

On the rocks of the Damúda group, and their associates in Eastern and Central India, as illustrated by the re-examination of the Rániganj field.—By W. T. BLANFORD, Esq. Geological Survey of India.

One of the most interesting problems in Indian Geology is the question of the age and mutual relations of the rocks containing coal in Bengal and Orissa. The fossils from the first named locality have long attracted notice in consequence of the great divergence shewn by them from European types of carboniferous vegetation, and of their identity with those from beds, also containing coal, in Australia. But these fossils being entirely vegetable, and fossil plants not having attracted, until very recently, the attention they deserved, except in the case of the true carboniferous flora of Europe and America, very little progress had been made towards ascertaining the geological relations of the Indian coal fields, until the commencement of the work of the Geological Survey of Mr. Williams. They were almost universally massed together as representatives of the carboniferous era, and the details of their geology were utterly unknown. They had not even received the attention which had been devoted to the rocks of Central, Western and Southern India.

Mr. Williams directed his attention rather to the economical than to the scientific questions presented to him, and he appears, in his examination of the Rániganj field, not only to have accepted the idea of the rocks being of true carboniferous age, but to have supposed that he found in the several beds composing them, representatives of the subdivisions recognized in Great Britain. But his observations on the geological relations of the beds among themselves are generally careful and accurate, his map is singularly correct, considering the very grave difficulties under which he worked, and although, partly perhaps owing to the small area which came under his observation, many essential circumstances escaped his notice, his accurate and trustworthy descriptions have since proved most valuable in shewing the relations of the rocks he surveyed to others which have since been examined.

The only other detailed geological observations are contained in

two papers by Mr. J. Homfray, one published in the Asiatic Society's Journal for 1842, the other published in 1847, and reports by Dr. McClelland, on the Kaharwali coal field, and on other portions of the tract of country between the Ganges and the Grand Trunk Road. It is impossible to consider any of these papers as contributions to science, all being extremely inaccurate. Indeed in one case injury has been done, the plates attached to Dr. McClelland's report, not being true delineations of the fossils they are intended to represent (a result perhaps of the difficulty of obtaining competent draughtsmen and lithographers in Calcutta) have caused erroneous opinions to be entertained in Europe, amongst Paleontologists, concerning the affinities of the plants figured.

Very little light came from Australia. The plants there associated with the coal were examined by Messrs. Morris and McCoy, and the rocks themselves by Clarke and Strzelecki. Unfortunately the last observers adopted different and irreconcilable opinions, the first named stating that the coal-bearing rocks were interstratified with others containing marine shells of carboniferous age, the other that they rested upon the marine beds. The relations of the plants were generally considered to be oolitic.

This last opinion was supported by the discovery in India of cycadaceous plants, as *Zamites*, *Pterophyllum*, &c., allied to forms supposed, until recently, to be characteristic of Jurassic and Upper Mesozoic rocks. These Cycads were moreover in places, as in Nagpúr and the Rájmahál hills, found in the neighbourhood of *Vertebraria*, *Glossopteris*, and other genera, peculiar to the coal-bearing rocks, and it was supposed that all were found in the same beds.

The examination of the beds of the Rájmahál hills, of Orissa, and of Central India, by the Geological Survey, together with the valuable observations and collections of the Rev. Mr. Hislop at Nagpúr, have, for some years past, been gradually throwing light upon the true relations of the various beds. The re-examination of the Rániganj or Damúda field during the past two years has supplied several important links in the chain of evidence, and the following is an abstract of the views of the writer upon the classification which may be adopted. The details of the survey of the Rániganj field will be published as usual as the memoirs of the Geological Survey.

The rocks of the Rániganj field and their approximate thickness in feet, are, in descending order,

1.—Panchit group,.....	{	Upper Panchits, ...	...	500
		Lower Panchits, ...	...	1,500
2.—Damúda group, ...	{	Rániganj series, ...	...	5,000
		Iron stones,...	...	1,500
		Lower Damúdas, ...	...	2,000
3.—Talchir group, ...		...	...	800
				<hr/>
				11,300
				<hr/>

Of these beds the Damúda group alone contains coal. This enormous thickness of beds is cut off on the south by a fault, *the downthrow of which cannot be less than 10,000 to 11,000 feet.*

The lowest or Talchir group, first separated in 1856 from observations in Orissa, consists of a series of fine sandstones and mudstones, frequently of a peculiar greenish colour, and becoming coarser towards the top, while towards the base they are commonly composed of the finest silt, in which there occur, in patches, gneiss boulders of enormous size, some having been measured as much as 15 feet in diameter. It is most difficult to account for so anomalous an occurrence as that of these huge blocks in the finest mud, for any current which could roll or even move the former would necessarily sweep away the latter, and although such a phenomenon appears absurd in India, judging from the climate of the present day, the action of ice, probably of the form known as ground ice, appears to be the only geological agent which can account for all the circumstances, by explaining the transport of the boulders.

The Talchir group had not undergone a very great amount of denudation, prior to the deposition of the Damúda rocks. It is, however, completely overlapped in the eastern portion of the Rániganj field, although well developed in the west. Very few fossils have as yet been obtained from these beds, those found are entirely plants, and shew distinctions from Damúda forms.

Beds belonging to the Talchir group have now been discovered in Orissa, in Central India, in Beerbhoom, where they occur in numerous scattered patches, and in one or two places on the west side of the

Rajmahál hills, besides their occurrence in the fields of Rániganj and Rámghar.

The *Damúda* series, thus named from its extensive development on the banks of the river *Damúda*, comprises, with perhaps one exception, all those rocks from which coal has been obtained in Bengal; the coal bearing rocks of the Himalaya, Khasi hills and Burma being, however, distinct. This series is divided in the Rániganj field by a mass of black shales, containing beds of clay ironstone, and attaining a total thickness of about 1,500 feet. There is evidence of unconformity between these shales and the Lower *Damúdas*, but none is clearly made out between them and the upper series or Rániganj beds, with which they are in consequence classed.

The Upper *Damúdas* of Rániganj must be carefully distinguished from those beds in Central India which have been called Upper *Damúdas*,* *Mem. Geol. Survey of India, Vol II. pp. 176, 312.* The Rániganj beds differ from the Lower *Damúdas* in mineral character, and also slightly, so far as is at present known, in fossil remains. The upper beds consist mainly of very thick false bedded sandstones, with seams of coal frequently continuous over considerable areas. The lower beds are much coarser and more conglomeritic, and are rarely false-bedded; their coal seams are numerous, but very variable in quality, and frequently thin out, or change into shale, or even sandstone, within very short distances.

The most characteristic fossil distinction between the two groups consists in the abundance of a species of plant referred by Mr. Oldham to *Schizonema*, in the upper division, which has not been found in the lower. No animal remains have as yet been discovered in the *Damúda* beds.

The upper or Rániganj series is not known to be represented beyond the *Damúda* field. The lower group is also found in Orissa, and along the Western side of the Rájmahál hills. The superiority of the coal of Rániganj is perhaps partly explained by the circum-

* This name was given for good geological reasons, as will be seen by reference to Vol. II. of the *Memoirs of the Geological Survey*. It has however proved an unfortunate appellation, as it conveys an incorrect idea of the relations of the beds, which contain a flora completely distinct from that of the true *Damúdas*. *see Mem. Geol. Survey, Vol II. p. 176.*

stance that most of the best seams occur in a group of rocks unrepresented in other fields. It is not known to which group the beds of Palámo Rámghar or* Central India belong.

Above the Damúda beds, and slightly unconformable upon them, occurs a series of coarse false bedded sandstones, with intercalations of red and grey clays, passing into shale in places. These beds are mainly developed in the Southern portion of the Rániganj field, where they form the mass of the fine hill of Panchit (Pachete), whence the name of Panchit series is suggested for them. The upper part of Panchit Behárináth and Garanji hills are composed of a coarse conglomerate, differing in mineral character from the lower portion of the formation.

This lower portion is of considerable interest, for, besides plants, the first distinct animal remains yet discovered in Bengal have been procured from them. These consist of various biconcave vertebræ and other bones, jaws and teeth, apparently reptilian, and of a small crustacean allied to *Æstheria*. The plants include, besides numerous peculiar forms, the *Schizonema*? so characteristic of the Rániganj series.

The *Æstherias* appear identical with those found by Mr. Hislop in the Mangáli shales of Nagpúr. From these shales was also procured a reptile, *Brachiops laticeps* of Owen, belonging to the same group as the *Labyrinthodon*. It seems probable that the Mangáli shales are the representatives of the Panchits of Bengal. The Upper Damúdas of Jabbalpúr may also be of the same age.

In the Rájmahál hills the Lower Damúdas are unconformably overlaid by a series of grits, conglomerates, and white clays. Above these, also unconformably, occur enormous flows of basaltic trap, with interstratifications of white and black shales, abounding in plants of the genera *Zamites*, *Pterophyllum*, *Pecopteris*, *Tæniopteris*, &c.

* Beds containing plants of Damúda age occur also at the base of the Himalayas of Sikkim, a circumstance first noted by Dr. Hooker, in his "Himalayan Journals," Vol. I. p. 403, and confirmed by myself in 1856. Nothing however could be made out of the extent of the beds, which are distinct from those containing coal on the Tista river. The only evidence of the existence of Damúdas were specimens of *glossopteris* and *vertebraria* found in loose blocks in a stream below Pankábári.

all quite distinct from Damúda forms. These beds were first accurately described by Professor Oldham in a paper published in the Society's Journal for the year 1853. They have since been named by him the Rájmahál series. It was, however, at first thought that a slight passage existed between the Damúda and Rájmahál groups, a view which Professor Oldham has since announced to be erroneous; the passage, if any exists, occurring in the conglomerates and grits interposed between the two series. *Memoirs of Geological Survey of India, Vol. II. pp. 313, 325.*

The conglomerates and grits of Panchit hill, provisionally termed the Upper Panchits, agree perfectly in mineral characters with those underlying the traps in the Rájmahál hills. As there is every probability that they occupy the same position in the general series, it is not unreasonable to suppose that they are an extension of the same beds.

A still higher group occurs in Orissa and in Central India, to which the name of Máhádeva has been given. No representatives of it are known in Bengal, and it is possibly considerably higher in the series than any of the groups above mentioned.* It is not by any

* Professor Oldham has suggested as probable that it is of Nummulitic (Middle Eocene) age. (*Mem. of the Geological Survey of India, Vol. I. p. 171 and Vol. II. p. 210 note*), and there are doubtless arguments in favor of his suggestion. . But the Máhádevas are in Central India overlaid unconformably by an intertrappean series abounding in a shell, *Physa Prinsepii*, said to be very closely allied to *Physa Nummulitica* of D'Archiac from the Nummulitic rocks of the Panjáb, if not identical with it. (See Hislop on the Tertiary beds and fossils of Nagpúr, *Quarterly Journal, Geological Society, Vol. XVI. pp. 163, 164*). By D'Orbigny (*Prodrome de Paléontologie, II. 299*) *Physa Prinsepii* was considered identical with *P. Gigantea*, Du Boissy, from beds near Rheims which are of the lowest Eocene age, even below the plastic clay, while Nummulitic rocks are considered by the best authors on the subject, as, at lowest, middle Eocene. There is much general similarity of facies between the fresh water (? land) shells of the Rheims beds (*Mem. de la Societé Geologique de France 2e. serie, Tome II. plate 6*) and those of the intertrappeans of Central India. The identifications of the *Physas* are dubious, especially that of D'Orbigny, but the resemblance of the facies is important. So far as this evidence goes, it tends to point out the intertrappean beds as at least as low in the series as the Nummulitics and possibly lower. In this event, from the great break between the intertrappeans and the Máhádevas the latter must, a fortiori, be of pre-Nummulitic date. But all the evidence either way is of an extremely slight description.

means certain that the beds of Orissa and Central India are of the same age.

The age of the rocks associated with the coal of Bengal is still undecided, but it is to be hoped that the examination of the reptilian remains from the Panchit beds may throw some light upon the question. The occurrence of the little *Æstheria*, a crustacean singularly abundant in the Trias of England and Germany, the coal field (Lower Mesozoic and probably Triassic) of Richmond, Virginia, U. S., and in Nagpúr in connexion with a reptile belonging to a group peculiar to the Trassic and Permian periods, (Rupert Jones on *Æstheria Minuta*, Quarterly Journal, Geological Society, XII.) seems to add weight to the gradually accumulating evidence in favor of these beds being classed with the still imperfectly known groups which are considered by European geologists to form the close of the Paleozoic and the commencement of the Mesozoic epochs. (See Professor Oldham's paper on the geological relations and probable geological age of the several systems of rocks in Central India and Bengal. Mem. Geological Survey of India, Vol. II. p. 295.)

There are three localities whence more accurate determination of the age of these rocks may be expected. Of these one is in Australia, the other two in India, on the banks of the Godavery, S. of Nagpur and in Cutch; and the attention of all interested on the Geology of India should be directed to the desirability of obtaining all possible accurate information from these places.

The following diagram represents the views above put forward of the relations of the different series referred to together with their distribution throughout Eastern and Central India.

	<i>Rániganj.</i>	<i>Rájmahál.</i>	<i>Orissa.</i>	<i>Nurbadda valley.</i>	<i>Nagpúr.</i>
1.	„	„	Máhádevas ?	Máhádevas. Lametas.	Máhádevas.
2.	„	Rájmaháls.	„	„	„
3.	{ Upper Pan- chits.	Conglomerates.	}	Upper Damúdas of Jubbulpúr.	Mangáli shales.
	{ Lower do.				
4.	{ Rániganj series.	}	}	}	Damúdas.
	{ Iron stones.				
	{ Lower Da- múdas.	Lr. Dms.	Lr. Dms. Lr. Dms.		
5.	Talchirs.	Talchirs.	Talchirs. Talchirs.		?



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