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DEPARTMENT OF GEOLOGY,
THE UNIVERSITY,
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T. P. CRIMES.

SEDGWICK MUSEUM,
CAMBRIDGE.
N. B. DHONAU.

1st December, 1967.

HIERARCHY IN STRATIGRAPHICAL NOMENCLATURE

SIR,—It is alarming to find that Mr. Hughes and his colleagues (*Geol. Mag.*, **104**, 634–5), in their revolt against the hierarchical system in stratigraphical nomenclature, are advocating the adoption of yet another " new nomenclature " with primary and secondary divisions.

Surely if a nomenclature is required for " time-scale points " we need no new system of " primary names ", but some indication of where, on the existing geological time-scale, such points fit. Nor would it be helpful to set up a new system of " secondary (combination) names " for " scale divisions between the time-scale points ", for, if such divisions refer " to the span between any pair of points on the time scale ", then these are chunks of geological time. If the " primary " nomenclature of geological time is to be free of any system of hierarchical classification, it must be divided into successive units, and only a numerical scheme seems reasonable, whether the units are years, or millions of years. If, on the other hand, one wants to refer to chunks of time with " secondary names ", then each chunk must, depending on its size, include varying amounts of time, the larger being inclusive of the smaller. So we have eras, periods and ages in geology, and millennia, centuries and decades in history. These become hierarchical systems as soon as more than one grade is used.

I am surprised that our Cambridge colleagues disagree that hierarchy should be used in stratigraphy, for a hierarchical system is almost essential if it is to form the basis of a nomenclature. Nouns in any language are names given to categories in a classification. Tables and chairs are names for classes in a hierarchy which includes lower divisions (e.g. arm-chairs and dining-tables) and are themselves included in higher divisions (furniture).

So far as I know, there are only two possibilities for ordering a classification ; one is hierarchical, the other serial. Combinations of the two systems are possible and indeed usual, as in the " analytico-synthetic " or " faceted " classification of library science, which employs hierarchical categories in most of its facets. Faceted classifications may be multi-dimensional when they have a special advantage for data-storage and retrieval. They are well adapted to punched-card systems and may be handled by computers. They are ill-adapted to nomenclature, tending towards polynomials.

To my mind the best *retrieval* system for the classification of geological time is a scale of years before the present ; this must be serial and may or may not be hierarchical. The only *nomenclatural* system likely to gain international acceptance will be a compromise between rival views, and must certainly be based on hierarchical principles. The proposals for a standard stratigraphical scale put forward by the Geological Society Sub-Committee (*Proc. geol. Soc. Lond.*, 1638, 75–87), to which I ascribe, are hierarchical. Both Messrs Hughes and Harland were members of this sub-committee. How can they now claim that a hierarchy is unnecessary ?

DEPARTMENT OF GEOLOGY,
THE UNIVERSITY,
LEICESTER.
P. C. SYLVESTER-BRADLEY.

1st January, 1968.

SIR,—(1) We welcome the opportunity to clarify our remarks on hierarchy in stratigraphy although they were only an incidental part of our main case for the use of reference points. Certainly hierarchy as generally employed is convenient, and also makes possible some economies of expression, particularly in allowing degrees of imprecision with larger divisions (e.g. mid-Bathonian, mid-Mesozoic). It does, however, lead to an unthinking grouping of rocks and history in a way that could be disadvantageous ; but these are matters of usage rather than principle and as a useful convention we do not attack it. The Geological Society Report specified the importance of reference points for constructing a standard stratigraphical scale ; we have taken this line of thought a step further. To implement these recommendations and define divisions, the " marker-points " would need to be labelled in some way. We think that named points will be found useful, but usage will decide and we do not consider this is controversial (our para. 9).

(2) On the other hand we do take issue with Professor Sylvester-Bradley when he argues an exclusive hierarchical principle in stratigraphy, and attacks our statement that such a principle is not essential (our para. 5*b*). To clarify the argument we reply to each of his paragraphs :

A. Ours may be a " new nomenclature ", but it does not have primary and secondary divisions. We proposed that the time-scale points should be named, and that these names be combined for divisions between *any* two points (our para. 5).

B. We do not agree (our para. 1) that there is an adequately-defined " existing geological time-scale ", and we fear that methods in recent use limit the possibility of agreeing one. The proposed solution is intended to supplement and perhaps supersede the present arrangements (our para. 9).

Certainly the intervals between time-scale points represent " chunks of geological time ", and larger chunks will be inclusive of *some* of the smaller. It may be compared with discussion of distances between places along, say, the A 6 road ; London to Derby includes Leicester to Loughborough, but so also does Market Harborough to Buxton. This is hierarchical, but it is an *overlapping* hierarchy unlike the *exclusive* hierarchy of the existing state of stratigraphical nomenclature.

C. We avoided the word " classification " in our letter as we do not regard it is a main object of stratigraphy. It is probable that stratigraphers will continue to use the present hierarchy in spite of its lack of flexibility, but a point scheme will both accommodate this and allow for its extension. As for Professor Sylvester-Bradley's domestic analogy, some chairs belong to the class " objects not made of wood ", but not all ; this class includes some but not all furniture, and so on.

D. We agree that some classifications can be ordered either hierarchically or serially. What cannot be ordered is an overlapping hierarchy of divisions, provision for which we consider desirable. Because *all* points can be ordered, and *some* divisions cannot, named points provide a simple nomenclature for all stratigraphical hierarchies. (The machine processing we envisage supersedes punched-cards which are unsuitable for economic reasons with such a large body of data.)

E. Our proposal is simple to use for storage and retrieval of stratigraphical data, as it records any time interval using the names of two reference points only. Our scheme also allows piecemeal revision including the insertion of additional points to the scale, as there is no need to re-catalogue any item of information. It is thus more economic for computer processing, than is an exclusive hierarchical arrangement

(3) The nature of the proposed Standard Stratigraphical Scale is not in dispute (our para. 2). Our suggestions concern the procedure for establishing the scale, the extension of its usefulness, and the management of a precise nomenclature. We do not accept the implication that any proposal for new nomenclature is by its novelty alarming. The prospect in data processing will so extend the powers of " memory ", that we ought now to be making arrangements for the greater precision which these powers can utilize.

DEPARTMENT OF GEOLOGY,
SEDGWICK MUSEUM,
CAMBRIDGE.
26th January, 1968.

N. F. HUGHES.
D. B. WILLIAMS.
J. L. CUTBILL.
W. B. HARLAND.

SIR,—May we be preserved from yet another system of stratigraphical nomenclature, whether based on time-scale points or otherwise (ref. Hughes *et al.*, 1967).

The Geological Society Stratigraphical Code Sub-Committee was concerned with devising a system which would finally eliminate the overlap of chronostratigraphic names which, for generations, has caused confusion to stratigraphers, and any duplicate nomenclatorial system (especially one based on different principles) is surely most undesirable.

If the need for a new chronostratigraphic reference system were to be established it should undoubtedly be a numerical one, based strictly on existing hierarchical procedures, which would be directly susceptible to data retrieval processes. As an example, the *johnstoni* Subzone (or its base horizon) might have the reference 5–2–1–1–2, the numbers referring to the Mesozoic Era (allowing, say, three numbers for the Pre-Cambrian), Jurassic Period, Hettangian Stage, *planorbis* Zone, *johnstoni* Subzone. Schemes of this kind are already in use for index purposes (Cohee, 1967 ; Dillon, 1967), and their formalization would make them universally applicable. Such a system would have the incidental advantage that there would be no limit to the fineness of subdivision for special purposes, but more importantly, it could be directly used for indexing the great mass of existing geological data.

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P. E. KENT.

BRITANNIC HOUSE,
MOOR LANE.
LONDON E.C.2.
29th January, 1968.