

recognized. The sequence of fossils consists of (in ascending order) *Glyphioceras Beyrichianum*, *Glyphioceras reticulatum* (type), *Glyphioceras reticulatum* (certain mutations, including *G. bilingue* (Salter)). Specimens of *Glyphioceras* approaching the characteristics of *Gastrioceras* in their mode of coiling and in ornament appear in abundance at horizons fairly well down in the *G. reticulatum* mutations beds; and near the summit of the Grit series they are very much in evidence. These specimens of early *Gastrioceras* differ considerably in their ornament from one another and form a complex group.

A study of the sutures of the above goniatites suggests that all the species belong to one group of closely allied forms. The *crenistris-sphaericum-striatum* group, which underlies the above zones and in Yorkshire characterizes the Upper Limestone Shales, is apparently (as was observed by Haug) a group distinct from the above. Very young sutures of *crenistris* closely resemble the adult sutures of the *reticulatum* group. A specimen of *sphaericum* has a spindle-shaped initial whorl. *G. Phillipsi* (F. & C.) appears to be a synonym of *G. striolatum* (Phill.).

## CORRESPONDENCE.

### PROFESSOR KENDALL ON ENGLISH ESKERS.

SIR,—Professor Kendall's article (GEOL. MAG., March, pp. 98–103) is based on a series of misquotations and misrepresentations and complaints as to the omission of irrelevant evidence. His irresponsibility as a critic lessens my satisfaction at his agreement, in the two cases with which he deals, with the essential conclusions of my paper, viz. that the Lanshaw Delves is a moraine and not an esker, and that the group of drifts near York are not concentric kames connected by osar.

The Lanshaw Delves belong to a double series of glacial formations which Professor Kendall fails to distinguish. One is the Lanshaw Delves itself, a continuous bank of sandy loam and angular unglaciated blocks of Millstone Grit. The other is a series of denuded mounds of ordinary glacial drift which extend for three or four miles eastward of the Lanshaw Delves and contain an abundance of Carboniferous Limestone. Professor Kendall misapplies the latter part of a paragraph from the Geological Survey Memoir on the Yorkshire Coalfield to the Lanshaw Delves. If he had included the first three lines of that paragraph it would have been clear that the part he quotes refers not to the Lanshaw Delves, but to some drift mounds miles eastward from it. The quotation is from the end of a section headed "High-level Eskers". Its first paragraph describes the Lanshaw Delves (p. 779), and the gravel mounds near Hawksworth. The second paragraph (p. 780) refers to the length and slope of the drift ridges. The third paragraph begins: "Besides the above there are several isolated mounds and banks

of this same gravel at Swartha Wood, Stocks Gate, and Askwith; at this last place, which is on the opposite side of the Wharfe, the gravel is only 425 feet above the sea. These mounds have been dug over," etc. The "these mounds", old lime-kilns and burnt stones, of the quotation by Professor Kendall are those at Swartha Wood, Stocks Gate, and at Askwith, which is four miles north-east of Lanshaw Delves.

The interest of the Lanshaw Delves in connexion with the esker question is that it was claimed as a high level esker; if so it is exceptional, and its explanation appeared difficult. I attached importance to this identification as it had been accepted by A. H. Green, whose work on eskers elsewhere gave weight to his opinion. Professor Kendall says that when I mentioned Green I meant Russell. That is not so. I referred to Green as the preface to the Memoir on the Yorkshire Coalfield states that he edited the whole of it, and internal evidence (e.g. the modification of the views expressed by Russell in 1873) suggests that Green wrote these paragraphs in the Memoir. Russell in 1873 said that the ridges including the Lanshaw Delves seem "to be undoubted eskers"; the text of the Memoir reduces this statement to "esker-like". According to the Preface to the Geological Survey Memoir, 92 S.E., 1879, the field-work for the Survey on the area including Lanshaw was done, not by Russell, but by Fox-Strangways! My impression from Russell's statements was that he had probably never seen the Lanshaw Delves. I did not quote the literature before 1878, as Green doubtless considered it all when preparing the paragraphs in the Yorkshire Coalfield Memoir.

The interpretation of the Lanshaw Delves as a moraine instead of an esker had three preliminary difficulties. First, the angular, unglaciated nature of the grit boulders. Second, the great difference in form of this bank from the neighbouring drift formations. It is so conspicuous that it is marked on half-inch-to-the-mile topographic maps, and is so regular that it has been often claimed as an artificial prehistoric earthwork. The name "Delves" appeared to support that view; accordingly before my visit I looked up the word in Wright's English Dialect Dictionary, where, among other meanings, is its use in West Yorkshire for to "split or rive the flag-rock". In that sense it seemed possible that the name had been suggested by the condition of many flagstone boulders in the Delves. The term is also used, as quoted by the *New English Dictionary*, for a sudden dip or slope of a hill, or for the descent of a path. Etymology, therefore, gave no definite help. I saw evidence of digging in the Delves, but nothing to decide whether it was to obtain limestone boulders from underlying boulder clay or was connected with the possible use of the bank as a prehistoric earthwork. Third, the absence or rarity of Carboniferous Limestone was a further difference from the adjacent glacial drifts. I did not say or conclude, as Professor Kendall seems to have inferred, that there was no Carboniferous Limestone in the Delves, for—as quoted in my paper—the Survey Memoir states

that the banks south of Ilkley sometimes rest on boulder clay; if that be the case with the Delves it would be strange if some Carboniferous Limestone material had not been included in that bank. In a much shorter examination of the mounds further east I saw plenty.

These objections to the morainic origin do not apply to the explanation of the Lanshaw Delves, which seems to me probable. The bank strikingly reminded me of some Scottish corrie moraines. In suggesting this explanation I did not deny either the former or contemporary existence of ice to the north of it, by which the drift mounds may have been formed as the lateral moraine of a Wharfedale glacier. On that question I have expressed no opinion. Whatever the origin of the mounds I regard the Lanshaw Delves as a later and more local formation.

I am obliged to Professor Kendall for calling my attention to the account of the Lanshaw Delves in the valuable paper by Jowett and Maufe; he remarks that my omission to quote it is unaccountable. I may therefore explain that in looking up the literature I trusted till the year 1914 to Shepherd's valuable bibliography; not finding any reference in its index to Lanshaw Delves, I examined the papers dealing with Ilkley and the valley of the Wharfe; but as Messrs. Jowett and Maufe's paper was entitled "The Glaciation of the Bradford and Keighley District", I did not expect to find any account of the Delves in it. I am glad to find that according to Messrs. Jowett and Maufe the top of the moor near the Lanshaw Delves was never covered by ice, and that they had already identified the Lanshaw Delves as a moraine.

The one formation in England for which there was high authority for identification as a "high level esker" (Moel-y-Crio, which is in North Wales, is so fragmentary that the case for it was less definite) is shown by Professor Kendall's article to be now unanimously accepted as a moraine, and the problem of the English eskers is thereby much simplified.

In regard to the drifts on the Aire Valley I agree with Professor Kendall that my paper gives no full account of them. It merely records facts which led me to agree with the Geological Survey Memoirs that these "gravel mounds" (e.g. Geol. Surv. Mem., 92, S.E., p. 12) were deposited in water.

In the case of the York and Escrick drifts it is unnecessary to follow Professor Kendall's summary of the history of the morainic theory. He misquotes me as describing "the two ridges as consisting of sand and gravel". I made no such statement. The remark which Professor Kendall has misquoted is that "Two curved bands of glacial sands and gravels occur . . ."; they occur upon the ridges which, as is clearly shown in the Geological Survey maps, consist mainly of boulder clay. Boulder clay does not form kames and osar; the possibility of those formations occurring near York is restricted to the bands of sand and gravel.

Professor Kendall's map, though it purports to be copied from those of the Geological Survey, exaggerates the moraine-like character of the two bands of sand and gravel by omission of the significant outcrop east of Naburn.

He complains of my having stated the height of the village of Stillingfleet, which was inserted to show that the sands and gravels there occur only 10 feet above the level of the Ouse and at the same height as the sands at Deighton Grove. Why should Professor Kendall transfer the height of Stillingfleet to the ridge near that village?

Professor Kendall does not reassert his view that the band from Fulford to Escrick is an esker. It is, of course, true that the lower part is covered by the Warp Clay so that it is invisible; but the osar structure should be recognizable in the exposed part in which there are good sections in a series of gravel pits. There is nothing in Professor Kendall's restatement of his views either to show that the Fulford-Escrick band of gravel is an osar or to overcome Professor Bonney's weighty objections to the view that the two crescentic ridges of drifts should be regarded as moraines, although Professor Kendall may regard acceptance of that identification as his shibboleth in glacial geology.

My paper was written in the hope that by summarizing the distribution of English esker formations (in accordance mainly with visits made to them during the past twenty-five years), and by calling attention to their apparent absence from many parts of the country, other examples would be recognized and recorded. In the classification on p. 42 of my paper I have included, with one exception, only kames which I have personally examined; the two osars are accepted on the evidence of Professor Boulton's paper and on information kindly supplied me by Mr. Dixon, which seemed conclusive. I hope that investigations similar to theirs will fill in some of the gaps on what appears to be the remains of a long series of kames with occasional osar along the line where the glaciers ended on the English lowlands.

J. W. GREGORY.

#### THE PETROLOGY OF THE PENNANT SERIES.

SIR,—Mr. E. Dixon, of H.M. Geological Survey, has kindly called my attention to an error in my paper in the February number of the Magazine. On p. 91, the statement "areas of Lower Coal *Measure* age were undergoing denudation" should, of course, read "areas similar to those of the Lower Coal *Series*, were undergoing denudation", as there is no evidence of the presence of Lower Coal *Measures* in South Wales.

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