

CHAPTER 7 Biostratigraphy

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EARLY CRETACEOUS

Introduction

Plant microfossils are abundant and diverse in the claystone and coal of the Casterton Formation, Crayfish Group and Eumeralla Formation, and only absent from sandstone. Terrestrial spores and pollen dominate the assemblages with high diversity in the Aptian to Albian, but reduced diversity in the Neocomian to ?Tithonian. Dispersed cuticle is also well represented throughout this interval (Rowett, 1994b).

Non-marine algae can be frequent, but only *Microfosta evansii* appears to have time significance. Spiny acritarchs and dinoflagellates are very rare, indicating some brackish intervals. A paralic dinoflagellate assemblage, probably of *Diconodinium davidii* Zone age, occurs in a few wells, possibly reflecting a marine maximum. Marine influence is concentrated in the western part of the basin, and may be more widespread in deeper rifted blocks as an extension of the more persistent marine influence seen in the Duntroon Basin. Such marine horizons have high correlative value as they probably reflect isochronous maximum flooding surfaces, but they may be thin. Drill cuttings may be the best means of detecting marine fossil indicators. Other fossil groups do not yet have proven potential for correlation.

Palynology

History of zonation

The widely used spore–pollen zonation of Helby et al. (1987) is essentially that of Dettmann (1963), based on Otway and Eromanga Basin data (Fig. 7.1). Subsequent Otway Basin studies have produced the refinements of Evans (1966) and Dettmann (1986). Problems applying the zonation are due to three factors, all of which complicate the correlation of the Neocomian to Aptian *Cyclosporites hughesii* Zone. These factors are (i) differences in ranges of taxa between basins, (ii) extreme scarcity of some index taxa, and (iii) different ranges being used by different authors in the Otway Basin.

DIFFERING INTER-BASIN SPECIES RANGES

Dettmann and Playford (1969) and Helby et al. (1987) attempted to produce zonations valid for all of eastern Australia (including the Otway and Eromanga Basins) despite some key species having different ranges between basins. Although generally successful, correlation of the base of the *C. hughesii* Zone of Helby et al. (1987) or its equivalent subzone of Dettmann and Playford (1969) is a problem, since the ranges of several important species are different, e.g. Dettmann (1986). As a result, the base of the *C. hughesii* Zone has been correlated differently by different authors. In particular, the oldest occurrences of *Pilosisporites notensis* and *Foraminisporis asymmetricus* are nearly always coincident in the Eromanga Basin, but consistently different in the Otway Basin. Morgan (1980), working in the Eromanga Basin, used oldest *P. notensis* to correlate the two. As a result, the *C. hughesii* Zone (*sensu* Dettmann and Playford, 1969) may extend to slightly older horizons than *C. hughesii* Zone (*sensu* Helby et al. 1987, fig. 10) This different usage has been most confusing and as a solution Morgan et al. (1995, app. 6) introduced a new zonal name (*P. notensis* Zone) for the Helby et al. (1987) concept.

SCARCITY OF KEY SPECIES

The above difficulties were largely caused by the extreme scarcity of some zonal fossils. Specifically, the base of the *C. hughesii* Zone was defined on the basis of the occurrence of youngest *Crybelosporites stylosus*, a species found to be too scarce to be reliable. Attempts to redefine this boundary on other criteria resulted in inconsistent usage as detailed above. Several other ‘zone markers’ of Dettmann and Douglas (1976) were found by Morgan et al. (1995) to be too scarce to be reliable, and other taxa with similar but more consistent ranges were substituted. Specifically, youngest *Cooksonites variabilis* was substituted for oldest

F. asymmetricus, oldest *P. notensis* substituted for youngest *Murospora florida*, and oldest *Dictyotosporites speciosus* substituted for youngest *C. stylosus*. These substitutions have varied the respective boundaries only slightly: up, not at all; and down, as shown in Figure 7.1.

Another key taxon which is very rare near its oldest occurrence is *Cicatricosisporites australiensis* (or other species of the genus), the species used to define the base of the Australian Cretaceous. This species is very consistent to frequent in the *Phimopollenites pannosus* to basal *P. notensis* Zones, rare but consistent in the upper *Foraminisporis wonthaggiensis* Zone, and extremely rare beneath. The defining criterion for the base of the *C. australiensis* Zone is thus useless in the Otway Basin, and the lower *C. australiensis* Zone cannot be distinguished from the *Retitriletes watherooensis* Zone. They were lumped by Morgan et al. (1995) as a 'lower *C. australiensis* to *R. watherooensis*' interval, which may therefore be entirely Cretaceous in age, but which might be partly Late Jurassic (Fig. 7.1). The presence of a Jurassic section in the Otway Basin is unproven; this interval is usually recorded from the Casterton Formation.

F. wonthaggiensis is also consistent in the *P. pannosus* to upper *F. wonthaggiensis* Zones, very scarce or absent in the lower *F. wonthaggiensis* Zone (as defined by oldest *D. speciosus* discussed above) and absent beneath. Correlation using oldest *F. wonthaggiensis* can thus be risky.

DIFFERING SPECIES RANGE CONCEPTS

Another significant problem is different ranges reported by different authors for the same species. In particular, Dettmann (1986) reported the following oldest occurrences in descending order: *F. asymmetricus*, *Triporoletes reticulatus*, coincident *P. notensis*/*F. wonthaggiensis*, then *D. speciosus*. Morgan et al. (1995) see them in a different order, namely *F. asymmetricus*, *P. notensis* coincident *T. reticulatus*/consistent *F. wonthaggiensis*, then absolute *F. wonthaggiensis* then *D. speciosus*. Clearly the two ranges for *P. notensis* cannot be easily reconciled but may be caused by diachronism within the basin, or by sample mix-up or contamination. R Morgan (Morgan Palaeo Associates, pers. comm., 1995) believes that oldest *P. notensis* is synchronous in the Otway and Eromanga Basins at base Aptian, for some of the geological reasons outlined below.

Zonation framework

Because of these complicating factors, the best approach is to erect a zonation which works in the Otway Basin (while changing the existing framework as little as possible) and makes sense against the geological and seismic constraints. The sequence of events shown in Figure 7.1 can be constructed and general agreement reached amongst palynologists active in the basin with the possible exception of Dettmann regarding oldest *P. notensis*. These zones can be named as in Figure 7.1 and applied easily in the South Australian Otway Basin at least. Close liaison with industry geologists and geophysicists indicates that the *P. notensis*/*F. wonthaggiensis* Zone boundary occurs consistently at the common angular unconformity at the base of the Eumeralla Formation, and can usually be located within metres using oldest *P. notensis* above the unconformity, and youngest occurrences of the alga *M. evansii* below. These palynological criteria are vital in the identification of Katnook Sandstone. Significant blooms of *M. evansii*, which probably represent maximum lake development, usually occur in the upper *F. wonthaggiensis* Zone in the Laira Formation and can be correlated locally (Morgan, 1993). However, locally (Kalangadoo 1) they may be reworked in to sediments above the unconformity. Much or all of the underlying section can also be truncated at the unconformity.

Research using quantitative dispersed cuticle and spore–pollen data has improved resolution of the Crayfish Group. The study, focusing on floristic trends and associations of common,

well-represented taxa, successfully subdivided the *F. wonthaggiensis* and *C. australiensis* Zones of Helby et al. (1987) into various palynological and dispersed cuticle zones (Rowett, 1994b, c).

No dinoflagellate zonation can yet be applied as marine influence is too minor and ephemeral. The late Aptian marine horizon noted above is a useful datum and more close-spaced sampling of cuttings, especially in deep palaeogeographic settings, may prove a more extensive marine section.

In summary, the correlative framework is fair to good. Too few core and sidewall samples have been studied from the bland assemblages of the Casterton Formation to consider them well controlled, and they could be all Cretaceous or partly Jurassic. Within the Neocomian, all zonal boundaries are based on oldest occurrences of fairly rare species and so boundaries may appear to be diachronous due to scarcity of marker species. Experience has shown that if these are absent from three or more consecutive samples then the absence is real. In the Laira Formation, local high resolution can be achieved using algal acmes. The top Crayfish Group unconformity can usually be located fairly precisely at the base of the *P. notensis* Zone as frequent excellent markers are available. Zones in the Eumeralla Formation interval can be confidently identified with the possible exception of the upper/lower *P. notensis* Zone boundary which is of lower confidence, being based on the youngest occurrence of the rare species *C. variabilis*.

Age control in the section is poor in the Neocomian as these continental palynofloras lack associated marine fossil control. The Aptian to Albian is well calibrated due to the marine megafauna associated with these zones in the Eromanga Basin to the north.

LATE CRETACEOUS

Introduction

Plant microfossils are abundant and diverse in claystone of the Late Cretaceous Sherbrook Group and only absent from sandstone lithologies. Terrestrial spores and pollen dominate, but are of more limited diversity in the Santonian to Cenomanian, reducing resolution. Dinoflagellates are much less frequent throughout, but are common and distinctive at certain horizons, providing useful correlations. Again, resolution is less in the early Santonian to Cenomanian. Other fossil groups are not very useful, although foraminifera have some application in the marine horizons.

Palynology

History of zonation

POLLEN AND SPORES

The spore–pollen zonation evolved in two halves. The older half (*Tricolporites apoxyexinus* to *Appendicisporites distocarinatus* Zones) was developed in the Otway Basin in response to oil company exploration (Dettmann and Playford, 1969). Palynofloras above this point were loosely grouped into a ‘*Nothofagidites* microflora’. The younger half of the palynological succession (*Nothofagidites senectus* to *Tricolpites (Forcipites) longus* Zones) was developed in the Gippsland Basin by Esso, and was published by Stover and Evans (1973), Stover and Partridge (1973) and Partridge (1976). These two halves were brought together by Helby et al. (1987), and provide the current framework (Fig. 7.1). The bases of the zones are mostly defined on oldest occurrences of key marker species, several of which are quite rare, near to the base of their range. They may therefore appear diachronous at times, especially in cuttings where specimens may be caved. The base of the *T. apoxyexinus* Zone is especially difficult, as the nominate species is always extremely rare. However, the base of a large increase in *Amosopollis cruciformis* is nearly coincident and may be more regionally valid. Other criteria are currently being tested.

DINOFLAGELLATES

The dinoflagellate zonation also evolved in a piecemeal fashion. The Campanian to Santonian *Xenikoon australis* to *Isabelidinium cretaceum* and Cenomanian *Ascodinium parvum* Zones were developed by Evans (1966) in the Otway Basin. The youngest zones are certainly the most distinctive and are easily recognised. The late Maastrichtian *Mannumiella druggii* Zone was developed in the Gippsland Basin and published by Partridge (1976) without definition. It is easily identified in the Otway Basin although often only as a brief interval. The *Conosphaeridium striatoconus* and *Odontochitina porifera* Zones were described from New Zealand by Wilson (1984), but the oldest occurrences of the nominate species can be very rare. All these were compiled, and the last three zones added, by Helby et al. (1987, fig. 2).

Several aspects of this framework require comment. Resolution is certainly best in the *X. australis* to *I. cretaceum* interval and new subzones are being tested. Below this, the *O. porifera* and *C. striatoconus* Zones frequently appear diachronous due to extreme scarcity to absence of zonal fossils. New zonal definitions in this interval are being tested, although the published definitions can be applied in more open marine sections in the Carnarvon and Perth Basins. The *Palaeohystricophora infusorioides*, *Isabelidinium korojonense* and *M. druggii* Zones can be reliably identified in favourable facies, but marginally marine to non-marine facies sometimes make interpretation difficult. The Cenomanian *Diconodinium multispinum* Zone has not yet been identified in the Otway Basin although it occurs in the Duntroon Basin to the west. This may be due to restricted marine facies and the absence of key fossils in the basin, or may be caused by a regional mid Cretaceous hiatus.

Age control for the Late Cretaceous is good, being based on planktonic foraminifera and nannofossils associated with the dinoflagellate zones in offshore Western Australia, and the Bight and Duntroon Basins.

TERTIARY

The Tertiary biostratigraphy is not discussed in detail. Plant microfossils are abundant and diverse in claystone of the Pebble Point – Dilwyn succession (Paleocene to Middle Eocene). Terrestrial spores and pollen are dominant and diverse, but marine dinoflagellates usually minor. Above the Dilwyn Formation, plant microfossils become less frequent and sporadic in occurrence because of the establishment of marine conditions represented by carbonates. However, palynology is still quite useful up to the Early Miocene, at least in Victoria. In contrast, foraminifera (particularly planktonic foraminifera) are not abundant in the Paleocene to Middle Eocene part of the succession but are often abundant in the younger strata.

FIGURES

- 7.1 Late Jurassic to Late Cretaceous palynological zonal nomenclature relevant to the Otway Basin

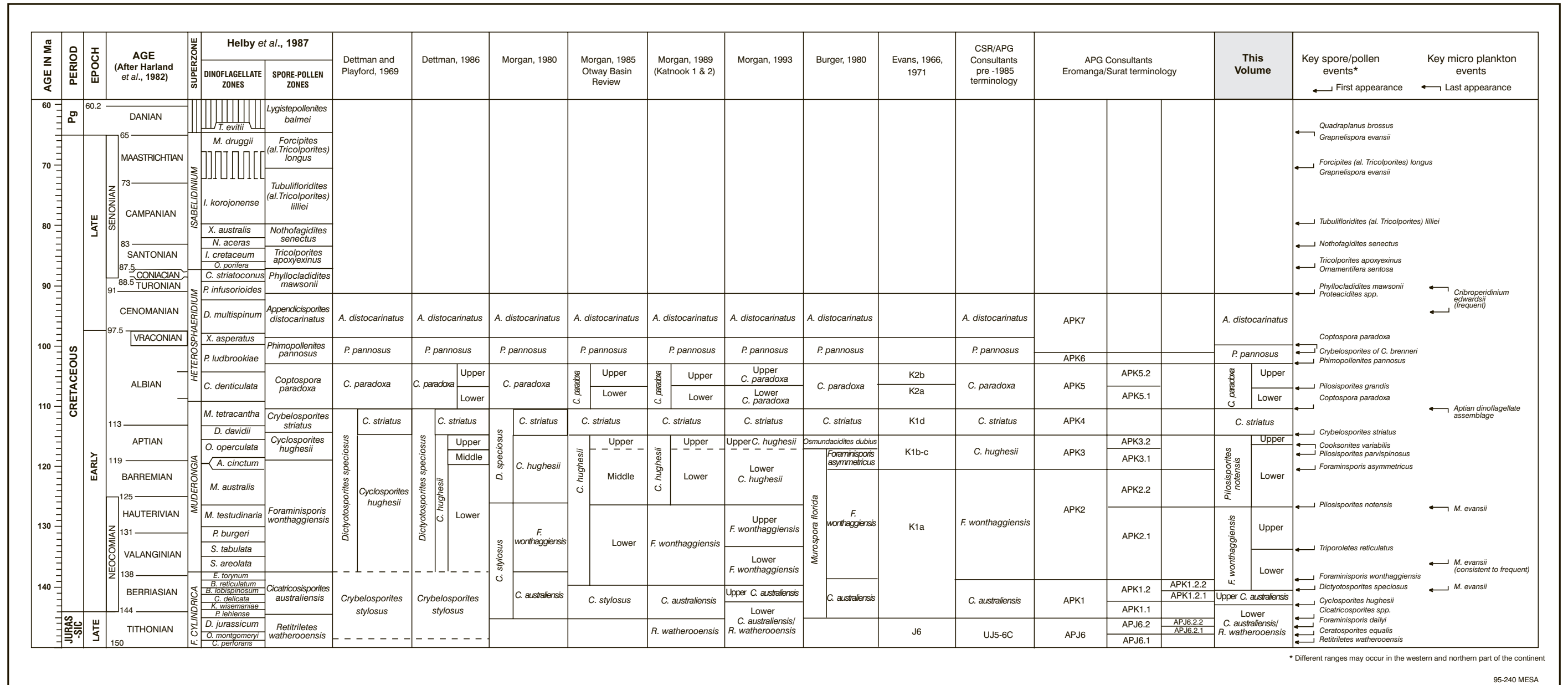


Fig. 6.1 Late Jurassic - Late Cretaceous palynological zonal nomenclature

* Different ranges may occur in the western and northern part of the continent