BMR Journal of Australian Geology & Geophysics, 9, 171-181

Calcareous nannofossils from the Toolebuc Formation, Eromanga Basin, Australia

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Calcareous nannofossils in the Toolebuc Formation reference section and in the lowermost Allaru Mudstone in BMR Boulia 3 suggest a middle to late Albian age. The evidence includes the presence of the key species *Prediscosphaera columnata* in assemblages overwhelmingly dominated by *Tranolithus orionatus*, the cool-water guide species *Seribiscutum primitivum, and Watznaueria barnesae.* Similar evidence is found in a core sample from BMR Tambo 38. Biostratigraphic subdivisions based on coeval foraminifera, dinoflagellates, spores and pollen are discussed. The nannofossil evidence points to deposition at high palaeolatitudes and/or in a near-surface cool-water regime in an isolated basin with intermittent connection to the open sea. Indications of environmental stresses are thought to be linked mainly with changes in the salinity of the near-surface waters. The nannofossil record depended not only on the initial presence of the nannoflora in the surface waters, but also on the effect on preservation of fluctuating (reducing and oxidising) conditions at the water/sediment interface, characteristic of epicontinental seas in high latitudes. A new calcareous nannofossil species, *Tegumentum toolebucum*, is described.

Introduction

The oil-shale-bearing Toolebuc Formation (Senior & others, 1975) has been the subject of diverse studies, but calcareous nannofossils in this formation have not been investigated hitherto, even though their presence was noted previously (e.g. Glikson, 1982). The unit is widespread in northern central Australia and its type section (BMR Boulia 3A) is in the Queensland portion of the Eromanga Basin (Fig. 1). Material studied herein is from BMR Tambo 38 and the reference section (BMR Boulia 3), which is only a few metres from the type section.

The Toolebuc Formation consists of calcareous oil shale and coquinite (Ozimic, 1982). The average thickness of the formation is 20m; the maximum is 35 m, in the Winton area (Ozimic & Saxby, 1983). Its type section is just 10.5 m thick. Ammonites, foraminifera, dinoflagellates, spores and pollen, fish remains, belemnites, pelecypods, and gastropods occur in the formation.

In addition to its apparent economic potential, the Toolebuc Formation is a good stratigraphic marker in the lower Cretaceous sequence of the Eromanga Basin: the formation can be easily identified in the subsurface by its strong gamma-ray anomaly (Senior & others, 1975). The Toolebuc Formation is overlain by the Allaru Mudstone and is underlain by the Wallumbilla Formation, part of the Rolling Downs Group. The age of the Toolebuc Formation has been regarded as middle to late Albian by several investigators (e.g. Haig, 1979).

Material studied. Core samples were examined from eight levels within the Toolebuc Formation reference section (BMR Boulia 3) and from four levels in the lower part of the overlying Allaru Mudstone in the same bore hole (Fig. 2). The upper and lower contacts of the Toolebuc Formation in BMR Boulia 3 are placed at the 25-m and 36-m levels, respectively. In addition, two samples (MFN-2436 & 2437) were studied from Core 5 in BMR Tambo 38 to the east. The material was examined by optical and scanning electron microscopy.

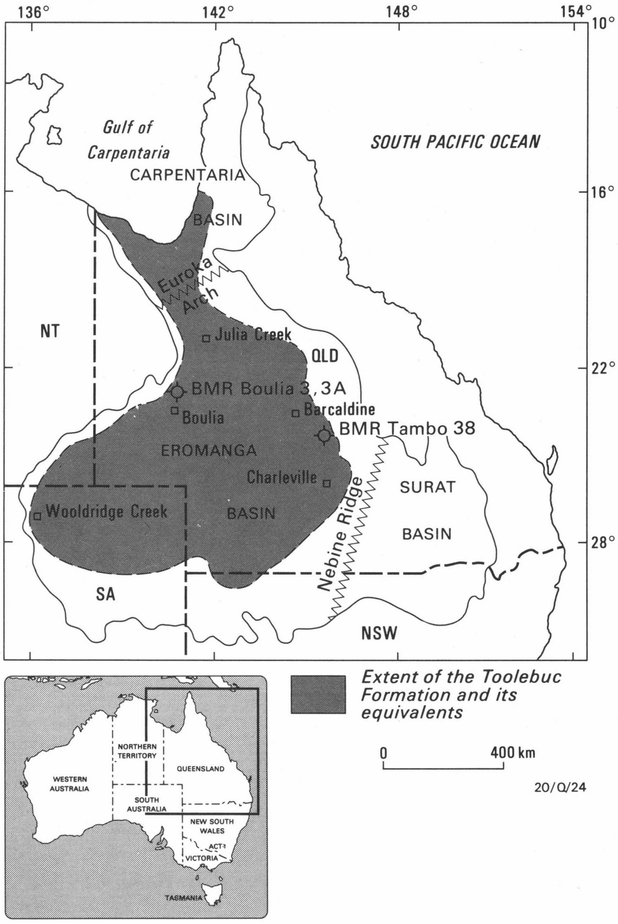

Figure 1. Locality map for BMR Boulia 3 and 3a, and BMR Tambo 38.

Biostratigraphy

Foraminiferal and palynological studies

Previous biostratigraphic works, based on assemblages of foraminifera, spores and pollen grains, and dinoflagellates occurring in the Toolebuc Formation and the lower part of the Allaru Mudstone, are discussed below.

In his study of the distribution of foraminiferal taxa within Aptian–Albian marine deposits in much of Queensland, Haig (1979) described the *Hedbergella inferacretacea* assemblage zone, based on material from the lowermost Allaru Mudstone and the Toolebuc Formation, as composed of abundant *H. inferacretacea*, common *H. delrioensis* and *H. planispira*, and very rare *H. punctata.* The age of the *H. inferacretacea* zone was inferred to be late middle to early late Albian, because it lies between the *Hedbergella delrioensis* assemblage zone, which includes evidence indicating late Albian (rather than Cenomanian) age, and the *Hedbergella planispira* assemblage zone, which is based on planktic taxa with ranges suggestive of an age no older than Albian (Haig, 1979). Other evidence cited by Haig (1979) for the age of his *H. inferacretacea* zone is the occurrence of an ammonite fauna suggestive of latest middle to early late Albian age (according to Day, 1969) in beds associated with the zone.

Scheibnerova (1980) used three benthic foraminiferal events to correlate Aptian–Albian rock units in Queensland and New South Wales with South Australia. She indicated that the

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Toolebuc Formation in the Boulia area is above her youngest datum, the earliest occurrence of *Lingulogavelinella frankei*, which was assigned an early late Albian age. The stratigraphic relationship between the *L. frankei* datum and the appearance of *Hedbergella* species is inconsistent according to Scheibnerova (1980), presenting a difficulty in relating the datum to the *Hedbergella* zones of Haig (1979).

Spores and pollen grains referable to the *Phimopollenites pannosus* zone (Dettmann & Playford, 1969) and dinoflagellates belonging to the lower (a) part of *Endoceratium ludbrookiae* zone (subzone a) have been recorded from the Toolebuc Formation (Morgan, 1978). Based on a comparison among the ranges of species occurring in Australia, Europe and Canada, Morgan (1980) suggested that the age of his lower (a) part of *E. ludbrookiae* zone (which he equated with the *P. pannosus* zone) is late Albian.

Sample No MFN	Formation	Levels in metres and (feet)	Nannofossils
2476		20.72 (68'0")	Absent
2477	Allaru	21.76–21.94 (71'5"–72'0")	Absent
2152	Mudstone	22.24–22.55 (73'0"–74'0")	Frequent
2478		22.55–22.85 (74'0"–75'0")	Traces
2153		25.90–28.90 (85'0"–95'0")	Absent
2154		29.54–29.85 (97'3"–98'2½")	Frequent
2480	Toolebuc	30.23–30.48 (99'0½"–100'2")	Traces
2481		31.07–31.17 (101'11½"–102'3½")	Absent
2155	Formation	31.30–31.65 (102'9"–103'10")	Frequent
2438		31.80–32.08 (104'4"–105'3")	Frequent
2156		33.29–33.52 (109'3"–110'2")	Common
2157		34.33–34.59 (112'8"–113'6")	Common

20/Q/26

Figure 2. Samples studied from BMR Boulia 3.

Distribution of calcareous nannofossils

The abundance of calcareous nannofossils varies greatly from one level to another within the Toolebuc Formation and the overlying Allaru Mudstone in BMR Boulia 3. However, some generalisation can be made. Frequent to common nannofossils occur consistently in the lower half of the Toolebuc Formation, with greatest abundance near the base of the formation (Fig. 2). The upper half of the Toolebuc Formation and the lower part of the Allaru Mudstone include several levels devoid of nannofossils or containing traces only of these fossils. The highest sample examined from the Toolebuc Formation (MFN-2153) and samples MFN-2476 & 2477 from the Allaru Mudstone are barren of nannofossils, and only a few poorly preserved specimens of the long-ranging *Watznaueria barnesae* were encountered in samples MFN-2480 (Toolebuc Formation) and MFN-2478 (Allaru Mudstone).

Preservation is generally poor, most assemblages showing dissolution effects and some containing a high percentage of nannofossil debris. Nannofossils in sample MFN-2438 are particularly etched, being represented by only solution-resistant taxa, including common *Watznaueria barnesae*, *Tranolithus exiguus, Seribiscutum primitivum*, and rare *Tranolithus orionatus* and *Watznaueria ovata.*

Except for *Watznaueria barnesae*, the taxa in samples MFN-2155 & 2152 are represented by small or 'dwarf' specimens. The nannofossil assemblage in sample MFN-2152 is of particular interest, as it is the only reasonably diversified assemblage recovered from the Allaru Mudstone during the present study.

Common and moderately well-preserved nannofossils were found in one sample (MFN-2437) from Core 5 of BMR Tambo 38; the other sample (MFN-2436) examined from the same core is devoid of calcareous nannofossils.

Nannofossil assemblages

Assemblages recovered from samples MFN-2156 & 2167 are similar and thought to represent the Toolebuc Formation assemblage in BMR Boulia 3. This assemblage is dominated by a few species, namely *Seribiscutum primitivum, Tranolithus orionatus, Watznaueria barnesae* and, to a lesser degree, *Tranolithus exiguus* and *Zygodiscus elegans.* Other species, including *Biscutum constans, Repagulum parvidentatum, Bidiscus rotatorius, Cretarhabdus conicus, C. surirellus, Parhabdolithus angustus, P. asper, Cyclagelosphaera* sp., *Prediscosphaera spinosa, Chiastozygus crucifer* (Noel) n. comb., *Biscutum gartneri, Hemipodorhabdus gorkae, Vekshinella crux, Corollithion rhombicum, C. geometricum, Bidiscus monocavus*, and *Zygodiscus compactus*, are frequent, whereas *Prediscosphaera columnata, Watznaueria britannica, W. ovata*, and *Manivitella pemmatoidea* are rare. *Cyclagelosphaera margereli, Loxolithus armilla, Grantarhabdus bukryi, Tubodiscus sp., Broinsonia* sp. and *Gartnerago* sp. are extremely rare.

The Allaru Mudstone assemblage in BMR Boulia 3 (sample MFN-2152) is composed of abundant *Watznaueria barnesae, Seribiscutum primitivum, Tranolithus orionatus/T. exiguus* and common *Scapholithus fossilis, Parhabdolithus asper, P. angustus, Prediscosphaera columnata, Biscutum constans, Bidiscus rotatorius, Tegumentum toolebucum* (new species), *Corollithion geometricum, Zygodiscus elegans*, and *Z. compactus. Angulofenestrallithus* sp., *Cyclagelosphaera margereli, Grantarhabdus bukryi* and *Biscutum gartneri* are frequent to rare. Forms referable to the genera *Cretarhabdus, Vekshinella, Chiastozygus, Zygodiscus* and *Lapideacassis* are present in a few numbers.

The assemblage identified from BMR Tambo 38 (sample MFN-2437) is dominated by *Watznaueria barnesae, Tranolithus exiguus/T. orionatus* and *Seribiscutum primitivum.* Other species, including *Watznaueria ovata, W. britannica, Prediscosphaera columnata, P. spinosa, Cretarhabdus surirellus, C. conicus, Biscutum constans, B. gartneri, Zygodiscus elegans, Vekshinella crux, Chiastozygus crucifer, Cyclagelosphaera margereli, Parhabdolithus splendens, P. angustus, Hemipodorhabdus gorkae, Bidiscus rotatorius* and *Gartnerago* sp. occur frequently.

Nannofossil biostratigraphy and age

The nannofossil biostratigraphy of the Albian, as based on studies by Thierstein (1971, 1973, 1974), Wise & Wind (1976), and Manivit (1979), is summarised in Figure 3. Each zone is based on the occurrence of its name species. These zones are universal in the sense that they have been identified from land-based sections in widely separated areas, including the Albian type area, and from deep-sea sections in all major oceans. Biostratigraphic units based on parts of the range of *Hayesites albiensis* (Manivit, 1971; Manivit & others, 1977) and those that use *Axipodorhabdus albianus* (Manivit, 1971; Hill, 1976; Roth, 1978) are not included in Figure 3. Taxonomic revision by Manivit & others (1977) necessitated renaming the

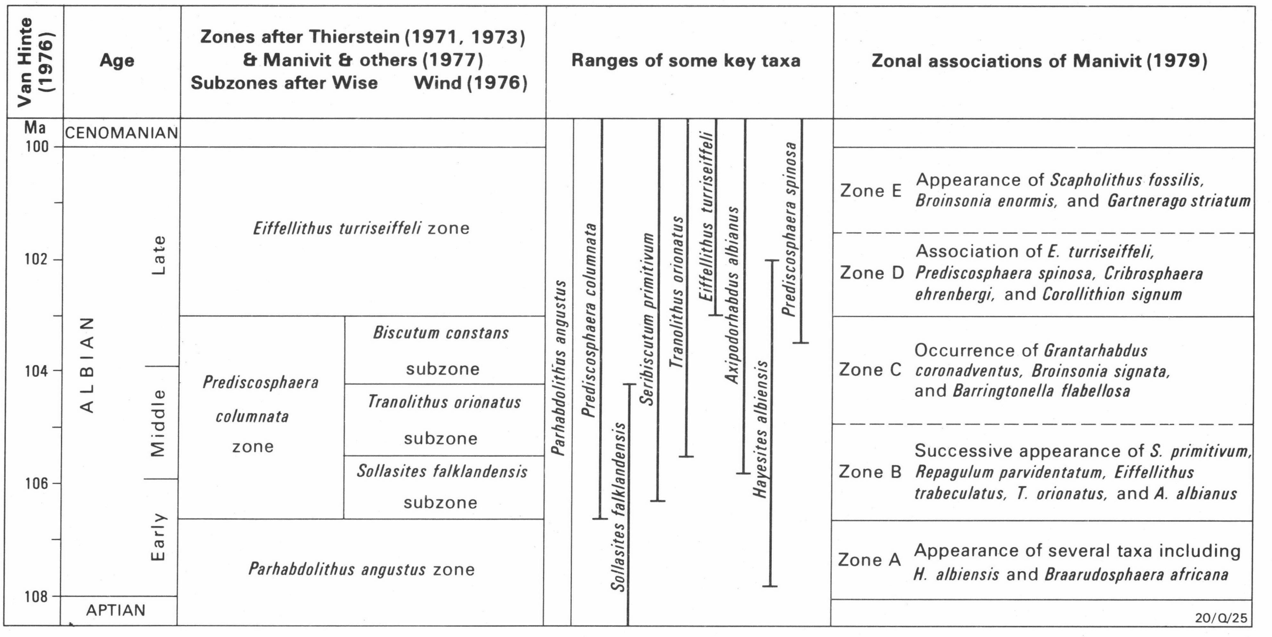

Figure 3. Albian calcareous nannofossil biostratigraphy.

Prediscosphaera cretacea zone of Thierstein (1971, modified Thierstein, 1973) to the *P. columnata* zone; most of the nannofossil works cited herein referred to the same zone as the *P. cretacea* zone. In addition to the events defining the Albian zones in Figure 3, Thierstein (1973, 1974), Hill (1976), and Manivit (1971, 1979), among others, listed events of earliest and latest appearance of large numbers of nannofossil taxa within the Albian, suggesting possibilities of a finer biostratigraphic resolution. A general consensus on the sequential order and importance of most of these events has not been reached, however. Bases of the vertical ranges of taxa in Figure 3 are in accord with results by Thierstein (1973, 1974) and Wise & Wind (1976). The range of *Hayesites albiensis* relative to other taxa is tentative (see Hojjatzadeh, 1981, for a compilation of some data regarding the relative range of *H. albiensis* and *Eiffellithus turriseiffeli*).

The events subdividing the *Prediscosphaera columnata* zone into three subzones (Fig. 3) are based on the taxa *Tranolithus orionatus* and *Sollasites falklandensis* (Wise & Wind, 1976). Known geographic distribution of *Tranolithus orionatus* suggests a strong likelihood of this species being cosmopolitan. *Sollasites falklandensis*, on the other hand, has been included among the few cool-water forms likely to be useful in biostratigraphic correlation of high-latitude sections (Wise & Wind, 1976); presently known geographic distribution of *S. falklandensis* is limited to two DSDP sites on the Falkland Plateau, South Atlantic. The Toolebuc Formation and the Allaru Mudstone include the name species of the *Prediscosphaera columnata* zone. The key taxa *Eiffellithus turriseiffeli* (Deflandre & Fert) Reinhardt, *Axipodorhabdus albianus* (Black) Wind & Wise , *Hayesites albiensis* Manivit and *Sollasites falklandensis* Filewicz, Wind & Wise were not encountered, but *Parhabdolithus angustus* is present and *Tranolithus orionatus* abounds. This suggests that the Toolebuc Formation and the Allaru Mudstone assemblages can be assigned to the upper part of the *P. columnata* zone, the *Biscutum constans* subzone of Wise & Wind (1976).

Assignment to the *Biscutum constans* subzone relies partly on negative evidence, i.e. the absence of both *Sollasites falklandensis* and *Eiffellithus turriseiffeli*, meaning that the assemblage is younger than the extinction event of *S. falklandensis* and older than the earliest appearance of *E. turriseiffeli. Sollasites falklandensis*, being an austral species, is akin to *Seribiscutum primitivum*, which is abundant among the Toolebuc Formation and Allaru Mudstone assemblages; these species occur together in part of the Albian section in the Falkland Plateau (Wise & Wind, 1976). Several investigators (Thierstein, 1974, 1976; Wise & Wind, 1976; Roth & Bowlder, 1981) have described *S. primitivum* as an excellent indicator for high-latitude or cool-water environments. This species has a bipolar distribution. It has been reported to occur in mid-Cretaceous sediments from the eastern Indian Ocean (Naturaliste Plateau DSDP Site 258, Wharton Basin DSDP Sites 256 & 257: Thierstein, 1974), South Atlantic Ocean (Falkland Plateau DSDP Sites 327 & 330: Wise & Wind, 1976), southern Sweden (Forchheimer, 1968 *in* Wise & Wind, 1976), Great Britain (Copt Point: Thiersten, 1974) and northern France (Manivit *in* Amadro & others, 1978). Other evidence supporting the placing of the Toolebuc Formation and Allaru Mudstone assemblages *high* in the *Prediscosphaera columnata* zone is inconclusive, depending on the published work consulted. Thus, the occurrence of *Prediscosphaera spinosa* may suggest a high level in the *P. columnata* zone, according to the data presented by Thierstein (1973, 1974), or even a level at the base of the younger *Eiffellithus turriseiffeli* zone (zone D of Manivit, 1979; Fig. 3). However, according to Wise & Wind (1976), *P. spinosa* occurs throughout the *P. columnata* zone in the Falkland Plateau section. Whether the concept of *P. spinosa* sensu Thierstein, Manivit, and Wise & Wind is the same or not, cannot be judged. Revision of the genus *Prediscosphaera* by Perch-Nielsen and Prins (*in* Perch-Nielsen, 1979) indicates the occurrence of at least four other species with crossbars similarly oriented as in *P. spinosa*, and these include a species known from Aptian sediments (Barrier, 1977).

Scapholithus fossilis, common in the Allaru Mudstone assemblage, is suggestive of zone E of Manivit (1979) (Fig. 3), but occurs sporadically low in the *P. columnata* zone in the Falkland Plateau section, according to Wise & Wind (1976).

It is concluded that while the evidence indicates that the Toolebuc Formation and the lowermost Allaru Mudstone assemblages belong to the later part of the *Prediscosphaera columnata* zone (the *Biscutum constans* subzone), it does not rule out a younger assignment.

Most of the *Prediscosphaera columnata* zone is middle Albian in age (Thierstein, 1973; Manivit & others, 1977), and only the uppermost part of the zone may be late Albian (Hailwood & others, 1979). The European type middle Albian 'Argiles tegulines' (northeastern France) contains a rich assemblage assignable to the *P. columnata* zone (Sissingh, 1977, 1978). The earliest appearance level of *Eiffellithus turriseiffeli* in the type upper Albian 'Marnes de Brienne' (northeastern France) has not been precisely documented yet. Nannofossil distributions in the Gault section at Copt Point, Great Britain, and in the Col de Palluel section, southeastern France (Thierstein, 1973), support the conclusion that the *P. columnata* zone extends into the upper Albian.

The nannofossils recovered from the reference section of the Toolebuc Formation and the lowermost Allaru Mudstone in BMR Boulia 3 suggest, therefore, a late middle to early late Albian age; a similar age range is also suggested by the nannofossils from Core 5 of BMR Tambo 38. Those in the lowermost Allaru Mudstone include perhaps more evidence to suggest the younger age limit.

Correlation

The present study provides evidence to directly relate local biostratigraphic units based on dinoflagellates, spores, and pollen grains to nannofossil zones applicable to marine Albian sediments from many other localities. McMinn & Burger have identified the lower (a) part of the *Endoceratum ludbrookiae* dinoflagellate zone as encompassing the Toolebuc Formation and extending into the Allaru Mudstone in BMR Boulia 3, and assigned spores and pollen grains in the same material to the *Phimopollenites pannosus* zone (D. Burger, personal communication). This indicates that the lower (a) part of the *E. ludbrookiae* dinoflagellate zone and the palynological *P. pannosus* zone can be equated with the later part of the nannofossil *Prediscosphaera columnata* zone (*Biscutum constans* subzone).

A similar (and perhaps more refined) conclusion can be drawn from material previously studied from the Naturaliste Plateau, DSDP Site 258. Biostratigraphic analyses of the middle-upper Albian section there were carried out by Thierstein (1974), who reported on the nannofossils, and by Morgan (1978), who studied the dinoflagellates. Nannofossils assignable to the *P. columnata* zone were identified in cores 23–20, and those belonging to the *Eiffellithus turriseiffeli* zone were found in cores 19–15. Dinoflagellates assignable to the lower (a) part of the *E. ludbrookiae* zone were identified in cores 21–18, which encompass the nannofossil *E. columnata/E. turriseiffeli* zonal boundary. The lower (a) part of the *E. ludbrookiae* zone at Site 258 equates with the later part of the *P. columnata* zone and the early part of the *E. turriseiffeli* zone.

Palaeoenvironment

Deposition of the Rolling Downs Group (including the Toolebuc Formation and Allaru Mudstone) took place in a shallow epicontinental sea in a cool humid region (e.g. Exon & Senior, 1976), much like those prevailing in the Baltic sea in the Holocene (Seibold & others, 1971). The straits connecting the sea to the open ocean were of limited extent (e.g. Ozimic, in press), and water exchange with the open ocean was intermittent – as attested to by variable nannosfossil content. As a result, density layering may have developed, consisting of a brackish surface-layer whose freshwater was provided by rivers, and a saline bottom-layer fed by saltwater inflow through the straits. The shallowness of the sea (foraminiferal evidence indicates a water-depth range of 100–200 m, according to Haig, 1979) and its narrow entrances meant that drastic changes in environment could occur with minor changes in sea level or tectonic movement at the straits.

In such an environment, marine planktic organisms (including calcareous nannoplankton) decline in abundance away from the straits, and their extent varies as surface-water properties fluctuate. Density layering in the water column means that the bottom waters are oxygen-poor, the pH is low, and reducing conditions may exist at the water/sediment interface, leading to dissolution of deposited calcareous planktic remains. Evidently, these reducing conditions disappeared and reappeared, resulting in the preservation of interbedded calcareous and non-calcareous beds, typical of the Rolling Downs Group (Exon & Senior, 1976).

The variable abundance and preservation of the calcareous nannofossils in the Toolebuc Formation and the Allaru Mudstone fit the general environmental model. The poor preservation of the nannofossils at most levels and their absence at others suggest that not only was the temporal distribution of the nannoflora in the surface waters very variable, but that the degree of dissolution of sedimented nannoplankton remains was also variable. At times, no nannoflora existed in the surface waters, and even when it did it was simply not preserved because of carbonate dissolution in bottom sediments.

The occurrence of nannofossil assemblages composed almost entirely of small ('dwarf') specimens in the Toolebuc Formation (sample MFN-2155) and in the lowermost Allaru Mudstone (sample MFN-2152) suggests environmental stresses or, the less likely, mechanical sorting. The environmental stresses are presumably caused by variation in the salinity of the surface waters, among other factors.

The abundant occurrence of *Seribiscutum primitivum* in the Toolebuc Formation and Allaru Mudstone suggests deposition at high palaeolatitudes and/or in a cool near-surface regime. The absence of *Parhabdolithus infinitus* (Worsley) Thierstein and *Rucinolithus irregularis* Thierstein, considered as Tethyan or low-latitude taxa (Thierstein, 1974), supports this conclusion. The predominance of *Hedbergella* within the planktic foraminiferal assemblages of the Toolebuc Formation was taken to suggest cold-water conditions by Haig (1979).

Systematic palaeontology

Taxa discussed below are arranged alphabetically by generic epithets. Negatives of all illustrated specimens are deposited in the Commonwealth Palaeontological Collection (CPC) in the Bureau of Mineral Resources, Canberra.

Genus ***Angulofenestrallithus*** Bukry, 1969
Angulofenestrallithus sp.
Figure 6H

Remarks. This form has a relatively narrow 2-cycle distal rim. Elements of the outer cycle imbricate sinistrally with sutures inclined counterclockwise, and turning to become subradial towards the outer margin. The inner cycle of the distal rim is constructed of blocky to square-outlined elements that slope towards the center of the nannolith. A network of polygonal perforations forms the large central area.

Angulofenestrallithus sp. differs from *A. snyderi* Bukry, 1969 by the counterclockwise inclination of the outer cycle of the distal rim and by the apparent absence of a stem.

Specimens of *Angulofenestrallithus* sp. are extremely rare in the material studied. Only the distal view of this form is available.

Genus *Bidiscus* Bukry, 1969

Remarks. The Cretaceous genus *Bidiscus* Bukry, 1969 has been regarded as a junior synonym of the Jurassic genus *Discorhabdus* Noel, 1965 by some investigators. However, these genera differ: *Bidiscus* lacks the stem characteristic to *Discorhabdus*. Black (1972) mentioned the possibility of *Bidiscus* being a descendant of *Discorhabdus*, because of the great resemblance between their isolated basal shields.

Bidiscus monocavus Bukry, 1969
Figure 4B

Bidiscus monocavus Bukry, 1969, p. 27, pl. 7, figs. 3–4.

Remarks. Element counts of specimens encountered indicate less elements than in the type material. The distal shield has 14 to 17 elements. The central opening is surrounded by a narrow cycle of small elements.

Bidiscus rotatorius Bukry, 1969

Bidiscus rotatorius Bukry, 1969, p. 27, pl. 7, figs. 5–9.

Remarks. The higher element counts of this form makes its identification very easy, even in poorly preserved material.

Genus *Biscutum* Black *in* Black & Barnes, 1959
Biscutum constans (Gorka) Black, 1967
Figure 4D

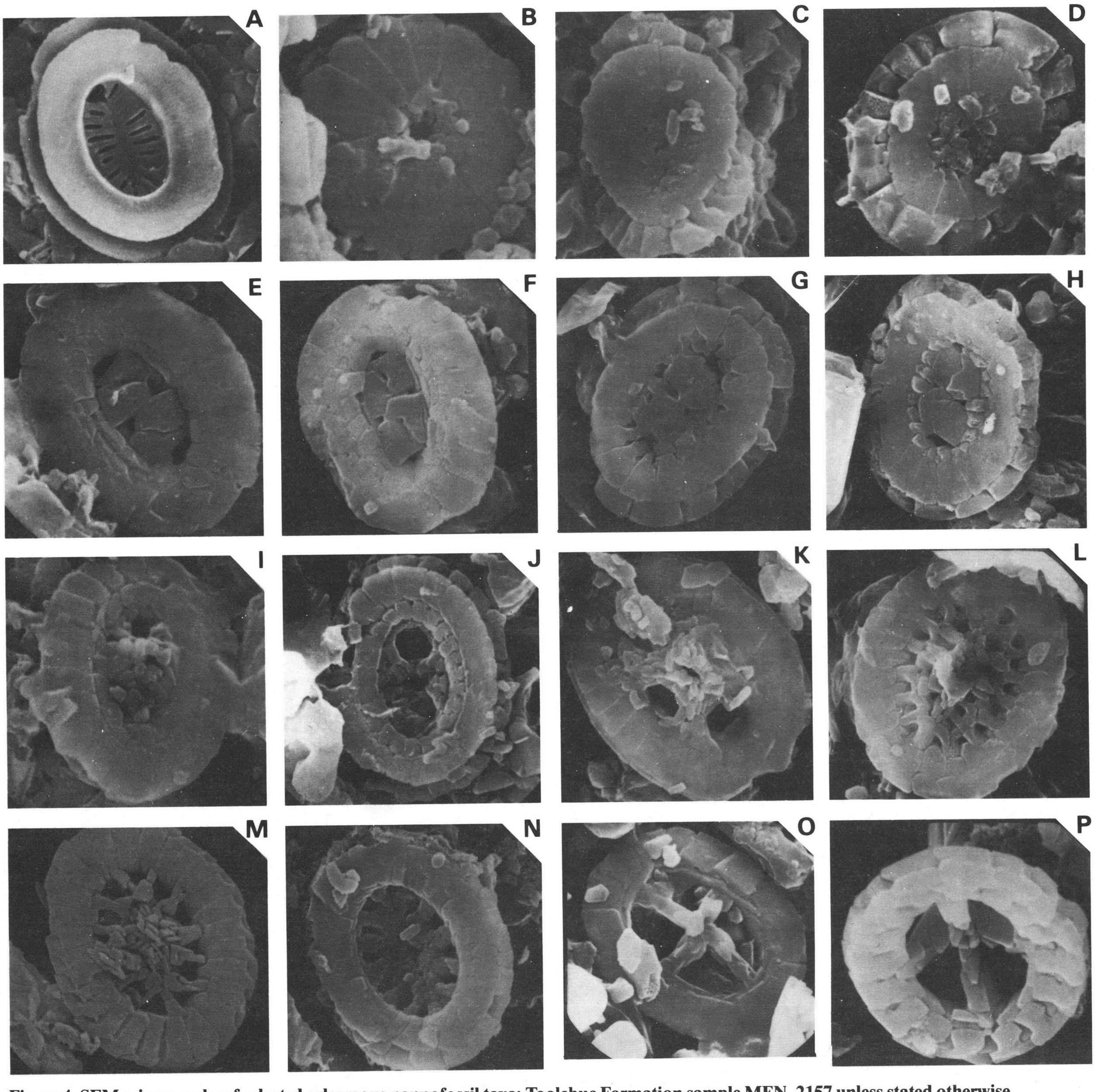

Figure 4. SEM micrographs of selected calcareous nannofossil taxa; Toolebuc Formation sample MFN–2157 unless stated otherwise.
A, *Repagulum parvidentatum* (Deflandre & Fert) from Allaru Mudstone sample MFN–2152, CPC25078 (proximal view) x9705; B, *Bidiscus monocavus* Bukry, CPC25079 (distal view) x11300; C, *Biscutum gartneri* Black, CPC25080 (proximal view) x9130; D, *Biscutum constans* (Gorka), CPC25081 (proximal view) x8220; E–H, *Seribiscutum primitivum* (Thierstein): E, from Toolebuc Formation sample MFN–2438, CPC25082 (distal view) x8260; F, CPC25083 (distal view) x7270; G, from Toolebuc Formation sample MFN–2438, CPC25084 (proximal view) x7290; H, CPC25085 (proximal view) x 6460; I–J, *Hemipodorhabdus gorkae* (Reinhardt): I, CPC25086 (distal view) x9430; J, CPC25087 (proximal view) x7990; K, *Grantarhabdus bukryi* Black, CPC25088 (distal view) x6710; L, *Cretarhabdus conicus* Bramlette & Martini, CPC25089 (distal view) x7110; M–N, *Cretarhabdus surirellus* (Deflandre & Fert): M, CPC25090 (distal view) x7040; N, CPC25091 (proximal view) x7500; O, *Prediscosphaera spinosa* (Bramlette & Martini), CPC25092 (distal view) x7150; P, *Prediscosphaera columnata* (Stover), CPC25093 (oblique proximal view) x9000.

Discolithus constans Gorka, 1957, p. 279, pl. 4, fig. 7.
Biscutum testudinarium Black *in* Black & Barnes, 1959, p. 325, pl. 10, fig. 1.
Biscutum castrorum Black *in* Black & Barnes, 1959, p. 326, pl. 10, fig. 2.
Cribrosphaerella tectiforma Reinhardt, 1964, p. 758, pl. 2, fig. 4.
Coccolithites polycingulatus Reinhardt, 1965, p. 39, pl. 3, fig. 2.
Cribrosphaera testiforma (Reinhardt) Reinhardt, 1966, p. 30, pl. 5, fig. 3; pl. 12, figs. 3–4; text-fig. 12.
Coccolithus oregus Stover, 1966, p. 39, pl. 1, figs. 8–9; pl. 8, fig. 4.
Biscutum constans (Gorka) Black, 1967, p. 139.

Biscutum gartneri Black, 1971
Figure 4C

Biscutum gartneri Black, 1971, p. 393, pl. 30, fig. 2.

Remarks. As mentioned by Black (1972), this form has a granular central area occupying about 1/2 the diameter of the proximal shield.

Genus *Chiastozygus* Gartner, 1968
Chiastozygus crucifer (Noel) n. comb.
Figure 5N

Zygolithus crucifer Noel, 1970, p. 30, pl. 3, figs. 11–15; pl. 4, figs. 1–6; text-fig. 4.

Genus *Corollithion* Stradner, 1961
Corollithion geometricum (Gorka) Manivit, 1971
Figure 6I

Discolithus geometricus Gorka, 1957, p. 259, pl. 4, fig. 8.
Zygolithus geometricus (Gorka) Stradner *in* Stradner, Adamiker & Maresch, 1968, p. 40, pl. 36; pl. 37, figs. 1–4.
Zygolithus sexiradiatus Pienaar, 1969, p. 116, pl. 4, fig. 9; pl. 10, fig. 9.
Corollithion ellipticum Bukry, 1969, p. 40, pl. 18, figs. 10–11.
Neococcolithes geometricus (Gorka) Hoffmann, 1970, p. 182, pl. 21, figs. 5–6; pl. 3, fig. 6; pl. 5, fig. 5.
Ellipsochiastus hexerratus Worsley, 1971, p. 130, pl. 1, figs. 24–25, ?26.
Actinozygus geometricus (Gorka) Rood, Hay & Barnard, 1971, p. 254, pl. 1, fig. 6.
Corollithion geometricum (Gorka) Manivit, 1971, p. 109, pl. 5, figs. 4–5.

Remarks. The narrow rim is composed of a proximal cycle of small rod-like elements, and a distal cycle of rectangular elements that are arranged radially to form a low wall. Specimens encountered have an open central pore.

Corollithion rhombicum (Stradner & Adamiker) Bukry, 1969
Figure 6J–K

Zygolithus rhombicus Stradner & Adamiker, 1966, p. 339, pl. 2, fig. 1; text-figs. 5–7.
Dictyolithus emendatus Lyulyeva, 1967, p. 96, pl. 4, fig. 41.
Corollithion rhombicum (Stradner & Adamiker) Bukry, 1969, p. 41, pl. 19, figs. 2–4.
Stradnerlithus rhombicus (Stradner & Adamiker) Noel, 1972, p. 106, pl. 3, fig. 4; text-fig. 3c.
Rhambolithion rhombicum (Stradner & Adamiker) Black, 1973, p. 97, pl. 30, figs. 2–4.

Genus *Cretarhabdus* Bramlette & Martini, 1964
Cretarhabdus conicus Bramlette & Martini, 1964
Figure 4L

Cretarhabdus conicus Bramlette & Martini, 1964, p. 299, pl. 3, figs. 5–8.
Cretarhabdella lateralis Black, 1971, p. 400, pl. 31, fig. 5.
Cretarhabdus barremianus Black, 1971, p. 402, pl. 31, fig. 3.
Cretarhabdus primus Black, 1971, p. 402, pl. 31, fig. 2.

Remarks. Prominent axial cross and more than one cycle of pores in the central area characterise this species.

Cretarhabdus surirellus (Deflandre & Fert) Reinhardt, 1970
Figure 4M–N

Discolithus surirella Deflandre & Fert, 1954, p. 144, text-figs. 30–31.
Discolithus ingens Gorka, 1957, p. 256, pl. 3, fig. 3.
Tremalithus romani Gorka, 1957, p. 246 & 271, pl. 2, fig. 5.
Coccolithus actinosus Stover, 1966, p. 138, pl. 1, figs. 15–16; pl. 8, fig. 7.
non *Polypodorhabdus actinosus* (Stover) Perch-Nielsen, 1968, p. 50, pl. 10, fig. 1–6.
non *Watznaueria actinosa* (Stover) Bukry, 1969, p. 31, pl. 9, fig. 12.
Cretarhabdus crenulatus hansmanni Bukry, 1969, p. 35, pl. 14, figs. 7–9.
Cretarhabdus surirellus (Deflandre & Fert) Reinhardt, 1970, p. 50, pl. 1, figs. 6–8; pl. 2, figs. 1–6; text-fig. 22.
Cretarhabdus actinosus (Stover) Forchheimer, 1972, p. 49, pl. 19, fig. 4.
Cretarhabdus cantianus Black, 1973, p. 51, pl. 18, figs. 2–13.
Cretarhabdus leporarii Black, 1973, p. 52, pl. 18, figs. 1–4.

Remarks. This species has been included in *Cretarhabdus crenulatus* Bramlette & Martini by many investigators. The number of struts or diagonal bars in the central area of *C. surirellus* is more than 8, which is the number in *C. crenulatus.*

Genus *Cyclagelosphaera* Noel, 1965
Cyclagelosphaera margereli Noel, 1965
Figure 6A–B

Cyclagelosphaera margereli Noel, 1965, p. 130, pl. 17, figs. 1–2; pl. 20, figs. 2–4; text-figs. 44–46.
Coccolithus sp. Black, 1965, p. 132, fig. 7.
Tergestiella ?margereli (Noel) Shumenko, 1969, p. 39, pl. 2, fig. 8.
Tergestiella ?reinhardtii (Perch-Nielsen) Reinhardt, 1971, p. 29, pl. 1, fig. 6; text-fig. 24.
Cyclagelosphaera casarubrensis Black, 1973, p. 76, pl. 25, figs. 1–3.
Cyclagelosphaera puncta Black, 1973, p. 76, pl. 25, fig. 13.
Cyclagelosphaera shenleyensis Black, 1973, p. 78, pl. 25, fig. 10; text-fig. 39.

Genus *Gartnerago* Bukry, 1969
Gartnerago sp.
Figure 6L

Remarks. Specimens referable to the genus *Gartnerago* Bukry, 1969 are extremely rare in the material studied. Poor preservation hampered specific identification.

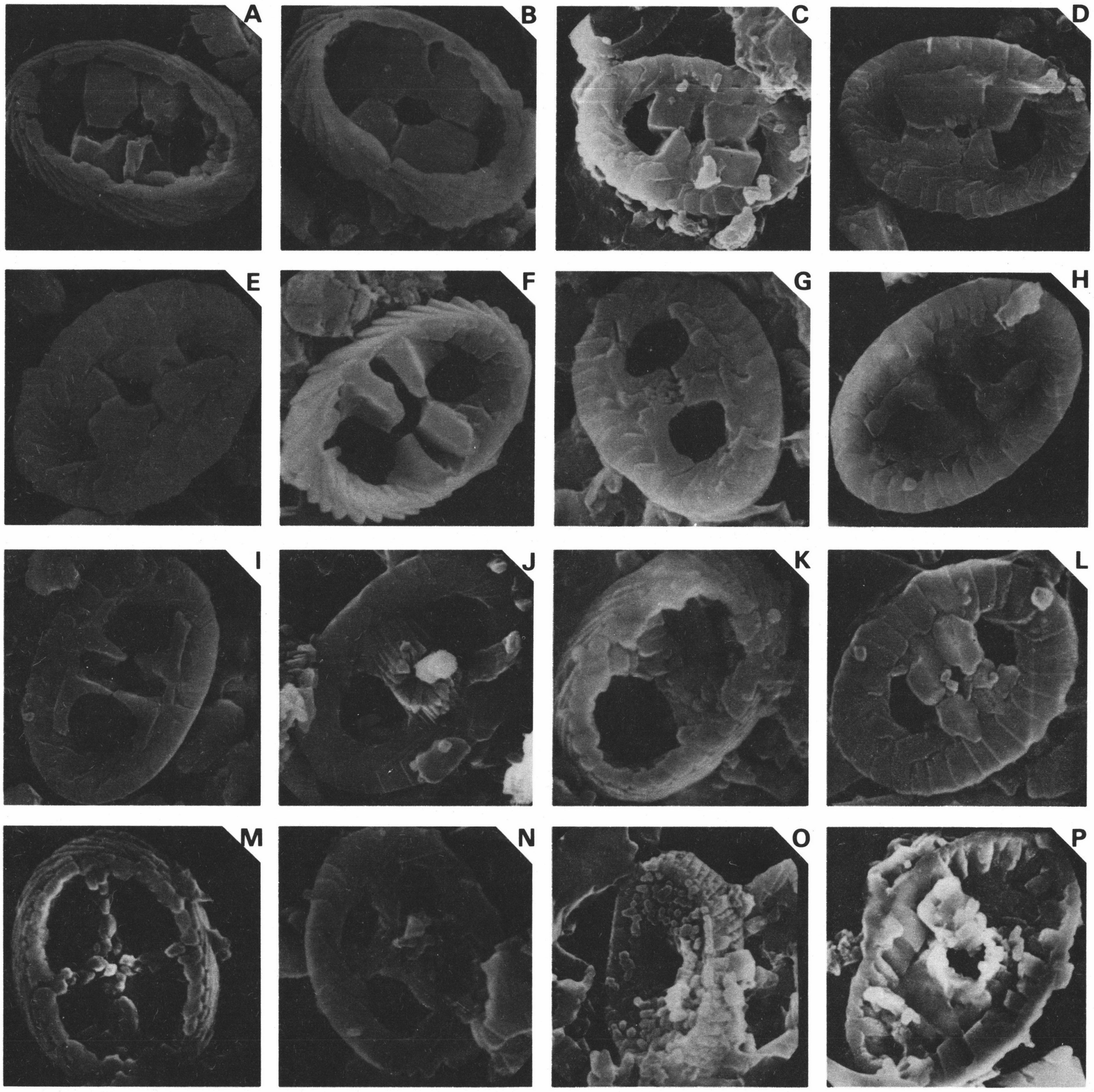

Figure 5. SEM micrographs of selected calcareous nannofossil taxa; Toolebuc Formation sample MFN-2157 unless stated otherwise.
A–E, *Tranolithus orionatus* (Reinhardt): A, CPC25094 (proximal view) x6720; B, CPC25095 (proximal view) x8000; C, CPC25096 (distal view) x5290; D, CPC25097 (distal view) x5680; E, CPC25098 (distal view) x6630; F, transitional form between *Tranolithus orionatus* (Reinhardt) and *T. exiguus* Stover, CPC25099 (proximal view) x7330; G–I, *Tranolithus exiguus* Stover: G, from Allaru Mudstone sample MFN-2152, CPC25100 (distal view) x8020; H, from Toolebuc Formation sample MFN-2438, CPC25101 (distal view, slightly corroded) x6150; I, from Allaru Mudstone sample MFN-2152, CPC25102 (distal view, more corroded) x6760; J–K, *Zygodiscus elegans* Gartner: J, CPC25103 (distal view) x6850; K, CPC25104 (proximal view) x9670; L, *Zygodiscus compactus* Bukry, CPC25105 (distal view) x9470; M, *Vekshinella crux* (Deflandre & Fert), CPC25106 (proximal view) x9600; N, *Chiastozygus crucifer* (Noel) n. comb., CPC25107 (distal view) x9490; O, *Parhabdolithus angustus* (Stradner), CPC25108 (oblique proximal view) x7040; P, *Parhabdolithus asper* (Stradner), CPC25109 (distal view) x8460.

Genus ***Grantarhabdus*** Black, 1972
Grantarhabdus bukryi Black, 1972
Figure 4K

Grantarhabdus bukryi Black, 1972, p. 43, pl. 11, figs. 1–4.

Genus ***Hemipodorhabdus*** Black, 1971
Hemipodorhabdus gorkae (Reinhardt) Grun *in* Grun & Allemann, 1975
Figure 4I–J

Podorhabdus gorkae Reinhardt, 1969, p. 933, pl. 1, figs. 1–2.
Hemipodorhabdus latiforatus Black, 1971, p. 404, pl. 31, fig. 6.
Hemipodorhabdus biforatus Black, 1972 (partim), p. 37, pl. 10, fig. 7 (non figs. 6, 8–10).
Hemipodorhabdus gorkae (Reinhardt) Grun *in* Grun & Allemann, 1975, p. 171.

Genus ***Loxolithus*** Noel, 1965
Loxolithus armilla (Black) Noel, 1965

Cyclolithus armilla Black *in* Black & Barnes, 1959, p. 327, pl. 12, fig. 2.
Loxolithus armilla (Black) Noel, 1965, p. 67, text-fig. 3.

Genus *Manivitella* Thierstein, 1971
Manivitella pemmatoidea (Deflandre *in* Manivit) Thierstein, 1971

Cricolithus pemmatoideus Deflandre *in* Manivit, 1965, p. 192, pl. 2, fig. 8.
Manivitella pemmatoidea (Deflandre *in* Manivit) Thierstein, 1971, p. 480, pl. 5, figs. 1-3.

Genus *Parhabdolithus* Deflandre, 1952
Parhabdolithus angustus (Stradner) Stradner *in* Stradner, Adamiker & Maresch, 1968
Figure 5O

Rhabdolithus angustus Stradner, 1963, p. 12, pl. 5, fig. 6.
Parhabdolithus elongatus Stover, 1966, p. 144, pl. 6, figs. 16-19; pl. 9, fig. 18.
Ahmuellerella angusta (Stradner) Reinhardt, 1966, p. 25, pl. 22, figs. 9-12.
Rhabdolithina angusta (Stradner) Reinhardt, 1967, p. 168, pl. 7, figs. 4-5.
Parhabdolithus angustus (Stradner) Stradner *in* Stradner, Adamiker & Maresch, 1968, p. 32, pl. 20, figs. 1-5.
Rhabdolithina extans Hoffmann, 1970, p. 187, pl. 3, fig. 5.
Rhagodiscus angustus (Stradner) Reinhardt, 1971, p. 23, pl. 2, figs. 1,2; text-fig. 10.

Parhabdolithus asper (Stradner) Manivit, 1971
Figure 5P

Discolithus asper Stradner, 1963, p. 11, pl. 2, figs. 4-5
Discolithus vagus Stover, 1966, p. 144, pl. 3, figs. 10-11; pl. 8, fig. 20.
Rhagodiscus asper (Stradner) Reinhardt, 1967, p. 161.
Parhabdolithus asper (Stradner) Manivit, 1971, p. 87, pl. 23, figs. 4-7.

Parhabdolithus splendens (Deflandre) Noel, 1969

Rhabdolithus splendens Deflandre, 1953, p. 1785, figs. 4-6.
Cretarhabdus splendens (Deflandre) Bramlette & Martini, 1964, p. 300, pl. 3, figs. 13-16.
Rhabdolithina splendens (Deflandre) Reinhardt, 1967, p. 167.
Actinozygus splendens (Deflandre) Gartner, 1968 (partim), p. 25, pl. 5, figs. 15-16; pl. 7, figs. 1-2; pl. 11, fig. 15; (non pl. 10, fig. 1).
Parhabdolithus splendens (Deflandre) Noel, 1969, p. 476, pl. 1, figs. 1-4, 7; text-figs. 1-2.

Genus *Prediscosphaera* Vekshina, 1959
Prediscosphaera columnata (Stover) Manivit, 1971
Figure 4P

Deflandrius columnatus Stover, 1966, p. 141, pl. 6, figs. 6-10; pl. 9, fig. 16.
Deflandrius cantabriegensis Black, 1967, p. 140, text-fig. 1.
Prediscosphaera columnata (Stover) Bukry & Bramlette, 1969, p. 372, pl. 2, fig. E, (invalid ICBN Art. 33, par. 4).
Prediscosphaera columnata (Stover) Manivit, 1971, p. 100, pl. 21, figs. 13-15.

Remarks. Hill (1967) indicated that it is difficult to differentiate between *Prediscosphaera columnata* and *P. cretacea* (Arkhangelskiy) Gartner, 1968 in plan view using optical microscopy, and used the structure of the central spine to differentiate between them. However, the basal disc of *P. columnata* is consistently smaller and more rounded than that of *P. cretacea.* Perch-Nielsen & Prins (*in* Perch-Nielsen, 1979) indicated the occurrence of two forms of *P. columnata*, differing in size and vertical range.

Prediscosphaera spinosa (Bramlette & Martini) Gartner, 1968
Figure 4O

Deflandrius spinosus Bramlette & Martini, 1964, p.302, pl. 2, figs. 17-20.
Eiffellithus cretaceus cretaceus (Arkhangelskiy) Reinhardt, 1965, p. 35, pl. 2, fig. 4; text-fig. 3.
Deflandrius cretaceus intercisus (Deflandre) Reinhardt, 1966 (partim), p. 35, text-fig. 20b; (non pl. 22, fig. 2; pl. 19, fig. 3; text-fig. 20a).
Prediscosphaera spinosa (Bramlette & Martini) Gartner, 1968, p. 20, pl. 2, figs. 15-16; pl. 3, figs. 9-10; pl. 5, figs. 7-9; pl. 6, fig. 16; pl. 11, fig. 17.

Genus *Repagulum* Forchheimer, 1972
Repagulum parvidentatum (Deflandre & Fert) Forchheimer, 1972
Figure 4A

Discolithus parvidentatus Deflandre & Fert, 1954, p. 23, text-figs. 28-29.
Tremalithus burwellensis Black *in* Black & Barnes, 1959, p. 324, pl. 8.
Coccolithus parvidentatus (Deflandre & Fert) Reinhardt, 1966, p. 20, pl. 20, figs. 1-2.
Dictyococcites burwellensis (Black) Black, 1967, p. 142.
Watznaueria ?parvidentata (Deflandre & Fert) Bukry, 1969, p. 33, pl. 12, figs. 5-8.
Reticulofenestra ?parvidentata (Deflandre & Fert) Noel, 1970, p. 94, fig. 22, pl. 36, figs. 8-14.
Tremalithus parvidentatus (Deflandre & Fert) Reinhardt, 1971, p. 31, figs. 29-30.
Repagulum parvidentatum (Deflandre & Fert) Forchheimer, 1972, p. 38, pl. 12, figs. 1-7.

Remarks. This small coccolith is easily identifiable with SEM by the very large number of narrow elements forming its distal and proximal shields.

Genus *Scapholithus* Deflandre & Fert, 1954
Scapholithus fossilis Deflandre & Fert, 1954

Scapholithus fossilis Deflandre & Fert, 1954, p. 51, pl. 8, figs. 12, 16-17.

Genus *Seribiscutum* Filewicz, Wind & Wise *in* Wise & Wind, 1976
Seribiscutum primitivum (Thierstein) Filewicz, Wind & Wise *in* Wise & Wind, 1976
Figure 4E-H

Tremalithus cf. *cretaceus* (Deflandre) Forchheimer, 1968, p. 36, pl. 3, fig. 6; text-figs. 2 (10), 14.
Cribrosphaerella primitiva Thierstein, 1974, p. 637, pl. 1, figs. 1-3.
Seribiscutum primitivum (Thierstein) Filewicz, Wind & Wise *in* Wise & Wind, 1976, p. 311, pl. 66, figs. 4-6; pl. 67, figs. 1-4.

Genus *Tegumentum* Thierstein *in* Roth & Thierstein, 1972
Tegumentum toolebucum Shafik, n. sp.
Figure 6M-P

Diagnosis. A species of *Tegumentum* with a narrow rim (thin wall) surrounding a large open central area that is spanned by a central structure varying from H-shaped with offset bars to X-shaped.

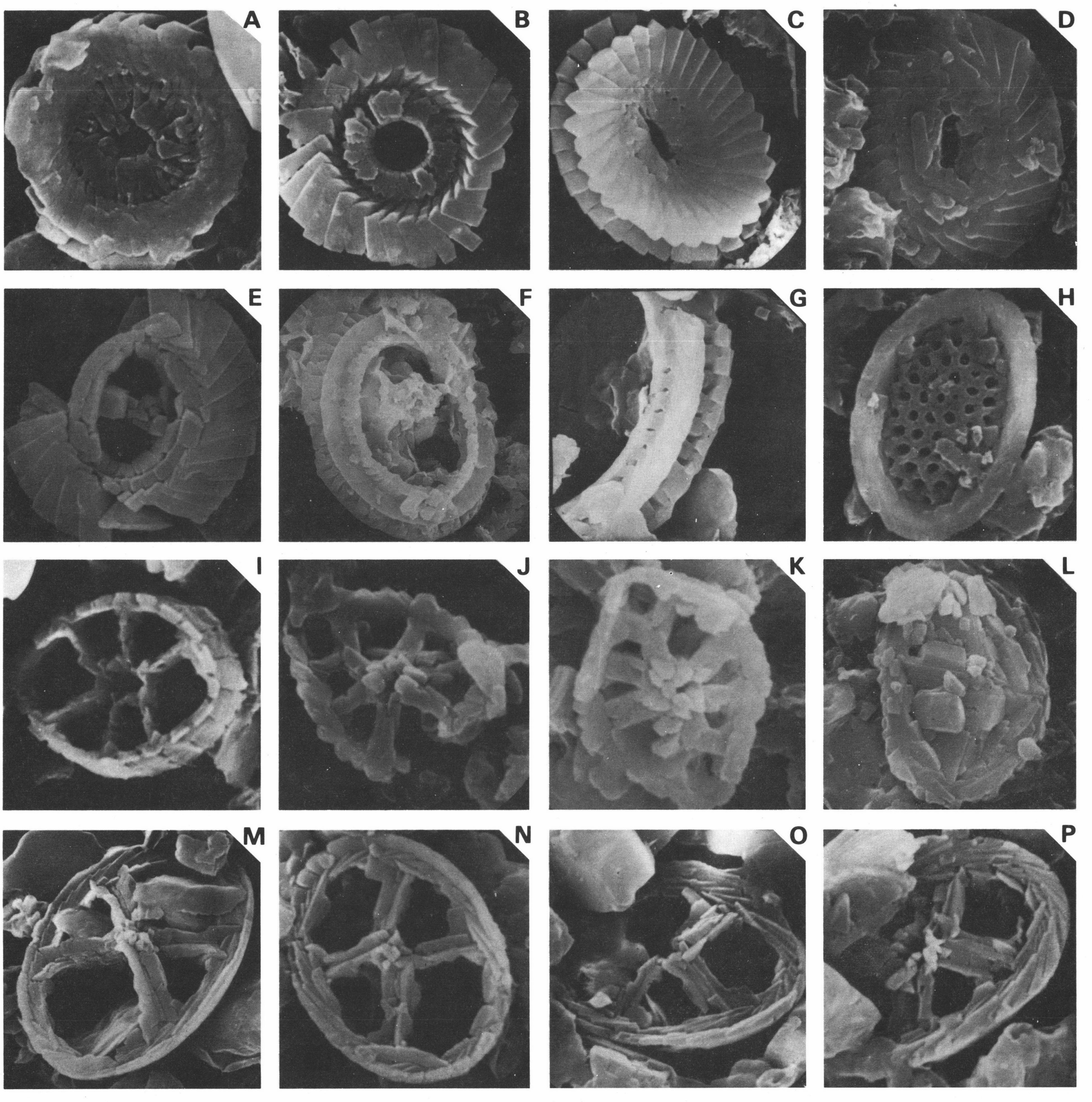

Figure 6. SEM micrographs of selected calcareous nannofossil taxa; Toolebuc Formation sample MFN-2157 unless stated otherwise.
A–B, *Cyclagelosphaera margereli* Noel: A, from Toolebuc Formation sample MFN-2155, CPC25110 (proximal view) x8770; B, CPC25111 (distal view) x8100; C–D, *Watznaueria barnesae* (Black): C, CPC25112 (proximal view) x6500; D, CPC25113 (distal view) x6190; E, *Watznaueria britannica* (Stradner), CPC25114 (distal view) x7500; F–G, *Tubodiscus* sp. :F, CPC25115 (oblique distal view) x2800; G, CPC25116 (oblique view) x5810; H, *Angulofenestrallithus* sp. from Allaru Mudstone sample MFN-2152, CPC25117 (distal view) x8880; I, *Corollithion geometricum* (Gorka) from Allaru Mudstone sample MFN-2152, CPC25118 (oblique proximal view) x13740; J–K, *Corollithion rhombicum* (Stradner & Adamiker): J, CPC25119 (distal view) x11190; K, CPC25120 (distal view) x11870; L, *Gartnerago* sp., CPC25121 (distal view) x6340; M–P, *Tegumentum toolebucum* Shafik n. sp. from Allaru Mudstone sample MFN-2152: M, CPC25122 (proximal view) x6690; N, CPC25123 holotype (proximal view) x10330; O, CPC25124 (proximal view) x9850; P, CPC25125 (proximal view) x10000.

Description. The elliptical narrow rim is composed of 2 cycles: the inner (corresponding to the wall in the original description of the type species of *Tegumentum*) is formed of dextrally imbricate elements that are separated by clockwise inclined sutures as can be seen in distal view, the outer cycle is constructed of vertically extending tabular elements that slightly imbricate. The large central area is spanned by a central structure that varies in shape. Typically, the central structure is H-shaped with bars being slightly offset, but forms with X-shaped crossbars were also noted. The distal side of the central structure is composed of plates arranged into two zones flanking a median strip composed usually of lath-like elements.

Remarks. This species differs from *Tegumentum stradneri* Thierstein, 1972 by its thin wall and its larger central area.

Holotype. CPC 25123.

Paratypes. CPC 25124, CPC 25125, and CPC 25122.

Type section. BMR Boulia 3, the lowermost part of the Allaru Mudstone.

Known vertical range. Middle-late Albian.

Genus *Tranolithus* Stover, 1966
Tranolithus exiguus Stover, 1966
Figure 5G–I

Tranolithus exiguus Stover, 1966, p. 146, pl. 4, figs. 19–21; pl. 9, figs. 3–4.
Tranolithus salillum (Noel) Crux, 1981 (partim), p. 638, fig. 2 (7,?8,?10,?12; non 10).

Remarks. The original description of this species is based on specimens with partially preserved central structure. In well preserved specimens, the centre of the coccolith is filled with small crystallites (Fig. 5G). The bases of the four components forming the central structure extend parallel to the major axis of the ellipse along the inner margin of the rim. Thierstein (1973) noted the occurrence of intermediate forms between *Tranolithus exiguus* and *T. orionatus* (Reinhardt), and Hill (1976) pointed out the possibility of *T. exiguus* and *T. orionatus* being end members of a single species.

Tranolithus orionatus (Reinhardt) Perch-Nielsen, 1968
Figure 5A–E

Discolithus orionatus Reinhardt, 1966, p. 42, pl. 23, figs. 22, 31–33.
Tranolithus phacelosus Stover, 1966, p. 146, pl. 4, figs. 23–25; pl. 9, fig. 6.
Tranolithus orionatus (Stover) Perch-Nielsen, 1968, p. 35, pl. 4, figs. 15–19; text-fig. 9.
Zygolithus phacelosus (Stover) Manivit, 1968, p. 280, pl. 1, fig. 12.
Tranolithus orionatus (Stover) Perch-Nielson, 1968, p. 35, pl. 4, figs. 15–19; text-fig. 9.
Zygodiscus phacelosus (Stover) Bukry, 1969, p. 61, pl. 35, fig. 12.

Remarks. A few specimens have, on their proximal side, relics of the proximal grid described by Crux (1981) in his emendment of the diagnosis of the genus *Tranolithus* Stover. Identification of *T. orionatus* is easy because of the characteristic 4 large blocky elements that fill most of the central area. However, partial dissolution of these central blocks may result in forms that are identifiable as transitional between this species and *Tranolithus exiguus* Stover (e.g. Fig. 5F). Verbeek (1977) indicated that the shape of the elements forming the central structure depends on the amount of secondary calcite, and included *T. exiguus*, *T. gabalus* Stover and *T. manifestus* Stover among the synonyms of *T. orionatus*.

Genus ***Tubodiscus*** Thierstein, 1973
Tubodiscus sp.
Figure 6F–G

?*Tubodiscus* sp. cf. *T. verenae* Thierstein - Wind & Wise *in* Wise & Wind, 1976, p. 307, pl. 67, figs. 5–6.

Remarks. The broadly elliptical narrow shield is constructed of 55–60 strongly dextrally imbricate elements separated by sutures that have a clockwise inclination changing into the reverse direction near the outer margin and the central tube. Elements of both shields extend in an interlocking fashion to form the central tube. This tube projects only a short distance above the smaller shield.

Forms described by Wind & Wise (*in* Wise & Wind, 1976) from the Albian of the Falkland Plateau (DSDP holes 327A & 330) compare well with the present form. However, the number of elements per shield in the Australian form is greater.

Genus ***Vekshinella*** Loeblich & Tappan, 1963
Vekshinella crux (Deflandre & Fert) Risatti, 1973
Figure 5M

Discolithus crux Deflandre & Fert, 1954, p. 143, pl. 14, fig. 4; text-fig. 55.
Zygolithus crux (Deflandre & Fert) Bramlette & Sullivan, 1961, p. 149, pl. 6, figs. 8–10.
Staurolithus crux (Deflandre & Fert) Caratini, 1963, p. 25.
Vekshinella stradneri Rood, Hay & Barnard, 1971, p. 249, pl. 1, fig. 2.
Vekshinella crux (Deflandre & Fert) Risatti, 1973, p. 19, pl. 7, figs. 24–25.

Genus ***Watznaueria*** Reinhardt, 1964
Watznaueria barnesae (Black) Perch-Nielsen, 1968
Figure 6C–D

Tremalithus barnesae Black *in* Black & Barnes, 1959, p. 324, pl. 9, figs. 1–2.
Colvillea barnesae (Black) Black, 1964, p. 311.
Coccolithus barnesae (Black) Bramlette & Martini, 1964, p. 298, pl. 1, figs. 13–14.
Watznaueria angustoralis Reinhardt, 1964, p. 753, pl. 2, fig. 2; text-fig. 4.
Tergestiella barnesae (Black) Reinhardt, 1964, p. 753.
Ellipsagelosphaera frequens Noel, 1965 (partim), p. 119, pl. 11, figs. 8–9; pl. 19, fig. 5; ?pl. 20, figs. 1, 6–8; text-fig. 35, ? 36; (non pl. 11, figs. 7, 10; pl. 12, figs. 1–10; pl. 13, figs. 1–10; pl. 16, figs. 1–11).
Maslovella barnesae (Black) Tappan & Loeblich, 1966, p. 43.
Coccolithus paenepelagicus Stover, 1966 (partim), p. 139, pl. 1, fig. 10; pl. 3, fig. 22B; pl. 8, figs. 5; (non pl. 1, fig. 11).
Watznaueria barnesae (Black) Perch-Nielsen, 1968, p. 69, pl. 22, figs. 1–7; pl. 23, figs. 1, 4, 5, 16; text-fig. 32.

Watznaueria britannica (Stradner) Reinhardt, 1964
Figure 6E

Coccolithus britannica Stradner, 1963, p. 10, pl. 1, fig. 7.
Watznaueria britannica (Stradner) Reinhardt, 1964, p. 753, pl. 2, fig. 3; text-fig. 5.
Ellipsagelosphaera lucasi Noel, 1965, p. 126, pl. 11, figs. 1–6; text-figs. 41–42.

Watznaueria ovata Bukry, 1969

Ellipsagelosphaera frequens Noel, 1965 (partim), p. 119, pl. 12, fig. 8; pl. 19, ?figs. 1, 4; (non pl. 11, figs. 7–10; pl. 12, figs. 1–7, 9–10; pl. 13, figs. 1–10; pl. 14, figs. 1–11; pl. 19, figs. 2, 3, 5; pl. 20, figs. 1, 6–8; text-figs. 37–40).
Watznaueria ovata Bukry, 1969, p. 33, pl. 11, figs. 11–12.
Ellipsagelosphaera ovata (Bukry) Black, 1973, p. 71, pl. 26, figs. 10–12.

Genus ***Zygodiscus*** Bramlette & Sullivan, 1961
Zygodiscus compactus Bukry, 1969
Figure 5L

Zygodiscus compactus Bukry, 1969, p. 59, pl. 34, figs. 1–2.

Zygodiscus elegans Gartner, 1968
Figure 5J–K

Zygodiscus elegans Gartner, 1968, p. 32, pl. 10, figs. 3–6; pl. 12, figs. 3–4; pl. 27, fig. 1.

Acknowledgements

I thank Drs. L. Frakes (Monash University) and N.F. Exon, J.M. Dickins, and D.J. Belford (BMR) for their comments and criticism. The discussions I had with Drs. V. Scheibnerova (NSW Geological Survey), N.F. Exon, and S. Ozimic (BMR) were stimulating.

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