THURSDAY, MARCH 14, 1872

LA SEINE*

IN carrying out the great works for the improvement and embellishment of Paris under the late Empire, all incidental discoveries of objects relating to art, history, and science, were systematically investigated, recorded, and preserved, instead of being left to the chance and uncertain description of casual and independent observers. In a liberal and enlightened spirit the Municipality of Paris and the Préfet of the Seine (M. Haussmann) established a proper organisation and a staff (*Service des fouilles et des substructions*) to follow up such discoveries, to take plans of old works, to preserve all art treasures or objects of scientific value; to note, in fact, and to investigate everything of interest. Men eminent in several departments were consulted, and engaged to draw up reports with full illustrations of the discoveries. By these judicious measures, the knowledge of the topography, antiquities, and archæology of Old Paris has been greatly advanced. Works of the Roman, Gallic, and Mediæval periods have been brought to light, surveys and plans made, and the more important specimens preserved *in situ* or in the public museums.

To M. Belgrand, the eminent and able engineer for the water supply and drainage of Paris, was deputed the work of recording all the geological and some of the archæological facts discovered during the construction of the large works on which he was engaged.

Paris up to the last few years had been supplied with water from local sources (river, canal, and wells), but as these were found insufficient and of indifferent quality, it was determined to seek for other and better sources of supply at a distance, and some large springs in the chalk district, respectively distant sixty and eighty-four miles from Paris, were eventually selected by M. Belgrand, and their waters were brought to Paris by means of aqueducts on a high level. In carrying out this great work, M. Belgrand made himself intimately acquainted with the hydrography of the Basin of the Seine. He explored every valley, and determined the *régime* of every important river. The result of the first part of the inquiry appeared in a valuable series of tables, showing the connection between the rainfall and the discharge of each river—the extent and nature of the floods, and the geological character of the ground with reference to the range and extent of the permeable and impermeable strata, and which he illustrated by a specially coloured map. In connection with the construction of the aqueducts, M. Belgrand had also to ascertain the nature of the surface and the contours of the hills and great plains along which he carried them, and to examine the many pits whence the materials for construction were obtained. This geological investigation led to the discovery of many interesting specimens, and further suggested many theoretical inquiries relating to the origin of the present surface, and to the *régime* of the old Seine during the later geological periods. The result of the inquiry is embodied in the three handsome quarto volumes before us—one of 255 pages of text, with 106 pages of introduction, descriptive of the country and giving the theoretical views; a second containing plates of fossils, of flint implements, and pit sections; and a third with extended coloured sections and a monograph by M. Bourguingnat of the shells found in the Drift beds.

Paris stands on Tertiary strata, from beneath which, at a distance of some miles, the chalk crops out and forms a belt many miles in width. These formations constitute a table land having a height of 100 to 200 feet along the sea coast of Normandy, and rising from 500 to 600 feet inland in Champagne. This district is traversed by the Seine and its tributaries, flowing in comparatively narrow valleys cut deep into the table land; while, on the extended upland plains thus formed, there rise, here and there, ranges of hills of Fontainebleau Sands or other later Tertiary strata. The strike of these hills is in a direction entirely distinct from that of the hill slopes flanking the river valleys and forming part of the present river-system. The latter range in various directions—north, north-east, south, and south-east—in accordance with the direction of the tributaries of the Seine until they join that river, the main channel of which has, from Montereau to the sea, a general direction south-east to north-west. M. Belgrand found that the hills on the plains nearly all ranged in this one given direction, or approximately from south-east to north-west, with intervening valleys having the same direction. Numerous such ridges, none being of any great length and all narrow and having this definite trend, are found to extend over the whole plateau area uninfluenced by the more tortuous deeper river-valleys which intersect the same area at various angles to their course. The river-valleys are covered with gravel formed of the *débris* of the rocks through which the present rivers flow, while the plateau valleys and plains are free from such *débris*, but are covered with a uniform layer of red clay or loam. Whence M. Belgrand concludes that the two systems of valleys have a different origin. He contends that it is not possible to have a true river channel without having more or less drifted gravels formed by the constant action of running water and by floods, and therefore that these higher valleys could not have been formed by river action, while at the same time their rectilinear and special bearing indicates that their formation is due to one common and independent cause.

M. Belgrand considers that the only explanation which will account for the phenomena presented by these higher-level valleys and hills, is the rapid and transient passage of a large body of water over the surface; and as the excavation of these higher valleys took place after the formation of the Fontainebleau Sands and of the Calcaire de Beauce (Miocene), and before the Pliocene period (for the *Elephas meridionalis* of the valley of the Eure shows that the land had then emerged), and as also, according to M. Elie de Beaumont, the elevation of the main chain of the Alps took place at the same period, M. Belgrand connects the two events and supposes that the sea of the Pliocene deposits of the Alpine area was thereby displaced and that it swept over this northern portion of France, denuding the softer portions of the strata and leaving narrow ridges of the harder portions

* *Le Bassin Parisien aux Ages Antéhistoriques.* Par M. Belgrand, Inspecteur-Général des Ponts and Chaussées, Directeur des Eaux et des Egouts de la Ville de Paris. (Paris: Imprimérie Imperial.)

all trending south-east to north-west (or in the direction from the Alps), standing out, on the denuded high plains, as monuments of its passage. M. Belgrand points out that where the Tertiary strata have presented a resistance which the waters could not overcome, the high-level valleys formed by the diluvial waters are, in such cases, fronted in the opposite range of hills, against which the mass of waters impinged, by a deep bay cut by the current in those hills, and that the waters thus checked in their course were turned off at acute angles, until they reached the main channel of the Seine, tending thereby to form secondary or tributary valleys, which, when the deluge had passed, contributed, with the Seine valley, to form the present lines of river drainage. Such volumes of water as we have depicted would, he argues, have swept the higher channels and plains clear of *débris*, leaving the denuded area covered merely with the silt thrown down from muddy waters, and depositing the coarser *débris* in the middle and lower range of the deeper channels through which the present rivers afterwards took their course. In support of this hypothesis, he shows that, whereas the basin of the Seine is now drained by the one river and its tributaries, the diluvial waters held their course straight across that basin and debouched in five main channels—one, marked by the hills of Montmorency and Satory, took the course of the Seine below Montereau to the sea, but in a more direct and broader line; the second took the course shown by the hills of Villers-Cotterets, thence across the present valley of the Oise, along the valley of the Pays de Bray, to the sea at Dieppe; the third followed in part the course of the Aisne, and then by the line of the Somme valley to the sea; and the fourth and fifth by those of the valleys of the Aulthie and Cauche. M. Belgrand accounts for the radidity and force of this cataclysm in the belief, which he shares with M. Elie de Beaumont, that the elevation of the Alps took place rapidly and suddenly.

But there was a second elevation of the Alps, at a later geological period, and which, according to M. Belgrand, may have produced a second deluge, not by the displacement of the sea, for then there were only lakes on the north-western side of those mountains, but by the sudden melting of the snow on that great range; and our author again adopts the views of M. Elie de Beaumont on this subject. This distinguished geologist propounded in 1847 the theory that that last convulsion of the Alps was accompanied by an enormous disengagement of those gases to which has been attributed the formation of the Dolomites and Gypsum beds of that chain, and that this caused the accumulated snows to melt in a very brief period of time (*un instant*). At the same time, according to the same authority, the Pliocene lakes of "La Bresse" were raised and drained. Thus, suggests M. Belgrand, this second convulsion might have caused another diluvial wave to pass over the basin of the Seine—an hypothesis also advanced by M. Elie de Beaumont, who speaks of "the probable concourse in this off-throw flood (*déversement*) towards the north-west, of the waters of the great lake of La Bresse, in the production of the diluvial phenomena observed in the neighbourhood of Paris."

We are disposed to agree with our author in the opinion, which we have elsewhere expressed, that the original contour of the surface with its higher valleys and hills, is due to a cause different from that which excavated the present river valleys—that it preceded and is independent of it—but we cannot agree with him as to the nature of that cause. Without going far into the argument, we may mention that the well-known fact of the gravel found in each tributary of the valley of the Seine, consisting of the *débris* of those rocks only through which that tributary flows, while in the Seine valley are found the *débris* of all the tributaries, together with its own and no more, is, it seems to us, a conclusive argument against the passage of a body of water from one great basin to another—against the flow of such a body of water from the Alps across the Jura, the great plains of the Doubs and the Soane, the southern prolongation of the Vosges, and, over the separating water-shed formed by the lower hills of Burgundy, to the Seine basin, and so to sea on the northern shores of France. Such a cataclysm must surely have spread the *débris* of the strata destroyed in its course north-westward along the tract over which it flowed. Some remains of the rocks of Switzerland, of those of the Vosges and of Burgundy, must surely have been detected in the course of its passage. How can the author account for the large blocks and abundant *débris* of the Seine valley—which blocks and *débris* he considers as originally due to this cataclysmic action—and yet overlook the almost necessary consequence of the introduction of some foreign elements into the Seine Basin, whereas none such exist. Not only is the *débris* of each great basin restricted to its own rocks, but even each tributary river valley has its own special rock *débris* and no other. M. Belgrand remarks, it is true, of the Somme Valley, which lies on the line of his third great diluvial water channel, and which prolonged south-east passes across the Oise valley and up that of the Aisne, that some *débris* of the older rocks of the latter areas have been found in the chalk valley of the Somme. But we must confess we have never found a trace of such a mixture, and we have particularly examined the Drift of those areas with a view to the determination of this point. At the same time the water-shed between the two valleys is so low that their complete separation in old times appears to us more remarkable than their present independence, and we can quite conceive the possibility of the Oise waters, when that river flowed at its higher level, passing at periods of flood into the valley of the Somme, and so carrying some small amount of *débris* across the present water-shed, especially as so good an observer as M. Buteux is referred to as the authority for this fact. If there, however, it is evidently quite the exception, and may be accounted for as just suggested.

With regard to the ingenious suggestion of M. Belgrand that some south-east and north-west valleys of the table-lands are faced on the opposite side of intersecting river valleys by a bay in the hills due to the violence of the checked diluvial waters, such for example as the amphitheatre in the hills on the west of the River Ecolle between Milly and Moigny and again at Soissy, it is to be remarked that such amphitheatres exist equally on the opposite or lee side of the hills towards La Ferté-Aleps and Maisse; and, further, that, in the same Tertiary area beyond the intersecting range of hills between the Ecolle and the Essonne (which according to M. Belgrand's views

should have acted as a breakwater), the south-east and north-west ridges again resume between the valleys of the Essonne and the Eure.

After the contour of the surface produced by this cataclysm, and by which M. Belgrand considers that all traces of any previous river courses must have been obliterated, the Seine and its tributaries began to flow at an elevation estimated by him of from 80 to 100 feet above the present level. This he proves, as we have already done, by the occurrence of the remains of land mammalia and of river and land shells in beds of Drift at that elevation above the Seine on some of the hills near Paris. This part of M. Belgrand's work is admirably illustrated, both by general and local sections, and contains valuable lists of the mammalian remains, in the determination of which he had the advantage of the high authority of the late M. Ed. Lartet. Here again we cannot, however, agree with him in his *modus operandi*. The great boulders of sandstone, meulière, granite, &c., found in the valley gravel of the Seine, are attributed by M. Belgrand in the first place to removal to the line of the Seine valley by diluvial action, and subsequently to their drifting along the valley channel by the river action during floods of the Quaternary period, and he gives some remarkable instances of the power of water to remove large blocks, and of the rate at which such blocks move. When, however, it is considered that the granitic rocks of the Morvan have been transported some 150 miles, and other rock boulders in proportion, that the angles of many of the large blocks of sandstone and of meulière constantly show little wear, and that they are dispersed irregularly and at various levels, some imbedded in soft clays, and others in sand or fine gravel and that these latter are often twisted and contorted, we can only explain the phenomena by the action of river ice and transport thereby.

M. Belgrand, on the other hand, shows that a prolonged and steady fall of rain, even if not very heavy, during the winter, now produces great floods—that such rivers as the Yonne and Cure flowing over impermeable strata are subject to sudden and great freshets after a heavy but short fall, whereas the Marne and Seine flowing over permeable strata have their floods retarded, but, at the same time, rendered more permanent by the rainfall having to pass through the strata and delivered in springs. He also shows that when the permeable strata become saturated by long-continued rains, they act as impermeable strata, and that the floods follow close on the rainfall besides being long maintained, so that in the remarkable and long wet winter seasons of 1658 and 1802 the Seine rose at Paris in the one case 29 feet, and in the other 24½ above its ordinary low level, and the floods in the last case lasted three months. M. Belgrand considers that this state of things was a normal condition during the Quaternary period, and he sees reason to believe that the rainfall at that period must have been very much greater than at present.

The ordinary low-water discharge of the Seine at Paris is 75 cubic metres per second; but during these great floods it rose to 2,400 and 2,000 cubic metres. M. Belgrand gives a list of eight such floods in the last two centuries, during which the discharge was above thirty times greater than the ordinary low-water discharge. In rivers flowing over more impermeable strata the difference is still greater; and he mentions that in the Loire at Orleans it has amounted to as much as 400 times, or 25 : 10,000. We may take the width of the Seine valley during the high-level gravel period at six kilometres, and during the low-level gravel period at about two kilometres; and M. Belgrand estimates that the river in flood had in the first instance a sectional area of 60,000 square metres, and in the second of 40,000 metres; and, calculating the flow at a given rate per second, the discharge, as compared with that of the present river, would be as under :—

Discharge per second of the Seine at Paris in the present period and during floods in past periods :—

		Extreme rise of river.	Discharge of river.
		Metres	Cubic Metres
Present River	low water	8·81	75
	flood-water		2,400
Old River during the Quaternary period	low level stage 20 / high level stage 13		27,000 to 60,000

Large as these Quaternary period quantities are, M. Belgrand thinks that there are cases of recent occurrence to prove that it is possible to realise them. He mentions a flood following on a heavy rainfall in the valley of the Armançon, a small river flowing over impermeable strata, with a basin of only 1,490 square kilometres, which had its discharge raised for a short time to 800 cubic metres per second; and he infers that under like conditions of rain and impermeability (by saturation and otherwise) the Seine, with its basin of 78,600 square kilometres, might have its discharge raised to 42,444 cubic metres, showing, that notwithstanding the size of the old river channels, the area drained during a period of greater rainfall would have sufficed for the necessary water supply.

In confirmation of this larger and more permanent supply of water, M. Belgrand instances the presence of the Hippopotamus, the remains of which are found at several places in the Seine basin as well as in that of the Somme, and which would have required for its existence larger and fuller rivers. He also derives a further argument in the presence of this animal, against a prolonged and severe winter cold, which he considers would have been fatal to it. M. Belgrand, nevertheless, argues that the presence of the Reindeer indicates the six summer months temperature of Scandinavia, not exceeding in the mean 8° centigrade; but with such a summer temperature we hardly see how he can avoid the three months' winter temperature of the same latitude or of 4·6 per cent. A still more extreme winter temperature is in fact indicated by the presence of the Musk Ox and the Marmot. It is to be observed also that the Reindeer at that time lived as far south as the Pyrenees, and that the physical condition of the drift deposits are, as we have before shown, strictly in accordance with a very low winter temperature. As the Hippopotamus is an extinct species, we do not know how far it may, like the extinct Elephants and Rhinoceroses, have been adapted to live in a severe climate. M. Belgrand's work is full of interesting details of the distribution of these and the other Quaternary animals, not only over the Seine Basin, but in some cases over the whole of France. He gives also

a monograph with figures, by M. Bourguingnat, of all the mollusca of this age found in the Seine Basin. This well-known conchologist makes out that out of a total of 76 there are 38 new species which he considers as extinct, a conclusion which we expect English conchologists will hardly be prepared to agree with, as they have detected no extinct species in these deposits, and find only a few which are not local—a view in which we also believe most French conchologists join. The author considers that the same mammalian fauna is common to both the high-level and the low-level gravels. In one main point, however, do these gravels differ. In those of the high-levels of Montreuil and Bicêtre no Human remains, no Flint Implements, have been found, whereas, in those of the low-levels of Clichy, Grenelle, &c., above 5,000 flints, more or less worked, are stated to have been found by a single collector. Besides these works of early Man, M. Belgrand states that human bones, skulls, and entire skeletons, have been found in these lower gravels ; but it seems to us that much of this evidence requires confirmation.

The Quaternary period of the Seine Basin is coeval, in M. Belgrand's opinion, with the Glacial period, and he considers that it was brought suddenly to a close with the low-level gravels. To this Quaternary period the peat deposits immediately succeed, owing, as the author ingeniously suggests, to the suddenly diminished rainfall leaving the rivers clearer and under conditions favourable for the growth of peat, which he shows never takes place in river valleys subject to frequent and heavy floods, but always in valleys where springs abound, and the floods are few and not turbulent.

The latter part of the work is occupied with a minute account of formation of gravel beds, and of the position of the Organic Remains, showing how all the features of those deposits are to be accounted for by ordinary river action, and that the mammalian remains are abundant precisely at those very places where a river with strong currents and numerous eddies would leave them. He endeavours to account also for the fact of all the bones of the larger animals being found in the coarser bottom beds of gravel, by the circumstance that these coarser beds were formed in those deeper water-channels along which only the larger carcases could have floated, and which were afterwards surmounted by those upper beds of sand and finer gravel, which he considers to be due to silting up (*alluvionnement*) of the channel where the river had changed its course to another channel. The brick earth or Loess is ascribed by him, as by English geologists, to river floods. But instead of considering it, as we do, to be produced by successive floods at all the various levels of the river, from the high to the low level, M. Belgrand admits but two levels, the high and the low, and that owing to a sudden elevation of the land, the excavation between these two levels was produced at once without intermediate stages. Consequently, he considers that the height of the Loess above these two levels marks in each case the rise of the flood waters. This, we think, is a weak point in his argument. According to his view, which he illustrates by a section, showing the range of the Loess up the hill slopes, he concludes that the floods of the low-level stage of the river rose, notwithstanding the width of the valley, to a height of 66ft., and during the high-level stage, to a height of 43ft., which give very much larger sectional areas for the river in flood than is otherwise necessary, and such as we conceive the area drained would have been insufficient to fill even with greatly larger rainfall. For, although the discharge of the Armançon may in a particular case of heavy rainfall have been so large as when multiplied by the whole area to give two-thirds of the required supply, still it is perfectly well known that the discharge by the main river never equals the sum of all its tributaries, and the discharge of the Seine at Paris on that occasion actually only rose to 1,250 cubic metres per second. There are besides beds of gravel on the slopes of Clichy towards Paris, and again on the slopes leading to Charenton distinct beds of gravel at intermediate levels, though of limited extent.

Thus, M. Belgrand ascribes the gravel beds and the Loess of the Seine Basin to old river action, referring the red loam alone of the higher plains above to diluvial causes, in opposition to the view usually received in France, according to which all these Drift beds are divided into the three diluvial deposits of *Diluvium gris*, *Diluvium rouge*, and *Limon* or *Loess*. As we have already expressed very similar views respecting the commonly accepted classification, we cordially agree with the author on this point.

The illustrations forming the second volume constitute a very interesting exhibition of the art of Photo-lithography. The execution varies a good deal, and there are plates which, though valuable for their truthfulness, are rather indistinct. Some of the representations of the Flint Implements are excellent. The work is somewhat large and costly ; but as a copious record of facts, an ingenious statement of theory, and a reliable representation of specimens, this work of M. Belgrand will be greatly valued by all those who feel an interest in the remarkable phenomena connected with the present configuration of the country, the distribution of life during the Quaternary period, and especially with the evidence bearing on the Antiquity of Man. J. P.

OUR BOOK SHELF

The Discovery of a New World of Being. By George Thomson. (Longmans, Green and Co., 1871.)

THE world discovered by this psychological Columbus is the "world of spirits," although he "disclaims all connection with so-called Spiritualists—a sect of modern times," whom he somewhat ungenerously "believes to be either dupes or knaves." Mr. Thomson believes that man consists of two "personalities," an animal personality or body, and a personality he calls spirit, which is the "knowing and conscious we," and which he believes to be as distinct from and as capable of being at almost any moment abstracted from the former as steam is from a steam-engine. Indeed, this latter phenomenon takes place every time the body "goes to sleep," to use the vulgar phrase ; for Mr. Thomson believes that the "animal life never sleeps, and cannot sleep, and that to say or think that it, or any other life, can sleep, in the popular sense of the word, is the most glaring absurdity that ever has had possession of the human mind." "What is meant properly by sleep," he goes on to say, "is simply the abstraction or withdrawal of the influence of a being, a spirit, from a being, an animal, the leaving of a servant to itself, from the influence of its lord and master." Mr. Thomson explains the phenomenon of dreaming to be the struggles of this "being, a spirit," to get out of and back into the house of its servant, the body. The frequently