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Cribroperidinium 'frigatense', a dinoflagellate cyst from the Late Jurassic-Early Cretaceous of Australasia

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Cribroperidinium 'frigatense', a dinoflagellate cyst from the Late Jurassic-Early Cretaceous of Australasia

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Foreword

This report is one a series representing the results of the BGS-AGSO collaborative work undertaken under the auspices of the Virtual Centre of Economic Micropalaeontology and Palynology (VCEMP) during financial year 2001-2002. This is a taxonomic report on a new dinoflagellate cyst species, termed *Cribroperidinium 'frigatense'*, which occurs from the early Oxfordian (Late Jurassic) to the mid Berriasian (Early Cretaceous) of Australia (Carnarvon Basin and the Timor Sea), Papua New Guinea, New Zealand and Misool, eastern Indonesia. It is most consistently present in the mid-late Kimmeridgian to mid Tithonian. Dr Robin Helby (Sydney) kindly supplied the specimens studied. It is an extremely distinctive species of dinoflagellate cyst with parasutural lineations of short, trabeculate spines. The description of this form will help in the definition of new subzones within the *Pyxidiella* and *Fromea cylindrica* superzones. It is intended to formally publish the principal text of this work in order that the validation of these subzones may proceed. Note that this internal report is not a publication in terms of International Code of Botanical Nomenclature (ICBN) criteria and this document does not formally validate the species.

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Summary

Cribooperidinium 'frigatense' is described from Australasia. It is an extremely distinctive species of dinoflagellate cyst with parasutural lineations of short, trabeculate spines. The species occurs from the early Oxfordian (Late Jurassic) (lower *Wanaea spectabilis* Interval Zone) to the mid Berriasian (Early Cretaceous) (upper *Cassiculosphaeridia delicata* Interval Zone) of Australia (Carnarvon Basin and the Timor Sea), Papua New Guinea, New Zealand and Misool, eastern Indonesia. It is most consistently present in the mid-late Kimmeridgian to mid Tithonian.

1 INTRODUCTION

A new dinoflagellate cyst species, *Cribroperidinium 'frigatense'*, is described herein from the Late Jurassic-Early Cretaceous of Australasia. This taxon ranges from the early Oxfordian (lower *Wanaea spectabilis* Interval Zone, Subzone 6ciii) to the early-mid Berriasian (upper *Cassiculosphaeridia delicata* Interval Zone, Subzone 4bi) (Foster, 2001) in Australia, Papua New Guinea, New Zealand and Misool, eastern Indonesia. In Australia it has been found in the Carnarvon Basin and the Timor Sea and is most consistently present from the mid-late Kimmeridgian (mid *Dingodinium swanense* Interval Zone, Subzone 6aii) to the mid Tithonian (upper *Dingodinium jurassicum* Oppel Zone, Subzone 5aii).

This contribution is one of a series which aim to provide the taxonomic foundation needed to formalise the extensively used subdivisions of the Australian Mesozoic palynozonation of Helby *et al.* (1987). The specimens studied are largely from the Frigate-1 and Hadrian-1 wells, offshore Bonaparte Basin, offshore north-western Australia (Figure 1; Appendices 1 and 2; Foster, 2001, fig. 1). Other material studied is from the Tithonian Lelinta Formation (Fageo Group) of Misool, eastern Indonesia. The type material is from the late Tithonian Frigate Shale Unit of the Flamingo Group (Mory, 1991) in the Frigate-1 well, which was drilled by Arco Australia/Western Mining Company (Figure 1). The material from the Hadrian-1 well is from the Kimmeridgian Marl of Gorter and Kirk (1995).

References to the author citations of other taxa discussed are given in Williams *et al.* (1998, p.747-817). The figured specimens are all housed in the Commonwealth Palaeontological Collection (CPC) of the Australian Geological Survey Organisation (AGSO), Canberra, ACT 2601, Australia (Appendices 1 and 2). This study was conducted using single species mount slides with multiple specimens.

2 SYSTEMATIC PALYNOLOGY

Division DINOFLAGELLATA (Bütschli 1885) Fensome *et al.* 1993

Subdivision DINOKARYOTA Fensome *et al.* 1993

Class DINOPHYCEAE Pascher 1914

Subclass PERIDINIPHYCIDAE Fensome *et al.* 1993

Order GONYAULACALES Taylor 1980

Suborder GONYAULACINEAE (autonym)

Family GONYAULACACEAE Lindemann 1928

Subfamily CRIBROPERIDINIOIDEAE Fensome *et al.* 1993

Cribroperidinium Neale & Sarjeant 1962 emend. Helenes 1984

Type species. Cribroperidinium sepimentum Neale & Sarjeant 1962

Cribroperidinium 'frigatense' (Figure 2)

Synonymy

1988 gen. et sp. indet. H (M.P.521); Helby *et al.*, fig. 16L.

1988 gen. et sp. indet. H; Helby *et al.*, fig. 19L.

Previous Australian usage

M.P. 99 (pars.)

M.P. 521 - Helby.

Leptodinium sp. 521 - Helby

M.P. 536

This species has been used in unpublished reports, which are now open file status. In order to maximise its utility, the informal codes are quoted here. 'M.P.' = microplankton.

Description. An intermediate to large species of *Cribroperidinium* with a short, foliate apical horn which may be entire or comprising coalescing/anastomosing solid, slender ornamental elements. It is dorsoventrally flattened and is elongate subpentangular (occasionally subhexagonal) to biconical in dorsoventral view. The autophragm is robust and smooth to microscabrate; it is approximately 1µm to 1.5µm in thickness. Occasional short (c. 2µm), solid, distally capitate, nontabular spines may be present. The parasutures indicate a sexiform gonyaulacalean paratabulation pattern with dextral torsion. The antapical (1'') paraplate is relatively small. The paratabulation is marked by characteristic lineations of densely and evenly inserted parasutural spines/denticles which are normally trabeculate. However, some epicystal elements are not connected by trabeculae and these short elements are distally capitate. The spines/denticles are solid, smooth and normally are around 4µm-5µm in height. Many of the longer elements on the hypocyst bifurcate distally. They are typically longest on the hypocyst, becoming markedly more prominent in an antapical direction. The paracingulum and parasulcus are indicated by lineations of trabeculate elements. The cyst is divided into two equal hemispheres by the paracingulum, which normally is around 5µm longitudinally. The parasulcus is not subdivided.

Dimensions in micrometres (µm) (20 specimens measured):

	Minimum	Mean	Maximum
Overall length of cyst (including horn):	80	98	118
Overall width of cyst (including ornament):	58	80	95
Length of apical horn:	7	10	13
Length of epicyst (including horn):	31	42	60
Length of hypocyst (including ornament):	40	53	69
Length of spines/denticles:	2	5	11

The measured specimens are from a sidewall core from the Frigate-1 well at 1233.00m, ditch cuttings from the Hadrian-1 well between 3295.00m and 3300.00m and outcrop material of the Tithonian Lelinta Formation (Fageo Group) from Misool, eastern Indonesia.

Comments. *Cribroperidinium 'frigatense'* is a highly distinctive species due to the characteristic parasutural trabeculate spines/denticles. It is a form in which recognition would be possible

based upon a relatively small fragment of the hypocyst. The parasutural ornament of trabeculate short elements is somewhat variable, largely due to differences in length of the spines/denticles and the possible presence of distal furcations (Figure 2). Many of the longer elements on the hypocyst bifurcate distally and this branching imparts a lacelike appearance. Occasionally, isolated or small groups of nontabular short spines/denticles may be present; these are most common on the epicyst. The length of the parasutural ornamentation is higher on the hypocyst and increases markedly towards the antapex. This phenomenon of antapically-increasing process size is common in dinoflagellate cysts. The ornamental elements are dense and evenly inserted, typically the distance between them varies from 1µm to 3.5µm, but is normally 2µm (Figure 2). The antapical (1'') paraplate is relatively small, and therefore may be closely related to *Cribroperidinium corrugatum* Riding & Helby 2001. *Cribroperidinium corrugatum*, from the mid- to late Kimmeridgian (*Dingodinium swanense* Interval Zone) of Australia, has an extremely small antapical paraplate (Riding & Helby, 2001). The apical horn of this species is variable in both size and form. Specimens with entire horns (i.e. extensions of the autophragm) are distally foliate. However, the horns of many individuals are formed from slender, solid, coalescing fibres or thin processes. The apical horns of these forms therefore resemble those of the Mid-Late Jurassic species *Trichodinium scarburghense* (Sarjeant 1964) Williams *et al.* 1993 (see Drugg, 1978, pl. 4, figs 2, 3).

Comparison. *Cribroperidinium 'frigatense'* is the only species of this diverse genus to have parasutural spines/denticles which are distally trabeculate. *Cribroperidinium boreas* (Davey 1984) Helenes 1984, from the late Barremian of eastern England, is the most similar species in that it has prominent, fenestrate parasutural crests (Davey, 1974, pl. 4, figs 1-4). The parasutural ornamentation of these two species is somewhat similar, but those of *C. 'frigatense'* are generally higher and are formed of distinct individual elements, which are joined distally. The parasutural crests of *C. boreas* are more entire and therefore genuinely fenestrate. Furthermore, *C. 'frigatense'* is distinctly subangular, whereas *C. boreas* is ovoidal. Also *C. boreas* has a strongly ornamented autophragm and is significantly smaller than *C. 'frigatense'*. Similarly, *C? perforans* (Cookson & Eisenack 1958) Morgan 1980 has prominent parasutural crests which are perforate. However, the fenestrae are small, subcircular and irregularly inserted (Cookson & Eisenack, 1958, figs 8, 9). The Kimmeridgian species *C. complexum* Bailey 1993 has parasutural crests which may have proximal vacuoles. These perforate crests of *C. complexum* are irregularly developed, but most often present around the antapex (Bailey, 1993, pl. 1). *Cribroperidinium erymnoseptum* Bailey 1993 also may have parasutural trabeculate spines. However, this form differs from *C. 'frigatense'* in that the parasutural ornament is highly variable and the low-relief ornamentation frequently comprises individual elements (Bailey, 1993, pl. 2). Another Late Jurassic species, *Cribroperidinium swithini* Williams *et al.* 1998, has perforate parasutural crests. However, this species has a prominently reticulate autophragm in addition to having irregularly perforate parasutural crests (Brenner, 1988, pl. 3, figs 2, 5). The Late Cretaceous species *Cribroperidinium graemei* Williams *et al.* 1998 also has irregularly perforate parasutural crests which bear a superficial resemblance to the parasutural ornamentation of *C. 'frigatense'*. However, *C. graemei* lacks evenly inserted trabeculate parasutural elements (Slimani, 1994, pl. 14, figs 5-11). *Cribroperidinium wilsonii* (Yun Hyesu 1981) Poulsen 1996 is characterised by a dense cover of parasutural and intratabular spines, however, however these are not trabeculate (Yun Hyesu, 1981, pl. 1, figs 2, 3, 6, 7).

Typically, representatives of *Cribroperidinium* have entire, distally smooth parasutural crests, such as *C? murochorum* Dürr 1987, *C. jubaris* (Davies 1983) Lentin & Williams 1985, *C. ventriosum* (O. Wetzel 1933) Lentin & Williams 1973, *C. vexillum* Prössl 1990 ex Prössl 1992 and *C. wetzelii* (Lejune-Carpentier 1939) Helenes 1984. The Early Cretaceous type species, *Cribroperidinium sepimentum*, has a prominent apical horn, microperforate autophragm and wide, perforate parasutural crests. Many Cretaceous forms have prominent apical horns and these include *C. aichmetes* (Sarjeant 1966) Helenes 1984, *C. confossum* (Duxbury 1977) Helenes

1984, *C. conopium* Duxbury 1983, *C? cornutum* Davey 1974, *C. fetchamense* (Sarjeant 1966) Helenes 1984 and *C. orthoceras* (Eisenack 1958) Davey 1969. The Kimmeridgian species *Cribroperidinium? longicorne* (Downie 1957) Lentin & Williams 1985 also has a prominent, slender apical horn. *Cribroperidinium 'frigatense'* also lacks prominent intratabular ridges/crests which represent growth bands and are typical of many Cretaceous and Palaeogene representatives of this genus, but are not a diagnostic feature (Gocht, 1979; Helenes, 1984, p. 110, 112). Examples of species with these prominent intratabular features are *Cribroperidinium? edwardsii* (Cookson & Eisenack 1958) Davey 1969, *C. giuseppei* (Morgenroth 1966) Helenes 1984 and *C. janinae* Górka 1982. Many Jurassic species of *Cribroperidinium* also lack intratabular ridges; these include *C. angulosum* (Gitmez 1970) Poulsen 1996, and *C? longicorne*. *Cribroperidinium 'frigatense'* has a relatively small antapical (1'') paraplate, similar to that of *Cribroperidinium corrugatum* Riding & Helby, 2001, but the latter species has an extremely thick, corrugate autophragm and prominent parasutural crests, which are irregularly perforate (Riding & Helby, 2001).

Scriniodinium heikei Prössl 1990, from the Albian of north-west Germany, has perforate parasutural crests which strongly resemble the trabeculate parasutures of *Cribroperidinium 'frigatense'* (Prössl, 1990, pl. 12, figs 1, 2, 4, 5, 9). However, *Scriniodinium heikei* is cavate, having a relatively small endocyst and does not exhibit dextral torsion.

Derivation of name. From the Frigate-1 well.

Holotype and type locality. Plate 1, figs 7, 8, specimen CPC 36671, from a sidewall core sample in the Frigate Shale Unit (Flamingo Group) of the Frigate-1 well at 1233.00m.

Stratigraphical distribution. *Cribroperidinium 'frigatense'* ranges from the early Oxfordian to the mid Berriasian in Australia, Papua New Guinea, New Zealand and Misool, eastern Indonesia. In Australia, it has been recorded from the Carnarvon Basin and the Timor Sea region. The Australasian zonal range of the species is from the lower *Wanaea spectabilis* Interval Zone (Subzone 6ciii) to the upper *Cassiculosphaeridia delicata* Interval Zone (Subzone 4bi). The zones are of Helby *et al.* (1987) and the subzones which subdivide these were illustrated, but not defined, by Foster (2001, fig. 2). It is most consistently present from the mid-late Kimmeridgian to the mid Tithonian; this interval comprises the mid *Dingodinium swanense* Interval Zone (Subzone 6aai) to the upper *Dingodinium jurassicum* Oppel Zone (Subzone 5aai). The species has previously been reported as gen. et sp. indet. H from the Tithonian Kinohaku and Puti Siltstones of Kawhia, New Zealand by Helby *et al.* (1988, figs 16L, 19L).

FIGURE CAPTIONS

Figure 1. Location map for the Frigate-1 and Hadrian-1 wells in the offshore Bonaparte Basin, Timor Sea, offshore north-western Australia.

Figure 2. *Cribroperidinium 'frigatense'*. All specimens from a sidewall core at 1233.00 m in the Frigate-1 well (photomicrographs 1, 2, 4, 5, 7-9) and outcrop sample 81FH66 from the Lelinta Formation (Fageo Group) of Misool, Indonesia (photomicrographs 3, 6). All photomicrographs were taken using plain transmitted light. Photomicrographs 6 and 9 are composites. Photomicrographs 7 and 8 are of the holotype, the remainder are topotypes (photomicrographs 1, 2, 4, 5 and 9) and paratypes (photomicrographs 3 and 6).

- 1 – CPC 36665, topotype; Frigate-1 well, sidewall core sample at 1233.00m, specimen in dorsal view, high focus. Note the subhexagonal outline and the dorsal torsion.
- 2 - CPC 36666, topotype; sample details as 1, specimen in dorsal view, low focus. Note the small apical protuberance and the uniform length of the parasutural ornamentation.
- 3 - CPC 36667, paratype; outcrop sample 81FH66 from Misool, Indonesia, specimen in ventral view, median focus.
- 4 - CPC 36668, topotype; sample details as 1, specimen in focus, high/median focus.
- 5 - CPC 36669, topotype; sample details as 1, specimen in dorsal view, high/median focus.
- 6 - CPC 36670, paratype; sample details as 3, specimen in oblique ventral view, composite of high and low focal levels.
- 7, 8 - CPC 36671, holotype; sample details as 1, specimen in dorsal view, high and low focus respectively.
- 9 - CPC 36672, topotype; sample details as 1, specimen in dorsal view, composite of median and low focal levels.

Appendix 1 SAMPLE DETAILS

1 LOCATIONS AND OPERATORS OF WELLS FROM WHICH MATERIAL HAS BEEN STUDIED

Well Name/Number	Latitude	Longitude	Operator
Frigate-1	13° 10' 42.99''S	127° 55' 29.00''E	Arco Australia
Hadrian-1	11° 40' 24.10''S	124° 59' 16.87''E	Western Mining Co.

2 OUTCROP MATERIAL FROM MISOOL, EASTERN INDONESIA

Sample Number	Lithostratigraphy	Age
81FH66	Lelinta Formation (Fageo Group)	Tithonian

Appendix 2 REGISTER OF FIGURED SPECIMENS

All figured specimens are listed here, together with essential details. The specimens are curated in the Commonwealth Palaeontological Collection (CPC) of the Australian Geological Survey Organisation, Canberra, ACT 2601, Australia. The location of the specimens on the microscope slides are all 'England-Finder' co-ordinates and were taken with the slide label to the left of the observer; the microscope stage opening away from the microscope user. The coding for types is as follows: H = holotype; P = paratype. All specimens which were examined during this study contributed to the species concept described. SGM = single grain mount. The single grain mounts do not have unique numbers; they are numbered sequentially for each species within a particular sample.

SPECIES	TYPE	FIG	SGM/SLIDE NO.	LOC.	WELL AND DEPTH (M)	CPC NO.
<i>Cribrroperidinium 'frigatense'</i>	T	1/1	SGM 2 (v)	R38/1	Frigate-1 1233.00*	36665
<i>Cribrroperidinium 'frigatense'</i>	T	1/2	SGM 2 (vi)	R38/1	Frigate-1 1233.00*	36666

<i>Cribroperidinium 'frigatense'</i>	P	1/3	SSM 10 (i)	L55	Misool sample 81FH66**	36667
<i>Cribroperidinium 'frigatense'</i>	T	1/4	SGM 2 (i)	R39	Frigate-1 1233.00*	36668
<i>Cribroperidinium 'frigatense'</i>	T	1/5	SGM 1 (i)	RJ43	Frigate-1 1233.00*	36669
<i>Cribroperidinium 'frigatense'</i>	P	1/6	SSM 5 (i)	O40/3	Misool sample 81FH66**	36670
<i>Cribroperidinium 'frigatense'</i>	H	1/7&8	SGM 1 (v)	K45/1	Frigate-1 1233.00*	36671
<i>Cribroperidinium 'frigatense'</i>	T	Pl. 1/9	SGM 2 (vi)	R41/1	Frigate-1 1233.00*	36672

* = sidewall core

** = outcrop sample

References

- BAILEY, D. A., 1993. Selected *Cribroperidinium* species (Dinophyceae) from the Kimmeridgian and Volgian of northwest Europe. *Journal of Micropalaeontology* 12, 219-225.
- BRENNER, W., 1988. Dinoflagellaten aus dem Unteren Malm (Oberer Jura) von Süddeutschland; Morphologie, Ökologie, Stratigraphie. *Tübinger Mikropaläontologische Mitteilungen* Nr.6, 115 p.
- COOKSON, I. C. & EISENACK, A., 1958. Microplankton from Australian and New Guinea Upper Mesozoic sediments. *Proceedings of the Royal Society of Victoria (New Series)* 70, 19-79.
- DAVEY, R. J., 1974. Dinoflagellate cysts from the Barremian of the Speeton Clay, England. In: *Symposium on Stratigraphic Palynology. Birbal Sahni Institute of Palaeobotany Special Publication No. 3*, 41-75.
- DRUGG, W.S., 1978. Some Jurassic dinoflagellate cysts from England, France and Germany. *Palaeontographica Abteilung B* 168, 61-79.
- FOSTER, C.B., 2001. Introduction. In: Laurie, J. R. and Foster, C. B. (eds). *Studies in Mesozoic Palynology II. Memoir of the Association of Australasian Palaeontologists* 24, i-iii.
- GOCHT, H., 1979. Korrelation von Überlappungssystem und Wachstum bei fossilen Dinoflagellaten (*Gonyaulax*-Gruppe). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 159, 344-365.
- GORTER, J.D. & KIRK, A.S. 1995. The Kimmeridgian Marl in the Timor Sea: relevance to regional evolution and possible hydrocarbons. *APEA Journal* 1995, 152-186.
- HELBY, R. MORGAN, R. & PARTRIDGE, A.D., 1987. A palynological zonation of the Australian Mesozoic. *Memoir of the Association of Australasian Palaeontologists* 4, 1-94.
- HELBY, R., WILSON, G.J., & GRANT-MACKIE, J.A., 1988. A preliminary biostratigraphic study of Middle to Late Jurassic dinoflagellate assemblages from Kawhia, New Zealand. *Memoir of the Association of Australasian Palaeontologists* 5, 125-166.
- HELENES, J. 1984. Morphological analysis of Mesozoic-Cenozoic *Cribroperidinium* (Dinophyceae), and taxonomic implications. *Palynology* 8, 107-137.
- MORY, A.J. 1991. Geology of the offshore Bonaparte Basin northwestern Australia. *Geological Survey of Western Australia Report* 29, 23 p.
- PRÖSSL, K.F., 1990. Dinoflagellaten der Kreide – Unter-Hauterive bis Ober-Turon – im niedersächsischen Becken. Stratigraphie und Fazies in der Kernbohrung Konrad 101 sowie einiger anderer Bohrungen in Nordwestdeutschland. *Palaeontographica Abteilung B* 218, 93-191.

RIDING, J.B. & HELBY, R., 2001. Dinoflagellate cysts from the Late Jurassic (Kimmeridgian) *Dinodinium swanense* Zone in the North-West Shelf and Timor Sea, Australia. *Memoir of the Association of Australasian Palaeontologists*, **24**, 141-176.

SLIMANI, H., 1994. Les dinokystes des Craies du Campanien au Danien a Halembaye, Turnhout (Belgique) et a Beutenaken (Pays-Bas). *Mémoires pour servir à l'Explication des Cartes Géologiques et Minières de la Belgique - Toelichtende Verhandelingen voor de Geologische en Mijnkaarten van België* No. 37, 173 p.

WILLIAMS, G.L., LENTIN, J.K. & FENSOME, R.A., 1998. The Lentin and Williams Index of fossil dinoflagellates 1998 edition. *American Association of Stratigraphic Palynologists Contributions Series* No. 34, 817 p.

YUN HYESU, 1981. Dinoflagellaten aus der Oberkreide (Santon) von Westfalen. *Palaeontographica Abteilung B* 177, 1-89.