

THE PROBLEM OF THE CRETACEOUS-EOCENE BOUNDARY

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OF all the 'Boundary Problems' in stratigraphy, the Cretaceous-Eocene boundary is the most interesting, and has been the subject of considerable study and discussion in many parts of the world. In all such studies, the usual tendency is to try to equate all correlations with those of the European stratigraphical scale and adopt the same terminology in describing the succession in the several places. While it is no doubt useful for us to have clear and definite ideas regarding the Cretaceous-Eocene transition in Europe in tackling similar problems in other countries, we must at the same time realise the inherent limitations in the process of long distance correlations and the danger in too readily importing 'European' ideas and seek to establish identity of chronological equivalence in widely separated parts of the earth.

It is obvious that the most favourable areas for the study of the Cretaceous-Eocene boundary are those places where we seem to have a continuous succession of marine fossiliferous sediments including the uppermost Cretaceous and the lowermost Eocene; if, in any area, this succession is not wholly marine but is interrupted by the occurrence of fresh water and fluviatile beds in between, conclusions regarding the boundary naturally become doubtful and controversial.

In many parts of the world the dividing line between the Cretaceous and the Eocene is clearly indicated by a stratigraphical and/or palaeontological break in the succession revealing an unconformity or disconformity, and there is no difficulty here in defining where the one system ends and the other begins. There are a few places, however, as for instance in parts of western Europe, where no such break is recognisable; and it is these areas, though very small in extent, that are of particular interest in the study of the Cretaceous-Eocene boundary, and as such deserve special attention.

The position regarding this part of the succession in the European stratigraphical scale is indicated in Fig. 1. There is no doubt that the strata right up to and including the Mæstrichtian belong to the Cretaceous; it is equally certain that the beds from the Thanetian upwards form part of the Eocene. Between these two subdivisions—the Mæstrichtian and the Thanetian—we have a series of beds in different places whose exact position

in the scale is uncertain and controversial and these are the beds which cover the Cretaceous-Eocene transition period. Such transition beds are found in parts of western Europe including N. France, Belgium and Denmark; and even there, they occur in a number of

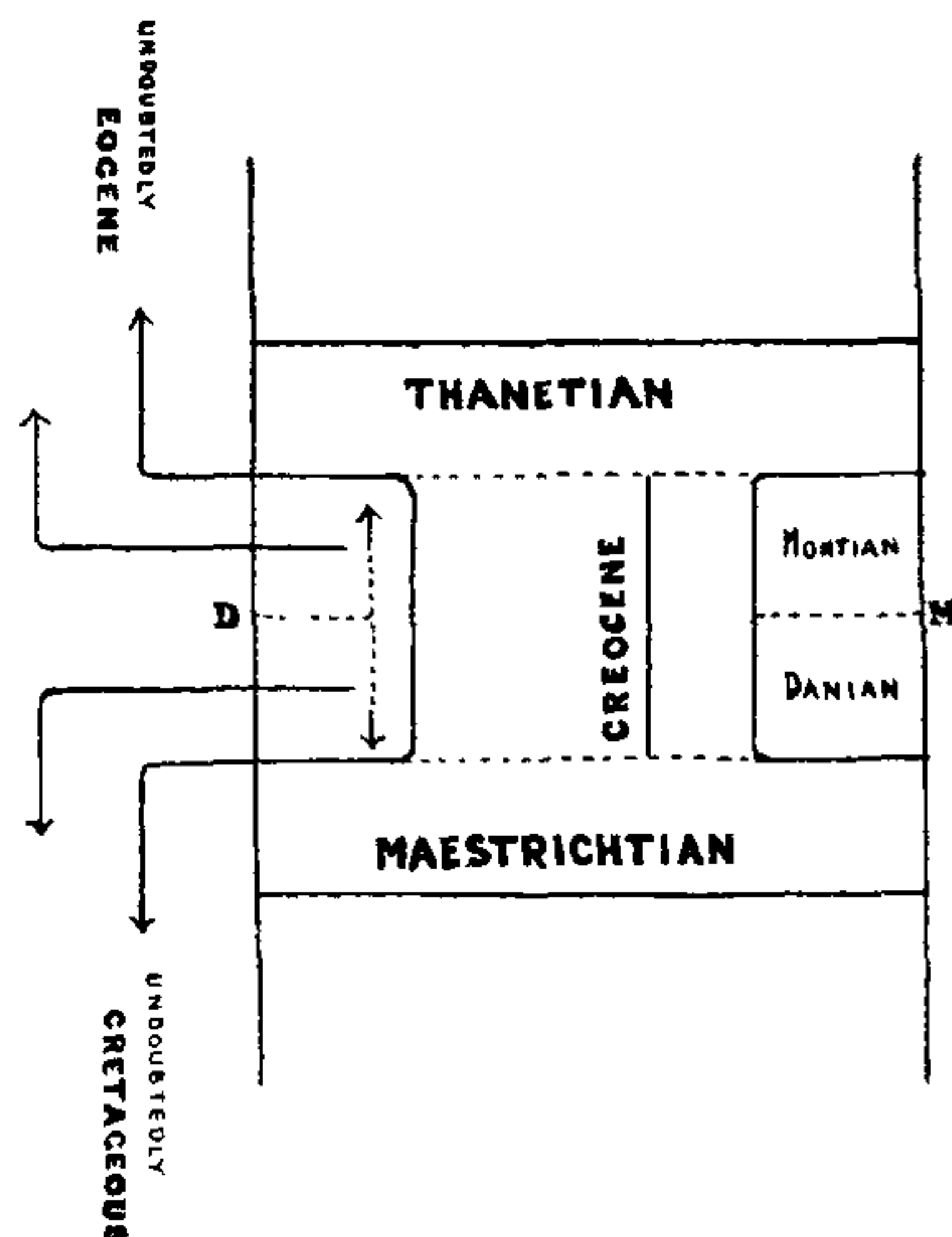


FIG. 1

The Cretaceous-Eocene Transition

small isolated patches with rapidly varying lithological and ecological facies. There is thus much difficulty in defining their classification and assigning the component beds as between the Cretaceous and Eocene. While a broad grouping of these beds into two divisions, the Danian and the Montian, is generally accepted, opinion regarding the relationships of each of these with the Cretaceous on the one hand and the Eocene on the other, have been varying. At one time it was thought that both the Montian and the Danian belonged to the Cretaceous; later, others believed that both of them formed part of the Eocene. Some others classified the Danian as the youngest Cretaceous unit including the Mæstrichtian and the Montian as its lower and upper subdivisions.

In accordance with the generally accepted scheme, the Mæstrichtian-Thanetian interval is shown in Fig. 1 as composed of the two divisions Danian and Montian, the dividing

line D M being drawn diagrammatically right in the middle and considered as demarcating the boundary between the Cretaceous and Eocene. But, actually, the position is not so simple. If we make a comparative study of different areas in and outside Europe, this significant line seems to shift upwards and downwards in the scale depending upon the local oscillations of sea level and varying with the particular basis, stratigraphical and/or palaeontological, on which we proceed to consider the question in each case. In some cases, the line shifts towards the Cretaceous side, thus reducing in degrees varying from place to place, the scope and importance of the Danian; while in others, the shift is towards the Eocene side, thus enlarging the Danian and correspondingly reducing the prominence of the Montian. The only satisfactory way to decide upon a boundary line in any area where we have such transition beds is to take a collective and comprehensive view of the stratigraphical and palaeontological evidences in that region with due regard to their previous and subsequent trends of development, and come to an agreement by a convention as to where to draw the boundary; for let us remember that where we have a really complete and continuous record of past changes, it is impossible to draw a hard and fast divisional line between the two systems which would hold good from all points of view, for the simple reason that such a line does not exist in nature.

The most important point to note is that any such boundary line which we may agree to draw between the Cretaceous and the Eocene upon the evidence in any particular area can hold good only for that region; it would be a great mistake to import those ideas to other parts of the world and seek to establish equivalence or non-equivalence of strata on the basis of one or two random criteria and thus try to solve the problem of the Cretaceous-Eocene boundary in these different places. On the other hand, the position in each region is to be judged on its own merits. While the general principles that must guide us are no doubt the same in all cases, the actual study of the transition and the drawing of a boundary line in any particular area must be decided on the evidences revealed in the localities concerned. It is particularly important for us to remember this point, for here, in India, we have

a most interesting field for the study of the Cretaceous-Eocene boundary* awaiting proper investigation. The free and indefinite use of the terms 'Danian' and 'Montian', and the uncritical manner in which names of fossils like *Nautilus danicus* and *Cardita beaumonti* have been used as age fixers, have largely added to our confusion and trouble in studying this problem here.

It is obvious that the Cretaceous-Eocene boundary lies somewhere in the Maastrichtian-Thauetian interval; and all the beds falling in this part of the stratigraphical succession in any part of the world will constitute the 'passage' from the Cretaceous to the Eocene in that area. As such passage beds are usually of shallow water origin occurring in small, scattered, and localised patches, and showing variations in the facies of deposition, the mutual correlation of their transitional stages are not easy to decipher in widely separated areas. In the present state of our knowledge, it is best that all such 'passage beds' in any particular area are clubbed together as a composite group to which the term CREOCENE may be applied. The actual level in this assemblage where we agree to draw the boundary line between the Cretaceous and the Eocene in any given area has to be decided on the basis of the available stratigraphical and palaeontological criteria in that particular area, without for a moment imagining that such a line should be of universal applicability and be constant in its relative stratigraphical position throughout the world. From the point of view of world stratigraphy, the recognition of the 'Creocene' beds in any place is the really important point; for it means that here we have a succession representing the passage (wholly or partly) from the one system to the other and hence worthy of detailed investigation as contributing to complete our picture of the geological history during the Cretaceous-Eocene transition period; where exactly we agree to draw the boundary line between the two systems in the 'Creocene' succession of any given area is a local matter and is of no great consequence from the larger point of view of Earth History as a whole.

* L. Rama Rao, Presidential Address to the Geology Section of the Indian Science Congress, 1940.