-producing country.

The Shatt-el-Gharraf (formerly marked on the maps as Shatt-el-Hai and Shatt-el-Amara, both names being now unknown locally, and never used) seems to have been originally a huge irrigation canal, which the spring floods from the Tigris have eroded, till in places along its course it averages over 75 yards in breadth, with banks of alluvial sand up to 18 feet in height. Commencing from the Tigris river opposite Kut, it runs southwards, passing the towns of Hai, Jelaat-sikker (corruption of Kalaat-es-sikker), and Shatra, dividing before it reaches the Euphrates into several channels, the principal one being near Nasriye. It is navigable along its whole length when the Tigris is in flood, and native craft pass up and down for a space of about four months during the year.

On our return journey from Nasriye, we rode along the Shatt-el-Gharraf to Kut, and thence along the Tigris to Baghdad. The country between Nasriye and Hai seems fairly prosperous, and there are many patches of cultivated ground along the edges of the Shatt el Gharraf. We saw here for the first time the use of long poles with a weight attached to one end, and supported on a pivot, used as in Egypt for drawing up water from the river by means of the bucket attached. The method used all along the Euphrates south of Musseyib is the "cherrid," or "kyart." This consists of a capacious leather bucket suspended over a bricked-in well, built in the river-bank, and having an inlet towards the river. The bucket is lowered into the well, and drawn out by a couple of oxen, to whose yoke the rope is attached, and who walk down an inclined plane dug in the ground so as to increase their pulling power.

From Kut to Baghdad the country away from the banks of the river Tigris is desert, dotted here and there with tepés and mounds, and furrowed with the remains of irrigation canals. There is the usual sparse vegetation, mainly camel thorn, and a species of dwarf mimosa, called "shokk;" but there is little that is beautiful in the desert in summer, except when the dull red glow which heralds the

approach of sunrise grows brighter, and, touching everything with shafts of pink and golden light, makes for a few brief minutes a glorious picture out of the sand and earth of the wilderness.

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## GEOGRAPHICAL WORK OF THE GEOLOGICAL SURVEY OF CANADA, 1900-1905.

By A. P. LOW, Director of the Geological Survey of Canada.

SHORT summaries of the geographical work of the Geological Survey of Canada were published annually in the *Geographical Journal* until the time of the death of Dr. G. M. Dawson, the late Director of the Survey. The present article is intended as a continuation of those summaries, and gives concisely the geographical work accomplished by the staff of the Geological Survey of Canada during the years of the present century.

The work of the survey may be divided into exploratory surveys of the more inaccessible northern portions of Canada, and the more detailed work necessary for the production of regional sheet maps. These latter are produced either in the flat in the eastern provinces, or with contours in the mountainous portions of the west. The surveys for the production of sheet maps are confined to the more accessible portions of the Dominion, in or close to civilization where exploratory work has already been done; in consequence, no attention is here given to the geographical results of this part of the work beyond an enumeration of the number of sheet maps published during the time under consideration. The account of the exploratory surveys, for convenience, is given in order from west to east, starting with Yukon territory and extending to Hudson bay and the Arctic islands of the east.

Exploratory surveys of the Yukon river and of several of its large tributaries were made by Dawson, McConnell, and McEvoy in the later years of the last century, and in continuation of these McConnell, in 1900, examined the Stewart river, a large eastern branch, from its mouth to Fraser falls, 200 miles up-stream. The survey of the upper water of this river was completed by Keele in 1905, and a survey from its headwaters across to and down the Peele river, a large western tributary of the Mackenzie river, was made the same year by Camsell. A number of the smaller tributaries of the Yukon have also been explored, and similar work has been carried on near the Alaskan boundary to the westward of the Yukon. As a result of these explorations, a fair idea of the geography and geology of Yukon territory has been obtained as far north as the Porcupine branch, which heads within a few miles of the lower part of the Mackenzie river, and there