MORGAN PALAEO ASSOCIATES

PALYNOLOGICAL/PETROLEUM GEOLOGICAL CONSULTANTS

POSTAL ADDRESS: Box 161, Maitland, South Australia 5573
DELIVERIES: 1 Shannon Tce, Maitland, South Australia 5573
Phone (088) 32 2795 Fax (088) 32 2798

PALYNOLOGY OF BHPP LOCH ARD-1,

OFFSHORE OTWAY BASIN, VICTORIA, AUSTRALIA

BY

ROGER MORGAN

for BHP PETROLEUM

May 1994

REF:OTW.RPLOCHAR

PALYNOLOGY OF BHPP LOCH ARD-1

OFFSHORE OTWAY BASIN, VICTORIA, AUSTRALIA

BY

ROGER MORGAN

CONTENTS **PAGE**

I SUMMARY

402.5m(swc), 430.0m(swc) ; upper *senectus* Zone (lower *australis* Dino Zone) : Campanian : very nearshore marine : immature

451.0m(swc), 489.0m(swc) : middle *senectus* Zone (upper *aceras* Dino Zone) : Campanian : nearshore marine : immature

534.5m(swc) : lower *senectus* Zone (middle to lower *aceras* Dino Zone) : Campanian : nearshore marine : immature

575.0m(swc) : upper *apoxyexinus* Zone (upper *cretacea* Dino Zone) : Santonian : nearshore marine : immature

650-70m(cutts) : upper *apoxyexinus* Zone (lower *cretacea* Dino Zone) : Santonian : nearshore marine : immature

762.0m(swc), 788.0m(swc) mid *apoxyexinus* Zone (788.0m upper *porifera* Dino Zone) : Santonian : nearshore marine : immature

820.0m(swc), 837.0m(swc), 875-90m(cutts), 915-25m(cutts) : lower *apoxyexinus* Zone : Santonian : nearshore marine to very nearshore marine : immature

927.0m(swc) : indeterminate (almost barren)

954.0m(swc), 1022.0m(swc) : upper *mawsonii* Zone : Coniacian-Turonian : very nearshore marine with significant freshwater algae at 1022m : immature

1048.0m(swc) : *mawsonii* Zone : Turonian : possibly non-marine lake : immature

1107.0m(swc), 1150.0m(swc) : lower *mawsonii* Zone : Turonian : non-marine to slightly brackish : immature

1186.0m(swc), 1188.0m(swc), 1200.0m(swc) : *distocarinatus* Zone (*infusorioides* Dino Zone at 1200.0m) : Cenomanian : non-marine lacustrine and marginally marine : immature

1208.0m(swc), 1329.0m(swc) : indeterminate (almost barren)

1344-59m(cutts) : *paradoxa* Zone : late Albian : slightly brackish : marginally mature.

II INTRODUCTION

After well completion, twenty five samples (21 swcs, 4 cuttings) were submitted for detailed study. These results are summarised herein.

Palynomorph occurrence data are shown as Appendix I and form the basis for the assignment of the samples to twelve spore-pollen and dinoflagellate units of Campanian to Albian age.

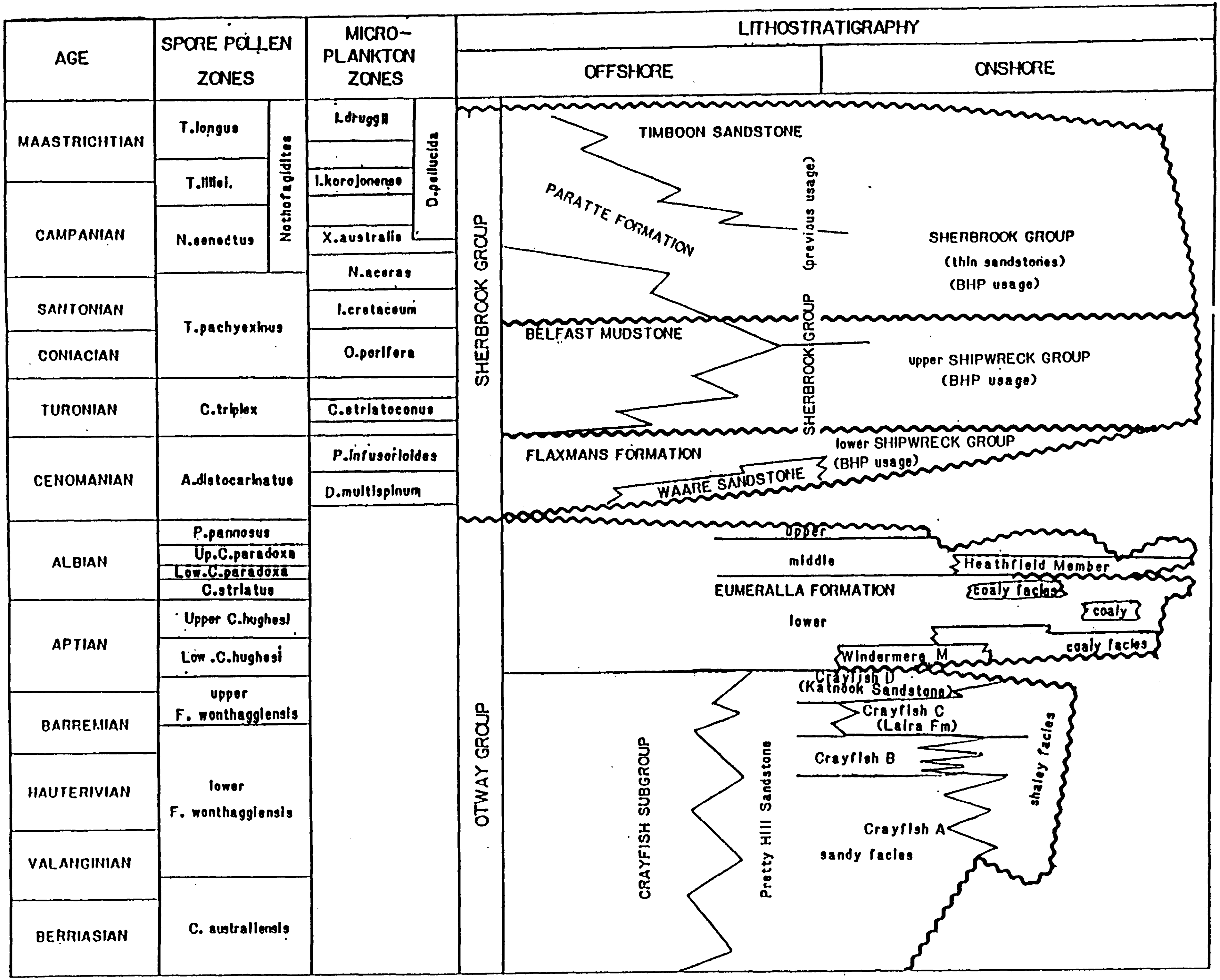
Specimen counts were made on all assemblages and expressed in the raw data as percentages. In the running text, percentages from cuttings are always bracketed (5%) to show that they may be inaccurate due to caving.

The Cretaceous spore-pollen zonation is essentially that of Dettmann and Playford (1969), but has been significantly modified and improved by various authors since, and most recently discussed in Helby et al (1987), as shown on Figure 1. The Late Cretaceous zonation has been modified by Morgan (1992) in project work for BHPP (Figure 2). Tertiary zones are essentially those of Partridge (1976).

Maturity data was generated in the form of Spore Colour Index, and is plotted on Figure 3 Maturity Profile of Loch Ard-1. The oil and gas windows on Figure 3 follow the general consensus of geochemical literature. The oil window corresponds to spore colours of light-mid brown (Staplin Spore Colour Index of 2.7) to dark brown (3.6). These correspond to vitrinite reflectance values of 0.6% to 1.3%. Geochemists argue variations on kerogen type, basin type and basin history. The maturity interpretation is thus open to reinterpretation using the basic colour observations as raw data. However, the range of interpretation philosophies is not great, and probably would not move the oil window by more than 200 metres.

Sample processing usually involves the following steps. Extra techniques are only used if required:

(a) digest about 10gm of crushed rock in 50% HF overnight
(b) wash out several times over 10 micron polyester sieve. Acidify with conc HCl if flourosilicate gel forms
(c) heavy liquid separation used concentrated $ZnBr_2$ with SG of 2.0.
(d) wash out float fraction over 10 micron polyester sieve. Acidify if $Zn(OH)_2$ precipitate forms
(e) mount a sieved kerogen slide
(f) oxidise in Schutze Solution (conc 30% HNO_3 with crystalline $KClO_3$)



FI' RE 1. CRETACEOUS REGIONAL FRAMEWORK, OTWAY BASIN

SPORE-POLLEN ZONES	SPORE-POLLEN HORIZONS	DINOFLAGELLATE ZONES	DINOFLAGELLATE HORIZONS
LONGUS upper	T. confessus T. sectilis 1	DRUGGII	M. conorata 1a
	G. rudata ● 1b		M. conorata 1c
LONGUS lower	N. senectus ● 1d		M. druggii 1e
	T. sabulosus 2a		I. pellucida 2
	T. longus 2b		
LILLEI upper		KOROJONENSE	I. korojonense 3 I. cretacea
LILLEI lower	T. sectilis 3a		
	T. lillei 3b		I. korojonense 3c I. pellucida
SENECTUS upper		AUSTRALIS upper	X. australis 4 X. ceratoides A. wisemaniae
			A. suggestium 4a
		AUSTRALIS lower	N. aceras 5 N. semireticulata X. australis ● 6
	G. rudata 7a	ACERAS upper	N. tuberculata 7 X. australis 7b
SENECTUS middle			N. tuberculata 7c N. semireticulata
			O. obesa 7d
	T. sabulosus 7e	ACERAS middle	T. suspectum Heterosphaeridium 10%+ 8
SENECTUS lower	N. senectus 9a	ACERAS lower	Heterosphaeridium 20%+ 9 N. aceras 9b
APOXYEXINUS upper		CRETACEA upper	I. belfastense 10 A. denticulata
			Heterosphaeridium 20%+ 10a
	A. cruciformis 1%		I. belfastense A. denticulata 11a
APOXYEXINUS middle	A. cruciformis 1-4% 11	CRETACEA lower	I. cretacea 11b
	12 A. cruciformis 10%+	PORIFERA	
APOXYEXINUS lower	12a A. cruciformis 10%+		O. porifera 12b
MAWSONII	A. distocarinatus 12c	STRIATOCONUS	
	consistent 13 A. distocarinatus	INFUSORIOIDES	C. edwardsii 14
	P. mawsonii 15a		C. edwardsii ● 15
DISTOCARINATUS			C. edwardsii ● 15b
	common saccates A. cruciformis		dinoflagellates

FIGURE 2 ZONATION USED HEREIN SHOWING THE NUMBERED HORIZONS AGAINST THE EXISTING FORMAL ZONATION.

● = frequent (4–10%) ⬤ = common (11–30%)

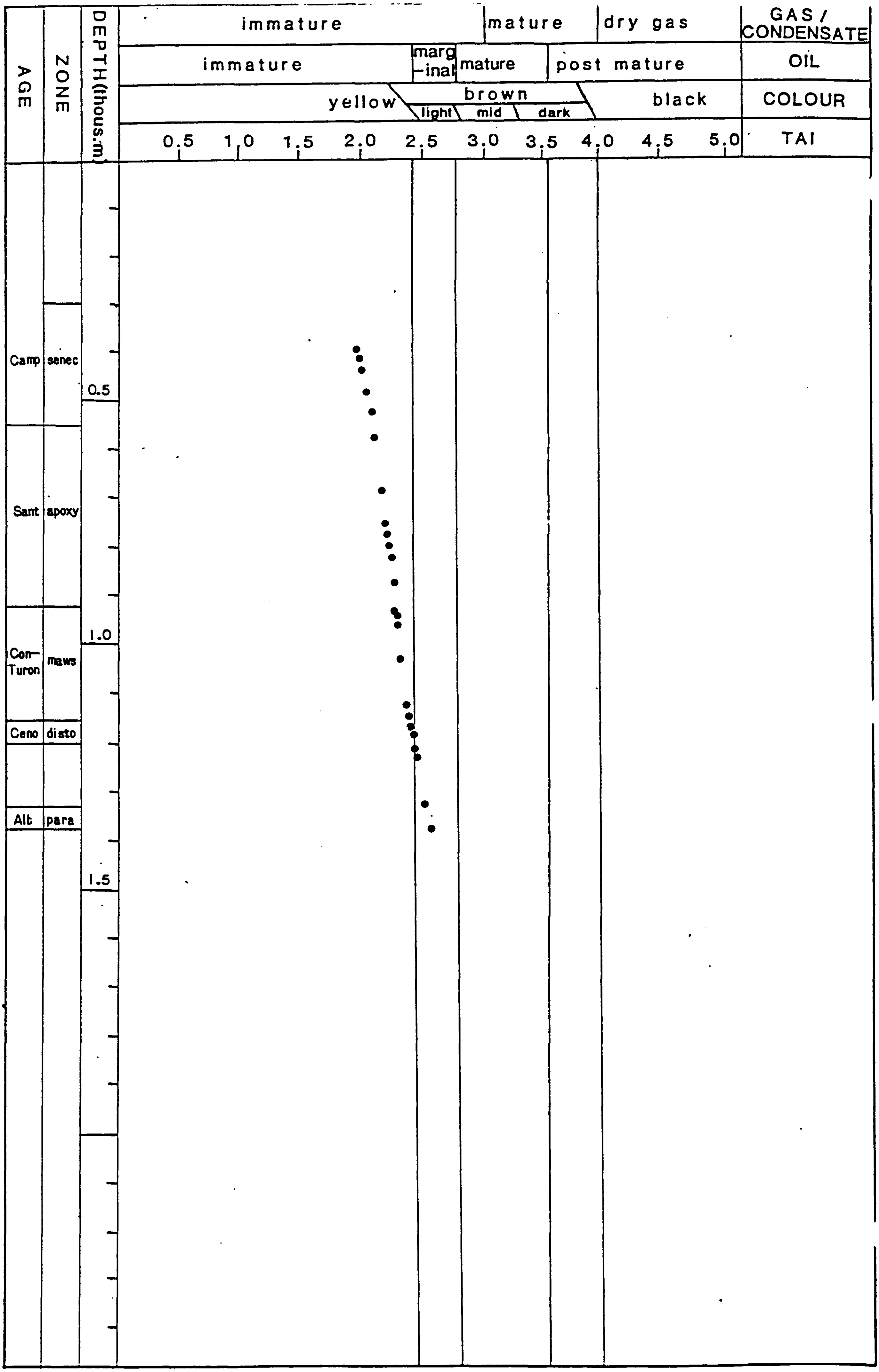


FIGURE 3 MATURITY PROFILE, BHPP : LOCH ARD-1

(g) wash out over 10 micron polyester sieve

(h) add 5% KOH to dissolve humic acids

(i) wash out over 10 micron polyester sieve

(j) examine under microscope for satisfactory oxidation. repeat steps f to g if required

(k) heavy liquid separation using $ZnBr_2$ solution (SG of 2.0)

(l) wash out float fraction using polyester sieve. Acidify if $Zn(OH)_2$ precipitate forms

(m) dehydrate onto coverslip

(n) mount microscope slides using Eukitt medium.

Sample examination usually involved the following steps:

(a) scan two traverses at x10 to log the bulk of the assemblage and get some idea of age

(b) scan at x40 and count the first 100 specimens to get percentage contents for each species. From this, saline "Microplankton Content" (%) can be developed to provide an index of marine influence. Where the sample is too lean to provide 100 specimens, frequency is estimated from the specimens seen with A=abundant, C=common, F=frequent, R=rare

(c) return to x10 to scan at least two large coverslips to log rare species, and finalise age conclusions. Log more slides if required.

(d) develop "Saline Microplankton Diversity" by counting up total species identified of dinoflagellates plus spiny acritarchs, as a second index of marine influence. This count includes species seen both inside and outside the court.

(e) develop "Freshwater Microplankton Content" by totally all freshwater algal elements (*Botryococcus*, *Schizosporis*, *Paralecaniella*, *Leiosphaeridia*, *Nummus*).

(f) examine sieved kerogen slide for specimens of *Cyathidites* to establish spore colour for Spore Colour Maturity Index.

III PALYNOSTRATIGRAPHY

A 402.5m(swc), 430.0m(swc) : upper *senectus* Zone (lower *australis* Dino Zone)

Assignment to the upper *Nothofagidites senectus* Spore Pollen Zone of Campanian age is indicated at the top by the absence of younger markers and at the base by oldest *Gambierina rudata*. Common forms are *Dilwynites granulatus*, *Falcisporites similis* and *Proteacidites* spp. Frequent are *Cyathidites* and *Microcachryidites*. Rare but significant are *Australopollis obscurus*, *Tricolpites sabulosus* and *Nothofagidites* spp. Very rare Permian reworking was seen.

Assignment to the lower *Xenikoon australis* dinoflagellate Zone is indicated at the top by youngest *Nelsoniella semireticulata* and *N. aceras*, and at the base by the continued presence of *X. australis*. All the dinoflagellate species are rare.

Very nearshore marine environments are indicated by the low dinoflagellate content (3% and 7% downhole) and their low diversity. Freshwater algae (*Botryococcus*) are significant at 402.5m suggesting lacustrine environments. Spores and pollen are abundant and diverse, with cuticle frequent at 402.5m.

Yellow spore colours indicate immaturity for hydrocarbons.

B 451.0m(swc), 489.0m(swc) : middle *senectus* Zone (upper *aceras* Dino Zone)

Assignment to the middle *N. senectus* Spore Pollen Zone of Campanian age is indicated at the top by the absence of younger markers and at the base by oldest *T. sabulosus*. Rare but significant are *Nothofagidites* spp, *Ornamentifera sentosa* and *Tricolpites gillii*. Common taxa are *F. similis* and *Proteacidites* spp. Frequent are *A. obscurus*, *Cyathidites minor*, *Dilwynites*, *M. antarcticus* and *Phyllocladidites mawsonii*. *T. sabulosus* is frequent at 430m and 451m. Minor Permian reworking was seen.

Assignment to the upper *Nelsoniella aceras* Dinoflagellate Zone is indicated at the top by youngest *Nelsoniella tuberculata* and at the base by oldest *X. australis*. Rare but significant species include *Areosphaeridium suggestium*, *Isabelidinium cretaceum* and *N. aceras*. No dinoflagellate species are frequent, but *Heterosphaeridium* spp are consistent.

Nearshore marine environments are indicated by the low dinoflagellate content (11% and 6% downhole) and diversity. Spores and pollen are abundant and diverse and cuticle fragments are common at 489m.

Yellow spore colours indicate immaturity for hydrocarbons.

C 534.5m(swc) : lower *senectus* Zone (lower to middle *aceras* Dinoflagellate Zone)

Assignment to the lower *N. senectus* Spore Pollen Zone is indicated at the top by the absence of younger markers, and at the base by oldest *N. endurus*. Rare elements include *A. obscurus*, *O. sentosa* and *Tricolporites apoxyexinus*. Common taxa are *Cyathidites minor*, *Dilwynites*, *Falcisporites similis* and *Proteacidites*. Frequent is *M. antarcticus*. Minor Permian reworking was seen.

Assignment to the lower or middle *N. aceras* Dinoflagellate Zone is indicated at the top by youngest *Odontochitina obesa* and at the base by oldest *Nelsoniella aceras* in swcs. *Heterosphaeridium heteracanthum* is frequent with *Isabelidinium cretaceum* and *Odontochitina operculata* consistent. A single *Amphidiadema denticulata* is considered reworked and rare *Heterosphaeridium cf laterobrachius*, *Odontochitina porifera* and *N. aceras* are age significant.

Nearshore marine environments are indicated by the low dinoflagellate content (14%) and diversity. Spores and pollen are abundant and diverse.

Yellow spore colours indicate immaturity for hydrocarbons.

D 575.0m(swc), 650-70m(cutts) : upper *apoxyexinus* Zone (575m upper *cretacea* Dino Zone, 650-70m lower *cretacea* Dino Zone)

Assignment to the upper *Tricolporites apoxyexinus* Zone of Santonian age is indicated at top and base by the absence of younger and older markers respectively and confirmed by the dinoflagellate data. *T. apoxyexinus* occurs at 575m, and the single *Appendicisporites distocarinatus* at 670m is considered reworked. Common are *Cyathidites* spp, *Dilwynites*, *Falcisporites* and

Microcachryidites. *Proteacidites* spp are frequent here, but not below, confirming the subzone. *A. cruciformis* is very rare, as is Permian reworking.

At 575m, the presence of *Isabelidinium belfastense rotundata* and *Amphiadema denticulata* indicate the upper *Isabelidinium cretaceum* Dinoflagellate Zone. *Odontochitina porifera* and *Heterosphaeridium cf laterobrachius* are also present, but no dinoflagellates are frequent. At 670m, oldest *I. cretaceum* with *Isabelidinium rectangulare rectangulare* and without younger markers considered in place, indicates the lower *I. cretaceum* Zone. Again, no dinoflagellates are frequent, but *Heterosphaeridium heteracanthum* is the most consistent.

Nearshore marine environments are indicated by low dinoflagellate content (5% and 9% downhole) and diversity, with spores and pollen abundant and diverse.

Yellow spore colours indicate immaturity for hydrocarbons.

E 762.0m(swc), 788.0m(swc) : middle *apoxyexinus* Zone (788.0m upper *porifera* Dino Zone)

Assignment to the middle *T. apoxyexinus* Zone of Santonian age is indicated at the top by youngest frequent *A. cruciformis* (4%) and at the base by the absence of older markers. Common are *Cyathidites* and *Falcisporites*. Frequent are *A. cruciformis*, *Dilwynites*, *Microcachryidites* and *Osmundacidites*. *Proteacidites* are very rare here and below. Very rare Permian and Triassic reworking are seen. *T. apoxyexinus* was not seen.

Dinoflagellates are scarce but include *Isabelidinium rectangulare* at 788m without younger markers, indicating the upper *Odontochitina porifera* Zone. Rare taxa include *O. porifera* (788m) and *Odontochitina cribropoda* (762m), confirming the assignment. The most frequent dinoflagellate is *H. heteracanthum* in both samples. *Trithyrodinium marshalli* and *Circulodinium deflandrei* are consistent.

Nearshore marine environments are indicated by the low dinoflagellate content (7% and 13% downhole) and diversity with abundant and diverse spores and pollen.

F 820.0m(swc), 837.0m(swc), 875-90m(cutts), 915-25m(cutts) : lower *apoxyexinus* Zone

Assignment to the lower *T. apoxyexinus* Zone of Santonian age is indicated at the top by the downhole influx of *A. cruciformis* and at the base by the absence of older markers. At 837m, *A. cruciformis* is 16% of the assemblage and the lower *T. apoxyexinus* Zone has certainly been penetrated. At 820m however, *A. cruciformis* is only 7% of the assemblage, and so somewhat transitional from the middle *apoxyexinus* Zone. Common taxa are *Cyathidites*, and *Falcisporites*. Frequent to common are *A. cruciformis*, *Dilwynites* and *Microcachryidites*. Rare Permian and Triassic reworking was seen, and inertinite dominates several assemblages.

Dinoflagellates are rare and lack zonal markers. *Trithyrodinium marshalli* is persistent to the interval base but not below and may have future potential. *C. deflandrei* is consistent throughout. *Isabelidinium balmei* occurs at 837m only. *Heterosphaeridium* spp and *Botryococcus* are the most frequent microplankton.

Environments are nearshore to very nearshore marine, as shown by low dinoflagellate content (6%, 7%, 9%, 1% downhole) and diversity, and dominant and diverse spores and pollen. Significant lacustrine influence is seen at 820m, 890m, and 925m as shown by significant freshwater algal *Botryococcus* (4%, 3% and 8%).

Yellow spore colours indicate immaturity for hydrocarbons.

G 927.0m(swc) : indeterminate

This sample was virtually barren, with only minor inertinite and extremely rare spores and pollen recovered.

H 954.0m(swc), 1022.0m(swc) : upper *mawsonii* Zone

Assignment to the upper *Phyllocladidites mawsonii* Zone of Coniacian-Turonian age is indicated at the top by youngest *Appendicisporites distocarinatus* and at the base by the downhole decrease in *Amosopollis cruciformis* (4% and 7% within the subzone, 1% or less below it). At the zone top, *Dilwynites* becomes more frequent, and *A. cruciformis* becomes less frequent. Within the zone, *Cyathidites*, *Dilwynites*, *Falcisporites* and

Microcachryidites are common, with *A. cruciformis* and *Podosporites microsaccatus* frequent. *A. distocarinatus* is very rare but consistent. Very rare Permian reworking was seen.

Dinoflagellates are very rare and mostly longranging. Youngest *Aptea* sp occurs at 954m and may have future potential. *H. heteracanthum* and *Botryococcus* continue to be the most frequent forms.

Very nearshore marine environments are indicated by low dinoflagellate content (5% and 2% downhole) and diversity with significant lake influence suggested by freshwater algal *Botryococcus* (2% and 8% downhole). Spores and pollen are common and diverse.

Yellow spore colours indicate immaturity for hydrocarbons.

I 1048.0m(swc) : *mawsonii* Zone, subzone indeterminate

This sample was extremely lean with minor inertinite and very rare palynomorphs. The presence of *P. mawsonii* indicates that zone, but it cannot be assigned to either subzone. Microplankton are very rare but only freshwater algal taxa were seen (*Botryococcus* and *Shizosporis*) suggesting non-marine lacustrine environments.

J 1107.0m(swc), 1150.0m(swc): lower *mawsonii* Zone

Assignment to the lower *P. mawsonii* Zone is indicated at the top by a downhole decrease in *A. cruciformis* (from around 5% above, to <1% in this subzone), and at the base by oldest *P. mawsonii*. Common are *Cyathidites*, *Dilwynites* and *Falcisporites* with *Gleicheniidites* abundant at 1150m only. Frequent are *Microcachryidites*. *A. distocarinatus* is very rare but consistent. Very rare Permian reworking was seen.

Dinoflagellates are extremely rare and not age diagnostic.

Environments are non-marine to slightly brackish with only one or two dinoflagellate specimens seen in each sample. Freshwater algal *Botryococcus* is frequent at 1107m and rare at 1150m suggesting lacustrine influence. Spores and pollen are abundant and diverse, with large cuticle fragments very common at 1107m.

Yellow to light brown spore colours indicate immaturity for hydrocarbons, but approaching early marginal maturity for oil.

K 1186.0m(swc), 1188.0m(swc), 1200.0m(swc) : *distocarinatus* Zone (*infusorioides* Dino Zone at 1200m)

Assignment to the *Appendicisporites distocarinatus* Zone of Cenomanian age is indicated at the top by the absence of younger markers and at the base by oldest *A. distocarinatus* and the absence of older markers. *Falcisporites similis* is abundant with *Cyathidites*, *Dilwynites* and *Microcachryidites* frequent to common. *A. distocarinatus* is rare but consistent and *Liliacidites kaitangataensis* and *Senectotetradites varireticulatus* occur at 1186 only. Permian and Triassic reworking are consistent and some Early Cretaceous taxa are reworked, especially at 1188m.

Dinoflagellates are present only at 1200m and include *Cribroperidinium edwardsii*, indicating the *Palaeohystrichophora infusorioides* Dinoflagellate Zone. All species are extremely rare.

Environments are non-marine lacustrine at 1186 and 1188m, shown by the total absence of dinoflagellates, frequent freshwater *Botryococcus* (10% and 3%), and diverse spores and pollen. At 1200m, marginally marine to brackish environments are shown by very rare dinoflagellates (2%), their very low diversity (3 species) and *Botryococcus* content (3%). Pollen and spores are abundant and diverse.

Yellow to light brown spore colours indicate immaturity for hydrocarbons, approaching early maturity for oil.

L 1208.0m(swc), 1329.0m(swc) : indeterminate

These two samples are extremely lean, yielding rare inertinite and very rare spores and pollen. Some of the spore pollen are clearly caved (*T. sabulosus*). No microplankton were seen but two few palynomorphs were observed to consider this diagnostic of non-marine environments.

M 1344-59m(cutts) : *paradoxa* Zone

Assignment to the *Coptospora paradoxa* Zone of Albian age is indicated at the top by youngest *C. paradoxa* (coincident with the downhole influx of fern spores including *Cicatricosisporites australiensis*, *Crybelosporites striatus*, *Foraminisporis asymmetricus*, *Trilobosporites trioreticulatus* and *Triporoletes bireticulatus)* and at the base on oldest *C. paradoxa*. Common are *Cyathidites minor*, *Falcisporites similis* and *Microcachryidites* while *C. australiensis* is frequent. *Senectotetradites varireticulatus* is also present.

Slightly brackish environments are favoured by very rare spiny acritarchs and a single dinoflagellate species. These could be caved in these cuttings, but the absence of other obvious caving suggests that they are probably in place. *Botryococcus* is very rare but spores and pollen are abundant and diverse.

Light brown spore colours suggest marginal maturity for oil but immaturity for gas/condensate.

IV CONCLUSIONS

The sampled section comprises the early Campanian to Albian (upper *senectus* to *paradoxa* Zones) in nearshore, marginally marine and non-marine environments. At the base, Albian Eumeralla Formation is securely dated in brackish environments. The Cenomanian *distocarinatus* Zone is marginally marine at the base, but shallows to freshwater lakes at the top. The Turonian lower *mawsonii* Zone is brackish while the Turonian-Coniacian upper *mawsonii* Zone deepens to become very nearshore marine. Further deepening occurs into the nearshore to very nearshore Santonian lower *apoxyexinus* Zone, then into the nearshore Santonian-Campanian middle *apoxyexinus* to middle *senectus* Zones. Above that, shallowing again occurs into the very nearshore marine Campanian upper *senectus* Zone. Younger section was not sampled.

At the base, the section is only marginally mature.

V REFERENCES

Dettmann ME and Playford G (1969) Palynology of the Australian Cretaceous : a review **In** Stratigraphy and Palaeontology. Essays in honour of Dorothy Hill, **KSW Campbell ED.** ANU Press, Canberra 174-210

Helby RJ, Morgan RP and Partridge AD (1987) A palynological zonation of the Australian Mesozoic **In** Studies in Australian Mesozoic Palynology **Assoc. Australas. Palaeontols. Mem 4** 1-94

Morgan RP (1992) Overview of new cuttings based Late Cretaceous correlations, Otway Basin, Australia **unpubl. rept. for BHPP**

Partridge AD (1976) The geological expression of eustacy in the early Tertiary of the Gippsland Basin **APEA J 16(1)** 73-79.

BASIN: OTWAY SPORE-POLLEN ZONES — ELEVATION: — KB: — GL:

WELL NAME: LOCH ARD-1 — TOTAL DEPTH:

AGE		PALYNOLOGICAL ZONES	HIGHEST DATA Preferred Depth	Rtg	HIGHEST DATA Alternate Depth	Rtg	LOWEST DATA Preferred Depth	Rtg	LOWEST DATA Alternate Depth	Rtg
NEOGENE	Plei	T. pleistocenicus								
	Plio	M. lipsus								
	Mio	C. bifurcatus								
		T. bellus								
		P. tuberculatus								
	Olig	upper N. asperus								
PALEOGENE	L.Eo	mid N. asperus								
	Mid Eo	lower N. asperus								
		P. asperopolus								
	Earl Eo	upper M. diversus								
		mid M. diversus								
		lower M. diversus								
	Pale	upper L. balmei								
		lower L. balmei								
LATE CRETACEOUS	Maas	upper T. longus								
		lower T. longus								
		T. lillei								
	Camp	N. senectus ♆	403	1			535	0		
	Sant	up T. apoxyexinus ♆	575	2			670	5		
		mid T. apoxyexinus ♆	762	0			788	1		
	Con	low T. apoxyexinus ♆	820	0			925	5		
	Tur	P. mawsonii ✡/♆	954	1			1150	0		
	Ceno	A. distocarinatus Ø/✡	1186	2			1200	1		
EARLY CRETACEOUS	Alb	P. pannosus								
		upper C. paradoxa ✡	1344	3						
		lower C. paradoxa					1395	4		
		C. striatus								
	Apt	upper C. hughesi								
		lower C. hughesi								
	l.Ne	F. wonthaggiensis								
	e.Ne	up C. australiensis								

Environments :

- o lacustrine (algal acritarchs).
- Ø non-marine (no or very few 5% algal acritarchs).
- ✡ brackish (spiny acritarch, no or very few dinoflagellates 1%).
- ✡/♆ marginal marine (1-5% very low diversity dinoflagellates).
- ♆ nearshore marine (6-30% low to medium diversity dinoflagellates).
- ♆/♆♆ intermediate marine (31-60% medium diversity dinoflagellates).
- ♆♆ offshore marine (61%-80% medium to high diversity dinoflagellates).
- ⊖ far offshore marine/oceanic (81%-100% high diversity dinoflagellates and/or planktonic forams).

Confidence Ratings :

0 : good to excellent with numerous zone fossils in core/swc.
1 : fair with rare zone fossils in core/swc.
2 : poor with non-diagnostic assemblage in core/swc. Often occurs next to a distinctive 0 to 1 rating, lacking the zone fossil seen adjacent.
3 : good with extinction event (top range) in cuttings.
4 : poor to fair with inception event (base range) in cuttings and therefore may be picked too low if caved or too high if swamped by cavings.
5 : poor with non-diagnostic assemblage in cuttings. Usually seen adjacent to a higher rating and picked on the absence of key zone fossil.
? : no confidence. Picked as a best guess in very poor data.

Data recorded by : Roger Morgan May 94

Data revised by : Roger Morgan May 94

PALYNOLOGICAL DATA SHEET

BASIN: OTWAY DINOFLAGELLATE ZONES ELEVATION: KB:__________ GL:__________

WELL NAME: LOCH ARD-1 TOTAL DEPTH:__________

AGE		PALYNOLOGICAL ZONES	HIGHEST DATA				LOWEST DATA			
			Preferred Depth	Rtg	Alternate Depth	Rtg	Preferred Depth	Rtg	Alternate Depth	Rtg
LATE CRETACEOUS	Maas	M. druggii								
	Camp	I. korojonense								
	Camp	upper X. australis								
	Camp	lower X. australis ✡/♀	403	1			430	0		
	Sant	N. aceras ♀	451	1			534	0		
	Sant	I. cretaceum ♀	575	0			670	4		
	Con	O. porifera ♀	788	2			788	0		
	Turo	C. striatoconus								
	Ceno	P. infusorioides ✡	1200	1			1200	1		

Environments :

- o lacustrine (algal acritarchs).
- Ø non-marine (no or very few 5% algal acritarchs).
- ✡ brackish (spiny acritarch, no or very few dinoflagellates 1%).
- ✡/♀ marginal marine (1-5% very low diversity dinoflagellates).
- ♀ nearshore marine (6-30% low to medium diversity dinoflagellates).
- ♀/♀♀ intermediate marine (31-60% medium diversity dinoflagellates).
- ♀♀ offshore marine (61%-80% medium to high diversity dinoflagellates).
- ⊖ far offshore marine/oceanic (81%-100% high diversity dinoflagellates and/or planktonic forams).

Confidence Ratings :

0 : good to excellent with numerous zone fossils in core/swc.
1 : fair with rare zone fossils in core/swc.
2 : poor with non-diagnostic assemblage in core/swc. Often occurs next to a distinctive 0 to 1 rating, lacking the zone fossil seen adjacent.
3 : good with extinction event (top range) in cuttings.
4 : poor to fair with inception event (base range) in cuttings and therefore may be picked too low if caved or too high if swamped by cavings.
5 : poor with non-diagnostic assemblage in cuttings. Usually seen adjacent to a higher rating and picked on the absence of key zone fossil.
? : no confidence. Picked as a best guess in very poor data.

Data recorded by : Roger Morgan May 94

Data revised by : Roger Morgan May 94

MORGAN PALAEO ASSOCIATES ... Palynological Consultants
Box 161, Maitland, South Australia, 5573.
phone (088) 32 2795 ... fax (088) 32 2798

C L I E N T: BHP PETROLEUM
W E L L: LOCH ARD #1
F I E L D / A R E A: OFFSHORE OTWAY BASIN

A N A L Y S T: ROGER MORGAN DATE : APRIL 1994
N O T E S: ALL DEPTHS ARE IN METRES
ALL FIGURES ARE PERCENTAGES BASED ON 100 SPECIMEN COUNT
"X" REPRESENTS RARE PRESENCE OUTSIDE THE COUNT
"A"= ABUNDANT, "C"= COMMON, "F"= FEW, "R" = RARE

RANGE CHART OF OCCURRENCES BY LOWEST APPEARANCE WITHIN GROUP

No.	Taxon	0402.5 SWC	0430.0 SWC	0451.0 SWC	0489.0 SWC	0534.5 SWC	0575.0 SWC	0650-70 CUTTS	0762.0 SWC	0788.0 SWC	0820.0 SWC	0837.0 SWC	0875-90 CUTTS	0915-25 CUTTS	0927.0 SWC	0954.0 SWC	1022.0 SWC	1048.0 SWC	1107.0 SWC	1150.0 SWC	1186.0 SWC	1188.0 SWC	1200.0 SWC	1208.0 SWC	1329.0 SWC	1344-59 CUTTS
1	MICROPLANKTON -FRESHWATER- %	2	0	0	<1	0	1	1	0	0	4	5	3	8	8	2	8	.	8	1	10	3	3	.	.	1
2	MICROPLANKTON -SALINE- %	3	7	11	6	14	5	9	7	13	6	7	9	1	.	5	2	.	<1	<1	0	0	2	.	.	<1
3	MICROPLANKTON -SALINE- DIVERSITY	6	13	11	10	19	14	18	7	11	5	7	6	4	4	3	5	.	1	2	0	0	3	.	.	2
4	MICRHYSTRIDIUM	2	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
5	ODONTOCHITINA OPERCULATA	.	1	.	1	2	X	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
6	CRIBROPERIDINIUM EDWARDSII	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
7	CYCLONEPHELIUM COMPACTUM	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	X	.	.	X	.	.	.
8	HETEROSPHAERIDIUM CONJUNCTUM	.	.	1	.	X	.	.	.	.	.	.	.	X	.	.	X	.	X	.	.	.	1	.	.	.
9	CYMATIOSPHAERA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.
10	CIRCULODINIUM SOLIDA	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.
11	HETEROSPHAERIDIUM HETEROCANTHUM	.	X	1	1	5	2	2	2	9	3	1	5	1	.	2	1	.	.	.	.	.	.	.	.	.
12	HETEROSPHAERIDIUM SOLIDA	.	.	.	.	X	.	X	.	1	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.
13	OLIGOSPHAERIDIUM COMPLEX	.	X	.	.	.	X	.	.	1	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.
14	SPINIFERITES FURCATUS/RAMOSUS	.	1	1	2	.	.	.	.	1	2	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.
15	APTEA SP	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.
16	CIRCULODINIUM DEFLANDREI	.	.	.	.	.	.	X	X	X	.	3	1	X	.	3	.	.	.	.	.	.	.	.	.	.
17	KIOKANSIUM POLYPES	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
18	TRITHYRODINIUM MARSHALLII	.	1	X	1	X	.	1	3	1	X	1	X	X	.	.	.	.	.	.	.	.	.	.	.	.
19	CHATANGIELLA MICROCANTHA	.	.	.	.	.	.	X	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.
20	EXOCHOSPHAERIDIUM PHRAGMITES	.	.	.	.	X	X	1	.	X	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
21	ODONTOCHITINA PORIFERA	.	X	.	.	1	X	.	.	X	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
22	CALLAOISPHAERIDIUM ASYMMETRICUM	.	.	.	1	X	.	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	ISABELIDINIUM BALMEI	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
24	PALAEOHYSTRICHOSPHORA INFUSORIOIDES	.	X	2	.	1	X	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.
25	TRITHYRODINIUM PUNCTATE	.	.	.	.	.	2	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.
26	XENASCUS CERATOIDES	.	.	.	.	X	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	CHATANGIELLA TRIPARTITA	.	.	.	.	.	.	.	X	X	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
28	ISABELIDINIUM RECTANGULARE CONTRACTUM	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29	ISABELIDINIUM RECTANGULARE DIVERSUM	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30	ISABELIDINIUM COOKSONIAE	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31	ODONTOCHITINA CRIBROPODA	.	.	.	.	2	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
32	ISABELIDINIUM BELFASTENSE	.	.	.	.	.	.	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
33	ISABELIDINIUM BELFASTENSE ROTUNDATA	.	.	.	.	?	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
34	ISABELIDINIUM CRETACEUM	.	.	.	X	3	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
35	ISABELIDINIUM RECTANGULARE RECTANGULARE	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
36	NELSONIELLA ACERAS	X	X	1	X	1	?	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
37	NELSONIELLA TUBERCULATA	.	.	X	X	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
38	ODONTOCHITINA STUBBY	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

No.	Species	0402.5 SWC	0430.0 SWC	0451.0 SWC	0489.0 SWC	0534.5 SWC	0575.0 SWC	0650-70 CUTTS	0762.0 SWC	0788.0 SWC	0820.0 SWC	0837.0 SWC	0875-90 CUTTS	0915-25 CUTTS	0927.0 SWC	0954.0 SWC	1022.0 SWC	1048.0 SWC	1107.0 SWC	1150.0 SWC	1186.0 SWC	1188.0 SWC	1200.0 SWC	1208.0 SWC	1329.0 SWC	1344-59 CUTTS
39	TRITHYRODINIUM THICK RETIC	.	.	.	.	.	1	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
40	AMPHIDIADEMA DENTICULATA	.	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
41	CANNINGIA SP	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
42	EURYDÎNIUM INGRAMII	.	.	X	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
43	HETEROSPHAERIDIUM CF LATEROBRACHIUS	.	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
44	MADURADINIUM PENTAGONUM	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
45	EUCLADINIUM MADURENSE	.	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
46	NELSONIELLA PSILATE	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
47	ODONTOCHITINA OBESA	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
48	ODONTOCHITINA OBESOPORIFERA	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
49	AREOSPHAERIDIUM SUGGESTIUM	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
50	XENIKOON AUSTRALIS	X	2	3	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
51	PTEROSPERMELLA AUREOLATA	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
52	GILLINIA HYMENOPHORA	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
53	MILLIOUDIDINIUM TENUITABULATUS	1	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
54	OLIGOSPHAERIDIUM PULCHERRIMUM	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
55	NELSONIELLA SEMIRETICULATA	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
56	SUBTILISPHAERA SP	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
57	AEQUITRIRADITES VERRUCOSUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	X
58	ARAUCARIACITES AUSTRALIS	1	3	1	1	.	1	1	2	.	.	1	2	1	.	.	5	X	2	2	2	2	3	.	.	1
59	BALMEISPORITES HOLODICTYUS	.	X	X	X	X	.	X	.	.	.	.	X	.	.	X	.	.	.	.	.	.	.	.	.	X
60	CALLIALASPORITES DAMPIERI	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	1	X	.	.	X
61	CERATOSPORITES EQUALIS	.	X	1	1	1	2	3	3	2	2	3	1	1	.	1	.	.	2	2	1	.	3	.	.	1
62	CICATRICOSISPORITES AUSTRALIENSIS	.	.	2	.	1	.	2	1	.	1	1	.	1	.	1	X	X	2	X	.	1	4	.	.	7
63	CONTIGNISPORITES COOKSONIAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
64	COPTOSPORA PARADOXA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
65	COROLLINA TOROSUS	2	1	1	.	1	2	1	3	2	3	1	2	2	X	1	1	X	2	2	.	2	1	.	.	2
66	CRYBELOSPORITES STRIATUS	.	.	.	.	.	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
67	CYATHIDITES AUSTRALIS	1	1	2	1	1	2	1	8	3	1	3	1	3	.	4	1	X	1	2	1	4	3	.	X	3
68	CYATHIDITES MINOR	3	7	4	5	12	10	8	7	15	15	13	11	10	.	12	8	X	14	8	8	16	11	.	X	26
69	DICTYOTOSPORITES SPECIOSUS	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	X	.	.	X
70	FALCISPORITES GRANDIS	3	4	2	2	3	6	3	5	3	2	4	5	3	X	6	1	.	1	1	1	8	4	.	.	2
71	FALCISPORITES SIMILIS	16	14	16	17	19	20	17	22	22	20	19	16	25	X	10	18	X	8	14	36	34	19	.	X	23
72	FORAMINISPORIS ASYMMETRICUS	.	X	1	.	X	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	X	.	.	.	X
73	GLEICHENIIDITES	1	4	2	4	2	2	9	1	2	7	2	3	3	.	1	3	.	1	35	5	2	1	.	X	2
74	ISCHYOSPORITES PUNCTATUS	.	.	.	1	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
75	KUYLISPORITES "ZIPPERI"	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
76	MICROCACHRYIDITES ANTARCTICUS	3	8	7	8	7	10	8	9	8	6	14	8	8	.	5	11	.	9	5	16	3	7	.	X	16

No.	Species	0402.5 SWC	0430.0 SWC	0451.0 SWC	0489.0 SWC	0534.5 SWC	0575.0 SWC	0650-70 CUTTS	0762.0 SWC	0788.0 SWC	0820.0 SWC	0837.0 SWC	0875-90 CUTTS	0915-25 CUTTS	0927.0 SWC	0954.0 SWC	1022.0 SWC	1048.0 SWC	1107.0 SWC	1150.0 SWC	1186.0 SWC	1188.0 SWC	1200.0 SWC	1208.0 SWC	1329.0 SWC	1344-59 CUTTS
77	OSMUNDACIDITES WELLMANII	2	3	3	5	1	1	1	4	4	2	1	1	1	.	2	1	.	1	1	3	4	2	X	X	9
78	PEROTRILETES JUBATUS/MORGANII	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.	X	.	.	1	.	.	.	.	.	X
79	PODOSPORITES MICROSACCATUS	5	1	2	6	3	4	6	1	5	2	6	7	3	.	4	3	.	2	5	4	1	8	.	X	3
80	RETITRILETES AUSTROCLAVATIDITES	2	4	1	1	2	1	1	3	2	4	1	1	2	.	2	1	.	1	1	1	5	3	.	X	1
81	SENECTOTETRADITES VARIRETICULATUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	X
82	TRILOBOSPORITES TRIORETICULOSUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	X
83	TRIPOROLETES BIRETICULATUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
84	TRIPOROLETES SIMPLEX	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X
85	VITREISPORITES PALLIDUS	.	4	5	4	2	1	2	4	3	1	.	2	X	.	X	5	.	1	1	1	2	3	.	.	2
86	STERIESPORITES ANTIQUASPORITES	1	1	1	3	1	1	1	1	2	3	1	1	2	.	1	2	.	1	1	1	2	1	.	X	.
87	TRICOLPITES GILLII	3	.	1	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.
88	TRICOLPITES SABULOSUS	3	4	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.
89	APPENDICISPORITES DISTOCARINATUS	.	.	.	.	.	.	X	.	.	.	.	.	.	.	X	X	.	X	X	X	?	X	.	.	.
90	CICATRICOSISPORITES HUGHESI	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
91	CLAVIFERA TRIPLEX	.	X	1	1	1	.	1	.	.	1	X	.	X	.	2	.	.	.	.	.	.	1	.	.	.
92	CYCADOPITES FOLLICULARIS	1	.	.	.	1	1	.	.	.	1	X	2	.	.	X	1	.	2	2	.	X	2	.	.	.
93	DICTYOTOSPORITES COMPLEX	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
94	DILWYNITES GRANULATUS	13	10	4	5	10	8	10	7	5	8	5	12	11	.	28	19	.	33	10	7	5	13	.	.	.
95	FORAMINISPORIS DAILYI	.	.	.	.	.	X	X	1	X	.	X	.	.	.	X	.	.	X	.	.	X	X	.	.	.
96	KLUKISPORITES SCABERIS	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	X	X	.	.	.
97	KUYLISPORITES LUNARIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
98	LAEVIGATOSPORITES OVATUS	5	.	.	1	.	.	.	.	.	1	.	.	.	.	1	.	X	.	1	2	.	2	.	.	.
99	LYCOPODIACIDITES ASPERATUS	1	.	.	.	.	.	1	1	.	X	1	1	.	.	1	1	.	3	.	.	X	1	.	.	.
100	CALLIALASPORITES TURBATUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
101	CYCLOSPORITES HUGHESI	.	.	.	.	.	X	.	.	.	.	.	.	.	.	X	.	.	.	.	.	X	.	.	.	.
102	FORAMINISPORIS WONTHAGGIENSIS	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.
103	LEPTOLEPIDITES MAJOR	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.
104	PILOSISPORITES GRANDIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.
105	PILOSISPORITES NOTENSIS	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.
106	RETITRILETES CIRCOLUMENUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.
107	VELOSPORITES TRIQUETRUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.
108	CINGUTRILETES CLAVUS	.	1	.	1	.	.	1	1	1	.	X	1	.	.	1	1	.	1	1	1	.	.	.	.	.
109	LILIACIDITES KAITANGATAENSIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.
110	CAMEROZONOSPORITES SOLIDA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	1	.	.	.	.	.	.
111	COPTOSPORA PILEOSA	X	X	.	.	.	X	1	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.
112	DENSOISPORITES VELATUS	.	.	.	.	X	.	.	.	.	.	X	.	.	.	.	.	.	.	1	.	.	.	.	.	.
113	PHYLLOCLADIDITES EUNUCHUS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
114	PHYLLOCLADIDITES MAWSONII	2	5	6	4	2	3	2	1	3	2	1	2	5	.	2	.	X	1	X	.	.	.	.	.	.

No.	Species	0402.5 SWC	0430.0 SWC	0451.0 SWC	0489.0 SWC	0534.5 SWC	0575.0 SWC	0650-70 CUTTS	0762.0 SWC	0788.0 SWC	0820.0 SWC	0837.0 SWC	0875-90 CUTTS	0915-25 CUTTS	0927.0 SWC	0954.0 SWC	1022.0 SWC	1048.0 SWC	1107.0 SWC	1150.0 SWC	1186.0 SWC	1188.0 SWC	1200.0 SWC	1208.0 SWC	1329.0 SWC	1344-59 CUTTS
115	TRIPOROLETES RETICULATUS	1	X	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	X	.	.	.	.	.	.
116	AMOSOPOLLIS CRUCIFORMIS	.	.	1	X	1	2	1	4	4	7	16	6	5	.	4	7	.	1	.	.	.	.	.	.	.
117	LEPTOLEPIDITES VERRUCATUS	.	.	.	.	X	.	.	.	.	.	.	.	1	.	X	.	.	X	.	.	.	.	.	.	.
118	AUSTRALOPOLLIS OBSCURIS	X	1	3	9	1	5	2	.	.	.	X	.	.	.	3	.	.	.	.	.	.	.	.	.	.
119	PHIMOPOLLENITES PANNOSUS	.	.	.	.	X	2	.	1	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
120	CAMEROZONOSPORITES OHAIENSIS	1	.	1	X	X	2	.	.	X	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.
121	FOVEOTRILETES PARVIRETUS	.	.	.	.	.	.	.	.	.	.	X	1	.	.	.	.	.	.	.	.	.	.	.	.	.
122	MUROSPORA FLORIDA	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.
123	PROTEACIDITES	13	11	12	7	12	5	6	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
124	CYATHEACIDITES TECTIFERA	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.
125	APPENDICISPORITES CF DISTOCARINATUS	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
126	RETITRILETES FACETUS	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
127	RETITRILETES NODOSUS	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
128	ORNAMENTIFERA MINIMA	.	.	.	X	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
129	ORNAMENTIFERA SENTOSA	X	.	.	X	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
130	PROTEACIDITES LARGE	X	X	X	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
131	AEQUITRIRADITES SPINULOSUS	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
132	NEORAISTRICKIA	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
133	TRICOLPORITES APOXYEXINUS	.	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
134	NOTHOFAGIDITES ENDURUS	5	1	1	1	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
135	NOTHOFAGIDITES PROTOSENECTUS	.	.	.	2	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
136	ERICIPITES SCABRATUS	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
137	LYGISTIPOLLENITES FLORINII	.	1	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
138	PHYLLOCLADIDITES VERRUCATUS	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
139	ANAPICULATISPORIS PRISTIDENTATUS	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
140	PERIPOROPOLLENITES POLYORATUS	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
141	GAMBIERINA RUDATA	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
142	NOTHOFAGIDITES SENECTUS	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
143	STERIESPORITES REGIUM	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
144	TRICOLPITES	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
145	TRICOLPITES CONFESSUS	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
146	TRICOLPITES RENMARKENSIS	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
147	TRICOLPORITES LILLIEI	?	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
148	BOTRYOCOCCUS	2	.	.	.	.	.	1	.	.	4	.	3	8	.	2	8	X	8	1	10	3	3	.	.	1
149	SCHIZOSPORIS RETICULATUS	.	.	.	.	.	.	X	.	.	X	.	.	X	.	.	.	X	.	.	.	.	.	.	.	.
150	NUMMUS MONOCULATUS	.	.	.	X	.	1	.	.	.	X	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.
151	REWORKING PERMIAN	X	X	X	X	X	1	.	X	X	.	.	1	3	.	.	1	.	X	.	.	1	1	.	.	.
152	REWORKING TRIASSIC	.	.	.	.	.	.	.	.	X	.	.	.	X	.	.	.	.	.	.	.	X	1	.	.	.

INDEX NUMBER	SPECIES
131	AEQUITRIRADITES SPINULOSUS
57	AEQUITRIRADITES VERRUCOSUS
116	AMOSOPOLLIS CRUCIFORMIS
40	AMPHIDIADEMA DENTICULATA
139	ANAPICULATISPORIS PRISTIDENTATUS
125	APPENDICISPORITES CF DISTOCARINATUS
89	APPENDICISPORITES DISTOCARINATUS
15	APTEA SP
58	ARAUCARIACITES AUSTRALIS
49	AREOSPHAERIDIUM SUGGESTIUM
118	AUSTRALOPOLLIS OBSCURIS
59	BALMEISPORITES HOLODICTYUS
148	BOTRYOCOCCUS
22	CALLAOISPHAERIDIUM ASYMMETRICUM
60	CALLIALASPORITES DAMPIERI
100	CALLIALASPORITES TURBATUS
120	CAMEROZONOSPORITES OHAIENSIS
110	CAMEROZONOSPORITES SOLIDA
41	CANNINGIA SP
61	CERATOSPORITES EQUALIS
19	CHATANGIELLA MICROCANTHA
27	CHATANGIELLA TRIPARTITA
62	CICATRICOSISPORITES AUSTRALIENSIS
90	CICATRICOSISPORITES HUGHESI
108	CINGUTRILETES CLAVUS
16	CIRCULODINIUM DEFLANDREI
10	CIRCULODINIUM SOLIDA
91	CLAVIFERA TRIPLEX
63	CONTIGNISPORITES COOKSONIAE
64	COPTOSPORA PARADOXA
111	COPTOSPORA PILEOSA
65	COROLLINA TOROSUS
6	CRIBROPERIDINIUM EDWARDSII
66	CRYBELOSPORITES STRIATUS
124	CYATHEACIDITES TECTIFERA
67	CYATHIDITES AUSTRALIS
68	CYATHIDITES MINOR
92	CYCADOPITES FOLLICULARIS
7	CYCLONEPHELIUM COMPACTUM
101	CYCLOSPORITES HUGHESI
9	CYMATIOSPHAERA
112	DENSOISPORITES VELATUS
93	DICTYOTOSPORITES COMPLEX
69	DICTYOTOSPORITES SPECIOSUS
94	DILWYNITES GRANULATUS
136	ERICIPITES SCABRATUS
45	EUCLADINIUM MADURENSE
42	EURYDINIUM INGRAMII
20	EXOCHOSPHAERIDIUM PHRAGMITES
70	FALCISPORITES GRANDIS
71	FALCISPORITES SIMILIS
72	FORAMINISPORIS ASYMMETRICUS
95	FORAMINISPORIS DAILYI
102	FORAMINISPORIS WONTHAGGIENSIS
121	FOVEOTRILETES PARVIRETUS
141	GAMBIERINA RUDATA
52	GILLINIA HYMENOPHORA
73	GLEICHENIIDITES
43	HETEROSPHAERIDIUM CF LATEROBRACHIUS
8	HETEROSPHAERIDIUM CONJUNCTUM
11	HETEROSPHAERIDIUM HETEROCANTHUM
12	HETEROSPHAERIDIUM SOLIDA
23	ISABELIDINIUM BALMEI
32	ISABELIDINIUM BELFASTENSE
33	ISABELIDINIUM BELFASTENSE ROTUNDATA
30	ISABELIDINIUM COOKSONIAE
34	ISABELIDINIUM CRETACEUM
28	ISABELIDINIUM RECTANGULARE CONTRACTUM
29	ISABELIDINIUM RECTANGULARE DIVERSUM
35	ISABELIDINIUM RECTANGULARE RECTANGULARE
74	ISCHYOSPORITES PUNCTATUS
17	KIOKANSIUM POLYPES
96	KLUKISPORITES SCABERIS
75	KUYLISPORITES "ZIPPERI"
97	KUYLISPORITES LUNARIS
98	LAEVIGATOSPORITES OVATUS
103	LEPTOLEPIDITES MAJOR
117	LEPTOLEPIDITES VERRUCATUS
109	LILIACIDITES KAITANGATAENSIS
99	LYCOPODIACIDITES ASPERATUS
137	LYGISTIPOLLENITES FLORINII
44	MADURADINIUM PENTAGONUM
4	MICRHYSTRIDIUM
76	MICROCACHRYIDITES ANTARCTICUS
1	MICROPLANKTON -FRESHWATER- %
2	MICROPLANKTON -SALINE- %
3	MICROPLANKTON -SALINE- DIVERSITY
53	MILLIOUDIDINIUM TENUITABULATUS
122	MUROSPORA FLORIDA
36	NELSONIELLA ACERAS
46	NELSONIELLA PSILATE
55	NELSONIELLA SEMIRETICULATA
37	NELSONIELLA TUBERCULATA

.34	NOTHOFAGIDITES ENDURUS
.35	NOTHOFAGIDITES PROTOSENECTUS
.42	NOTHOFAGIDITES SENECTUS
.50	NUMMUS MONOCULATUS
31	ODONTOCHITINA CRIBROPODA
47	ODONTOCHITINA OBESA
48	ODONTOCHITINA OBESOPORIFERA
5	ODONTOCHITINA OPERCULATA
21	ODONTOCHITINA PORIFERA
38	ODONTOCHITINA STUBBY
	OLIGOSPHAERIDIUM COMPLEX
	OLIGOSPHAERIDIUM PULCHERRIMUM
.28	ORNAMENTIFERA MINIMA
.29	ORNAMENTIFERA SENTOSA
77	OSMUNDACIDITES WELLMANII
24	PALAEOHYSTRICHOSPHORA INFUSORIOIDES
.40	PERIPOROPOLLENITES POLYORATUS
78	PEROTRILETES JUBATUS/MORGANII
.19	PHIMOPOLLENITES PANNOSUS
.13	PHYLLOCLADIDITES EUNUCHUS
.14	PHYLLOCLADIDITES MAWSONII
.38	PHYLLOCLADIDITES VERRUCATUS
04	PILOSISPORITES GRANDIS
05	PILOSISPORITES NOTENSIS
79	PODOSPORITES MICROSACCATUS
23	PROTEACIDITES
30	PROTEACIDITES LARGE
51	PTEROSPERMELLA AUREOLATA
80	RETITRILETES AUSTROCLAVATIDITES
06	RETITRILETES CIRCOLUMENUS
26	RETITRILETES FACETUS
27	RETITRILETES NODOSUS
51	REWORKING PERMIAN
52	REWORKING TRIASSIC
49	SCHIZOSPORIS RETICULATUS
81	SENECTOTETRADITES VARIRETICULATUS
14	SPINIFERITES FURCATUS/RAMOSUS
86	STERIESPORITES ANTIQUASPORITES
43	STERIESPORITES REGIUM
56	SUBTILISPHAERA SP
44	TRICOLPITES
45	TRICOLPITES CONFESSUS
87	TRICOLPITES GILLII
46	TRICOLPITES RENMARKENSIS
88	TRICOLPITES SABULOSUS
	TRICOLPORITES APOXYEXINUS
	TRICOLPORITES LILLIEI
82	TRILOBOSPORITES TRIORETICULOSUS
83	TRIPOROLETES BIRETICULATUS
15	TRIPOROLETES RETICULATUS
84	TRIPOROLETES SIMPLEX
18	TRITHYRODINIUM MARSHALLII
25	TRITHYRODINIUM PUNCTATE
39	TRITHYRODINIUM THICK RETIC
07	VELOSPORITES TRIQUETRUS
85	VITREISPORITES PALLIDUS
26	XENASCUS CERATOIDES
50	XENIKOON AUSTRALIS