Palynological analysis of six cuttings samples between 640 and 695 metres in Baleen–1, Gippsland Basin.

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INTERPRETATIVE DATA

Summary

Six new cuttings samples were collected and analysed over a 55 metre interval from 640 to 695m in Baleen–1. The bottom three sample are dominated by spore-pollen belonging to the *Nothofagidites asperus* Zone and are characteristic of the Gurnard Formation, whilst the top three samples are dominated by dinoflagellate cysts belonging to the *Fromea leos* Zone and are characteristic the informal "Early Oligocene Wedge" found sporadically at the base of the Seaspray Group. When combined with the sidewall core lithologies and electric log character the boundary between these two units is best placed at 654m. Based on this pick the assemblage recorded from the cuttings at 665m is interpreted as substantially caved. The stratigraphic succession in the well is summarised in Table 1, and the zone assignments of the individual samples provided in Table 2.

Table 1: Palynological Summary for Baleen–1.

AGE	UNIT/FACIES	SPORE-POLLEN ZONES (MICROPLANKTON ZONES)	DEPTHS mKB
RECENT to Early MIOCENE	GIPPSLAND LIMESTONE Seafloor to 586m	No palynology dating.	
Early MIOCENE to OLIGOCENE	LAKE ENTRANCE FORMATION 586 to 638m	No palynology dating.	
Early OLIGOCENE	"Early Oligocene Wedge" 638 to 654m	Lower *P. tuberculatus* (*F. leos*)	640 to 650m (640 to 650m)
Middle to Late EOCENE	LATROBE GROUP Gurnard Formation 654 to 699m	Middle *N. asperus* Lower *N. asperus*	665 to 670m 685 to 695m
EOCENE?	LATROBE GROUP Undiff. coarse clastics 699 to 708m	No palynology dating	
LATE ALBIAN	STRZELECKI GROUP 708 to 1030mTD	*C. paradoxa* †	709 to 840m†

† Zone picks after Harris (1982).

Introduction

The collection and preparation of six new palynological samples from Baleen–1 was undertaken as part of a larger review project for Basin Oil Pty Ltd, revising the age dating and correlation of the Gurnard Formation in the wells Flathead–1, Judith–1, Patricia–1, Sperm Whale–1 and Whale–1, located on the Northern Strzelecki Terrace in the offshore Gippsland Basin. The samples were collected by the author from the Victorian Department of Natural Resources & Environment on 13th September 2000, and submitted to Laola Pty Ltd in Perth for palynological processing. The prepared palynological slides were returned during the next two weeks and Provisional Reports on the new analyses for Baleen–1 were submitted on the 25th September and 2nd October.

Although an average of 15 grams of washed and dried cuttings were processed for each sample, recovery of the organic residues was low to very low with generally only one palynological slide per sample available for study. Fortunately, the palynomorph concentrations on these slides was high enabling high diversity spore-pollen assemblages and moderate diversity microplankton assemblages to be recorded. Details of zone assignments, confidence ratings and key comments are given in Table 2, with basic sample data provided in Table 3, and visual residues yields, palynomorph preservation and recorded species diversity provided in Table 4. Results of the assemblage counts are provided in Table 5, and a listing of all known spore-pollen and microplankton identified provided in Table 6. Author citations for spore-pollen species can mostly be sourced from Stover & Partridge (1973, 1982), and for the microplankton species from the indexes of Williams *et al.* (1998) and Fensome *et al.* (1990). Species names followed by “ms” or “†” are unpublished manuscript names.

Geological Discussion

The palynological assemblages from the six cuttings samples fall into two groups. The top three samples contain abundant microplankton (average 54%) interpreted to be from the *F. leos* Zone of the *Operculodinium* Superzone. These assemblages are Early Oligocene in age and are interpreted to be part of the basal Seaspray Group. The bottom three cuttings in contrast are dominated by spore-pollen, with the microplankton abundance declining to about 8%. In addition these lower samples contain the shallowest occurrences of several distinctive Eocene species in the well, and are therefore interpreted as derived from the Gurnard Formation.

Notwithstanding the distinct separation of the assemblages it is clear that there are significant cavings in all assemblages and therefore the cuttings depths may not necessarily be providing true ages for the intervals sampled. However, combining the new palynological analyses with a review of the lithological succession based on the sidewall core descriptions and the electric logs, provides a revised interpretation of the stratigraphic succession which is compatible with these latest results.

Down to at least 584.9m most sidewall cores are described as calcarenites or argillaceous calcilutites that can broadly be equated with the Gippsland Limestone. Between 590m and 627m the recovered sidewall cores are described as calcilutite claystones with the lithologies becoming finer-grained and darker in colour downhole. This interval is interpreted as a gradational change into the Lakes Entrance Formation with the upper boundary of that formation placed at the electric log break at 586m.

In the next lithological unit, distinguished between 638m and 654m, the sidewall core at 640m is described as a dark brownish-red calcisiltitic to calcilutitic claystone with an estimated 50% $CaCO_3$, while the two deeper sidewall cores at 646m and 651m are described as dark grey calcareous claystones containing an estimated 10% $CaCO_3$. The original palynological and micropalaeontological reports by Harris (1982) and Paltech (1982) assign a Late Eocene age to these samples, and therefore the interval was included within the Gurnard Formation in the Well Completion Report. The new palynological analyses indicate the interval is actually Early Oligocene in age and should be referred to the Early Oligocene Wedge (EOW) a longstanding informal term used to express a particular complication at the base of the Seaspray Group.

The term EOW originated in Esso Australia Ltd in the late 1970s or early 1980s, but has not been referred to in publications (except incorrectly by Thompson, 1986, p.60). It defines the interval below the seismic pick for the “top of Latrobe” down to the best lithological and palaeo pick for the boundary between calcareous sediments of the Seaspray Group and the non-calcareous Gurnard Formation, or if the latter is not present the quartz sands of the underlying Latrobe coarse clastics. The EOW occurs on the flanks of the major structures (eg. Fortescue) and may contain either or both the Upper *N. asperus* and the basal part of the *P. tuberculatus* Zones, as well as the *F. leos* microplankton Zone.

Although the foraminiferal zones J–1, J–2 and K have been identified from the unit it often lacks foraminifera as a consequence of post-depositional diagenesis. The unit exists because the "**Top of Latrobe" seismic mapping surface** actually corresponds to a position **within** the basal part of the Seaspray Group. This subtle discrepancy does not matter when mapping across the top of major structures where the EOW and *F. leos* Zone are missing, but becomes increasingly important on the western and northern flanks of structures where it is common to find extra interposed section.

The presence of a sharp electric log break at 638m combined with the unusual brownish-red colour of the claystone in the sidewall core at 640m suggests the top of the EOW in Baleen–1 is a sequence boundary unconformity. The record of planktonic foraminifera assigned to the J–1 zone from part of the sidewall core at 627m suggests this unconformity lies within the Early Oligocene. However, if the two lithologies with discrete foraminiferal faunas described from that sidewall core by Paltech (1982), represent mixing due to reworking the unconformity on top of the EOW could correlate with the major Mid-Oligocene sequence boundary at 30 Ma (see Haq *et al.*, 1987).

Based on the sidewall descriptions the revised top of the Eocene Gurnard Formation needs to be placed the above sidewall core at 658m, which is described as a dark red-brown limonite siltstone with 20% quartz and no recorded carbonate component. The recovery of the dinocyst *Gippslandica* (al. *Vozzhennikovia*) *extensa* from this sample by Harris (1982) is consistent with this assignment. This choice would also be consistent with the rare occurrence of Eocene spore-pollen in the cuttings at 665m, even though the bulk of that assemblage appears to be derived from the younger *F. leos* Zone. Obviously the latter component of the assemblage is caved.

Accepting that the sidewall core at 658m is from the Gurnard Formation the best position on the electric logs for the top of the formation is at 654m. As all deeper sidewall cores down to 698m (with exception of sidewall core at 685m) contain either glauconite or its oxidation product limonite the base of the Gurnard Formation is placed at the electric log break at 699m. Results from both the original palynological study (Harris,1982), and the cuttings analysed in this report indicate that this 45 metre thick Gurnard Formation contains spore-pollen representative of both the Lower and Middle *N. asperus* Zones and microplankton diagnostic of the *D. heterophlycta* and *C. incompositum* Zones, but unfortunately neither study provides sufficient information to subdivide the formation. That awaits a new study of the palynological assemblages from the sidewall cores.

Discussion of Assemblages

Lower *Proteacidites tuberculatus* spore-pollen Zone and
***Fromea leos* microplankton Zone.**
Interval: 640 to 650 metres, caved to 665 metres.
Age: Basal Early Oligocene.
The three shallower cuttings sample are all dominated by microplankton which averaged 54% of combined SP and MP count. The microplankton assemblages were overwhelmingly dominated by *Spiniferites* (average 63% of MP count), with *Operculodinium centrocarpum* (average 9%) and *Protoellipsodinium simplex* ms (average 3.5%) the next most prominent dinoflagellates. These three dominant forms are characteristic of the Oligocene to Pliocene *Operculodinium* Superzone, with the consistent presence of *Fromea leos* ms (average 2%) placing the assemblages in the oldest *F. leos* Zone of the superzone.

The associated spore-pollen assemblages are dominated by *Nothofagidites* pollen (average 57%) and can be assigned to the *P. tuberculatus* Zone on the consistent presence of the spore *Cyatheacidites annulatus,* and the rare occurrence of the eponymous species *P. tuberculatus* (only recorded at 650m). Assignment to the Lower *P. tuberculatus* Zone (= *G. nebulosus* Subzone) is based on the associated microplankton as the key marker species *Granodiporites nebulosus* was not found. Younger marker species recorded in the assemblages, eg. *Foveotriletes lacunosus* at 665 and *Cyathidites subtilis* in the deeper cuttings at 685m, are interpreted as caved.

The LADs (Last Appearance Datums) of *Proteacidites adenanthoides, P. crassus* and *P. unicus* ms at 665m suggest the Late Eocene Middle *N. asperus* Zone has been penetrated even though the bulk of this assemblages is clearly younger.

***Nothofagidites asperus* spore-pollen Zone.**
Interval: 670 to 695 metres, probably extending up 665 metres.
Age: Middle to Late Eocene.
The three deeper cuttings samples are characterised by a marked decline in microplankton abundance to an average of only 8% of the combined SP and MP

count. Although the change in assemblage character confirms the Eocene Gurnard Formation has been penetrated confident zone assignment is hampered by the low recoveries of palynomorphs and rarity of key index species. There is also little change in the species abundances in the assemblages which continue to be dominated by *Nothofagidites* pollen (average 50%).

The samples at 665 and 670m are assigned to the Middle *N. asperus* Zone on the LADs of *Proteacidites adenanthoides* and *P. crassus* at 665m, and the FAD (First Appearance Datum) of *Proteacidites stipplatus* at 670m, assuming the latter is not caved. The samples at 685m and 695m are assigned to the Lower *N. asperus* Zone on the consistent presence of *Proteacidites pachypolus* and the increase in frequency of species more typical of the Lower subzone. These include *Proteacidites recavus* at 685m, and *Anacolosidites luteoides* and *Proteacidites reflexus* at 695m. The record of the acritarch *Paucilobimorpha spinosus* (= *Tritonites spinosus* of Marshall & Partridge, 1988) at 685m was originally interpreted to favoured a Middle *N. asperus* Zone assignment for this sample (Provisional Report No. 3), but on the balance of evidence this species is more likely caved.

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Table 2: Interpretative data from Baleen–1 well.

Sample Type	Depth	Spore-Pollen Zone (Microplankton Zone)	CR*	Comments and Key Species Present
Cuttings	640m	Lower *P. tuberculatus* (*Fromea leos* Zone)	D4 D2	MP 51%; *Nothofagidites* pollen 57% *Spiniferites* dinocysts 64% of MP count. LAD of *Fromea leos* ms.
Cuttings	650m	Lower *P. tuberculatus* (*Fromea leos* Zone)	D4 D2	MP 44%; *Nothofagidites* pollen 59% *Spiniferites* dinocysts 56% of MP count.
Cuttings	665m	Mixed assemblage of Lower *P. tuberculatus* (*Fromea leos* Zone) with rare spore-pollen no younger than Middle *N. asperus* Zone		MP 66%; *Nothofagidites* pollen 54% *Spiniferites* dinocysts 70% of MP count. Top of Eocene identified based on LADs of *Proteacidites adenanthoides*, *P. crassus* and *P. unicus* ms.
Cuttings	670m	Middle *N. asperus* Zone (microplankton zone indeterminate)	D4	MP 5%; *Nothofagidites* pollen 47% FADs of *Proteacidites stipplatus* and *P. tuberculatus* and LAD of *Proteacidites pachypolus*
Cuttings	685m	Lower *N. asperus* Zone (rare MP suggest equivalence to younger *C. incompositum* Zone)	D4	MP 13%; *Nothofagidites* pollen 55% LADs of pollen *Proteacidites recavus* and key acritarch *Paucilobimorpha spinosus*.
Cuttings	695m	Lower *N. asperus* Zone (microplankton zone indeterminate)	D1	MP <5% *Nothofagidites* pollen 68% LADs of pollen *Anacolosidites luteoides* and *Proteacidites reflexus*.

MP %= microplankton expressed as % of combined SP & MP count.
Nothofagidites % = abundance expressed as % of SP count only.
FAD & LAD = First & Last Appearance Datums.
*CR = Confidence Ratings

*Confidence Ratings used in STRATDAT database and applied to Table 2.

Alpha codes: Linked to sample		**Numeric codes:** Linked to fossil assemblage		
A	Core	**1**	**Excellent confidence:**	High diversity assemblage recorded with key zone species.
B	Sidewall core	**2**	**Good confidence:**	Moderately diverse assemblage recorded with key zone species.
C	Coal cuttings	**3**	**Fair confidence:**	Low diversity assemblage recorded with key zone species.
D	Ditch cuttings	**4**	**Poor confidence:**	Moderate to high diversity assemblage recorded without key zone species.
E	Junk basket	**5**	**Very low confidence:**	Low diversity assemblage recorded without key zone species.

BASIC DATA

Table 3: Basic sample data on new samples processed from Baleen–1.

Sample Type	Depth	Lithology	Weight (grams)
Cuttings	640m	Medium brown grey glauconitic mudstone	12.0
Cuttings	650m	Loose and clumped greenish grey sandy mudstone	15.6
Cuttings	665m	Medium greenish grey mudstone (sand size particles)	14.1
Cuttings	670m	Greenish grey sandy mudstone	13.6
Cuttings	685m	Greenish brown glauconitic sandstone (loose sandstone)	17.1
Cuttings	695m	Loose greenish brown glauconitic sandstone	16.7
		Average:	**14.9**

Table 4: Basic assemblage data on samples examined in Baleen–1.

Sample Type	Depths	Visual Yield	Palynomorph Concentration	Preservation	No. SP Species	No. MP Species
Cuttings	640m	Low	High	Fair	37+	18+
Cuttings	650m	Low	High	Fair	30+	18+
Cuttings	665m	Low	Very High	Poor	50+	25+
Cuttings	670m	Low	High	Fair	44+	12+
Cuttings	685m	Very Low	High	Poor	52+	11+
Cuttings	695m	Very Low	Moderate	Good	39+	9+
				Averages:	**42+**	**15+**

Table 5 : Baleen–1 BASIC DATA Palynomorph Assemblage Counts.						
Sample Type	**Cts**	**Cts**	**Cts**	**Cts**	**Cts**	**Cts**
Depth (m)	**640**	**650**	**665**	**670**	**685**	**695**
SPORE-POLLEN SPECIES						
Baculatisporites spp.		0.9%				
Cyathidites spp. large >40µm		0.9%				
Cyathidites spp. small <40µm	3.8%	1.8%	4.1%	3.9%	4.6%	2.2%
Dictyophyllidites spp.				0.7%	0.6%	0.5%
Herkosporites elliottii		0.9%	1.4%	1.3%		
Gleicheniidites circinidites			1.4%			0.5%
Laevigatosporites spp.	1.9%		1.4%	0.7%	3.4%	0.5%
Monolete spores undiff:			1.4%	0.7%	1.1%	0.5%
Stereisporites spp.	1.0%	1.8%	1.4%	1.3%		
Trilete spores undiff.	1.0%	0.9%		0.7%	0.6%	1.1%
Tripunctisporis maastrichtiensis				0.7%		0.5%
TOTAL SPORES:	**8%**	**7%**	**11%**	**10%**	**10%**	**6%**
GYMNOSPERMS						
Araucariacites australis	4.8%	3.6%	5.4%	9.2%	1.1%	3.2%
Dilwynites spp.	10.6%	5.4%	4.1%	3.9%	0.6%	4.3%
Lygistepollenites florinii	1.0%	1.8%	2.7%		1.7%	2.2%
Microalatidites palaeogenicus					0.6%	
Phyllocladidites mawsonii	3.8%	9.0%	9.5%	9.2%	2.9%	8.1%
Podocarpidites spp.	4.8%	3.6%	5.4%	3.9%	5.1%	5.9%
Trichotomosulcites subgranulatus					1.1%	
TOTAL GYMNOSPERM POLLEN:	**25%**	**23%**	**27%**	**26%**	**13%**	**24%**
ANGIOSPERM pollen undiff.	1.0%	0.9%		0.7%	1.7%	2.2%
Anacolosidites luteoides						0.5%
Cupanieidites orthoteichus					0.6%	
Haloragacidites harrisii	3.8%	4.5%	4.1%	8.6%	8.6%	10.8%
Ilexpollenites spp.	1.0%					
Malvacipollis spp.		0.9%		0.7%		1.1%
Myrtaceidites mesonesus/parvus		0.9%			0.6%	
Nothofagidites asperus		0.9%			0.6%	
Nothofagidites deminutus	4.8%	6.3%	4.1%	3.3%	5.7%	5.9%
Nothofagidites emarcidus/heterus	50%	48%	47%	41%	43%	41%
Nothofagidites flemingii	1.0%	0.9%		0.7%	2.3%	1.1%
Nothofagidites vansteenisii	1.0%	2.7%	4.1%	1.3%	4.0%	
Proteacidites obscurus				0.7%		
Proteacidites annularis		1.8%		1.3%		0.5%
Proteacidites pachypolus					0.6%	
Proteacidites spp.	3.8%	1.8%	1.4%	2.0%	5.1%	1.6%
Tricolp(or)ates spp.	1.0%		1.4%	3.3%	4.0%	5.9%
TOTAL ANGIOSPERM POLLEN:	**67%**	**69%**	**62%**	**64%**	**77%**	**70%**
TOTAL SPORE-POLLEN COUNT:	**104**	**111**	**74**	**152**	**175**	**186**
MICROPLANKTON						
Dinoflagellates undiff:	6%	10%	10%	50%	52%	44%
Achomosphaera spp.		1%				11%
Cyclopsiella vieta		1%				11%
Dapsilidinium pseudocolligerum	5%	3%	2%			
Fromea sp. cf. F. chytra	4%	6%				
Fromea leos†	1%	2%	3%	25%	8%	11%
Hystrichokolpoma rigaudiae	3%		1%		4%	
Impagidinium spp.	2%	1%	1%			
Lingulodinium machaerophorum		1%	3%			
Nematosphaeropsis rhizoma†	1%					
Operculodinium centrocarpum	9%	12%	6%		12%	
Protoellipsodinium simplex†	5%	3%	3%	25%	8%	
Pyxidinopsis pontus†		1%	1%			11%
Spinidinium spp.						11%
Spiniferites spp.	64%	56%	70%		16%	
Systematophora placacanthum	1%	1%				
MICROPLANKTON COUNT:	**109**	**86**	**143**	**8**	**25**	**9**
TOTAL SP & MP COUNT:	**213**	**197**	**217**	**160**	**200**	**195**
Microplankton as % SP + MP:	51%	44%	66%	5%	13%	5%
OTHER PALYNOMORPHS						
Fungal spores & hyphae	5.8%	4.8%	3.1%	4.8%	2.9%	9.7%
TOTAL COUNT:	**226**	**207**	**224**	**168**	**206**	**216**
† Manuscript Species						

Table 6 : Baleen–1 BASIC DATA Palynomorph Distribution Chart.

Sample Type:	Cts	Cts	Cts	Cts	Cts	Cts
Depth (m):	**640**	**650**	**665**	**670**	**685**	**695**
SPORE-POLLEN SPECIES						
Anacolosidites luteoides						X
Araucariacites australis	5%	4%	5%	9%	X	3%
Baculatisporites spp.	X	X			X	
Banksieacidites arcuatus					X	
Beaupreaidites elegansiformis			X			
Beaupreaidites trigonalis†	X		X			
Beaupreaidites verrucosus				X		
Bluffopollis scabratus			X			
Camarozonosporites heskermensis					X	X
Cupanieidites orthoteichus			X		X	
Cupressacites sp.			X			
Cyatheacidites annulatus	X	X	X	CV		CV
Cyathidites australis		RW		RW		
Cyathidites palaeospora	4%	2%	4%	4%	5%	2%
Cyathidites subtilis					CV	
Dacrycarpidites australiensis			X	X		X
Dicotetradites clavatus					X	
Dictyophyllidites arcuatus	X		X	X	X	X
Dilwynites granulatus	11%	5%	4%	4%	X	4%
Dilwynites tuberculatus		X	X			
Dryptopollenites semilunatus			X		X	
Foveotriletes balteus	X					X
Foveotriletes crater				CV	CV	
Foveotriletes lacunosus			CV			
Foveotriletes palaequetrus			X		X	
Gleicheniidites circinidites		X	X	X	X	X
Haloragacidites harrisii	4%	5%	4%	9%	9%	11%
Haloragacidites trioratus				X		
Herkosporites elliottii		X	X	X	X	X
Ilexpollenites spp.	X		X			
Ischyosporites gremius	X	X				
Ischyosporites irregularis†	X		X	X	X	
Laevigatosporites major	X		X	X	X	X
Laevigatosporites ovatus	X	X	X	X	X	X
Latrobosporites marginatus	X					
Liliacidites spp.	X		X			
Lygistepollenites florinii	X	2%	3%	X	2%	2%
Malvacipollis robustus†		X				
Malvacipollis subtilis		X	X	X	X	X
Matonisporites ornamentalis			X			
Micrantheum spinyspora	X					
Microalatidites palaeogenicus					X	
Milfordia homeopunctatus						X
Myrtaceidites mesonesus/parvus		X	X		X	
Nothofagidites asperus	X	X	X	X	X	
Nothofagidites brachyspinulosus	X					
Nothofagidites deminutus	5%	6%	4%	3%	6%	6%
Nothofagidites emarcidus/heterus	50%	48%	47%	41%	43%	41%
Nothofagidites falcatus	X	X	X	X	X	X
Nothofagidites goniatus	X		X	X	2%	X
Nothofagidites flemingii	X	X	X	X		X
Nothofagidites vansteenisii	X	3%	4%	X	4%	X
Parvisaccites catastus				X		
Phyllocladidites mawsonii	4%	9%	9%	9%	3%	8%
Podocarpidites spp.	5%	4%	5%	4%	5%	6%
Polypodiidites perverrucatus	X	X	X			
Proteacidites spp.	4%	2%	X	2%	5%	2%
Proteacidites adenanthoides			X	cf.		cf.
Proteacidites annularis		2%	X	X	X	X
Proteacidites crassus			X			X

Table 6 : Baleen–1 BASIC DATA Palynomorph Distribution Chart.

Sample Type:	Cts	Cts	Cts	Cts	Cts	Cts
Depth (m):	640	650	665	670	685	695
Proteacidites obscurus				X	X	
Proteacidites latrobensis					X	X
Proteacidites nasus						X
Proteacidites pachypolus				X	X	X
Proteacidites pseudomoides					X	
Proteacidites recavus					X	
Proteacidites reflexus						X
Proteacidites stipplatus	X			X		
Proteacidites tuberculatus		X		cf.	CV	
Proteacidites unicus†			X			
Reticuloidosporites minisporis	X			X	X	
Retitriletes spp.	X			X	X	
Rugulatisporites mallatus	X			X		X
Santalumidites cainozoicus						X
Sapotaceoidaepollenites rotundus					X	
Schizocolpus marlinensis						X
Stereisporites antiquisporites	X	2%	X	X	X	
Stereisporites australis			X		X	
Trichotomosulcites subgranulatus	X				X	
Tricolpites thomasii						X
Tricolp(or)ates spp.	X	X	X	3%	4%	6%
Tricolporites adelaidensis			X			
Tricolporites leuros			X	X		
Tripunctisporis maastrichtiensis				X	X	X
Verrucatosporites alienus			X	X	X	
Verrucosisporites kopukensis						X
MICROPLANKTON						
Achomosphaera spp.	X	X	X	X		X
Apteodinium australiense	X	X	X			
Cyclonephelium sp. nov.	X	X	X			
Cyclopsiella vieta	X	X	X	X	X	X
Dapsilidinium pseudocolligerum	X	X	X			
Fromea sp. cf. F. chytra	X	X	X			
Fromea leos†	X	X	X	X	X	X
Fromea spp.				X	X	X
Hystrichokolpoma rigaudiae	X	X	X		X	
Impagidinium spp.	X	X	X			
Lingulodinium machaerophorum	X	X	X	X		X
Lingulodinium solarum	cf.	X	cf			X
Nematosphaeropsis rhizoma†	X		X			
Operculodinium centrocarpum	X	X	X	X	X	
Paralecaniella indentata			X	X		
Paucilobimorpha spinosus					X	
Pentadinium laticinctum			X	X		
Protoellipsodinium clavatus†			X			
Protoellipsodinium simplex†	X	X	X	X	X	
Pyxidinopsis beta†		X			X	
Pyxidinopsis pontus†	X	X	X			X
Rottnestia borussica			X			
Spinidinium spp.						X
Spiniferites spp.	X	X	X		X	X
Stephanodinium sp. cf S. spiniferum			X			
Systematophora placacanthum	X	X	X			
Tectatodinium marlum†				X		
Tectatodinium ovatum†			X			cf.
Tectatodinium pellitum		X	X	X		X
† Manuscript Species						
X = Present (<1%)						
CV = Caved						
RW = Reworked						
cf. = Compare with						