Journal of Micropalaeontology, **15**: 55–67.

Dinoflagellate cyst distributions and the Albian–Cenomanian boundary (mid-Cretaceous) at Cordebugle, NW France and Lewes, southern England

BRUCE A. TOCHER[1] & IAN JARVIS[2]

[1] Palynological Research Centre, Institute of Earth Studies, University of Wales, Aberystwyth, Dyfed SY23 3DB, UK.
[2] School of Geological Sciences, Kingston University, Penrhyn Road, Kingston upon Thames, Surrey KT1 2EE, UK.

ABSTRACT - The Albian–Cenomanian boundary successions at Livet Quarry, Cordebugle and Rodmell Cement Works, Lewes are described. Moderately abundant and diverse dinoflagellate cyst assemblages comprising 89 taxa are recorded and related to ammonite, foraminiferal and other faunal data from the two sites. The genus *Ovoidinium* forms a major component of cyst assemblages from the boundary intervals at both localities. *Ovoidinium scabrosum* (Cookson & Hughes) Davey is replaced by abundant *Ovoidinium verrucosum verrucosum* (Cookson & Hughes) Davey close to, and possibly at, the stage boundary, offering a potential dinoflagellate cyst marker for the base of the Cenomanian Stage. The published ranges of a number of species are extended. Six taxa are recorded for the first time from NW Europe: *Apteodinium reticulatum* Singh, *Disphaeria macropyla* Cookson & Eisenack, *Nematosphaeropsis densiradiata* (Cookson & Eisenack) Stover & Evitt and *Pervosphaeridium cenomaniense* (Norvick) Below occur in the high Upper Albian; *Ovoidinium verrucosum* (Cookson & Hughes) *ostium* (Davey) Lentin & Williams and *Tanyosphaeridium salpinx* Norvick are recorded from the lowest Lower Cenomanian. Increased cyst abundance and diversity at Lewes when compared with Cordebugle is related to the more basinal setting of the former locality. *J. Micropalaeontol.* **15**(1): 55–67, April 1996.

INTRODUCTION

The Cenomanian Stage, at the base of the Upper Cretaceous Series, is marked throughout most of NW Europe by the appearance of pelagic carbonates (chalks and marls), replacing dominantly siliciclastic sediments (sandstones and mudstones) of the Lower Cretaceous. This major lithological change was a consequence of the continuing rise in eustatic sea-level, that began in the earliest Cretaceous and which, by the Early Cenomanian, had drowned most available siliciclastic source areas, to form a broad shallow epicontinental sea (Hancock & Kauffmann, 1979; Juignet, 1980; Hancock, 1990, 1992). The sharp lithological change which occurs regionally at the bottom of the Cenomanian has recently been confirmed as a major sequence boundary, and is generally associated with a small hiatus (Amédro, 1992; Hart *et al*., 1992; Juignet & Breton, 1992; Robaszynski *et al*., 1992). This was probably caused by a minor regressive event (Cooper, 1977; Haq *et al*., 1987; Simmons *et al*., 1991; Amédro, 1992) or period of still-stand (Hancock, 1989), superimposed on the main mid-Cretaceous sea-level rise.

In this paper, we describe the dinoflagellate cyst distributions of samples taken across two Albian–Cenomanian boundary intervals, one from NW France and the other from southern England. Samples of 10 g were processed using standard palynological acid digestion techniques, and the strew mounts examined under a light microscope. Slides and residues are stored in the reference collection of the Palynological Research Centre, Institute of Earth Studies, University of Wales, Aberystwyth, UK. In all cases, samples were precisely located within existing detailed litho- and biostratigraphic frameworks, enabling new observations to be made on the ranges and assemblages of dinoflagellate cysts during the Early–Late Cretaceous transition.

CORDEBUGLE

Cordebugle, 10 km SE of Lisieux, département of Calvados, NW France, is situated close to the western limit of the 'Normandy Basin' (Juignet, 1980; Juignet & Breton, 1992), a structurally and sedimentologically distinct area located on the western margin of the Cretaceous Anglo-Paris Basin (Fig. 1). The region lies less than 100 km NE of the Armorican Massif, a significant local source of sediment through most of the Cenomanian which resulted in the accumulation of thick siliciclastic packages on the adjacent 'Maine Platform'. However, further to the northeast, coeval Normandy deposits are dominantly pelagic, if somewhat marginal in nature. Thick glauconitic sands (the Gaize and Glauconie de base) of Albian age are here overlain by cherty, locally sandy, glauconitic Cenomanian chalks with prominent hardgrounds at several levels.

Livet Quarry, situated to the west of Cordebugle village (Fig. 1), is a large working sand pit which exposes more than 30 m of mid-Cretaceous (Aptian–Cenomanian) sediments resting unconformably on Upper Jurassic (Oxfordian) sands and clays. The quarry (Coordonées Lambert of the Institut géographique National de France: x = 455,40; y = 157,80) has been described previously by Juignet (1974). Thirteen samples (Crd. 1–13) were collected across the Albian–Cenomanian boundary (Figs 2, 3). All of the residues contained palynomorphs, and a total of 66 species and subspecies of dinoflagellate cysts have been recorded (representative specimens are illustrated in Plates 1, 2;

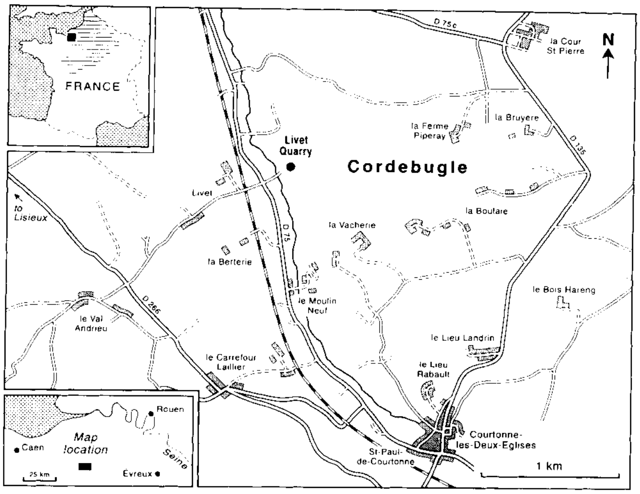

Fig. 1. Location maps for Livet Quarry, Cordebugle. The regional map (upper left) shows the position of the study area in relation to the Cretaceous Anglo-Paris Basin (horizontal ornament).

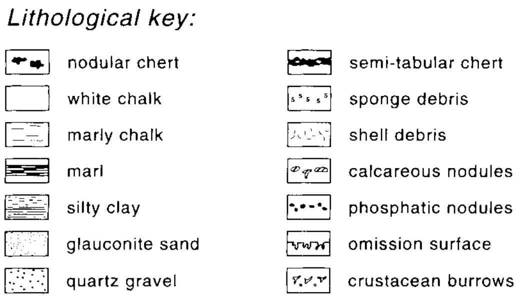

Fig. 2. Key to main lithologies occurring in the Cordebugle and Lewes sections (Figs 3, 5).

Appendix 1). Since many samples yielded <200 individuals, cyst abundances are reported as absolute numbers (Fig. 3).

Lithostratigraphy

Approximately 19 m of Aptian shallow-marine sands and gravels (Sables ferrugineux Formation) overlie the Cretaceous unconformity at Cordebugle. Above this, more than 15 m of glauconitic Albian–Cenomanian sediments, the Glauconie de base and Craie glauconieuse Formations, are exposed.

Glauconie de base The Glauconie de base rests with a sharp contact on a thin (10 cm) iron-cemented pebbly sandstone at the top of the Sables ferrugineux. Our first sample (Crd. 1) was taken 30 cm above this contact. The Glauconie de base (Figs 2, 3) comprise 7.3 m of extremely glauconitic sands, with coarse-grained lenses, interbedded with more argillaceous horizons. The sediments are heavily bioturbated at several levels, and yield macrofossils from the upper beds. A distinctive omission surface overlain by glauconitic sands and gravels (Crd. 2) containing small black phosphatic nodules occurs 1.8 m above the base. Abundant fauna, dominantly bivalves and brachiopods, occur at two levels: the lower (Crd. 5) is a 1.0 m thick bed containing calcareous nodules with sponges; the upper (Crd. 7) occurs at the summit (top 0.9 m) of the formation. A thick coarse-grained dark green glauconitic sand (Crd. 6) containing abundant crustacean burrows, *Spongeliomorpha annulatum* Kennedy, occurs between these two beds.

Craie glauconieuse de St Jouin The base of the Craie glauconieuse de St Jouin is marked by a prominent omission surface (Juignet & Breton, 1992; Fig. 3) overlain by green to dark brown bioturbated glauconitic sands (Crd. 8) containing *S. annulatum* and fragments of bivalve shells. The St Jouin Formation is accessible for approximately 6 m and comprises green and dark brown glauconitic sediments at the base, passing up into paler-coloured marly sediments above. Scattered, partly silicified, carbonate nodules are common in the middle of the sequence, below and immediately above a well-developed omission surface termed the 'Livet' surface by Juignet (1974). Above this, there is a dramatic change in lithology with glauconitic marls at the very base (Crd. 12) overlain (Fig. 3) by creamy-brown marly chalks containing numerous closely spaced tabular and semi-tabular bands of large, irregular, cavernous grey cherts.

Biostratigraphy

Macrofossils records, particularly ammonites, provide the initial means of constraining the age of the succession at Cordebugle, but further biostratigraphic refinement has been possible by incorporating our new palynological data.

Glauconie de base The lowest macrofaunal records from the Glauconie de base are from 3.5 m above the bottom of the formation, where the ammonite *Sharpeiceras laticlavium* (Sharpe) has been recorded (Juignet, 1974) in association with abundant bivalves, *Lima* sp., *Chlamy* sp., and brachiopods, *Cyclothyris difformis* (Valenciennes in Lamarck) and terebratulids. The occurrence of *Sharpeiceras* clearly demonstrates that this bed is Lower Cenomanian (Wright & Kennedy, 1984, 1987a). Additional ammonite records from the overlying Craie glauconieuse (see below), indicate that this level must lie within the lowest Lower Cenomanian *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone. However, in the absence of definitive Albian taxa, macrofaunal records do not allow the Albian–Cenomanian boundary to be placed in the succession with any confidence. The top of the Glauconie de base contains large sponges, bivalves *Spondylus striatus* (J. Sowerby), *Gryphaeostrea canaliculata* (J. Sowerby), *Inoceramus* sp., *Chlamys* sp., *Lima* sp. and brachiopods, principally *Cyclothyris difformis* and terebratulids.

Seven samples (Crd. 1–7) were collected from the Glauconie de base for palynological analysis. Samples Crd. 2–4 displayed the incoming of a number of stratigraphically significant taxa, including *Endoceratium dettmanniae* (Cookson & Hughes) Stover & Evitt; emend. Harding & Hughes, *Florentinia deanei* (Davey & Williams) Davey & Verdier, *Ovoidinium verrucosum verrucosum* (Cookson & Hughes) Davey, *Exochosphaeridium bifidum* (Clarke &

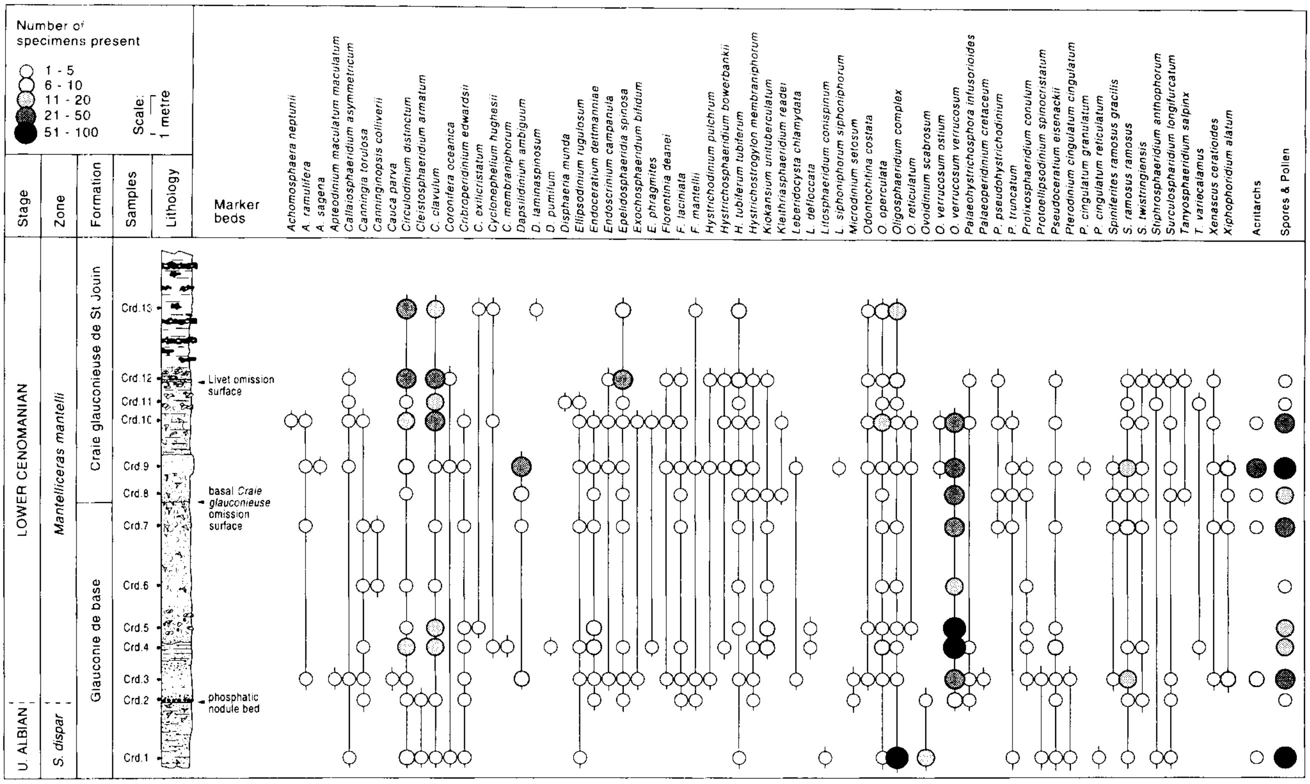

Fig. 3. Stratigraphy and palynomorph distribution across the Albian–Cenomanian boundary at Livet Quarry, Cordebugle. Cyst abundances plotted as absolute numbers recovered. See Fig. 2 for lithological key.

Verdier) Clarke *et al.*, *Hystrichosphaeridium bowerbankii* Davey & Williams, *Prolixosphaeridium conulum* Davey, *Cyclonephelium hughesii* Clarke & Verdier and *Leberidocysta defloccata* (Davey & Verdier) Stover & Evitt, whose first appearances elsewhere are taken to indicate strata of latest Albian (*S. dispar* ammonite Zone) age (Davey & Verdier, 1973; Fauconnier, 1979; Foucher, 1981; Costa & Davey, 1992).

The last appearances of *Litosphaeridium conispinum* Davey & Verdier; emend. Lucas-Clark and *Protoellipsodinium spinocristatum* Davey & Verdier (Pl. 2, fig. 11) occur in our lowest samples from the Glauconie de base (Crd. 1 and 3 respectively). These species have not been recorded previously from sediments above the Upper Albian *Mortoniceras* (*Mortoniceras*) *inflatum* ammonite Zone (Davey & Verdier, 1973; Foucher, 1981; Costa & Davey, 1992). Certainly, our lowest sample at Cordebugle (Crd. 1) contains a very different dinoflagellate cyst assemblage [dominated by *Oligosphaeridium complex* (White) Davey & Williams with subordinate *Ovoidinium scabrosum* (Cookson & Hughes) Davey; Pl. 2, fig. 3] compared to the immediately overlying beds containing typical *S. dispar* Zone forms. No macrofauna have been recovered from this part of the sequence, so it is possible that the lowest beds of the Glauconie de base (i.e. below the phosphatic nodule bed) are *M.* (*Mortoniceras*) *inflatum* Zone. However, *P. spinocristatum* (Crd. 3; Pl. 2, fig. 11) is also recorded higher in the succession at Cordebugle and at Lewes (see below) together with assemblages of typical *S. dispar* Zone dinoflagellate cysts, indicating that the species must extend further up in the Upper Albian than recognized previously. Similarly, although *L. conispinum* is recorded only from our basal sample at Cordebugle, it was also recovered from the *S. dispar* Zone at Lewes. The age of the oldest beds of the Glauconie de base, therefore, remains uncertain, but on balance, is most probably *S. dispar* Zone.

Craie glauconieuse de St Jouin Phosphatized fragmented internal moulds of ammonites [*Schloenbachia varians* (J. Sowerby) *subplana*, *S. varians subtuberculata*, *S. varians subvarians*], along with sponges, *Inoceramus* sp. and bryozoans, occur approximately 2 m above the base of the St Jouin Formation. The ammonite assemblage confirms the Cenomanian age of this bed (Wright & Kennedy, 1987b), a dominance of *Schloenbachia* spp. being common in the lowest Lower Cenomanian *N. carcitanense* Subzone (Hancock, 1991).

A more diverse phosphatised ammonite fauna has been recorded (Juignet, 1974) from immediately above the Livet Omission Surface, including abundant *Neostlingoceras carcitanense* (Matheron), together with *Anisoceras jacobi* (Breistroffer), *Hyphoplites falcatus falcatus* (Mantell), *H. curvatus arausionensis* (Hébert & Munier-Chalmas), *H. curvatus curvatus* (Mantell), *S. varians subplana* and *Forbesiceras largilliertianum* (d'Orbigny). This assemblage is

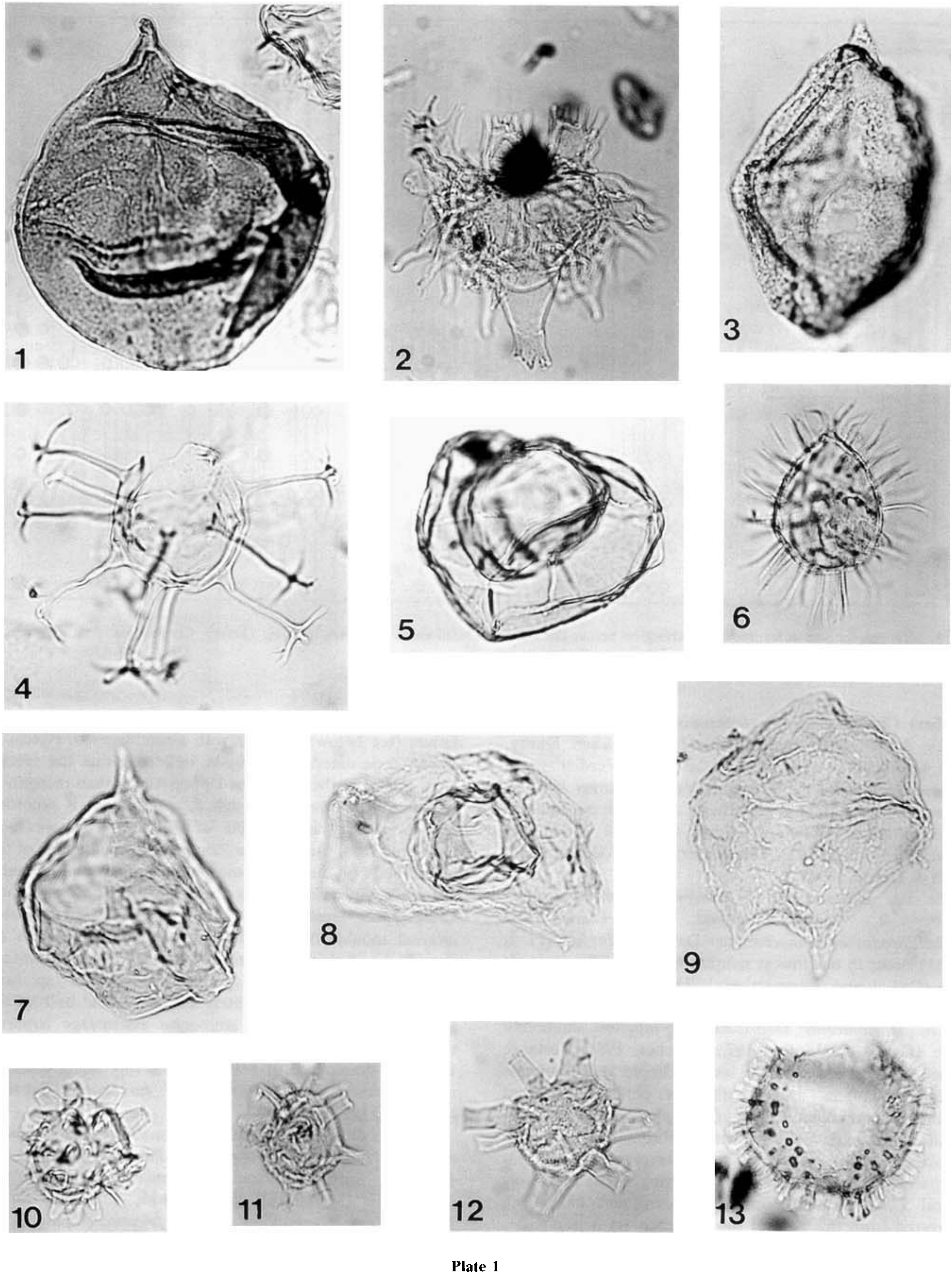

Plate 1

typical of the *N. carcitanense* Subzone. *Mantelliceras cantianum* Spath provides the only biostratigraphically useful macrofossil recovered from the cherty upper beds of the Craie glauconieuse, although ammonite records from elsewhere in the region (Juignet, 1974) suggest that the base of the overlying mid-Lower Cenomanian *M. saxbii* Subzone lies above the exposed section at Cordebugle.

Several stratigraphically significant dinoflagellate cysts have been recorded from the Craie glauconieuse. Most importantly, the last appearances of *Canningia torulosa* Davey & Verdier and *O. verrucosum verrucosum* (Cookson & Hughes) Davey occur within the lower beds (Crd. 10) of the Craie glauconieuse, indicating that this part of the succession is basal Lower Cenomanian (Foucher, 1981; Costa & Davey, 1992). This conclusion is confirmed by the presence of a *Schloenbachia*-dominated ammonite assemblage (see above) at this level.

Two dinoflagellate cysts species are recorded for the first time from the Anglo-Paris Basin. *Ovoidinium verrucosum* (Cookson & Hughes) *ostium* (Davey) Lentin & Williams (Crd. 9, 10) has previously been described from Albian–Lower Cenomanian strata in Saskatchewan (Davey, 1970), and *Tanyosphaeridium salpinx* Norvick which occurs in the Lower Cenomanian at Cordebugle (Crd. 8, 12), but has only been recorded before from Aptian–Albian strata in Australia (Norvick, 1976; Morgan, 1980).

LEWES

Lewes lies 9 km north of the East Sussex coast of southern England. The Upper Cretaceous of this region is characterized by thick successions of basinal chalks (Rawson *et al.*, 1978; Mortimore & Pomerol, 1987), typical of the central Anglo-Paris Basin. The supply of coarse detritus was cut-off to the area in the latest Aptian, the Albian being represented by a thick succession of silts and clays (Lake *et al.*, 1987) passing up, via a thin development of glauconitic marls, into a pelagic carbonate sequence of rhythmically bedded marls and limestones in the Cenomanian. No Upper Albian sands (Upper Greensand Formation) occur around Lewes, although this facies is well developed in coastal exposures at Eastbourne, 23 km to the southeast.

Rodmell Cement Works, 4 km SE of Lewes, once a complex of three pits (Fig. 4), now almost entirely infilled, prior to 1991–2 exposed strata ranging from Upper Albian to Lower Turonian. The locality (also referred to in the literature as Beddingham Limeworks) was described previously by Gaster (1929), Kennedy (1969), Carter & Hart (1977), Wright & Kennedy (1984) and Lake *et al.* (1987). Borehole data from the quarry were presented by Price (1977) and Lake *et al.* (1987). The Albian–Cenomanian boundary was exposed on the edge of a large flooded clay pit (Fig. 4, Pit 1; UK National Grid Reference: TQ 441 071). The Lower–Middle Cenomanian was best seen in an adjacent pit (Pit 2, TQ 438 067), 500 m to the south.

Five samples (Rod. 1–5) were collected across the Albian–Cenomanian boundary for palynological analysis; one additional sample (Rod. 6) was obtained from the Middle Cenomanian. Each preparation contained a diverse assemblage of dinoflagellate cysts, a total of 85 cyst taxa being recorded (Fig. 5; Plates 1, 2; Appendix 1). Since all samples yielded several hundred individuals, cyst occurrences are reported as percentage abundances (Fig 5), based on counts of 200 individuals per slide.

Lithostratigraphy

More than 25 m of section, including the uppermost beds of the Upper Gault Clay Formation (Upper Albian) and the lower beds of the Lower Chalk Group, Glauconitic Marl and overlying Chalk Marl Formations (Lower–Middle Cenomanian), were intermittently exposed in Rodmell Pits 1 and 2.

Upper Gault Clay The summit of the Upper Gault Clay was exposed at Rodmell Pit 1 (Fig. 4), where it consisted of approximately 1 m of blue-grey bioturbated silty clay, passing up into 3 m of light brown silty calcareous and micaceous bioturbated clay. The silt content increased towards the top of the succession and occasional thin diagenetically laminated units were present. The top of the Upper Gault was marked by a sharply defined omission surface which was penetrated by numerous glauconitic sand-filled *Thalassinoides* burrows (Fig. 5). The sediment within these burrows was identical to that which immediately overlay the omission surface, forming the basal facies of the Lower Chalk, Glauconitic Marl. The facies consisted of intensely bioturbated, light brown and green, friable, glauconitic marly sands. An unconformity of up to 15° has been observed by other workers (Wright

Explanation of Plate 1

Representative Upper Albian–Lower Cenomanian dinoflagellate cysts from Cordebugle and Lewes. Figure captions include species name, author(s), sample number, preparation number, and England Finder co-ordinates. Samples are deposited in the reference collection of the Palynological Research Centre, Institute of Earth Studies, Aberystwyth. All specimens were photographed at ×500. **Fig. 1.** *Apteodinium maculatum* (Eisenack & Cookson, 1960) *grande* (Cookson & Hughes, 1964) Below, 1981, Rod. 1, MCP/1293, H24/2. **Fig. 2.** *Florentinia laciniata* Davey & Verdier, 1973; Crd. 4, MCP/3157, R27/2. **Fig. 3.** *Apteodinium reticulatum* Singh, 1971, Rod. 3, MCP/1291, R24/4. **Fig. 4.** *Oligosphaeridium complex* (White, 1842) Davey & Williams, 1966, Rod. 1, MCP/1293, J49/4. **Fig. 5.** *Stephodinium coronatum* Deflandre, 1936, Rod. 1, MCP/1293, O31. **Fig. 6.** *Coronifera oceanica Cookson* & Eisenack, 1958; emend. May, 1980, Crd. 1, MCP/3154, H27. **Fig. 7.** *Apteodinium maculatum maculatum* Eisenack & Cookson, 1960, Rod. 3, MCP/1291, G18/2. **Fig. 8.** *Disphaeria macropyla* Cookson & Eisenack, 1960; emend. Norvick in Norvick & Burger, 1976, Rod. 3, MCP/1291, R46/2. **Fig. 9.** *Palaeoperidinium cretaceum* Pocock, 1962; emend. Davey, 1970; emend. Harding, 1990, Rod. 1, MCP/1293, D33 **Fig. 10.** *Litosphaeridium conispinum* Davey & Verdier, 1973; emend. Lucas-Clark, 1984, Rod. 3, MCP/1291, T25. **Fig. 11.** *Litosphaeridium arundum* (Eisenack & Cookson, 1960) Davey, 1979; emend. Lucas-Clark, 1984, Rod. 3, MCP/1291, K31/3. **Fig. 12.** *Litosphaeridium siphoniphorum siphoniphorum* (Cookson & Eisenack, 1958) Davey & Williams, 1966; emend. Lucas-Clark, 1984, Rod. 2, MCP/1292, L54/3. **Fig. 13.** *Circulodinium distinctum* (Deflandre & Cookson, 1955) Jansonius, 1986, Crd. 1, MCP/3154, Q43/4.

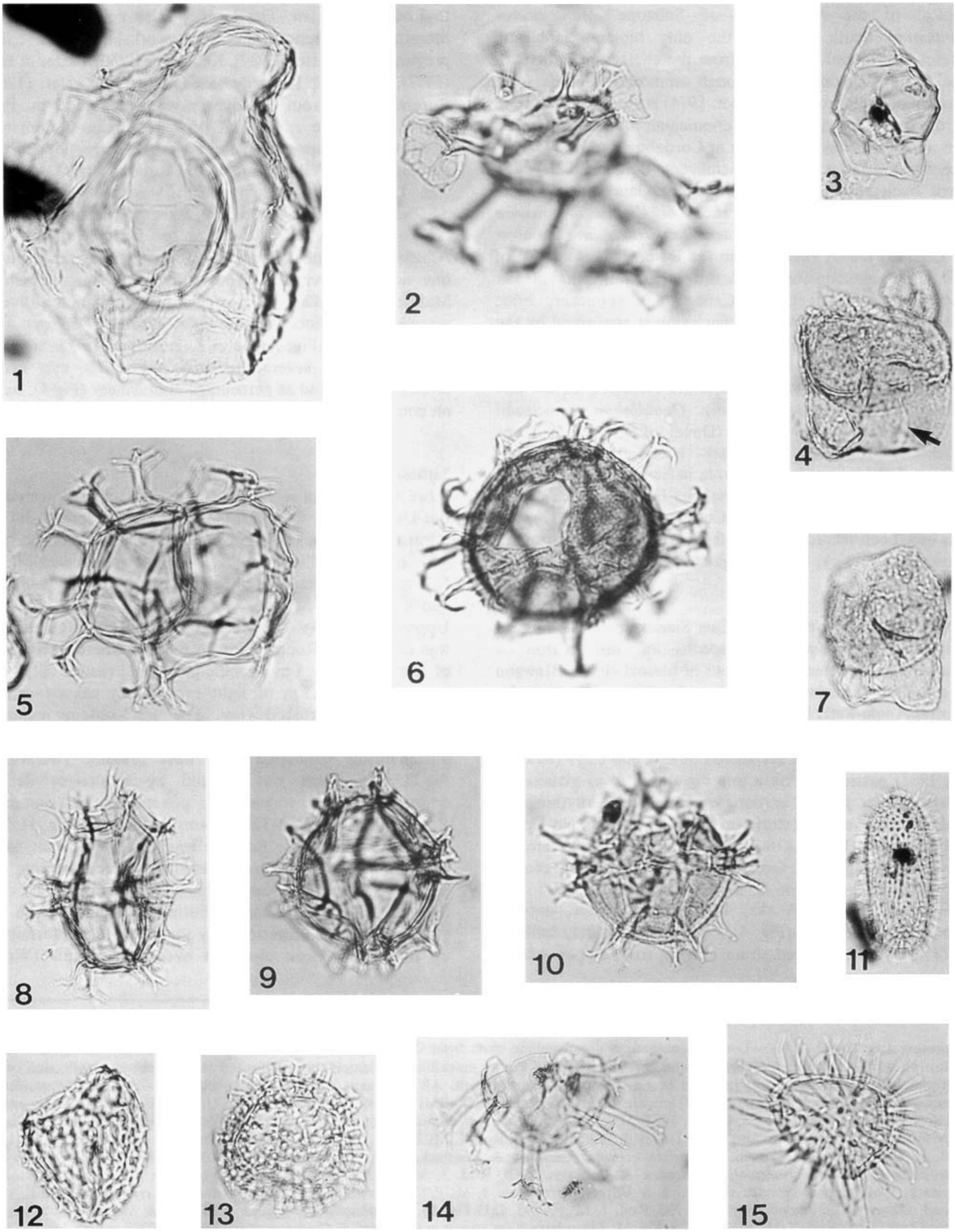

Plate 2

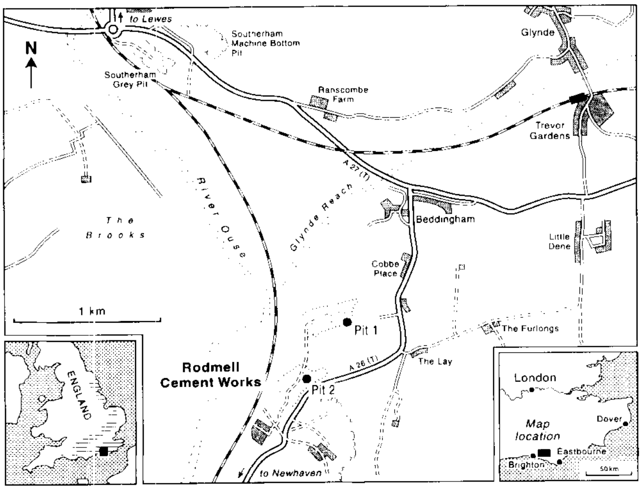

Fig. 4. Location maps for Rodmell Cement Works, Lewes. The regional map (bottom left) shows the distribution of major Cretaceous outcrops in the UK (horizontal ornament). The pits have now been largely filled and the site is being reclaimed for agricultural use.

& Kennedy, 1984) between the Upper Gault and Glauconitic Marl.

Glauconitic Marl Abundant, small (1–3 cm), black phosphatic clasts and common bivalve shell fragments, including small *Aucellina*, occurred up to 15 cm above the base of the Glauconitic Marl. The glauconite content decreased rapidly upwards and virtually disappeared in a more indurated limestone which occurred at the top of the unit (Kennedy, 1969), and marked the boundary with the overlying Chalk Marl. Macrofossils were poorly preserved in the basal Glauconitic Marl, but prominent *Thalassinoides* and other burrows occurred throughout. Sparse ammonites and common *Inoceramus crippsi* Mantell have been recorded at the summit of the formation (Kennedy, 1969), which is approximately 1.5 m thick. Palynological samples (Fig. 5, Rod. 1–5) were taken across the Upper Gault/Glauconitic Marl boundary from 4 m below to 0.7 m above the contact.

Chalk Marl Nearby, in Rodmell Pit 2, intermittent exposures of Chalk Marl occurred within a 20 m thick succession of interbedded greyish white limestones and medium to pale grey marls. One small exposure near the summit of the succession contained abundant *Orbirhynchia mantelliana* (J. de C. Sowerby) brachiopods and *Sciponoceras* heteromorph ammonites, with common *I. crippsi* and echinoid fragments These beds have been termed the upper *O. mantelliana* band (Lake *et al.*, 1987; = *O. mantelliana* band of Kennedy, 1969), and occur only a few metres below the boundary between the Chalk Marl and the overlying Grey Chalk Formation. A single sample was taken from this interval (Fig. 5, Rod. 6) for palynological analysis.

Biostratigraphy

Published macro- and microfossil records, principally ammonites and foraminifera, provide a means of determining the age of the succession at Rodmell. When combined with our new dinoflagellate cyst data, they enable a highly refined biostratigraphy to be developed.

Upper Gault Clay No stratigraphically significant macrofossils have been recorded from the summit of the Upper Gault at Rodmell. However, the foraminiferal assemblage in these beds (Carter & Hart, 1977) includes large numbers of planktonic *Globigerinelloides bentonensis* (Morrow), indicative of the Upper Albian *G. bentonensis* Zone. Evidence of a stratigraphic gap at the Upper Gault/Glauconitic Marl contact is provided by the benthonic foraminiferal biostratigraphy (Carter & Hart, 1977; Lake *et al.*, 1987) which demonstrates that the uppermost Upper Albian (Zone 6a of Carter & Hart, 1977; Zone 9 of Price, 1977) is absent. This suggests that the *S. dispar* ammonite Zone is incomplete, the top of the Gault at Rodmell probably falling within the lower part of the *Mortoniceras* (*Durnovarites*) *perinflatum* Subzone (Price, 1977; Lake *et al.*, 1987).

Samples from the Upper Gault (Fig. 5; Rod. 1–3) contain a number of dinoflagellate cyst species whose first appearances are thought (Clarke & Verdier, 1967; Davey & Verdier, 1973, 1976; Verdier, 1975; Fauconnier, 1975, 1979; Foucher, 1979, 1981; Costa & Davey, 1992) to indicate strata of latest Albian, *S. dispar* Zone age. These include *Cribroperidinium exilicristatum* (Davey) Stover & Evitt, *Exochosphaeridium bifidum* (Clarke & Verdier) Clarke *et al.*, *Heterosphaeridium*? *heteracanthum* (Deflandre & Cookson) Eisenack & Kjellstrom, *Kleithriasphaeridium readei* (Davey & Williams) Davey & Verdier, *Leberidocysta defloccata* (Davey & Verdier) Stover & Evitt,

---

Explanation of Plate 2

Representative Upper Albian–Lower Cenomanian dinoflagellate cysts from Cordebugle and Lewes. See Pl. 1 for conventions. **Fig. 1.** *Disphaeria munda* (Davey & Verdier, 1973) Norvick in Norvick & Burger, 1976, Rod. 1, MCP/1293, W22/2. **Fig. 2.** *Stiphrosphaeridium anthophorum* (Cookson & Eisenack, 1958) Lentin & Williams, 1985, Crd. 12, MCP/3165, Q53/1. **Fig. 3.** *Ovoidinium scabrosum* (Cookson & Hughes, 1964) Davey, 1970, Crd. 1, MCP/3154, U27/1. **Fig. 4.** *Ovoidinium verrucosum* (Cookson & Hughes, 1964) *ostium* (Davey, 1970) Lentin & Williams, 1975, Rod. 4, MCP/1290, P47/4. Arrow indicates characteristic opening in the posterior pericoel. **Fig. 5.** *Hystrichostrogylon membraniphorum* Agelopoulos, 1964, Rod. 1, MCP/1293, G52/3. **Fig. 6.** *Achomosphaera crassipellis* (Deflandre & Cookson, 1955) Stover & Evitt, 1978, Rod. 3, MCP/1291, G37/1. **Fig. 7.** *Ovoidinium verrucosum verrucosum* (Cookson & Hughes, 1964) Davey, 1970, Rod. 4, MCP/1290, L38/4. **Fig. 8.** *Spiniferites twistringiensis* (Maier, 1959) Fensome *et al.*, 1990, Rod. 1, MCP/1293, M46/1. **Fig. 9.** *Pterodinium cingulatum cingulatum* (O. Wetzel, 1933) Below, 1981, Rod. 1, MCP/1293, M52/4. **Fig. 10.** *Pterodinium cingulatum reticulatum* (Davey & Williams, 1966) Lentin & Williams, 1981, Rod. 2, MCP/1292, W36/3. **Fig. 11.** *Protoellipsodinium spinocristatum* Davey & Verdier, 1971, Crd. 1, MCP/3154, M29/4. **Fig. 12.** *Ellipsodinium rugulosum* Clarke & Verdier, 1967, Rod. 1, MCP/1293, T32. **Fig. 13.** *Dapsilidinium ambiguum* (Deflandre, 1937b) Wheeler & Sarjeant, 1990, Rod. 1, MCP/1293, G37/4. **Fig. 14.** *Oligosphaeridium reticulatum* Davey & Williams, 1966, Rod. 4, MCP/1290, Q50/1. **Fig. 15.** *Cleistosphaeridium clavulum* (Davey, 1969) Below, 1982, Crd. 2, MCP/3155, H18.

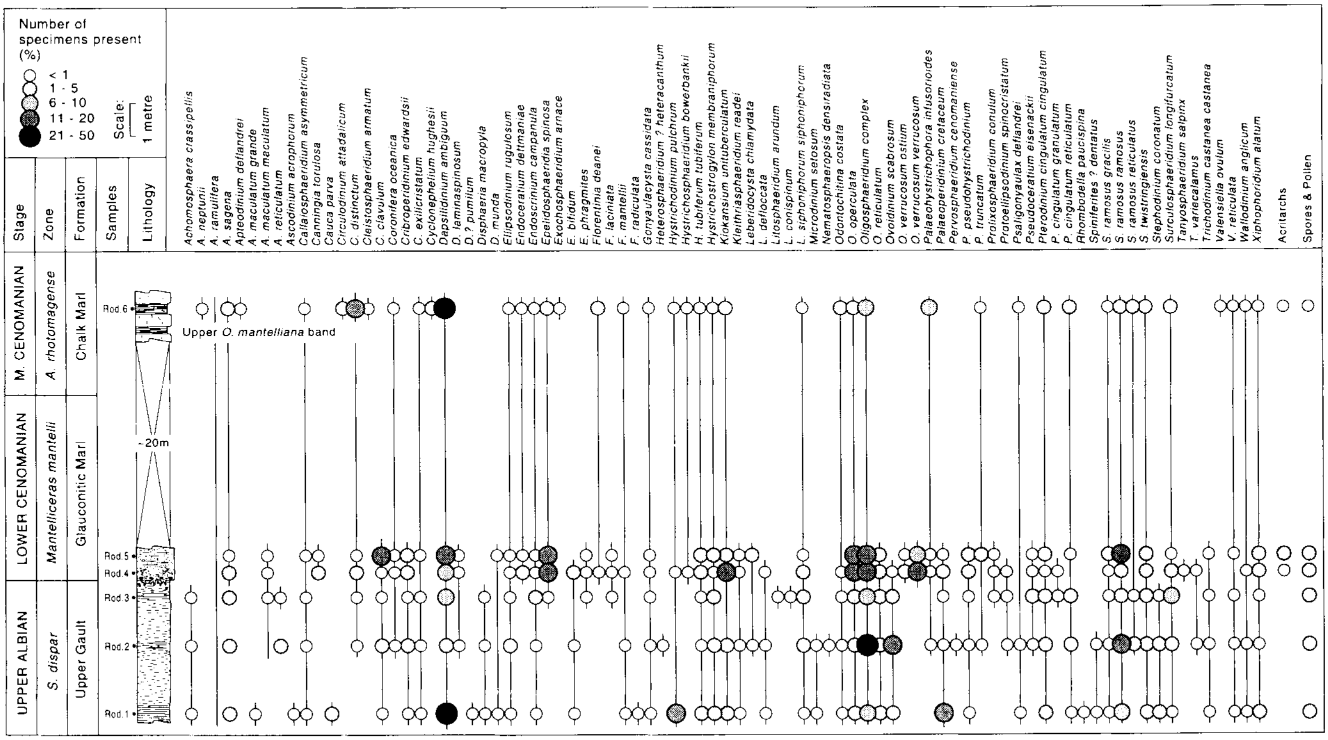

Fig. 5. Stratigraphy and palynomorph distribution across the Albian–Cenomanian boundary at Rodmell Cement Works, Lewes. Cyst abundances reported as percentages, based on counts of 200 specimens per slide. See Fig. 2 for lithological key.

Litosphaeridium siphoniphorum siphoniphorum (Cookson & Eisenack) Davey & Williams; emend. Lucas-Clark (Pl. 1, fig. 12), *Odontochitina costata* Alberti; emend. Clarke & Verdier, *Palaeohystrichophora infusorioides* Deflandre and *Pervosphaeridium pseudohystrichodinium* (Deflandre) Yun. The last appearances of *Rhombodella paucispina* (Alberti) Duxbury and *Apteodinium maculatum grande* (Cookson & Hughes) Below in our basal sample (Rod. 1), and those of *Litosphaeridium arundum* (Eisenack & Cookson) Davey emend. Lucas-Clark and *L. conispinum* in sample Rod. 3, are also regarded as being indicative of the uppermost Albian (Foucher, 1981; Costa & Davey, 1992).

Overall, the dinoflagellate cysts assemblages recovered from the Upper Gault at Rodmell are representative of the Upper Albian. However, *Oligosphaeridium reticulatum* Davey & Williams (Pl. 2, fig. 14) must have a more extensive range than recorded previously from the Anglo-Paris Basin. This species has not been described before from pre-Cenomanian sediments (Davey & Williams, 1966; Davey, 1969; Foucher, 1979), yet is common in all of our Upper Gault material (Fig. 4).

A number of taxa present as minor components of our assemblages (Fig. 5; Appendix 1), have not been recorded before from the Anglo-Paris Basin. *Apteodinium reticulatum* Singh (Rod. 3; Pl. 1, fig. 3) was first described (Singh, 1971) from the Upper Albian of Canada. *Disphaeria macropyla* Cookson & Eisenack; emend. Norvick (Rod. 2, 3; Pl. 1, fig. 8) was originally described from the Turonian of Australia by Norvick (1976), although Morgan (1980) also reported this species as occurring in the uppermost Upper Albian *S. dispar* Zone of Australia. *Nematosphaeropsis densiradiata* Cookson & Eisenack (Rod. 2) was previously known only from the low-Upper Albian, *Mortoniceras* (*Mortoniceras*) *inflatum* Zone of Australia (Morgan, 1980), while *Pervosphaeridium cenomaniense* (Norvick) Below (Rod. 2) has only been recorded previously from Albian–Cenomanian sequences in Australia (e.g. Norvick, 1976).

Glauconitic Marl The upper beds of the Glauconitic Marl at Rodmell have yielded a sparse and unusual unphosphatized basal Lower Cenomanian *M. mantelli* Zone, *N. carcitanense* Subzone ammonite fauna, including numerous heteromorphs (*Neostlingoceras, Idiohamites*), *Schloenbachia* and, locally, *Stoliczkaia* (*Lamnayella*) (Kennedy, 1969; Wright & Kennedy, 1984). The occurrence of *Stoliczkaia* is noteworthy given that *Mantelliceras*, the definitive Cenomanian genus (Birkelund *et al.*, 1984), is known to be derived from a *Stoliczkaia* stock (Hancock, 1991), yet is itself unrecorded from the basal Glauconitic Marl at Rodmell. The ammonite assemblage recorded, therefore, appears to retain some Albian affinities.

The bottom of the Glauconitic Marl marks the appearance of keeled planktonic foraminifera, particularly *Rotalipora appenninica* (Renz), definitive of the Upper Albian–Lower Cenomanian *R. appenninica* Zone (UKP.1 of Hart *et al.*, 1989). However, the basal Glauconitic Marl contains a benthonic foraminiferal assemblage which indicates the upper part of the Lower Cenomanian *Flourensina intermedia*/*Arenobulimina anglica* Concurrent Range Zone (Zone 8 of Carter & Hart, 1977; UKB.2 of Hart *et al.*, 1989), demonstrating that in addition to Zone 6a, Zone 7 (UKB.1) and the lower portion of Zone 8 (UKB.2) are also unrepresented. A comparable, and often greater, stratigraphic gap occurs throughout most of southern England (Carter & Hart, 1977) and northern France (Robaszynski *et al.*, 1980; Amédro, 1983, 1992; Robaszynski & Amédro, 1986), and is equivalent to several metres of sediment in the more complete borehole sections described from Folkestone, East Kent, and offshore in the English Channel (La Manche).

Samples from the Glauconitic Marl (Rod. 4, 5) contain a number of species whose first appearances lie (Davey & Verdier, 1973; Foucher, 1979, 1981; Fauconnier, 1979; Costa & Davey, 1992) within the Upper Albian *S. dispar* Zone of the Anglo-Paris Basin. These are: *Achomosphaera sagena* Davey & Williams; *Canningia torulosa*; *Ovoidinium verrucosum verrucosum* (Pl. 2, fig. 7); *Endoceratium dettmanniae* (Cookson & Hughes) Stover & Evitt; emend. Harding & Hughes; *Florentinia deanei*; *Hystrichosphaeridium bowerbankii*. Most of these are minor elements of the flora, except *O. verrucosum verrucosum* which occurs commonly in, and is restricted to, the Glauconitic Marl.

Protoellipsodinium spinocristatum Davey & Verdier, a species which is thought to last occur in the Upper Albian *Mortoniceras* (*Mortoniceras*) *inflatum* ammonite Zone, is recorded from the Upper Gault (*S. dispar* Zone) and a single specimen also occurred in our basal Glauconitic Marl sample (Rod. 4). However, the observed angular discordance, the associated sudden facies change from silty clays to coarse glauconitic sands, and the proven hiatus at the contact, would suggest that this last specimen is most likely a remanié element in the assemblage. Similarly, the coincident first appearances of some rarer species might be a consequence of condensation at the contact.

Several species, whose last appearances are thought to occur within the lowest Cenomanian (Foucher, 1981), occur in the Glauconitic Marl at Rodmell. These include *Ovoidinium scabrosum, O. verrucosum verrucosum, Palaeoperidinium cretaceum* Pocock; emend. Davey; emend. Harding (Pl. 1, fig. 9), *Pterodinium cingulatum* (O. Wetzel) *reticulatum* (Davey & Williams) Lentin & Williams (Pl. 2, fig. 10) and *Canningia torulosa*. In addition, the last appearance of *Disphaeria munda* (Davey & Verdier) Norvick in sample Rod. 5, suggests a slightly younger age for this species than the previously published Late Albian top occurrence (e.g. Davey & Verdier, 1973). With one exception (*P. cingulatum reticulatum*), all of these taxa are absent in our sample from the upper part of the Chalk Marl (Fig. 5), which is consistent with them disappearing within the Lower Cenomanian. However, we have taken too few samples to place their last occurrences more precisely. Our records of *P. cingulum reticulatum* in the Middle Cenomanian indicates a more extensive range for this species.

Ovoidinium verrucosum ostium (Pl. 2, fig. 4) and *Tanyosphaeridium salpinx*, species which have not been recorded previously from the Anglo-Paris Basin, both occur in our basal Glauconitic Marl sample (Rod. 4). This confirms our records of these taxa from the basal Craie glauconieuse (Lower Cenomanian *M. mantelli* Zone) at Cordebugle (see above) and suggests that they probably have a widespread occurrence within the Anglo-Paris Basin.

Chalk Marl The upper *O. mantelliana* band constitutes the summit of the low Middle Cenomanian ammonite *Acanthoceras rhotomagense* Zone, *Turrilites costatus* Subzone (Kennedy, 1969; Wright & Kennedy, 1984), and also coincides with the top of the planktonic foraminiferal *Rotalipora reicheli* Zone (UKP.2). This level lies within the benthonic foraminiferal *P. cenomana* Interval Zone (UKB.5 of Hart *et al.*, 1989), at the summit of Zone 11(i) of Carter & Hart (1977; *Arenobulimina anglica/Plectina cenomana* Concurrent Range Zone); its top marks the so-called mid-Cenomanian non-sequence, above which there is a sudden and marked increase in the planktonic/benthonic ratio of the foraminiferal assemblages. The base of the mid-Middle Cenomanian ammonite *T. acutus* Subzone is taken at the top of the brachiopod band.

Stratigraphically significant species are rare in our single Chalk Marl sample (Rod. 6). However, the continued presence of *Cribroperidinium exilicristatum, Endoceratium dettmanniae and Epelidosphaeridia spinosa* (Cookson & Hughes) Davey, are consistent with this part of the sequence being no younger than Middle to early Late Cenomanian (Foucher, 1981; Jarvis *et al.*, 1988; Costa & Davey, 1992).

DISCUSSION

Palynomorph assemblages recovered from Cordebugle are of moderate abundance and diversity (Fig. 3). However, in the upper part of the Glauconie de base and lowest Craie glauconieuse de St Jouin, these assemblages are dominated to a large extent by specimens of *Ovoidinium* (particularly *O. verrucosum verrucosum*) and bisaccate pollen grains. This dominance continues up to sample Crd. 10 (a level yielding common *Schloenbachia* ammonites), above which *Ovoidinium* disappears and assemblages consist predominantly of *Cleistosphaeridium clavulum* (Davey) Below (Pl. 2, fig. 15), *Circulodinium distinctum* (Deflandre & Cookson) Jansonius (Pl. 1, fig. 13) and *Epelidosphaeridia spinosa* (Cookson & Hughes) Davey. This change is associated with declining glauconite and the appearance of silicified nodules in the sediment, but takes place below the major facies change to flinty marls which occurs somewhat higher, above the Livet Omission Surface (Fig. 3).

Dinoflagellate cyst assemblages from Lewes are more abundant and diverse than those from Cordebugle, but are similar in a number of respects. The genus *Ovoidinium* is again a major component throughout the uppermost Upper Albian–basal Lower Cenomanian, but particularly in the lowest Lower Cenomanian Glauconitic Marl where *O. verrucosum verrucosum* appears in large numbers. At both localities *Ovoidinium scabrosum* is essentially replaced by *O. verrucosum verrucosum* close to, and most probably at, the Albian–Cenomanian boundary and *Cleistosphaeridium clavulum* is abundant in the uppermost beds yielding *Ovoidinium*. However, other elements of the flora, particularly *Dapsilidinium ambiguum* (Deflandre) Wheeler & Sarjeant (Pl. 2, fig. 13), *Epelidosphaeridia spinosa, Kiokansium unituberculatum* (Tasch) Stover & Evitt, *Odontochitina operculata* (O. Wetzel) Deflandre & Cookson, *Oligosphaeridium* complex and *Spiniferites ramosus ramosus* (Ehrenberg) Mantell are also important components of assemblages recovered across the stage boundary at Lewes. These latter taxa occur, but do not represent major components of coeval assemblages at Cordebugle. Furthermore, terrestrially derived material represents a much greater proportion of the palynofacies at Cordebugle. These differences reflect the contrasting palaeogeographic settings of the two sites. Cordebugle was situated in a shallower-water sediment-starved marginal environment close to the western edge of the Anglo-Paris Basin. In contrast, Lewes was located in a deeper basinal setting far removed from continental influences, promoting increased phytoplankton productivity and diversity but reduced terrestrial input.

CONCLUSIONS

The last appearances of *Litosphaeridium conispinum* Davey & Verdier; emend. Lucas-Clark and *Protoellipsodinium spinocristatum* Davey & Verdier occur in the high Upper Albian *S. dispar* Zone (*M.* (*M.*) *rostratum* Subzone) and not in the low–mid-Upper Albian *M.* (*M.*) *inflatum* Zone as suggested by previous workers. The last occurrence of *Rhombodella paucispina* (Alberti) Duxbury is confirmed as being Upper Albian in this region. The range of *Oligosphaeridium reticulatum* Davey & Williams is extended down into the Upper Albian *M.* (*M.*) *rostratum* Subzone.

The last appearances of *Canningia torulosa* Davey & Verdier and *Ovoidinium verrucosum verrucosum* (Cookson & Hughes) Davey lie within the lowest Lower Cenomanian *Mantelliceras mantelli* Zone (N. carcitanense Subzone). The latter taxa replaces *O. scabrosum* (Cookson & Hughes) Davey, forming a major component of the cyst assemblage at the base of the Cenomanian at Rodmell and dominates the stage boundary transition at Cordebugle; the appearance of *O. verrucosum verrucosum* potentially represents a basal Cenomanian marker event. *Ovoidinium verrucosum* (Cookson & Hughes) *ostium* (Davey) Lentin & Williams, recorded for the first time in NW Europe, forms a minor element of our basal Cenomanian assemblages.

Apteodinium reticulatum Singh, *Disphaeria macropyla* Cookson & Eisenack; emend. Norvick, *Nematosphaeropsis densiradiata* (Cookson & Eisenack) Stover & Evitt and *Pervosphaeridium cenomaniense* (Norvick) Below occur in the Upper Albian *S. dispar* Zone (*M.* (*M.*) *rostratum* Subzone); all four taxa are recorded for the first time from the Anglo-Paris Basin. *Tanyosphaeridium salpinx* Norvick, also previously unknown from NW Europe, is recorded from the basal Lower Cenomanian.

The range of *Pterodinium cingulum* (O. Wetzel) *reticulatum* (Davey & Williams) Lentin & Williams is extended up into the Middle Cenomanian *A. rhotomagense* Zone (*T. costatus* Subzone).

ACKNOWLEDGEMENTS

Initial phases of this research were undertaken at the School of Earth Sciences, University of Greenwich (previously part of City of London Polytechnic). Subsequent support from the University of Wales, Aberystwyth and Kingston University is gratefully acknowledged.

APPENDIX 1

List of dinoflagellate cyst taxa recorded (for further taxonomic details and references see Lentin & Williams, 1993). Locality records (C = Cordebugle; R = Rodmell) and figured taxa (details in parentheses) are indicated.

Achomosphaera crassipellis (Deflandre & Cookson, 1955) Stover & Evitt, 1978; C, R (Pl. 2, fig. 6).
A. neptunii (Eisenack, 1958) Davey & Williams, 1966; C, R
A. ramulifera (Deflandre, 1937) Evitt, 1963; C, R.
A. sagena Davey & Williams, 1966; C, R.
Apteodinium deflandrei (Clarke & Verdier, 1967) Lucas-Clark, 1987; R.
A. maculatum (Eisenack & Cookson, 1960) *grande* (Cookson & Hughes, 1964) Below, 1981; R (Pl. 1, fig. 1).
A. maculatum maculatum Eisenack & Cookson, 1960; C, R (Pl. 1, fig. 7).
A. reticulatum Singh, 1971; R (Pl. 1, fig. 3).
Ascodinium acrophorum Cookson & Eisenack, 1960; R.
Callaiosphaeridium asymmetricum (Deflandre & Courteville, 1939) Davey & Williams, 1966; C, R.
Canningia torulosa Davey & Verdier, 1973; C, R.
Canninginopsis colliveri (Cookson & Eisenack, 1960) Backhouse, 1988; C.
Cauca parva (Alberti, 1961) Davey & Verdier, 1971
Circulodinium attadalicum (Cookson & Eisenack, 1962) Helby, 1987; R.
C. distinctum (Deflandre & Cookson, 1955) Jansonius, 1986; C, R (Pl. 1, fig. 13).
Cleistosphaeridium armatum (Deflandre, 1937) Davey, 1969; C, R.
C. clavulum (Davey, 1969) Below, 1982; C, R (Pl. 2, fig. 15).
Coronifera oceanica Cookson & Eisenack, 1958; emend. May, 1980; C, R (Pl. 1, fig. 6).
Cribroperidinium edwardsii (Cookson & Eisenack, 1958) Davey, 1969; C, R.
C. exilicristatum (Davey, 1969) Stover & Evitt, 1978; C, R.
Cyclonephelium hughesii Clarke & Verdier, 1967; C, R.
C. membraniphorum Cookson & Eisenack, 1962; C.
Dapsilidinium ambiguum (Deflandre, 1937) Wheeler & Sarjeant, 1990; C, R (Pl. 2, fig. 13).
D. laminaspinosum (Davey & Williams, 1966) Lentin & Williams, 1981; C, R.
D.? pumilum (Davey & Williams, 1966) Lentin & Williams, 1981; C, R.
Disphaeria macropyla Cookson & Eisenack 1960; emend. Norvick in Norvick & Burger, 1976; R (Pl. 1, fig. 8).
D. munda (Davey & Verdier, 1973) Norvick in Norvick & Burger, 1976; C, R (Pl. 2, fig. 1).
Ellipsodinium rugulosum Clarke & Verdier, 1967; C, R (Pl. 2, fig. 12).
Endoceratium dettmanniae (Cookson & Hughes, 1964) Stover & Evitt, 1978; emend. Harding & Hughes, 1990; C, R.
Endoscrinium campanula (Gocht, 1959) Vozzhennikova, 1967; C, R.

Epelidosphaeridia spinosa (Cookson & Hughes, 1964) Davey, 1969; C, R.
Exochosphaeridium arnace Davey & Verdier, 1973; R.
E. bifidum (Clarke & Verdier, 1967) Clarke *et al.*, 1968; C, R.
E. phragmites Davey *et al.*, 1966; C, R.
Florentinia deanei (Davey & Williams, 1966) Davey & Verdier, 1973; C, R.
F. laciniata Davey & Verdier, 1973; C, R (Pl. 1, fig. 2).
F. mantellii (Davey & Williams, 1966) Davey & Verdier, 1973; C, R.
F. radiculata (Davey & Williams, 1966) Davey & Verdier, 1973; emend. Davey & Verdier, 1976; R.
Gonyaulacysta cassidata (Eisenack & Cookson, 1960) Sarjeant, 1966; R.
Heterosphaeridium? heteracanthum (Deflandre & Cookson, 1955) Eisenack & Kjellstrom, 1971; R.
Hystrichodinium pulchrum Deflandre, 1935; C, R.
Hystrichosphaeridium bowerbankii Davey & Williams, 1966; C, R.
H. tubiferum tubiferum (Ehrenberg, 1838) Deflandre, 1937; emend. Davey & Williams, 1966; C, R.
Hystrichostrogylon membraniphorum Agelopoulos, 1964; C, R (Pl. 2, fig. 5).
Kiokansium unituberculatum (Tasch, 1964) Stover & Evitt, 1978; C, R.
Kleithriasphaeridium readei (Davey & Williams, 1966) Davey & Verdier, 1976; C, R.
Leberidocysta chlamydata (Cookson & Eisenack, 1962) Stover & Evitt, 1978; emend. Fechner, 1985; emend. Marheinecke, 1992; C, R.
L. defloccata (Davey & Verdier, 1973) Stover & Evitt, 1978; C, R.
Litosphaeridium arundum (Eisenack & Cookson, 1960) Davey, 1979; emend. Lucas-Clark, 1984; R (Pl. 1, fig. 11).
L. conispinum Davey & Verdier, 1973; emend. Lucas-Clark, 1984; C, R (Pl. 1, fig. 10).
L. siphoniphorum siphoniphorum (Cookson & Eisenack, 1958) Davey & Williams, 1966; emend. Lucas-Clark, 1984; C, R (Pl. 1, fig. 12).
Microdinium setosum Sarjeant, 1966; emend. Below, 1987; C, R.
Nematosphaeropsis densiradiata (Cookson & Eisenack, 1962) Stover & Evitt, 1978; R.
Odontochitina costata Alberti, 1961; emend. Clarke & Verdier, 1967; C, R.
O. operculata (O. Wetzel, 1933) Deflandre & Cookson, 1955; C, R.
Oligosphaeridium complex (White, 1842) Davey & Williams, 1966; C, R (Pl. 1, fig. 4).
O. reticulatum Davey & Williams, 1966; C, R (Pl. 2, fig. 14).
Ovoidinium scabrosum (Cookson & Hughes, 1964) Davey, 1970; C, R (Pl. 2, fig. 3).
O. verrucosum (Cookson & Hughes, 1964) *ostium* (Davey, 1970) Lentin & Williams, 1975; C, R (Pl. 2, fig. 4).
O. verrucosum verrucosum (Cookson & Hughes, 1964) Davey, 1970; C, R (Pl. 2, fig. 7).
Palaeohystrichophora infusorioides Deflandre, 1935; C, R.
Palaeoperidinium cretaceum Pocock, 1962; emend. Davey, 1970; emend. Harding, 1990; C, R (Pl. 1, fig. 9).
Pervosphaeridium cenomaniense (Norvick in Norvick & Burger, 1976) Below, 1982; R.
P. pseudhystrichodinium (Deflandre, 1937) Yun, 1981; C, R.
P. truncatum (Davey, 1969) Below, 1982; emend. Masure 1988; emend. Harker in Harker *et al.*, 1990; C, R.
Prolixosphaeridium conulum Davey, 1969; C, R.
Protoellipsodinium spinocristatum Davey & Verdier, 1971; C, R (Pl. 2, fig. 11).
Psaligonyaulax deflandrei Sarjeant, 1966; emend. Sarjeant, 1982; R.
Pseudoceratium eisenackii (Davey, 1969) Bint, 1986; C, R.
Pterodinium cingulatum cingulatum (O. Wetzel, 1933) Below, 1981; C, R (Pl. 2, fig. 9).
P. cingulatum (O. Wetzel, 1933) *granulatum* (Clarke & Verdier, 1967) Lentin & Williams, 1981; C, R.
P. cingulatum (O. Wetzel, 1933) *reticulatum* (Davey & Williams, 1966) Lentin & Williams, 1981; C, R (Pl. 2, fig. 10).
Rhombodella paucispina (Alberti, 1961) Duxbury, 1980; R.
Spiniferites? dentatus (Gocht, 1959) Lentin & Williams, 1973; emend. Duxbury, 1977; R.
S. ramosus gracilis (Davey & Williams, 1966) Lentin & Williams, 1973; C, R.
S. ramosus ramosus (Ehrenberg, 1838) Mantell, 1854; C, R.
S. ramosus reticulatus (Davey & Williams, 1966) Lentin & Williams, 1973; R.
S. twistringiensis (Maier, 1959) Fensome *et al.*, 1990; C, R (Pl. 2, fig. 8).
Stephodinium coronatum Deflandre, 1936; R (Pl. 1, fig. 5).
Stiphrosphaeridium anthophorum (Cookson & Eisenack, 1958) Lentin & Williams, 1985; C (Pl. 2, fig. 2).
Surculosphaeridium? longifurcatum (Firtion, 1952) Davey *et al.*, 1966; C, R.
Tanyosphaeridium salpinx Norvick in Norvick & Burger, 1976; C, R.
T. variecalamus Davey & Williams, 1966; C, R.
Trichodinium castanea castanea (Deflandre, 1935) Clarke & Verdier, 1967; R.
Valensiella ovulum (Deflandre, 1947) Eisenack, 1963; emend. Courtinat, 1989; R.
V. reticulata (Davey, 1969) Courtinat, 1989; R.
Wallodinium anglicum (Cookson & Hughes, 1964) Lentin & Williams, 1973; R.
Xenascus ceratioides (Deflandre, 1937) Lentin & Williams, 1973; C.
Xiphophoridium alatum (Cookson & Eisenack, 1962) Sarjeant, 1966; C, R.

Manuscript received November 1993
Manuscript accepted June 1994

REFERENCES

Amédro, F. 1983. L'Albien de la bordure septentrionale du bassin de Paris. Mise en évidence d'un contrôle tectonique de la sédimentation. *Géologie de la France*, **3:** 179–192.

Amédro, F. 1992. L'Albien du bassin anglo-parisien : Ammonites, zonation phylétique, séquences. *Bulletin Centres de Recherches Exploration-Production Elf-Aquitaine*, **16:** 187–233.

Birkelund, T., Hancock, J. M., Hart, M. B., Rawson, P. F., Remane, J., Robaszynski, F., Schmid, F. & Surlyk, F. 1984. Cretaceous stage boundaries-proposals. *Bulletin of the Geological Society of Denmark*, **33:** 3–20.

Carter, D. J. & Hart, M. B. 1977. Aspects of mid-Cretaceous stratigraphical micropalaeontology. *Bulletin of the British Museum (Natural History) Geology*, **29:** 1–135.

Clarke, R. F. A. & Verdier, J. P. 1967. An investigation of microplankton assemblages from the Chalk of the Isle of Wight, England. *Verhandelingen Koninklijke Nederlandse Akadamie van Wetenschappen Afdeling Natuurkunde, Eerste Reeks*, **24:** 1–96.

Cooper, M. R., 1977. Eustacy during the Cretaceous: its implications and importance. *Palaeogeography Palaeoclimatology Palaeoecology*, **22:** 1–60.

Costa, L. I. & Davey, R. J. 1992. 3. Dinoflagellate cysts of the Cretaceous System. *In* Powell, A. J. (Ed.), *A Stratigraphic Index of Dinoflagellate Cysts*, 99–154, British Micropalaeontological Society Series, Chapman & Hall, London.

Davey, R. J. 1969. Non-calcareous microplankton from the Cenomanian of England, northern France and North America, Part I. *Bulletin of the British Museum (Natural History) Geology*, **17:** 103–180.

Davey, R. J. 1970. Non-calcareous microplankton from the Cenomanian of England, northern France and North America, Part II. *Bulletin of the British Museum (Natural History) Geology*, **18:** 333–397.

Davey, R. J. & Verdier, J. P. 1973. An investigation of microplankton assemblages from latest Albian (Vraconian) sediments. *Revista Espanola de Micropaleontologia*, **5**, 173–212.

Davey, R. J. & Verdier, J. P. 1976. A review of certain non-tabulate Cretaceous hystrichospherid dinocysts. *Review of Palaeobotany and Palynology*, **22:** 307–335.

Davey, R. J. & Williams, G. L. 1966. The genus Hystrichosphaeridium and its allies. In: Davey, R. J. *et al.* (Eds), Studies in Mesozoic and Cainozoic dinoflagellate cysts. *Bulletin of the British Museum (Natural History) Geology Supplement*, **3:** 157–175.

Fauconnier, D. 1975. Répartition des Peridiniens de l'Albien du Bassin de Paris. Rôle stratigraphique et liason avec le cadre sédimentologique. *Bulletin Bureau de Recherches géologiques et minières (deuxième série)*, **1:** 235–273.

Fauconnier, D. 1979. Les dinoflagellés de l'Albien et du Cénomanien inférieur du Bassin de Paris. *Document Bureau de Recherches géologiques et minières*, **5:** 151 p.

Foucher, J. -C. 1979. Distribution stratigraphique des kystes de dinoflagellés et des acritarches dans le Crétacé supérieur du Bassin de Paris et de l'Europe septentrionale. *Palaeontographica Abteilung B*, **169:** 78–105.

Foucher, J.-C. 1981. Kystes de dinoflagellés du Crétacé moyen européen: proposition d'une echelle biostratigraphique pour le domain nord-occidental. *Cretaceous Research*, **2:** 331–338.

Gaster, C. T. A. 1929. Chalk zones in the neighbourhood of Shoreham, Brighton and Newhaven, Sussex. *Proceedings of the Geologists' Association*, **39:** 328–340.

Hancock, J. M. 1989. Sea-level changes in the British region during the Late Cretaceous. *Proceedings of the Geologists' Association*, **100:** 565–594.

Hancock, J. M. 1990. Cretaceous. *In* Glennie, K. W. (Ed.), *Introduction to the Petroleum Geology of the North Sea* (3rd ed.), 255–272, Blackwell, Oxford.

Hancock, J. M. 1991. Ammonite scales for the Cretaceous system. *Cretaceous Research*, **12:** 159–291.

Hancock, J. M. 1992. Late Cretaceous. *In* Cope, J. C. W., Ingham J. K. & Rawson, P. F. (Eds), *Atlas of Palaeogeography and Lithofacies*. Geological Society, London, Memoir, **13:** 134–139.

Hancock, J. M. & Kauffmann, E. G. 1979. The great transgressions of the Late Cretaceous. *Journal of the Geological Society*, London, **136:** 175–186.

Haq, B. U., Hardenbol, J. & Vail, P. 1987. Chronology of fluctuating sea levels since the Triassic. *Science*, **235:** 1156–1167.

Hart, M. B., Bailey, H. W., Crittenden, S., Fletcher, B. N., Price, R. J. & Swiecicki, A. 1989. Cretaceous. *In* Jenkins, D. G. & Murray, J. W. (Eds), *Stratigraphical Atlas of Fossil Foraminifera*, British Micropalaeontological Society Series, 273–371, Ellis Horwood, Chichester.

Hart, M. B., Simmons, M. D. & Williams, C. L. 1992. Sequence stratigraphy and sea-level changes in the mid-Cretaceous (Albian–Turonian) of southern England; a preliminary investigation. *Proceedings of the Ussher Society*, **8:** 7–10.

Jarvis, I., Carson, G. A., Cooper, M. K. E., Hart, M. B., Horne, D., Leary, P. N., Rosenfeld, A. & Tocher, B. A. 1988. Microfossil assemblages and the Cenomanian-Turonian (late Cretaceous) Oceanic Anoxic Event. *Cretaceous Research*, **9:** 3–103.

Juignet, P. 1974. *La transgression crétacée sur la bordure orientale du Massif armoricain*. Thèse de Doctoral d'état, l'Université de Caen.

Juignet, P. 1980. Transgressions–régressions, variations eustatiques et influences tectoniques de l'Aptien au Maastrichtian dans le Bassin de Paris occidental et sur la bordure de Massif Armoricain. *Cretaceous Research*, **1:** 341–357.

Juignet, P. & Breton, G. 1992. Mid-Cretaceous sequence stratigraphy and sedimentary cyclicity in the western Paris Basin. *Palaeogeography Palaeoclimatology Palaeoecology*, **91**, 197–218.

Kennedy, W. J. 1969. The correlation of the Lower Chalk of south-east England. *Proceedings of the Geologists' Association*, **80:** 459–560.

Lake, R. D., Young, B., Wood, C. J. & Mortimore, R. N. 1987. *Geology of the country around Lewes*. Memoir British Geological Survey, Sheet 319 (England and Wales).

Lentin, J. K. & Williams, G. L. 1993. Fossil dinoflagellates: index to genera and species. *American Association of Stratigraphic Palynologists, Contributions Series*, **28**.

Morgan, R. 1980. Palynostratigraphy of the Australian Early and Middle Cretaceous. *Geological Survey of New South Wales Palaeontology Memoir*, **18:** 1–38.

Mortimore, R. N. & Pomerol, B. 1987. Correlation of the Upper Cretaceous White Chalk (Turonian to Campanian) in the Anglo-Paris Basin. *Proceedings of the Geologists' Association*, **98:** 97–143.

Norvick, M. S. 1976. Mid-Cretaceous microplankton from Bathurst. In: Norvick, M. S. & Burger, D. (Eds), Palynology of the Cenomanian of Bathurst Island, Northern Territory, Australia. *Australia Bureau of Mineral Resources, Geology and Geophysics Bulletin*, **151:** 21–113.

Price, R. J. 1977. The stratigraphical zonation of the Albian sediments of north-west Europe, as based on foraminifera. *Proceedings of the Geologists' Association*, **88:** 65–91.

Rawson, P. F., Curry, D., Dilley, F. C., Hancock, J. M., Kennedy, W. J., Neale, J. W., Wood, C. J. & Worssam, B. C. 1978. *A correlation of Cretaceous rocks in the British Isles*. Geological Society, London, Special Report, **9**.

Robaszynski, F. & Amédro, F. 1986. The Cretaceous of the Boulonnais (France) and a comparison with the Cretaceous of Kent (United Kingdom). *Proceedings of the Geologists' Association*, **97:** 171–208.

Robaszynski, F., Amédro, F., Foucher, J. -C., Gaspard, D., Magniez-Jannin, F., Manivit, H. & Sornay, J. 1980. Synthèse biostratigraphique de l'Aptien au Santonien du Boulonnais á partir de sept groupes paléontologiques: foraminifères, nannoplancton, dinoflagellés et macrofaunes. Zonations micropaléontologiques integrées dans le cadre du Crétacés boréal nord-européen. *Revue de Micropaléontologie*, **22:** 195–321.

Robaszynski, F., Juignet, P., Gale, A. S., Amédro, F. & Hardenbol, J. 1992. Sequence stratigraphy in the Upper Cretaceous of the Anglo-Paris Basin, exemplified by the Cenomanian stage. *In Mesozoic and Cenozoic Sequence Stratigraphy of European Basins, Dijon, May* 1992, Abstracts, p. 80.

Simmons, M. D., Williams, C. L. & Hart, M. B. 1991. Sea-level changes across the Albian–Cenomanian boundary in south-west England. *Proceedings of the Ussher Society*, **7:** 408–412.

Singh, C. 1971. Lower Cretaceous microfloras of the Peace River area, northwestern Alberta. *Research Council of Alberta Bulletin*, **28:** 301–542.

Verdier, J-P. 1975. Les Kystes de dinoflagellés de la section de Wissant et leur distribution stratigraphique au Crétacé moyen. *Revue de Micropaléontologie*, **17:** 191–197.

Wright, C. W. & Kennedy, W. J. 1984. The Ammonoidea of the Lower Chalk. Part 1. *Monograph of the Palaeontographical Society, London*, **137:** 1–126.

Wright, C. W. & Kennedy, W. J. 1987a. The Ammonoidea of the Lower Chalk. Part 2. *Monograph of the Palaeontographical Society, London*, **139:** 127–218.

Wright, C. W. & Kennedy, W. J. 1987b. 7. Ammonites. *In* Owen, E. & Smith, A. B. (Eds), *Fossils of the Chalk*. Palaeontological Association Field Guides to Fossils, **2:** 141–182.