

JURASSIC-CRETACEOUS BOUNDARY PALYNOLOGY IN EUROPE

N. F. HUGHES

University of Cambridge, Department of Geology, Sedgwick Museum, Downing Street,
Cambridge CB2 3EQ, England, U.K.

ABSTRACT

A brief discussion is given of a sequence of five major problems involved in the making of a palynological contribution to the calibration of a boundary-stratotype section for a period boundary in the Global Stratigraphic Scale. It has been assumed that the Jurassic-Cretaceous boundary description will be in Europe in as low a palaeolatitude as possible, and that it will not be taken to coincide with any described event of biologic evolution. The most appropriate and useful palynomorphs for close stratigraphic study at this level appear to be those of the *Cicatricosisporites* and *Classopollis* groups; *Trilobosporites*, *Aequitriradites*, *Januasporites* and others are for various reasons considered less useful. A revised succession of *Cicatricosisporites* taxa is provided through the probable time interval required, and a reconciliation of published taxon-concepts and names is attempted.

Key-words — Palynostratigraphy, Jurassic-Cretaceous boundary, Europe.

सारांश

यूरोप में जुरेसिक-क्रीटेशियस परिसीमा का परागाणविक अध्ययन — नार्मन एंफ़ो ह्यूजिज़

पाँच प्रधान समस्याओं वाले एक अनुक्रम का संक्षिप्त विवेचन किया गया है। ये समस्यायें विश्व स्तरिकीय पैमाने में एक कालांत परिसीमा हेतु स्तरप्ररूप खंड के अनुसंधान का परागाणविक योगदान विकसित करने में संसक्त हैं। यह माना गया है कि यूरोप में जुरेसिक-क्रीटेशियस परिसीमा का उतना ही कम वर्णन होगा जितना कि एक निम्न पुराग्रथांस संभव हो तथा इसे जैव-विकास की किसी भी वर्णित घटना के समकालीन नहीं माना जायेगा। इस स्तर पर सूक्ष्म स्तरिकीय अध्ययन के लिए सिकेट्रिकोसिस्पोराइटिस एवं क्लासोपोलिस समूहों के परागाणविक रूपक सबसे अधिक उपयुक्त एवं उपयोगी प्रतीत होते हैं। ट्राइलोबोस्पोराइटिस, ऐक्वी-ट्राइरेडाइटिस, जैनुआस्पोराइटिस एवं अन्य बीजाणु विभिन्न कारणों वश कम उपयोगी माने गये हैं। सिकेट्रिकोसिस्पोराइटिस वर्गकों का एक संशोधित अनुक्रम अपेक्षित सम्भावित समय-अंतराल के द्वारा प्रस्तुत किया गया है तथा प्रकाशित वर्ग-धारणाओं एवं नामों के समाधान का प्रयास किया गया है।

INTRODUCTION

AS in the case of other stratigraphic boundaries, palynologists should be prepared to participate in the selection description of boundary-stratotypes when they are studied by the appropriate bodies of the IUGS Stratigraphy Commission. The study of the Jurassic-Cretaceous boundary has already begun in Europe.

The five problems involved for palynologists are (i) method of pressing for inclusion of a requirement that palynomorphs be regarded as essential fossils in any boundary stratotype section that is considered and selected, (ii) selection of a palynofacies to recommend as practicable

and suitable, (iii) formation of opinion on the approximate time-level and palaeolatitude that is desirable, (iv) decision on palyno morph groups that bear sufficient recognizable characters to provide useful discrimination at the time and place concerned, and (v) agreement on taxonomic style to express this discrimination in a usable manner.

REQUIREMENTS FOR PALYNO MORPHS IN BOUNDARY STRATOTYPE SECTIONS

Many stratigraphers and other geologists accept that palynomorphs are the main effective fossil links between marine and non-marine strata in post-Ordovician periods; palynomorphs were considered at

some points in the pioneer discussions of the Silurian-Devonian boundary. It is my impression, however, that as yet palynologists are by no means automatically included in discussions of sections for other boundaries, and their problems are therefore not considered in a primary role in many such discussions. It is perhaps necessary first to discover whether palaeopalynologists themselves believe this element to be important in erecting definitions for points in a global stratigraphic scale.

Practicable and Suitable Palynofacies — The great stratigraphic successes of dinoflagellate and acritarch study in recent years have meant that some stratigraphers think of these as the necessary and suitable palynomorphs for boundary sections. This is, however, not so because in pre-Neogene time dinoflagellates were essentially marine, and their presence in marine interdigitations in non-marine sequences is very restricted.

The palynofacies required is identified as from the tidal outer reaches of major distributory streams of a delta out to the main delta slope; in such areas the maximum of land-originated miospores that is possible should be mingled with dinoflagellates and other marine fossils. Although there will seldom be a complete range of miospores present, the parallel presence of dinoflagellates is desirable but not essential. Identification of such a suitable facies should be possible from the palynomorph content of samples.

Selection of Approximate Level for Boundary — The approximate level for a boundary-point should be selected to accord with tradition of usage, but should not be made to coincide with the evidence for any event whether lithologic, bio-evolutionary, or other; it should be merely an arbitrarily chosen point in a continuous rock section. The apparent incoming of a spore type is undesirable as a marker as also is the appearance of a cephalopod or any other taxon.

In the case of the Jurassic-Cretaceous boundary there is little tradition to follow because the main marine sections were not known in the early days. For a long time the top of the English Purbeck beds was assumed to be the top of the Jurassic although it was not marine; now it has been realized that the 'Purbeck' facies is diachronous and is even to some extent

so within southern England between the Dorset type Purbeck and Sussex. Because of this there is no objection to divide the time of occurrence of this facies in England so that the formation of the upper part, now known as the Durlston beds in Dorset, falls within the Cretaceous period (Text-fig. 1).

Palaeolatitude — A boundary point should be taken in a low a palaeolatitude as possible so that correlation may be direct with both palaeohemispheres, neither becoming unduly isolated in a separate realm or province. In the present case the problem is whether the marine faunal realm for selection should be Tethyan or Boreal, with the realm boundary crossing Europe. The Siberian floral province of the Soviet Far East is in a higher palaeolatitude; the main floras of the southern hemisphere, e.g. from the Argentine, India and Australia were in relatively high southern palaeolatitudes but their palynomorph assemblages appear to be sufficiently cosmopolitan despite some differences.

Consequently although the choice is by no means already confined to Europe, such a choice would not be particularly disadvantageous to palynologists as far as is known at present.

Selection of Suitable Palynomorph Types — At this stratigraphic level, the number of distinct morphologic types in a palynomorph assemblage may well be about sixty but most of these are not suitable for stratigraphic use because the taxa in current use in their morphologic groups are considered to be long-ranging. Most of the gymnospermous pollen taxa show too few characters at the optical level for it to be possible to split them for effective stratigraphic use until they have been suitably studied by SEM and TEM; the exceptions are the bisaccates which have hitherto proved too difficult, and the multi-aperturates including *Classopollis* and *Dicheiropollis* which have the advantage of wide-spread low palaeolatitude distribution.

Most spores can be adequately studied at optical level. The numerous relatively unsculptured types can be dismissed as bearing too few characters. *Cicatricosisporites* has been studied and bears adequate characters, but at the required time had not reached great diversity. *Trilobosporites* developed at about the most



TEXT-FIG. 1 — Map of southern England to show extent of data available for Berriasian reconstructions. Abbreviations: C=Cuckfield, D=Durlston, H=Hastings, K=Kingsclere, NC=West Norfolk, S=Swindon, T=Thames, Oxfordshire, WA=Vale of Wardour, WI=Winchester, WM=Warlingham, WO=Worbarrow, Dorset.

useful time but the species are of rather too great size, which tends to exclude them from finer-grained sedimentation. *Aequitridites*, *Januasporites*, etc. have not proved sufficiently frequent in occurrence to be really useful, although when available their characters will probably be adequate.

Taxonomy — Assuming that taxa are used, in preference to morphologic grade observations, it will almost certainly be necessary to erect new taxa for use in the boundary section strata. Published taxa are too broad and are in many cases based on types from other stratigraphic levels which renders them ineffectively long-ranging. Comparison records (Hughes, 1975), referred preferably to immutable biorecords, should therefore be used if possible.

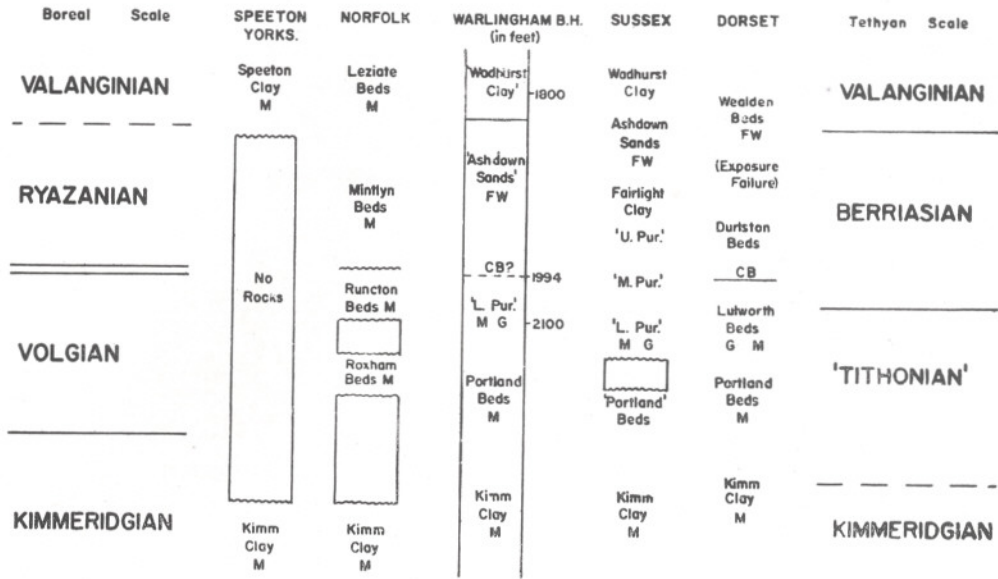
EUROPEAN SECTIONS UNDER CONSIDERATION

The marine sections in southern France considered by the special boundary collo-

quium in Lyon in 1973 (Enay, 1975) refer to the Tethyan Realm and are in strongly calcareous sequences. Also considered by other committees have been the mixed marine and non-marine sections around the Anglo-German island at the southern margin of the Boreal Realm, both in England and Germany. Additionally sections in both the southern and northern USSR have recently been discussed (Druschits & Vakhrameev, 1976).

The beginning of the Berriasian is now believed (Casey, 1974) to have been earlier than the beginning of the Boreal Ryazanian division (Text-fig. 2). A decision on boundary-level has not yet been reached between these two and intermediates, and because none of the sections is complete throughout, such a decision would affect the choice of area.

At present the English sections perhaps offer the greatest palynologic potential at outcrop, but they are by no means yet considered satisfactory in other respects.



TEXT-FIG. 2 — Table of important sections in Britain related to the Jurassic-Cretaceous boundary problem. Abbreviations: M=marine, G=evaporites, FW=essentially non-marine.

PALYNOMORPHS IN THE SOUTHERN BOREAL SECTIONS

As stated in Hughes (1974) and Druschits and Vakhrameev (1976), *Cicatricosisporites* group spores enter the succession in small numbers of specimens in the Volgian, diversify steadily in Berriasian (or Ryazanian) time and diversify strongly in Valanginian time. Unfortunately the taxa used and their nomenclature appear to be different in each country; and further, several of the taxa are insecurely based and some of them even referred to types in irrelevant later Cretaceous stages. As a result most of the species mentioned have little or no stratigraphic value, and will therefore be ineffective for calibrating a boundary-stratotype section.

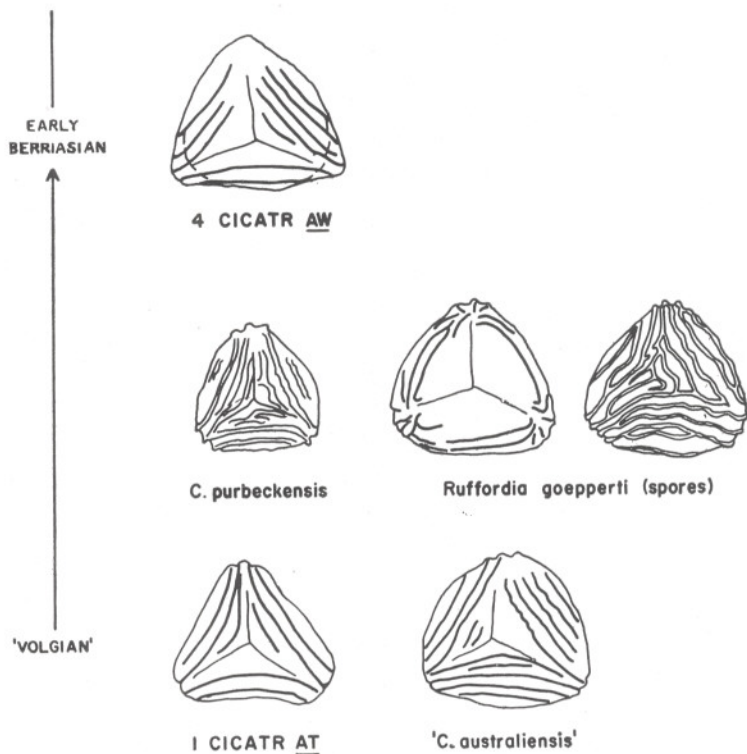
CICATRICOSISPORITES GROUP: EARLIEST CRETACEOUS

The principal *Cicatricosisporites* taxa which have been distinguished in this earliest period of development of the group are illustrated in stratigraphic order of entry in Text-figs 3 and 4. They are expressed as biorecords in the system of Hughes and Moody-Stuart (1969) in which paper (pp.

106-109) there are comments on the relationship of these biorecords to various taxa used by other authors (Bolikhovitina, 1961; Pocock, 1962; Döring, 1965; Burger, 1966); some further comments are added here. The biorecords (which pre-date Norris, 1969) are preferred here simply because they are immutable reference points for comparison, whereas virtually all the other species have become 'balloon taxa' (see Hughes, 1970); as already explained elsewhere (Hughes, 1975) the names given to the biorecords can easily be made more euphonious and communicable, once they are taken into general use for their properties.

1. NFH/JCMS 1 CICATR AT: found first in small numbers in Volgian strata such as the Portland beds, being referred by Norris (1969) to *C. australiensis* (Cookson) Potonié in his assemblages A and B. *C. sprumonti* was used by Döring (1965), but the size range is unsatisfactory, apparently because of preparation treatment.

2. NFH/JCMS 3 CICATR AR: found first in small numbers by Norris (1969) in his Assemblage B (Warlingham B.H. 2027-2000 feet) and listed as *C. purbeckensis*



TEXT-FIG. 3A

sp. nov. This perhaps also resembles fairly closely the spores taken *in situ* from *Ruffordia goepperti* (see Hughes & Moody-Stuart, 1966).

3. NFH/JCMS 4 CICATR *AW*: found first in small numbers in Early Berriasian strata at 1987 feet in Warlingham borehole. Norris (1969) used *Plicatella abaca* (Burger) for such spores in his Assemblage B (Warlingham B.H. 2027-2000 feet) but this appears likely to be due to lack of separation of 4 CICATR *AW* from 2 CICATR *AF* which enters at this lower level. '*Anemia*' *exiloides* (Mal.) Bolkh. has been used by Russian authors in a similar sense.

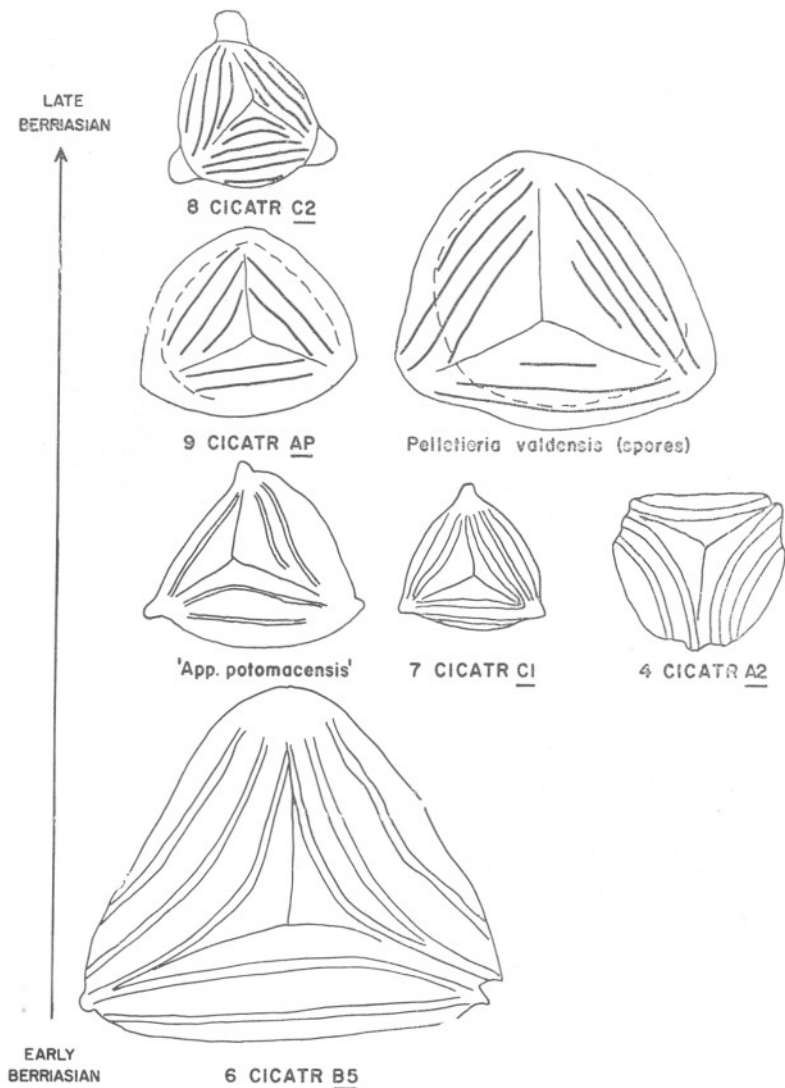
4. NFH/JCMS 6 CICATR *B5*: this large spore does not survive whole unless sedimentation (as expressed by 'Fern Spore Size index') allows. It enters at Warlingham B.H. 1915 feet. Norris (1969) recorded something similar under *C. angicanalis* Döring, 1965, but that species is

weakly based on a small number of specimens.

5. NFH/JCMS 7 CICATR *C1*: this important taxon enters at Warlingham B.H. 1887 feet. A few cf. B specimens have been recorded from just below 1900 feet, as also recorded by Norris (1969).

6. NFH/JCMS 5 CICATR *A2*: also enters the succession at Warlingham B.H. 1887 feet. Not recorded by Norris (1969) who did not work above 1900 feet in this borehole.

7. NFH/JCMS 9 CICATR *AP*: a large spore which enters at 1873 feet at Warlingham B.H. This is probably close to the spores taken *in situ* from *Pelletieria valdensis* (see Hughes & Moody-Stuart, 1966). Various authors have tried to include these in *C. brevilaesuratus* Couper, 1958 but as has been shown by Kemp (1970) this Barremian (and thus irrelevant) species was wrongly described by Couper because of inappropriate preparation treatment.



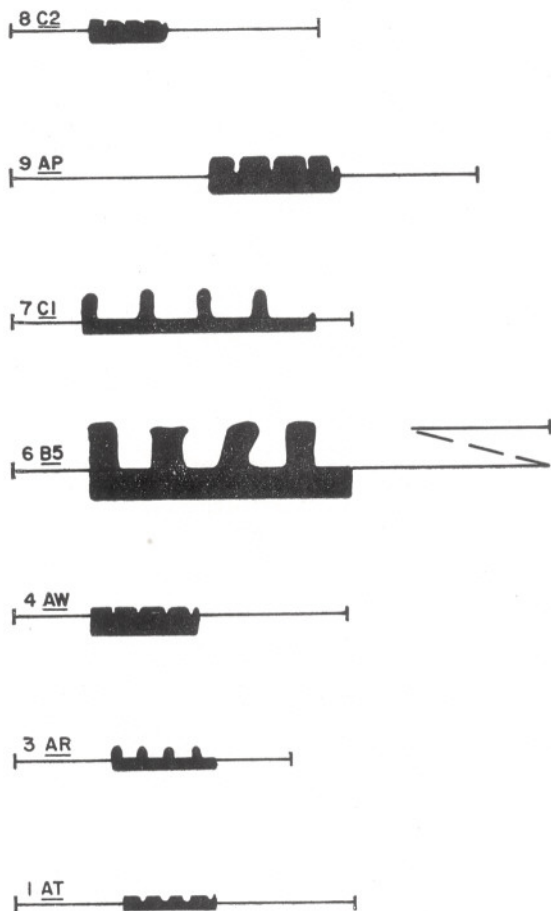
TEXT-FIG. 3B — Diagrams of species rank taxa of *Cicatricosisporites* in succession upwards from the earliest occurrence in strata of 'Volgian' age through to Late Berriasian $\times 500$. Biorecords (e.g. 1 *CICATR AT*) from Hughes and Moody-Stuart, 1969. Spores *in situ*, from Hughes and Moody-Stuart, 1966; other records from Norris, 1969.

C. magnus Döring, 1965 may be close to this taxon.

8. NFH/JCMS 8 *CICATR C2*: this very distinctive Late Berriasian taxon enters at Wurlingham B.H. 1819 feet. Both Döring (1965) and Burger (1966) recorded this morphological type but placed it in *Appendicisporites tricornitatus* Weyland & Greifeld, 1953, an irrelevant Senonian species. Some Russian authors (Bolkhovitina, 1961)

appear to have absorbed it with the very different 7 *CICATR C1* (see above) in *Appendicisporites macrorhizus* (Mal.) Bolkh., thus losing the stratigraphic distinction.

Of the authors mentioned above Hughes and Moody-Stuart (1969) and Norris (1969) appear to have had the most complete continuous section in southern England, both in borehole and outcrop. The borehole sections of Döring (1963) from 'German



TEXT-FIG. 4—Diagrams ($\times 500$) of four muri and lumina, set on a bar representing maximum diameter of spore, for each species rank taxon of *Cicatricosisporites*, corresponding to Text-fig. 3. Biorecord 3 CICATR AR is closely similar to *C. purbeckensis* Norris.

Wealden' A-G apparently began a little later, but the chief difficulty is with large specimen sizes apparently caused by swelling in preparation. The first species of Burger (1966) from the Netherlands boreholes is *Plicatella abaca*, indicating that these sections began a little later still; unfortunately Burger mostly used names from other parts of the column. The consolidated account of Russian sections (Druschits & Vahkrameev, 1976) shows '*A*'. *exilioides* as the earliest species at approximately the time of 4 CICATR AW; this later appearance of the group may be due to higher palaeolatitudes for most Russian sections. An unexplained Russian record frequently quoted is *C. tersa* from nearly

as low as *C. exilioides*; the several illustrations do not provide a proximal view which was a difficulty encountered in 10 CICATR A5S but this appears first in Valanginian strata in England (e.g. Warlingham B.H. 1740 feet).

It is possible therefore to say that, when interpreted, almost all these sections mentioned above agree in the order of entry of spores; and although the English section may eventually prove to be incomplete, the others as published are even less complete.

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