

to take his place. Mr. Moon was also deeply interested in the microscopic study of rocks, and a plan was being elaborated with the writer for the photographing of some of the rock-slides contained in the Geological Survey collections. The description of St. John's Island, in valued collaboration with Mr. Campbell Smith and Dr. Spencer, was a first visible result of his interest in petrography. But his greatest interest was aroused by his discovery of the Diatomaceae in the Miocene of the Egyptian Oilfields region. He at once re-examined the series of Oilfield samples kept in the Geological Museum at Cairo, and found that they were of widespread distribution. Keenly anxious for the fullest information he was in continuous communication with Dr. Rendle and Messrs. Payne and Taylor at the time of his death. It was one of the pleasures of my own official life to have this enthusiastic author bringing me the latest letters he had received, or showing me many of the beautiful objects which, with the delicate sense of touch possessed by him, he had mounted with great skill and care.

The presence at the funeral of the chief representatives of the Egyptian scientific services and societies indicated in what high personal esteem he was held and the deep sympathy felt for Mrs. Moon in her sudden bereavement. His colleagues (especially those in the Department of Mines and in the Geological Museum at Cairo, with whom he was most brought in contact) deeply feel the loss of one who was both a valued colleague and a friend.

CORRESPONDENCE.

ZONES AND PHASES IN THE UPPER PART OF THE AVONIAN.

SIR,—Workers in the Carboniferous Limestone of the North of England are under a debt of gratitude to Mr. Hudson for the important paper on faunal horizons in the Lower Carboniferous of North-West Yorkshire, published in your issue of April (p. 181). It will greatly facilitate correlation with other areas and, in conjunction with Bisat's invaluable work on the goniatites, goes far towards settling the long-standing questions of the positions or position, in terms of the Yoredale sequence, of the Pendleside Limestone and the reef-limestones of the Craven knolls.

In comparison with accurate correlation it matters little what labels we give to the pigeon-holes of our systems of classification, and the following remarks, therefore, are intended in no way to detract from the value of Mr. Hudson's work.

He seems to be under a misapprehension as to the meaning given by Vaughan to the terms "standard" and "phasal", a misapprehension apparently due to the heading of a table in one of the brief papers¹ in which this worker compressed so many ideas.

¹ "Faunal Succession in the Lower Carboniferous (Avonian) of the British Isles," *Rep. Brit. Assoc. for 1909* (Winnipeg), 1910, table ii.

The table sets out phases in the Avonian with reference to the equivalent zones that are based on standard faunas, but the heading "Phasal Equivalents of Avonian" might be and, indeed, appears to have been, taken to imply that the "standard" zones, including $D\gamma$, are phasal, which would be a contradiction in terms as used by Vaughan and myself. In reality the "phasal equivalents" in the table are the zaphrentid-phases and *Modiola*- and *Posidonomya*-phases in the columns to the right of the "standard" zones. That this was Vaughan's intention when making the table I have no doubt, for I frequently had the advantage of discussing "standard" and "phasal" deposits with him, both terms being originally his. "Standard" limestones yield an abundant and unrestricted coral and/or brachiopod fauna (locally either order may predominate), and are appreciably pure and bedded (i.e. devoid of reef-structures); the phasal deposits are distinguished therefrom by a predominance of certain fossils and by lithological peculiarities.

I was, therefore, following Vaughan strictly in using $D\gamma$ as a purely zonal horizon immediately above D_2 . I was discussing a sequence, the West Cumbrian, that was almost similar in facies to the Yoredales and included a sensibly exact reproduction of the Great or Main Limestone. In using $D\gamma$ Vaughan states, after the remark quoted by Mr. Hudson (p. 181), that it is typically expressed in the fauna of the Main Limestone of the Yoredales, and that D_3 connotes a phasal fauna.

My use of $D\gamma$ for the Cumbrian equivalents of the Main Limestone and higher Avonians, therefore, means no more than that they should be separated from D_2 below, and that, pending the report of the B.A. Committee now considering the question, we may go on using $D\gamma$ for them. Whether $D\gamma$ is the best symbol is another matter.

So much for the label. The question of phases, now raised, may perhaps be developed somewhat, as much has been learnt since the term was first used for Avonian sediments.

The selection of a particular kind of limestone and fauna as "standard" is arbitrary, and our dubbing other kinds "phases" in no way derogates from their importance or, if suitable, from their value in zoning. It may be, indeed, that the general deposits of the Avonian sea where freest from local influences, are the zaphrentid-phases, and that these should therefore be the "standards". For in the southernmost outcrop in Pembrokeshire ² the Tournaisian and the Visean, which as wholes there attain probably their most complete and deepest-water developments in this country, consist with the exception of little more than S_2 and D_1 , of zaphrentid-phase deposits.

As to the use of "phases" in zoning, those that are characterized

¹ In "A Sketch of the Geology of the Whitehaven District," *Proc. Geol. Assoc.*, vol. xxxvi, 1925, p. 51.

² "The County around Pembroke and Tenby," *Mem. Geol. Surv.*, 1921, p. 73.

by an abundance of goniatites promise to afford a means of splitting up the highest beds of the Lower Carboniferous into narrower subdivisions than can be done on the basis of changes in the "standard" fauna. The value of goniatites was long ago recognized by Wheelton Hind, and in the hands of Bisat¹ they already point the way to order out of the chaotic and conflicting groupings of the strata near the border of the Lower and the Upper Carboniferous.

Goniatite-phases and coral-and-brachiopod limestones are antithetical, and not related to one another in terms of depth of the area of deposition. Though the former are typical of the Upper Carboniferous and the latter of the Lower, the two facies tend to characterize different regions, and the goniatite-invasion has reached some places earlier than others.

It would appear that the contemporaneity of goniatite-phases with "standard" deposits and tendency to mutual exclusiveness of the two may necessitate two parallel sets of zones, the one based on "standard" faunas, the other on goniatites. This work, and the establishment of correspondences between the two sets, have been greatly advanced by Bisat, Hudson and others, and will weld into a harmonious whole the fruitful labours of Garwood, Hind, and Vaughan.

ERNEST DIXON.

SEASCALE, CUMBERLAND.

¹ The Carboniferous Goniatites of the North of England and their Zones," *Proc. Yorks. Geol. Soc.*, vol. xx, 1923-4, pp. 40-124.